THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF TRANSPORT & HIGHWAYS

ROAD DEVELOPMENT AUTHORITY

KANDY MULTIMODAL TRANSPORT TERMINAL DEVELOPMENT PROJECT

FUNDED BY

WORLD BANK

REQUEST FOR PROPOSAL
(Single Stage Two Envelope)

For

DESIGN AND CONSTRUCTION OF KANDY MULTIMODAL TRANSPORT TERMINAL

RFP NO.: RDA/WB/KMTT /ICB/W/01

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October 2022

Request for Proposals
Works

Design and Build
(Single-Stage Two Envelope)

Procurement of a Contractor for Design and Construction of Kandy Multimodal Transport Terminal

RFP NO.: RDA/WB/KMTT /ICB/W/01

Volume 02 of 05

Employer	**:** Road Development Authority
Project	**:** Kandy Multimodal Transport Terminal Development Project
Contract Title	**:** Design and Construction of Kandy Multimodal Transport Terminal
Country	**:** Sri Lanka
Credit No.	**:** 6623-LK(CONCESSIONAL CREDIT) & 6624-LK(NON CONCESSIONAL CREDIT)
RFP NO.	**:** RDA/WB/KMTT /ICB/W/01
Issued on	**:** 01.10. 2022

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A. ENVIRONMENTAL AND SOCIAL (ES) REQUIREMENTS

A.1. ENVIRONMENTAL AND SOCIAL REQUIREMENTS

The Environmental and Social requirements have been based on **The World Bank Environmental and Social Framework.** Accordingly, project has completed the Environmental and Social Impact Assessment and resettlement action Plan for all resettlement activities of the project. Both reports have already been published in Ministry web site. Accordingly, Environmental and Social Commitment Plan has been prepared on which all parties involved in the project have to commit and adhere in implementation of the project. Environmental Safeguard Measures are given below.

A.2. ENVIRONMENTAL AND SOCIAL COMMITMENT PLAN

1. The Government of Sri Lanka will be implementing the Kandy Multimodal Transport Terminal Project (the **Project**), with the involvement of the following Ministries/agencies/units: Ministry of Transport & Highways/ Road Development Authority. The International Development Association (hereinafter the Bank/the Association) has agreed to provide financing for the Project.

2. The Government of Sri Lanka will implement material measures and actions so that the Project is implemented in accordance with the Environmental and Social Standards (**ESSs**). This Environmental and Social Commitment Plan (**ESCP**) sets out the material measures and actions, any specific documents or plans, as well as the timing for each of these.

3. The Government of Sri Lanka will also comply with the provisions of any other E&S documents required under the ESF and referred to in this ESCP, such as Environmental and Social Management Plans (ESMP), Resettlement Action Plans (RAP), and Stakeholder Engagement Plans (SEP), and the timelines specified in those E&S documents.

4. The Government of Sri Lanka is responsible for compliance with all requirements of the ESCP even when implementation of specific measures and actions is conducted by the Ministry, referenced in 1. above.

5. Implementation of the material measures and actions set out in this ESCP will be monitored and reported to the Bank by the Government of Sri Lanka as required by the ESCP and the conditions of the legal agreement, and the Bank will monitor and assess

progress and completion of the material measures and actions throughout implementation of the Project.

6. As agreed by the Bank and the Government of Sri Lanka, this ESCP may be revised from time to time during Project implementation, to reflect adaptive management of Project changes and unforeseen circumstances or in response to assessment of Project performance conducted under the ESCP itself. In such circumstances, the Ministry of Transport & Highways/ Road Development Authority will agree to the changes with the Bank and will update the ESCP to reflect such changes. Agreement on changes to the ESCP will be documented through the exchange of letters signed between the Bank and the Ministry of Transport & Highways/ Road Development Authority. The Ministry of Transport & Highways/ Road Development Authority will promptly disclose the updated ESCP.

7. Where Project changes, unforeseen circumstances, or Project performance result in changes to the risks and impacts during Project implementation, the Government of Sri Lanka shall provide additional funds, if needed, to implement actions and measures to address such risks and impacts.

Material Measures and actions to be committed by the proposer are given in Table A.1.

Table A.1: Material Measures and Actions

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
MONITORING AND REPORTING			
A	**REGULAR REPORTING**		
	• Prepare & submit to the Bank regular monitoring reports on the environmental, social, health and safety issues & performance of the Project, including but not limited to the implementation of the ESCP, status of preparation and implementation of E&S documents required under the ESCP, stakeholder engagement activities, functioning of the grievance mechanism(s).	Every six months, within 15 days of the end of the six-month period	Supervision Consultant,
	• Engage stakeholders and third parties (independent experts, local communities, and NGOs) to complement or verify PMU's own monitoring activities.	Every quarter, within 15 days of the quarter	Supervision consultant
	• Collaborate with other agencies and third parties who are responsible for managing specific risks and impacts and implementing mitigation measures to establish such mitigation measures.	Throughout project implementation	Supervision consultant
B	**INCIDENTS AND ACCIDENTS**		
	• Promptly notify the Bank through PMU of any incident, including GBV, or accident related to the Project which has, or is likely to have, a significant adverse effect on the environment, the affected communities, the public or workers.	Within 24 hours of the incident taking place	Supervision consultant,

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
	• Provide sufficient detail regarding the incident or accident, indicating immediate measures taken or that are planned to be taken to address it, and any information provided by any contractor and supervising entity, as appropriate.	Within 3 days of the incident/accident taking place	Supervision consultant/ Contractor
	• Prepare a report on the incident or accident and propose any measures to prevent its recurrence.	Within 7 days of the incident/accident taking place	Supervision consultant/ Contractor
C	**CONTRACTOR'S MONTHLY REPORTS**		
	• Ensure that contractors submit their monthly performance reports, including implementation of the ESMP, to the PMU.	Monthly, within 5 days of end of the month	Supervision Consultant
ESS1: ASSESSMENT AND MANAGEMENT OF ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS			
1.1	**ORGANIZATIONAL STRUCTURE**		
1.2	**ENVIRONMENTAL AND SOCIAL ASSESSMENT**		
	• Support the PMU to update, adopt, and implement, the Environmental and Social Management Plan that has been prepared for the Project in line with the finalized design, in a manner acceptable to the Bank.	At finalization of civil works designs, and implement through civil works	Supervision Consultant
	• Incorporate climate and disaster risks-related elements/measures into the project design.	Finalization of detailed project design	Supervision Consultant, Contractor, PMU
	• Ensure carryout a crack survey to establish the baseline condition of structures in the buffer zone (100m radius from project boundary) prior to commencement of construction.	Prior to commencement of civil works	Supervision Consultant

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
1.3	**MANAGEMENT TOOLS AND INSTRUMENTS**		
	• Implement ESMP to manage project's environmental and social risks and impacts in accordance with the timeframes specified and review the status of implementation of ESCP as part of ESF monitoring and reporting.	Throughout the construction period	Supervision Consultant
	• Monitor and evaluate the implementation of the ESMP, including Contractor's ESMP.	Monthly, within 5 days of end of month	Supervision Consultant
1.4	**MANAGEMENT OF CONTRACTORS**		
	• Include relevant sections of the ESMP, SEP, LMP (that will fall under the purview of the contractor) in the bidding documents.	Prior to tender publishing	PMU E&S Staff, Supervision Consultant
	• Ensure the contractor submits to the PMU the following plans, in a form that is acceptable to the client and in line with the client's ESIA/ESMP o Contractor's ESMP o Waste Management and Disposal Plan o Health and Safety Plan o Road safety monitoring plan o Traffic management plan	At finalization of detail designs prior to the contractor being mobilized at site and before commencement of any civil works	Supervision Consultant
	• Carry out regular monitoring to ensure that all contractors engaged on the project operate in a manner consistent with the requirements of the ESSs, including the specific requirements set out in the ESCP.	Throughout the construction period	Supervision Consultant

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
ESS2: LABOR AND WORKING CONDITIONS			
2.1	**LABOR MANAGEMENT PROCEDURES**		
	• Implement the labor management procedures (LMP) prepared in accordance with the requirements of national law and ESS2, which clearly spells out the (i) terms and conditions of employment; (ii) measures to ensure nondiscrimination and equal opportunity; (iii) provisions to form workers' organizations; and (iv) prevention of child and forced labor	Throughout the project period	Supervision Consultant and Contractor
2.2	**GRIEVANCE MECHANISM FOR PROJECT WORKERS**		
	• Ensure establishment, maintain, and operate a grievance redress mechanism for Project workers to raise workplace concerns, as described in the LMP and consistent with ESS2.	Information relating to GRM to be disseminated to project workers prior to commencement of any works Effective GRM for workers maintained throughout project implementation.	Supervision Consultant
2.3	**OCCUPATIONAL HEALTH AND SAFETY (OHS) MEASURES**		
	• Ensure Prepare, adopt, and implement a Health and Safety Plan as specified in the ESMP including emergency prevention and preparedness specified in 1.2 above.	Prior to commencement of civil works and throughout project implementation	Supervision Consultant

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
ESS3: RESOURCE EFFICIENCY AND POLLUTION PREVENTION AND MANAGEMENT			
3.1	• Ensure preparation of GHG emission assessment and mitigation plan for the construction phase.	Prior to the commencement of the civil works contract	Supervision Consultant
3.2	• Develop measures to ensure KMTT is designed, constructed and operated with environmentally sound systems for solid/wastewater collection and disposal	Design & construction stage	Supervision Consultant and Contractor
3.3	• Adopt and implement resource efficiency measures in design, construction and operation of the KMTT, as per green design criteria and measures outlined in the ESMP. • Obtain the Green Building Accreditation for KMTT from UDA. Ensure that final building designs and construction methods are aligned with accreditation criteria and that application for accreditation be filed at the end of project closure	Throughout final design preparation and implementation	PMU E&S Staff, Supervision Consultant and Contractor.
ESS4: COMMUNITY HEALTH AND SAFETY			
4.1	**COMMUNITY HEALTH AND SAFETY**		
	• Recruit a health and safety expert to the contractor's team to obtain specialist guidance on managing anticipated safety risks throughout the construction and operational phases through appropriate designs, construction methods and operational mechanisms.	With the commencement of the civil works contract	Contractor, Supervision Consultant and PMU
	• Evaluate the risks and impacts of the project on the health and safety of communities, and incorporate mitigation measures into the project specific Health and Safety Plan to avoid (i) safety risks causing from structural elements of	Prior to the commencement of the civil works contract	PMU E&S Staff, Supervision Consultant and contractor

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
	the project and; (ii) incremental risks of public's potential exposure to operational accidents or natural hazards, including extreme weather events;		
	• Ensure preparation and implementation of an emergency response plan during construction and operation phases of the project.	Prior to commencement of civil works	Supervision Consultant /Contractor
	• Conduct independent reviews throughout the stages of project design, construction, operation, and decommissioning particularly when structural elements or components of a project area are situated in high-risk locations, including those with risk of extreme weather or slow onset events, and their failure or malfunction may threaten the safety of communities.	During construction stage	Supervision Consultant and Contractor
	• Establish and implement appropriate quality management systems to anticipate and minimize risks and impacts of services provided by project on community health and safety.	Throughout the project period	Supervision Consultant and contractor
	• Incorporate sufficient mitigation measures in the final ESMP to avoid health and safety risks on communities, including GBV risks, that may be caused from behavior of project workers, labor influx, and emergency situations.	Prior to the commencement of the civil works	Supervision Consultant and contractor
	• Incorporate adequate mitigation measures into the ESMP to avoid or minimize the potential for community exposure to water-borne, water based, water-related, and vector-borne diseases and communicable and non-communicable diseases, that could result from project activities, taking into consideration the higher sensitivity of vulnerable	Prior to the commencement of the civil works	Supervision Consultant and contractor

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
	groups.		
4.2	**TRAFFIC AND ROAD SAFETY**		
	• Ensure Development and implementation a traffic management plan including technically and financially feasible road safety measures throughout project life cycle to avoid potential traffic and road safety risks to workers, communities, and road users.	Prior to commencement of civil works	Supervision Consultant
4.3	**GENDER BASED VIOLENCE (GBV) AND SEXUAL EXPLOITATION AND ABUSE (SEA)**		
	• Incorporate appropriate measures, based on GBV risk assessment as recommended in World Bank's Good Practice Note, to both Contractor's ESMP and the contractual agreements.	Prior to commencement of civil works	Supervision Consultant
ESS5: LAND ACQUISTION, RESTRICTIONS ON LAND USE AND INVOLUNTARY RESETTLEMENT			
5.1	**RESETTLEMENT PLAN**		
5.2	**COMMUNITY ENGAGEMENT**		
5.3	**COMPENSATION AND BENEFITS FOR AFFECTED PERSONS**		
5.4	**GRIEVANCE REDRESS MECHANISM (see under ESS10)**		
ESS6: BIODIVERSITY CONSERVATION AND SUSTAINABLE MANAGEMENT OF LIVING NATURAL RESOURCES			
	• Develop and adopt appropriate measures in the ESMP to prevent contamination of the Meda Ela from the construction of the proposed infrastructure.	Prior to commencement of civil works	Supervision Consultant, Contractor
ESS7: INDIGENOUS PEOPLES/SUB-SAHARAN AFRICAN HISTORICALLY UNDERSERVED TRADITIONAL LOCAL COMMUNITIES			

No.	Material Measures and Actions	Timeframe	Responsible Entity/Authority
	Not applicable to KMTT		
ESS8: CULTURAL HERITAGE			
	• Implement the chance find procedures in the ESMP for chance find archaeological objects encountered during construction with expert recommendations from the Department of Archaeology as necessary.	During construction period	Supervision Consultant, Contractor
ESS9: FINANCIAL INTERMEDIARIES			
	Not applicable to KMTT		
ESS10: STAKEHOLDER ENGAGEMENT AND INFORMATION DISCLOSURE			
10.1	**STAKEHOLDER ENGAGEMENT PLAN (SEP) PREPARATION AND IMPLEMENTATION**		
10.2	**GRIEVANCE REDRESS MECHANISM**		
CAPACITY SUPPORT (TRAINING)			
	• Provide training to contractors and project workers on (i) occupational health and safety (OHS); (ii) labor management procedures (LMP); (iii) emergency prevention and preparedness and response arrangements to emergency situations; and (iv) prevention of gender-based violence and sexual exploitation and abuse (v) Chance find procedures for archaeological assets	At contract mobilization and repeated during project implementation as needed.	Supervision Consultant, Contractor

B. SCOPE OF WORK

B.1. INTRODUCTION

Kandy Multi-modal Transport Terminal (KMTT) is planned to be located in a place that is predominantly surrounded by a number of colonial style buildings (Railways stores, Post office building, Bogambara Prison and Railway Station and Building Structures). It will also be located in the urban context of Kandy city, which has traditional Kandyan Architecture (characterized by temple architecture). Another key feature of KMTT would be its geographical positioning which will be in the valley of Hantana and Bahirawa Kanda.

The conceptual design of KMTT, a transport terminal with modern facilities, and its form has been determined by its functional requirements. The architectural style does not aim to "mimic" heritage, rather integrate into the existing site conditions and surrounding landscape. Instead the KMTT is juxtaposition of the old and new in unified way. The KMTT design philosophy is such that the built form and architectural design, must remain true to its functional aspect, and not imitate or copy heritage designs, but to "fit in". Therefore, the iconic status of this building, is not through a literal interpretation of a heritage building, but rather, derived from the modern reiteration and interpretation of traditional design philosophies within a modern functional setting.

Similarly, the interior of the building has been conceptualized to integrate the modern functional requirements of the Terminal facility, with that of the traditional.

B.2. PROJECT LAYOUT

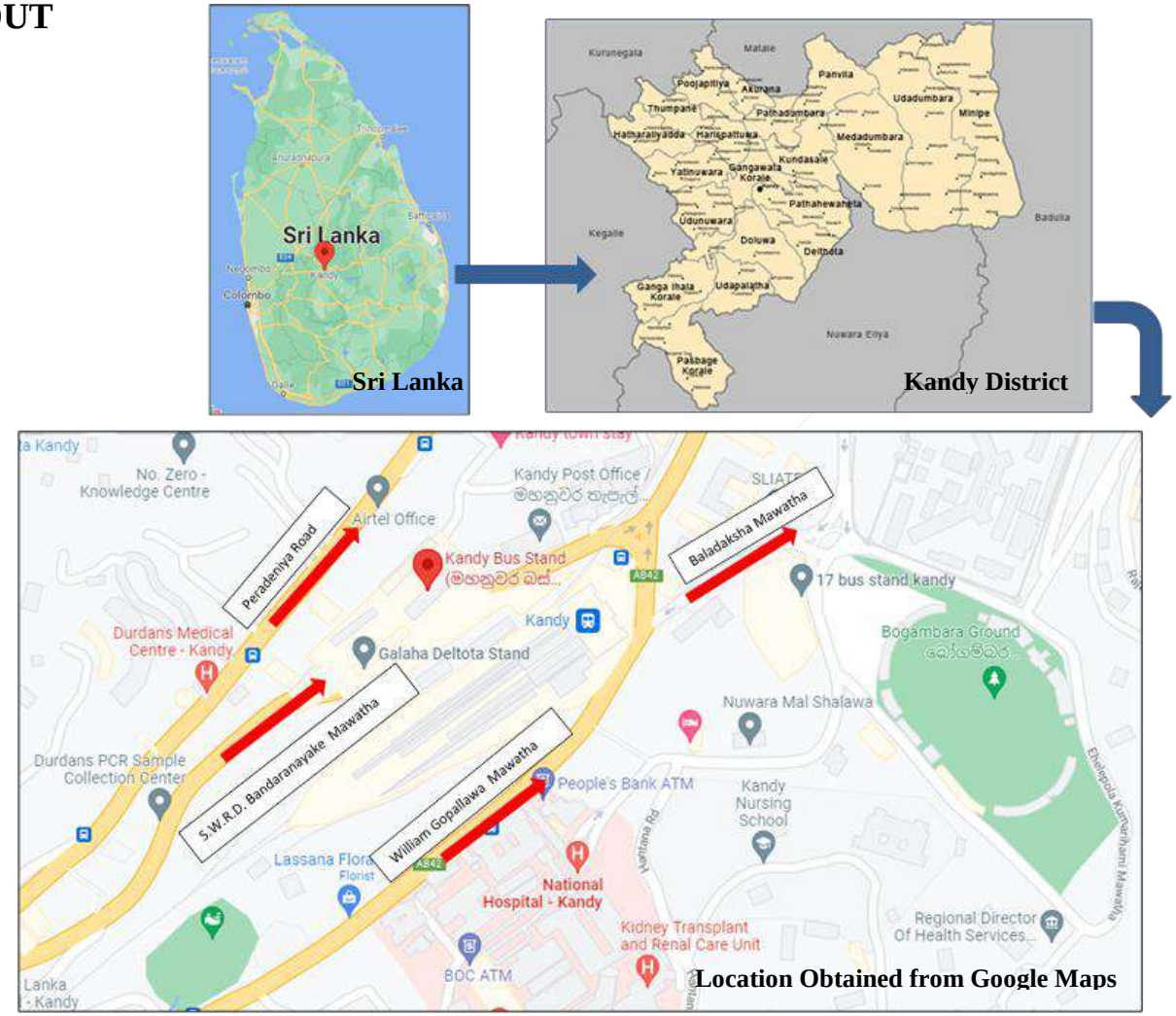


Figure B.1. Location of KMTT

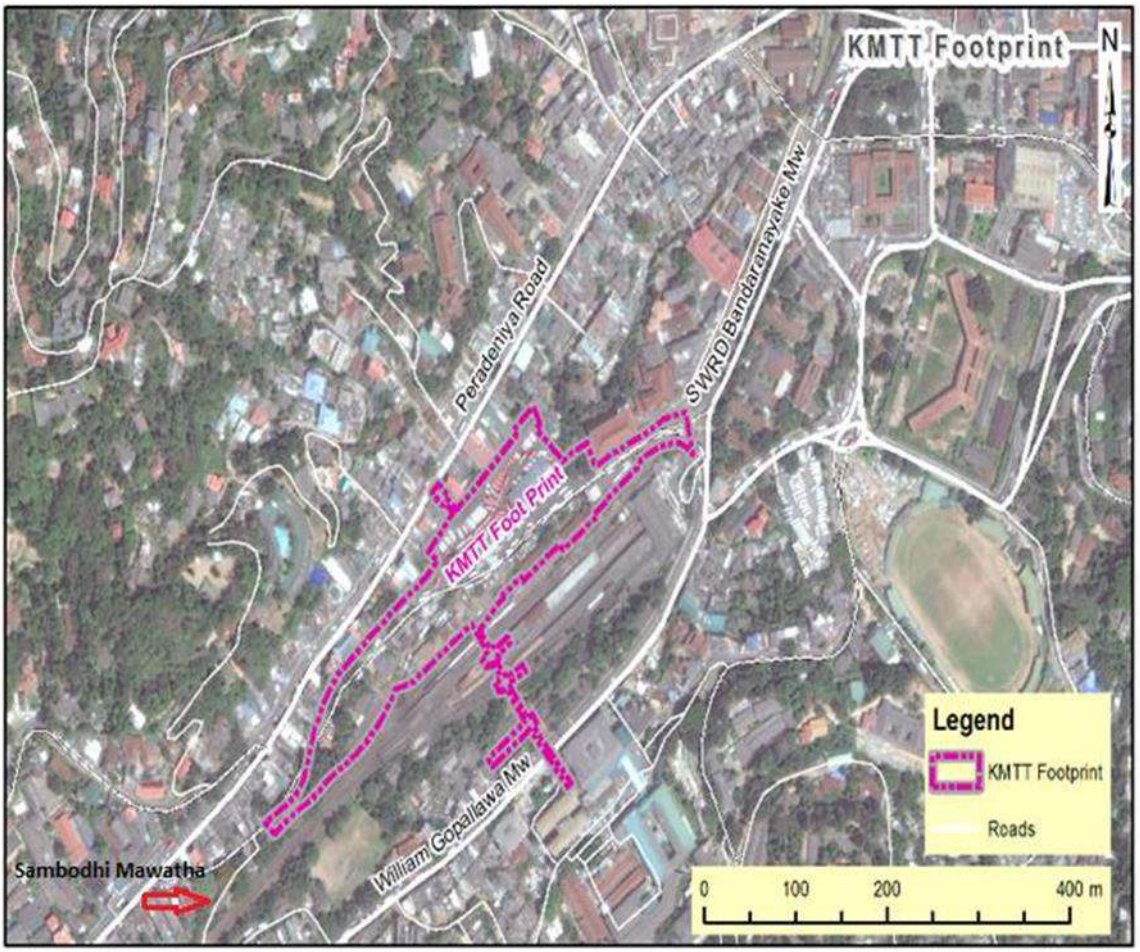


Figure B.2: Foot Print of KMTT

B.3. BACKGROUND STUDY

The Ministry of Highways with the financial and technical assistance of the World Bank, is expecting to develop transport facilities in the Kandy, city. It has been recognized that significant improvement in its transport function is vital for resurgence of Kandy as a heritage city with modern amenities. The Kandy Transport Improvement Project (KTIP) has examined requirements for public transport and traffic management in Kandy and recommended an integrated package of investment and organizational measures. These form one of the core activities of the Kandy City intervention of the Client.

The core strategy of the KTIP is to improve the quality of public transport in Kandy so that it would be able to retain its current 60% share of the road passenger transport market in the future even when per capita incomes increase. It also envisages that the current share of railway passenger transport be increased to around 10%. Thus, creation of modern infrastructure, improving service

delivery, integration between transport modes and their respective organization and ensuring sustainability of both the infrastructure and the transport services in the future becomes specific long-term development objectives for Kandy. A comprehensive set of traffic management measures also forms a central part of KTIP and the Client. These will enhance the functionality and quality of the city, and will significantly improve the operating environment for public transport in Kandy.

Taking recommendations of KTIP forward, Ministry of Defence and Urban Development commissioned a study to suggest improvements in Public Transport system and prepare a Traffic Management Plan (PTTM) to improve the traffic circulation in Kandy. As a summary, extracted from PTTM report - 2015/16, [1] the following major issues were identified. Approximately 330,000 passengers were boarding and alighting per day at all three spatially scattered bus terminals namely (1) Good-shed, (2) Clock-tower and (3) Torrington. These scattered terminals forced to transfer a high rate of the passengers between terminals and it created high pedestrian movements adversely contributing to the traffic congestion in the city roads. The lack of the pedestrian walking facilities, poor passenger services, lack of accessibility and infrastructure further increased the discomfort not only for transferring passengers but also to the passengers who ends their trip in Kandy.

There are a total of 294 bus routes (215 intra-provincial and 79 inter-provincial routes) serving the City of Kandy provided by both private as well as government owned (Sri Lanka Transport Board -SLTB) bus operators. Schedule bus arrivals under the current service plan (inter and intra provincial services) at the time of study stands at 7039 trips per day (24 hours) on a total 294 routes. A similar number of departures are also planned aggregating of over 14,000 scheduled bus movements per day. Nevertheless only 71% of the schedules are operated on an average day, resulting in around 4,968 bus arrivals an equal number of departures making a total of approximately 10,000 bus movements per 24 hours. It is expected to handle 330,000 passengers per day with over 5000 bus trips from 193 bus routes mainly from 3 bus corridors.

Out of 5000 bus trips around 2100 bus trips will be terminated at the KMTT at boarding and alighting bays. All other bus trips will be converted to touch and go trips where they will have bays to unload and pick passengers and continue the trip to other destination of the trip or back to the origin. By this rearrangement, demand for bus parking within city will be reduced and the bus parking will be provided within KMTT only for the routes terminated at KMTT. Out of 5000 bus-trips, only 3% of bus-trips were by-passing the Kandy City and the rest of 97% (including both intra and inter) were terminating at those three terminals.

Out of terminating bus-trips, 69% terminated at Goods shed terminal, 22.5% at Clock Tower and the balance 5.5% terminated at Torrington bus terminal. Out of 333,000 passengers, almost 43% of these passengers were through passengers who require transfers from one bus to another bus to complete their journey while the balance 57% ended their journey in the Kandy city area. Based on above facts, the study has emerged with the conceptual plan of Kandy Multimodal Transit Terminal (KMTT) that is likely to reduce the negative impacts of bus operations on the city traffic. It has been conceived to capture synergies of integrated

interventions in public transport and traffic management with a view to improve the overall operating environment for bus services in Kandy. Moreover, the new terminal building should be a modern and iconic piece of infrastructure for Kandy City while aligning to its architectural heritage. The detail design of KMTT would consider the below mentioned improvement/features of KMTT and the design brief annexed to this RFP as the supplementary document.

B.4. OBJECTIVES

Major improvements targeted by this KMTT development are:

- Bringing all three existing bus terminal scattered around Kandy city under one roof at Good-shed area (also referred to as KMTT) of nearly three acres of land adjacent to Kandy railway station eliminate unnecessary walking along city roads for transfers.
- Bus route operational changes through infrastructure modification within the terminal by providing four different types of bus bays for „Touch and Go", „Boarding and Alighting", „Layover Parking", „Operation & Maintenance" with different bays.
- Provision of easy access for passengers both from Peradeniya road and William Gopallawa Mw by connecting those two roads with a skywalk which connect the KMTT, the railway station and the Kandy Hospital with vertical access.
- Provision of „Kiss-and-Ride" facility at ends of skywalk along both Peradeniya road and William Gopallawa Mw.
- Direct access for people from Kandy hospital to both bus and railway terminals and to Peradeniya road via „Kiss-and-Ride" facility along William Gopallawa Mw, which would be then connected via an extended skywalk on hospital side along William Gopallawa to convert movement of passengers from „valley" to straight path.
- Necessary provisions for an elevated pedestrian connection shall be provided to the

skywalk at Vertical Core 9 location, in order to provide access to the Bogambara Ground along the William Gopallawa Mawatha as per a pending proposal in future. (Refer Section G - Drawings)

- Additional provision to be provided at the Terminal Building for an elevated bridge over the railway track for bus movement connecting the Terminal Building and Baladaksha Mawatha (Refer Figure B.1)
- Parking facility for para-transit modes like three-wheel, taxi, and also limited parking for private vehicle as well.
- Avoiding at-grade crossing between passengers and buses as much as possible through elevated and/or underpass accesses, limiting through movement of other vehicles through KMTT facility.
- Provision of long layover parking area for buses, fuelling facility for buses, ticketing facilities, passenger waiting areas, passenger information system through full-fledged Terminal Operating System (TOS), loading bays for long layover buses, Touch-and- Go bays for short layover buses, infrastructure facility provision for future integration of bus operation with railway with seamless access and payment gates by proving a common platform between both bus and railway terminal, commercial vendors for passenger convenience, rest area for bus drivers, office space for regulators and terminal control staffs, ATM facilities, etc.

The design of the KMTT shall also fulfill the operational requirements identified in PTTM project consultants' reports. The Design & Build Contractor shall prepare a matrix of design requirements and features of the design and report in design reports how those are satisfied by the design.

B.5. DESIGN REQUIREMENTS

In order to accomplish the construction of a modern bus terminus at KMTT whose design integrates easy passenger movement to abutting railway station and contains all the bus operations and passenger-centric facilities, amenities with the look and feel of a world class terminus and also to allow for future volume growth and commuting habits and its impact on the termini and surrounding areas, roads etc. for the next 20 years the expected design should comprise of main features described below.

Along with the Employer‟s Requirement the Employer also provides a Concept Design based on the demand required for bus operation and the space available at the proposed location. As per the

Concept Design, and the main objectives following features should be incorporated in the design.

- Bus Bays for dropping and picking passengers
- Parking spaces of buses inside KMTT
- Intermediate transport mode facility such as auto rickshaw, taxi, car, etc. for accessing KMTT
- Safe and separate entry for buses and passengers
- Measuring station for environment quality management
- Passenger movement integration with different modes between bus, railway and intermediate transport.
- Ease of transfer between different modes
- Efficient bus and passenger movement and circulation plan
- Modern passenger amenities and concourse
- Technology assisted fare pre-payment system
- Passenger information system
- Environmental concerns - reductions in energy use, pollution, noise and visual intrusion as well as environmentally sensitive urban design.
- Physical infrastructure such as rooms for Operation Control Centre, Electronic Ticketing Machine downloading, Rest rooms for Crew etc. for installation of technology assisted TOS (Terminal Operating System) for efficient bays, parking and layover control and management at KMTT
- Compatibility with heritage architecture flavor of Kandy city

B.6. PROJECT BRIEF

B.6.1 MAIN FEATURES

KMTT Concept Designs provided by the Employer have been developed around two key design arrangements.

- Building Arrangement
- Circulation Arrangement

Building Arrangement

The building arrangement consists of three buildings.

- Terminal Building which provides terminal facility spanning over three levels, connected through an underground passageway and an overhead skywalk.
- Parking Building for Bus Bays and Parking areas spanning over the two floors- ground and first floor level of KMTT.
- Arcade Building houses vendors‟ shops and other commercial facilities in the Ground floor and rest room facilities for Railway Staff in the upper floor.

Circulation Arrangement

This arrangement also consists of two main segments namely

- Vehicle circulation is expected to be provided through ramps and road network within KMTT premises
- Pedestrian / Passenger circulation to be provided via vertical cores (stairs, ramps, elevators and escalators) skywalk, underpass connections.

Pedestrian access to KMTT shall be provided along the Skywalk through the following access points:

1) Entrance 01 from Peradeniya Road (North Western side)
2) Entrance 02 From William Gopallawa Mawatha (South Eastern side)
3) Entrance 03 from Railway Track
4) Entrance 04 from Post office side and High school side of SWRD Bandaranayake Mw

Each arrangement will be elaborated below. The Proposer shall integrate the two arrangements effectively along with the guidance provided in the Concept Design. Special features

explained in Section B.7 shall also be incorporated in the final design.

B.6.2. FUNCTIONALITY BRIEF

Table B.1: Functionality Brief

SN	Attribute	Mention	Annotations
(1)	Terminal Typology	Inter-provincial and intra-provincial including local routes	
(2)	Terminal Size	Approximately 12 acres	
(3)	Land owning Agency	State Owned Land	
(4)	Terminal Management	Central Province Passenger Transport Services Authority (CP-PTSA)	
(5)	Passengers flow (during 24 hours)	Estimated footfall of **3,30,000** persons per day **KMTT's Main Complex** Nearly 65,000 passengers will terminate their journeys at KMTT and equal number of passengers will wait inside KMTT terminal area for boarding the long route buses **Touch-n-Go Area in KMTT** Nearly 100,000 passengers will alight from touch-n-go buses who will dwell around briefly around the KMTT complex and equal number of passengers will wait in this area on the designated platforms to board the T-n-G buses.	Growth Projections: 2% in passenger volumes over the next 5 years
(6)	Bus flow (during 24 hours)	a) About **2089** bus departures with equal number of arrivals. Both intra and inter provincial route buses will commence their trips from KMTT and shall require regular fixed bay area for dropping/picking passengers. (B & A Bays) b) About **3381** intra-provincial bus departures with equal number of arrivals. Both will be pass through from KMTT in separate Touch-n-Go bays	Figures estimated have factored in enhanced operation ratio of 80% (from current 71 %.)

B.6.3 TERMINAL BUILDING

The main terminal building of the KMTT will be a three-story building. The majority of the passenger movement will be confined to this building. The bus operation; Touch and Go and Boarding and Alighting bays will be located within the terminal building. The functional requirement of the building has been specified as below.

B.6.3.1 FACILITY REQUIREMENT

There shall be facilities for bus operation, monitoring, and administration. Stair cases, ramps, elevators and escalators for passenger movement including facility for disabled persons shall also be provided. Facilities required by passengers as washrooms & toilets, rest rooms, seating area, ticketing area, public information displays and centers, food and shopping outlets shall be also provided within the terminal as specified below.

Features expected in Ground Floor Level

- 22 Bus Parking bays, 5 Boarding & Alighting bays and 13 Touch & Go bays
- Provision for 2 dedicated Operation and Management Bay for buses
- Emergency vehicle bay
- Vertical circulation cores- elevators, staircases
- Connections to the both underground pedestrian walkways
- Driveways around the building
- Circulation ramps for buses
- Min of 30 nos. shops for commercial activities (6‟X6‟)
- *Adequate seating arrangement for the passengers*
- *Area for operations and administration*
- *Fast foods & Takeaway shops area*
- *Public Toilet facilities (Male /female /disable)*
- *Enquiries & police post*
- *Public utilities such as ATM machines & cloak room*

Refer Table B.2 & B.3 for Passenger & operational Amenities

Features expected in First Floor Level

- 18 „Bus Parking‟ bays, 27 „Boarding and Alighting‟ bays
- Emergency vehicle bay
- Vertical circulation cores – elevators, staircases and public utilities
- Circulation ramps for busses
- Special provision to be designed for a proposed elevated road for bus movement towards Baladakha Mawatha. (Refer.Figure B.1)
- *Area for operations and administration*
- *Public Toilet facilities (Male /female /disable)*

Refer Table B.2 & B.3 for Passenger & operational Amenities

Features expected in Second Floor Level

- Arrival Plaza & Public Concourse
- Vendors‟ Square (Min 30 numbers of 2400mm x 2400mm of shops and stores)
- Other commercial area (Min 08 numbers of 4800mm x 4800mm shops)
- Pedestrian connection towards Peradeniya Road through the Vendors‟ Square
- Pedestrian connection towards William Gopallawa Mawatha along sky walk through Core 8
- Pedestrian connection towards S.W.R.D Bandaranayake Mawatha through Core 4
- *Passenger ticketing (12 counters) and waiting areas (600 seats)*
- *Lounge and food court (Min 6 Nos food stalls. size 24 Sq.m)*
- *Passenger utilities (2 mini banks, 08 Nos of ATM/CDM , Public Toilet facilities (Male /female /disable), drinking water, Baby care room, pharmacy, first aid room, Cloak room*
- *Area for administration and operations of terminal*
- *Staff utilities & amenity area with toilet facility*
- *Police post*

Refer Table B.2 & B.3 for Passenger & operational Amenities

Note: Parking buses in reversed direction (facing the road side) is considered much safer to the passengers and more convenient for traffic movement. This may be considered in the design. Bay directions indicated in the concept design may be altered to accommodate the above requirement.

B.6.4. PARKING BUILDING

The parking building of the KMTT will be mainly used for parking of bus and private vehicles. The level of passenger circulation within this building will be limited. Within the Ground Floor of the Parking Building provisions for private vehicle and taxi parking will be provided while first floor will allocate for bus parking only. However, the private vehicle circulation will be strictly confined to the Parking building in order avoid any interference with the bus operation.

Features expected in Ground Floor Level

- Parking area for 40 cars & 60 Three wheelers
- Service connections to first floor Bus Parking
- Circulation ramps
- Drive ways
- Vertical circulation core
- *Rest areas for 150(min) nos of bus drivers*
- *Food Court of Min*
- *Public Toilet facilities (Male /female/Disable)*
- *Area for administration*

Refer Table B.2 & B.3 for Passenger & operational Amenities

Features expected in First Floor Level

- 56 „Bus Parking" bays
- Circulation ramps for busses
- *Public Toilet facilities (Male/Female, Disable)*

Refer Table B.2 & B.3 for Passenger & operational Amenities

Note: Features shown in *Italic form* shall be cross referred with Table B.2 & B.3.

DETAILED MISCELLANEOUS FEATURES TO BE INCORPORATED IN THE TERMINAL AND PARKING BUILDINGS

a) Common & operational Amenities for Terminal, Operational, Management and Passenger Comfort

Apart from the specific requirements inside the Terminal and Parking Buildings, following amenities shall also be provided inside the KMTT premises in order to ensure smooth flow of operational, management and passenger comfort. Even though preferred locations for the amenities have been recorded in the table below, the Proposer may decide the most appropriate location considering a more efficient operational sequence. The Proposer could also suggest additional floors or Mezzanine floors in order to cater to the given requirement.

Table B.2: Passenger Amenities in KMTT

SN	Amenity	Qty.	Preferred Building T- Terminal	Preferred Floor	Approx. min. floor	Remarks
1	Ticketing counters	12	T	2nd F	90	
2	Mini banks	2	T	2nd F	60	
3	ATM/CDM	6	T	2nd F & GF	60	
		2	P	GF	20	
4	Cloak room	1	T	2nd F	60	
5	Eateries and food court	6 Stalls in 24 Sq.M	T	2nd F	550	
		1	P	GF	400	
6	Fast foods & Takeaway	1	T	GF	30	
7	Drinking water		T & P	All floors		As per the standards
8	Toilets(Male, Female, Disable)		T	All floors		
			P	GF		
9	Baby care room		T	2nd F	15	
10	Pharmacy		T	2nd F	20	
11	First aid room		T	2nd F	15	

Table B.3: Operational and Management Amenities in KMTT

SN	Amenity	Qty.	Preferred Building T- Terminal P- Parking	Preferred Floor	Approx. min. floor area (Sq.M)	Remarks
1	Office Space		T or P	Any floor	Total -715 SLTB - 400 CP-PTSA-230 NTC 85	Total 715 Sq.m For 3 institutes
2	Enquiry room (3 Counters)	1	T	GF	24	
3	Defect Reporting Room and Repair room	1	T	GF	24	
4	Rest Room (dormitory-Bunker beds for 150 crew members)	1	P	Any floor	550	
5	Locker Room (for crew and staff)	1	P	Any floor	25	Min. 100 no. of lockers
6	Cash Room	1	P or T	Any floor	25	
7	Training/conference Room	1	P or T	Any floor	60	
8	Toilet (Crew) with shower facilities *(Male and Female)*	1	P	Any floor	As per the standards	
9	Toilet (Staff) *(Male and Female)*	1	P or T	Same as office floors	As per the standards	
10	Control Centre for Terminal Operation System	1	T	GF	150	
11	ETM Room for down loading & ETM charging racks (Pigeon hole charging)	1	T	GF	35	
12	Data storage- secured room for tapes and data, (near the control center)	1	T	GF	15	
13	Security Posts (portable cabins as well as masonry)		P and T	Gates, GF,1st F,2nd F		Varies at designated places
14	Environmental Quality Management Room	1	T	GF	10	

b) IT Based Terminal Operating System (TOS)

There will be an IT based Terminal Operating System to control bus operation as well as to provide information to passengers with respect to time of departure and location of respective bus bay. The system has already been developed. All hardware requirements along with below listed facilities for the system need to be included in the construction contract as per the requirement of the system and information display.

- Space for Workstations (Bus Operation Control Center)
- Space for Display Walls x 4 nos
- Space for key equipment and personnel

Hardware shall be provided to cater to the functions of the Terminal Operating System (Bus operating Control Centre) mentioned below;

- Live monitoring of Bus Operations and Schedules
- Bus Handling System (instructions to buses, tracking buses to parking, communicating with operator offices and personnel at platforms, timekeepers etc)
- Bus entry and exit control with barrier operations at selected locations
- Bus identification and number plate recognition facility
- Communications with Time Keepers (at platforms and outside KMTT)
- Bus Crew Communication (through mobile)
- GPS data receipts
- ETM data receipts
- Handling Passenger Complaints (through phones, mobile and passenger app, website)
- Communication with Internal Police post
- Passenger Information Systems
- Communications with external offices
- Connection with rail station and taxi stand
- Passenger Announcements
- Emergency Handling
- Handling Bus Breakdowns, Accidents

- Handling Public Incidents (There should be a separate office for this)
- Tracking of Authorized personnel
- Maintaining the Passenger apps
- Updating schedules
- Maintaining the web portal
- Managing Traffic in and around KMTT and outside
- SMS gateway
- Data Analytics and MIS functions
- Connection with Ticketing and reservation areas
- Entrances Monitoring and Terminal Waiting Areas monitoring
- Bus Loading Gates handling
- Corridors/Walkways (at key locations) monitoring

B.6.5 ARCADE BUILDING

The Arcade building will mainly comprise of;

- Commercial Area with 16 Numbers of 3600mm x 3600mm shops at floor level with adequate common toilet facility
- 16 Numbers of Guest rooms at First and Second floor levels with adequate common
- toilet facility (male, female separate)
- 3m wide Pedestrian Arcade
- Access from William Goppallawa Mawatha to sky walk through the Arcade Building
- Access path towards the nine storied accommodation building / rail track through the
- Ground floor of Arcade building.

Note: Please refer "B.8 Constraints to the design" in this section to estimate the impact on the Arcade building due to the widening of the William Gopallawa road as per the new proposal submitted by Road Development Authority of Sri Lanka.

B.6.6. VERTICAL CORES

The vertical movement of commuters within the KMTT shall be mainly through lifts, escalators, ramps and staircases with dedicated facilities for the disabled. There shall be minimum ten vertical cores. Four main cores will be located inside the KMTT premises while the rest shall be located outside as indicated in the Concept Design. Cores have been marked as "Vertical Core 1 to 10"

Table B.4: Vertical Cores

Elements	Terminal Building	Railway Track Area	Parking Building area
Elevators	14	5	0
Escalators	2	6	0
Staircases	5	3	1
Ramps	0	1	1

Note: Number of vertical cores may be increased as per the detailed design with the passenger flow, standards and building regulations. The Proposer is anticipated to take necessary actions.

B.6.7. UNDERPASS

The connection that runs in the basement level through the terminal building has been specified as the Underpass in the Concept Drawing (Refer the mentioned revised areas annexed in Volume 04 of Drawings). Features required are listed below.

- 20 ft. (min) wide pedestrian underpass connection between the main terminal building (Core 2) and main vertical circulation core (Core 1) which provides access to the skywalk.
- 20 ft. (min) Pedestrian under pass connecting main terminal building (Core 3) and „Goods Shed 01"(Core 5) through the Pedestrian circulation core near S.W.R.D. Bandaranayake Mawatha (Core 4)
- Minimum of 35 Numbers of shops (2400mm x 2400mm) for vendors around core 1 & 2. Graffiti walls shall be include to the design.
- Minimum of 20 Numbers of shops (2400mm x 2400mm) for vendors around core 3, 4 & Graffiti walls shall be include to the design.

B.6.8. SKY WALK

The skywalk shall be connected between Peradeniya Road and William Gopallawa Mawatha as shown in Conceptual Architectural Drawings through the terminal building over the Railway

premises with a connection to Railway station, extending towards the Kandy General Hospital premises. This should provide easy and short distance movement between two roads, KMTT and Railway station. This pedestrian sky walkway shall be connected to second floor level of the terminal building where passenger concourse is located. Considering the new access and connection points facilitated by the skywalk, it has been conceptualized as a large pedestrian boulevard, with street like commercial and recreational activities.

The main features of the Sky Walk are listed below.

- Approximately 200m long walkway connecting Peradeniya road & William Goppallawa Mawatha through KMTT
- Extension to the Kandy base hospital.
- Access to the both sides of William Goppallawa Mawatha via two vertical circulation cores (Staircase and lift).
- Connection to the vertical circulation core (Core 5) providing access to Kandy railway platform extended with wide lobby area shall be provided for future expansion of Matale railway platform.
- Connection to the main circulation core (Core 1) providing access to the main terminal building through an under pass.

B.6.9. RENOVATION OF GOODS SHED 1 AND GOODS SHED 3 BUILDINGS

Goods Shed 1 and Goods Shed 3 buildings shall be renovated for construction of shops. The Proposer shall bear in mind that the two buildings have been classified as buildings with archeological features thus special permission shall be obtained from the Department of Archeology, Sri Lanka. The buildings shall be renovated with special adherence to converse

the prevailing features of the building.

B.7. SPECIAL FEATURES

- **Re-fueling Station**

There is a need to construct a refuelling station within the KMTT premises. Refuelling station has to be incorporated into the KMTT according to the guidelines provided by Ceylon Petroleum Cooperation (CEPETCO). The refuelling station will only serve the private and Sri Lanka Transport Board (SLTB) buses (not for private vehicles) and will operate as its own facility by the KMTT operator. It can accommodate fuelling of 04 nos of vehicals at a time. It is anticipated that 02 will be dedicated for SLTB use and 02 for Pvt Buses. In addition to, the facility will have;

- 04 Numbers of Despenser with 02 Numbers hose nozzles in each
- 04 Numbers of 5000 gal underground disel tanks (02 for operation & 02 Nos for Bulk storage)
- Airpump
- 25 kVA backup generator
- Operational office

- **Electrical vehicle recharging facilities**

Infrastructure facilities shall be provided at designated locations for Electric vehicle charging.

- **Rainwater Harvesting system**

Demand and Supply Calculation for the Rainwater harvesting system shall be carried out. Percentage of total water demand to be fulfilled by Rainwater shall be estimated and provided to the system accordingly.

- **Landscape**

The Proposer should carry out the landscape design. The landscape for the removal and reposition of the old Crane belonging to the SLR at an appropriate location should be included in the landscape design.

- **Solar Panels**

Solar Panels shall be introduced to the premises with the intention of fulfilling the electricity requirement partially or fully. Location for panels shall be decided by the Proposer.

- **Sump and Overhead Tank**

Water Demand for the users of the building shall be provided within the premises.

- **CCTV**

The facility will be required in Building Management and Bus Operation Control Room. Special viewing will be required at Bus Entry Points, Bay areas, Parking areas etc.

- **Passenger Information display**

At least 3 size of display (Large, Medium and small) shall be located at appropriate locations. There is no restriction to locate display units for displaying advertisements without interfering the smooth flow of operations of the KMTT premises.

- **Generator, Transformer, Electrical room, pump room**

- **Solid waste collection area/room with road access**

The Proposer is expected to make use of the Concept Design provided by the Employer as a basic guideline, to integrate the features and functions together and develop the ultimate design to achieve the objectives at the optimal level. Especially the clear widths of the walkways / skywalk to be compatible with the passenger flow. The mentioned cases on the concept drawings (Addendum) should be addressed in the schemetic and detailed design. The Proposer shall also prepare a new as built site survey (including available actual land area, existing levels, existing services, etc.) prior to the finalization of the design.

B.8. CONSTRAINTS TO THE DESIGN

- **Disruption at site due to Meda- Ela**

The Meda Ela is the water body that drains the storm water from city area and over flow of Kandy Lake. It runs through the KMTT site as a covered underground section and exposes itself as an open channel outside the boundary. The Proposer is expected to take the location of the water body into the consideration during the design stage & diversion or refurbishment of the Meda Ella should be plan out as per the prevailing conditions. (Refer Annexure C1)

- **Kandy Municipal Council Water pumping line**

The permanent location & level of the KMC water line within the KMTT premises should be taken in to consideration during the design of underpass & foundations. (Refer Annexure C4)

- **Telecommunication and Electricity lines**

Telecommunication and Electricity lines have been relocated temporarily to allow easy access and acquirement of the site. The Proposer is expected to take these temporary locations into account and carry out his work at site. The Proposer is also anticipated to locate the utility lines permanently within the KMTT premises. (Refer Annexure C3)

- **Sewerage lines**

The permanent sewerage lines across the KMTT premises have not been completed. A by- pass connection is currently in use within the site. The Proposer is expected to consider the future connection and proper arrangement and permanent path for sewerage line with secondary connection. (Refer Annexure C3)

- **Widening of William Gopallawa Mawatha**

As per the Concept Design provided by the Employer, William Goppallawa Mawatha has been indicated as a two lane road. A new proposal forwarded by the Road Development Authority of Sri Lanka has decided to widen the road into four lanes. The Proposer is expected to consider this arrangement in his design. Refer Annex C8 for further clarifications..

- **Location of Bo tree and Buddha Statue and Banyan Tree**

A Bo tree & a Buddha statue worshiped by people for some time & a vastly spread out Banyan tree are located within the KMTT premises. Proposer is expected to preserve these items by incorporating those in to the design.

B.9. GUIDELINE PRINCIPLES FOR DESIGN DEVELOPMENT

With respect to the objectives, design requirements, main features and special features provided in earlier sections, KMTT designs for architectural design and civil construction shall need to incorporate and showcase the following guidelines as well;

- Complying with prevailing building regulations, guidelines, planning, zoning and security concerns of relevant local authorities, UDA and state organizations, Kandy City Development plans.
- The design shall be substantially responsive to the Employer‟s requirements and the space allocations indicated in this document.
- The Proposer shall follow international standards and trends applicable to multimodal transport terminal buildings of this nature.
- The architectural design shall pose appropriate design concepts to endure climatic and weather conditions prevailing throughout the year of Sri Lanka.
- Demonstrating modern and energy efficient, green building designs for quality infrastructure that suitably incorporates various architectural facets of the heritage
- The designs shall manifest sensitivities of environment friendly, urban designs that aim to reduce energy usage, carbon footprint, noise and air pollution level within and surround areas of the terminal
- Providing appropriate designs that integrate passenger movement from within and around the surrounding areas of the terminal to the abutting railway station and assimilate all bus-operations and passenger-centric facilities within the terminal fluidly
- Designs shall account for future demographic & economic growth volumes, commuting habits and its impact on the terminal, surrounding areas and connected infrastructure i.e. roads, water supply, sewerage & drainage, power etc. for next 20 years.
- The designs shall ensure safe and easy passenger access to the terminal and include gate restricted entry to adjoining railway station. It shall include all public safety as well as road safety measures. Pedestrian walkways, sidewalks and crossings shall be designed for adequate public safety and convenience. Access shall be provided to the railway area only at the designated locations / entrances with necessary access control measures.

- Integration of various modes of transit- public as well as private transport such as buses, railways, three wheelers, private cars and two wheel automobiles with other intermediate transport within and the surrounding areas of KMTT. The designs shall ensure easy transfer to various modes and transit points through efficient passenger and vehicular circulation and safe pedestrian walkways.

- Selection of materials, finishes, fittings and accessories suitable and compatible with the usage, function, environment and aesthetics of the proposed project.
- The designs shall provide for well-defined and State of Art passenger facilities such as passenger waiting areas, food courts, ticketing and enquiry counters, drinking water facilities and rest rooms etc. in the terminal building, adjoining blocks and connected public areas.

C.SITE INFORMATION

C.1. KANDY CITY PROFILE

Kandy city is located at N7 17 37 E80 38 25 at an elevation of 500 m above mean sea level and 115 km from Colombo, Sri Lanka‟s the commercial capital. The city is located on a mountainous terrain surrounded by the Mahaweli River by 3 sides and the other side by the Hantane range of hills all of which creates natural transport barriers to reach the city from outside. Home to the Sri Dalada Maligawa – the beautiful temple that houses the tooth relic of Lord Buddha – Kandy is also a popular stop during July/August when the annual Esala Perehera (holy festival) takes to the streets of the city. The cool climate of the hills is a relief after the cloying heat of the lowlands, and the lovely Kandy Lake and the drives around it are set amidst great scenic beauty. Kandy is synonymous with arts and crafts of Sri Lanka than anywhere else in the country.

At present Kandy is the capital of the Central Province and has well developed commercial and service industry considered second only to Colombo and is also a national transport node. The city was declared as one of the 704 cultural heritage sites in the world by the UNESCO in 1988 and is thus a popular destination for both foreign and local tourists. With its unique topography and features, Kandy is a city where there are many constraints for any expansion of its transport infrastructure.

C.1.1. SITE LOCATION

The proposed location is the present Good Shed busstand which is at the heart of the Kandy city.

The proposed project site will encompass the following lands;

- Current Good Shed bus stand
- Railway land adjacent the Good Shed Bus stand
- Railway lands adjacent to William Gopallawa Mw
- S.W R D Bandaranayake Mw. Which belongs to the Road Development Authority (RDA) and a small portion of private lands.

The Proposed site is situated in a highly urbanized area of the Kandy City. Geographically it is at a lower elevation surrounded by hilly areas. The total area of approx. 8 acres encompassing the project site and 500m from the perimeter of the site can be defined as project affected area. Map of project site and areas affected during construction period is provided in **Figure C.1 & Figure C.2.**

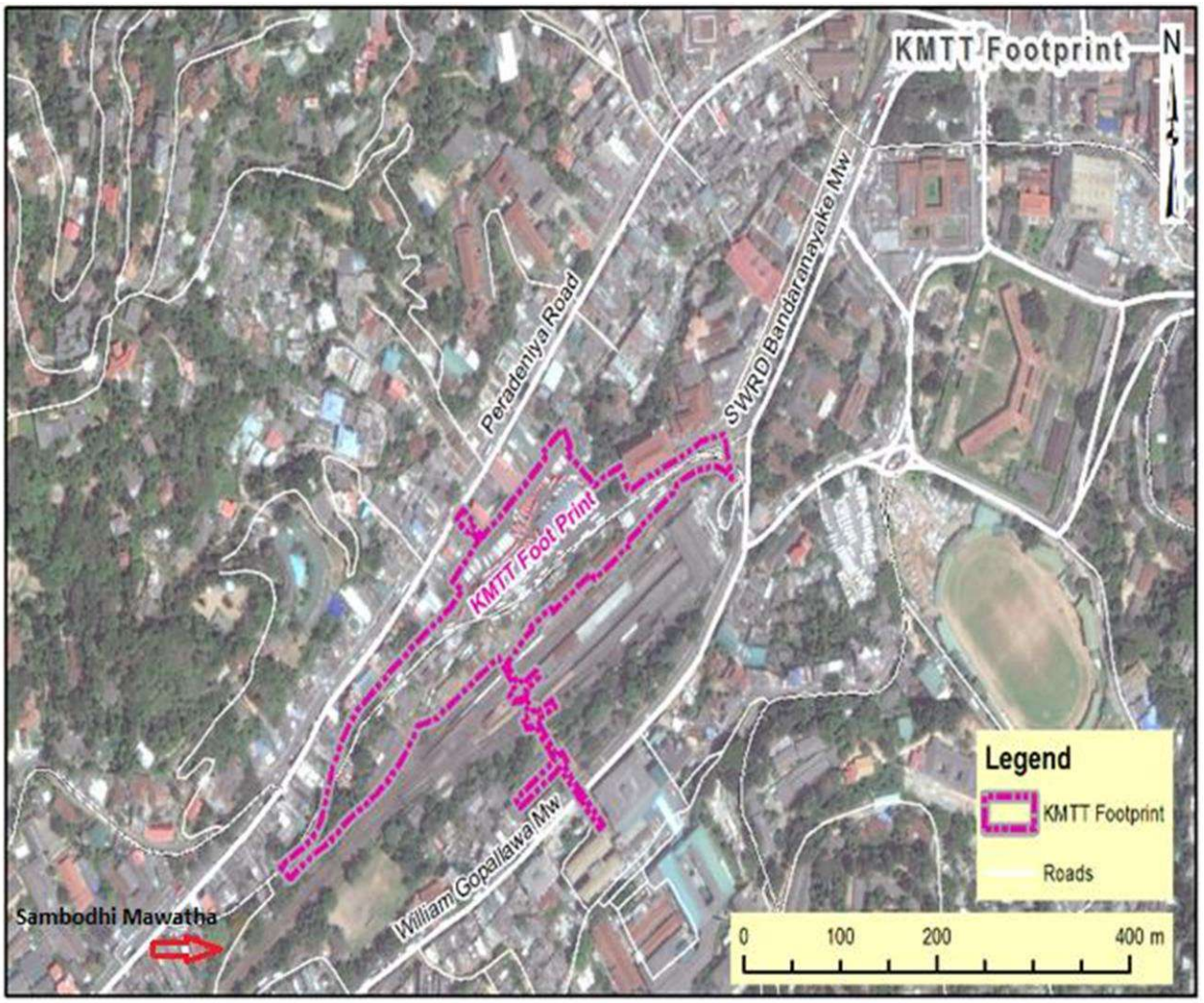


Figure C.1: Map of Project Site

Figure C.2.: Areas Affected During Construction Period

C.1.2. ADJACENT LAND AND FEATURES

The site is situated in a highly built up area of the city of Kandy adjacent to the Kandy Railway Station, Kandy old and new Post Offices, Several Government offices and Commercial Buildings. The site is situated in a lower elevation between Peradeniya road and William Gopallawa Mawatha. The site borders a number of dilapidated and structurally unsound private buildings along its northern boundary. In addition, there are number of utility structures located in the proposed project area, such as electricity lines, water supply, storm water drains, telephone lines etc. Meda Ela, the main drainage canal that runs through the city traverses underneath the site as a tunnel and opens up at the end of the project site.

The lands where the KMTT is to be built belong to the Sri Lanka Railway Department (SLRD) and the Regional Passenger Transport Authority (RPTA) and Road Development Authority (RDA). The lands in which is the sky walk is to be built belong to the SLRD, the Road Development Authority (RDA) and a small portion of private land will also be required, and it is under the land acquisition process and will be cleared by the commencement of the work.

The Kandy Post Office, the Kandy Regional Mail Sorting Centre, the Kandy Postal Training Institute, Sri Lanka Telecom Regional Office etc. are located adjacent to the KMTT site. Access to these premises is via the SWRD Bandaranayake Mawatha and will not be interrupted during the construction phase.

C.2. TOPOGRAPHY SURVEY

The land survey plan is given in the Plan No Maha/MHN/2-17/654R and the topographical plan is given in Annex C.01.

C.3. ENVIRONMENTAL AND SOCIAL BASELINE DATA

C.3.1. ENVIRONMENT DATA

The project area lies in the physiographic region of Highlands, and the topography range about 512 m - 515 m MSL. The topography in this area consists of an undulating terrain. The Topography map of the proposed project area is shown in the following Figure C.3.

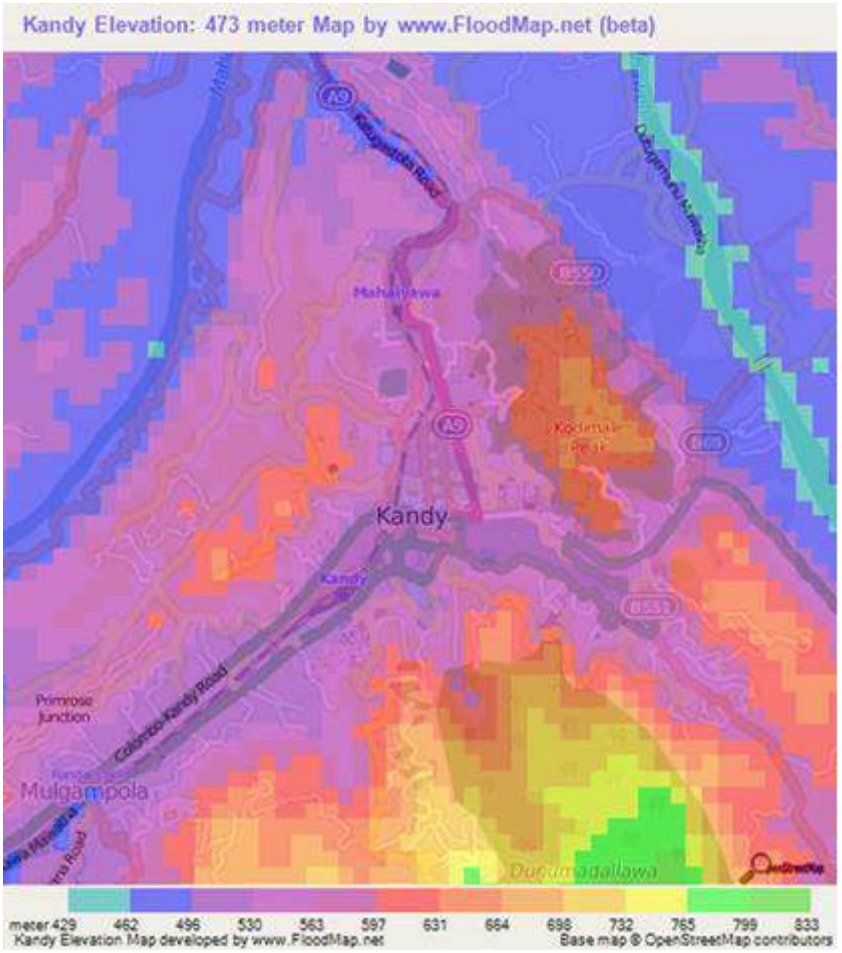


Figure C.3: Topography map of the Project area

C.3.1.1. Soil (*type and quality*)

The main soil type is the Reddish Brown Latosolic (RBL) soils and Immature Brown Loams (IBL) made from the weathering of underlying rocks and boulders and rock outcrops. The top soil of RBL soil is reddish brown or brown, while the sub soil is red to dark reddish brown and the top soil color of IBL soil is dark brown to dark gray brown with a dark yellowish brown to brown sub soil.

The texture of RBL soil is mostly clay loam and the distinct feature of this soil is well- developed structure with friable consistence to tolerate wide range of moisture conditions. Hence, the RBL soil is very productive.

The texture of IBL soil is loam and contains minerals such as mica and feldspar. Both soil types are favorable for the deep-rooted trees, which already exists in the area.

The central province including the Kandy district is considered as Central Fragile Area due to the vulnerability to landslides and hence the Soil Conservation Act No. 25 of 1951, as amended by Act No.24 of 1996 has been declared as conservation areas. The proposed boundary of the “Conservation Areas” coincides with the 300m contour line with a few exceptions.

The National Building Research Organization (NBRO) has delineated such areas in relation to the degree of the potential risk for development activities. As shown in the Landslide hazard zone map (Annex 5) of sheet 54 for Kandy (which includes the project area) published by National Building Research organization and the Survey Department (2000), shows that the proposed project area denoting in "Yellow" color is considered as "Modest Level of Land slide Hazard" where slight danger of landslides exists.

Bore hole investigations were done though twenty-five locations for geological survey for representing the entire site. As per the results, Bedrock consists of Biotite Gneiss and weathered Marble rocks, upper most layer is a filling which is lateritic filing mixed ungraded garbage and boulders. From the filled layer to bedrock, dense sand layer is observed. Sand layer is softening closer to groundwater table due to fluctuation of ground water table.

C.3.1.2. Surface water

The historic Kandy lake and the associated stream network is the most immediate surface water body in the close proximity to the project site (Figure 5.2). The water floor is towards the Western reach of the Kandy city, where Meda Ela empties to Mahaweli River at Gatambe junction in 2.4 km from the site. The Meda Ela spill canal is the most immediate surface water way found at the close proximity to the project site.

The key hydro morphological features of the Kandy Lake is given below;

The Kandy lake consists of a perimeter of 3.4 km (2.1 mi) and a maximum depth of 18 m (59ft). Spill level above: 1,740 M.L.S., capacity: 704 acre-feet, catchment area: 1.045 Q.M.I. A decorative wall, called the „walakulu wall", runs for 630 m (2,070 ft) alongside the banks of the Kandy lake. In the middle of the lake is an island housing the Royal Summer House. The Sri Dalada Maligawa, or the Temple of the Sacred Tooth Relic, is located besides the lake across the road. On the opposite side of the road from the Temple of the Tooth Relic is the Royal Bathouse

The pollution levels of the Kandy lake is a serious problem. The Government Agencies and the surrounding schools are trying to mitigate the problem by controlling polluting inputs into the lake, monitoring the water quality, placing signs and operating environmental societies. Until 1960, the Kandy Water Board used the lake to distribute water to the surrounding areas. They stopped pumping water from the lake because of the increase in water pollution.

Table C.1: Water Quality of the Main Waterbodies Located near the Project Sites

Waterbody	TDS (mg/L)	E Coli (cfu/100 ml)	COD (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)
Kandy Lake	110 55	10 1600	2 34	32 98	2.4 11.9	0.05 0 .12	0.8 20
Meda Ela (UC)	32 184	230 1400	12 130	32 184	3 61	0.08 1.67	0.4 1.3
Mahaweli River	29 315	6 164	3 34	73 440	1.3 3.3	0.2 0.91	1.9 14

(source: http://wepa-db.net/activities/2014/20141127/pdf/2_3_WEPA%20Gemunu%20Herath%20Final%2028-11-14.pdf)

The water quality of the main waterbodies located near the project sites are provided in Table C.01. The Meda Ela (urban canal) is mainly a stream with pollutants. The Kandy lake and the Meda Ela are eutrophic. High coliform levels found in all sources indicate that surface water is contaminated by fecal waste.

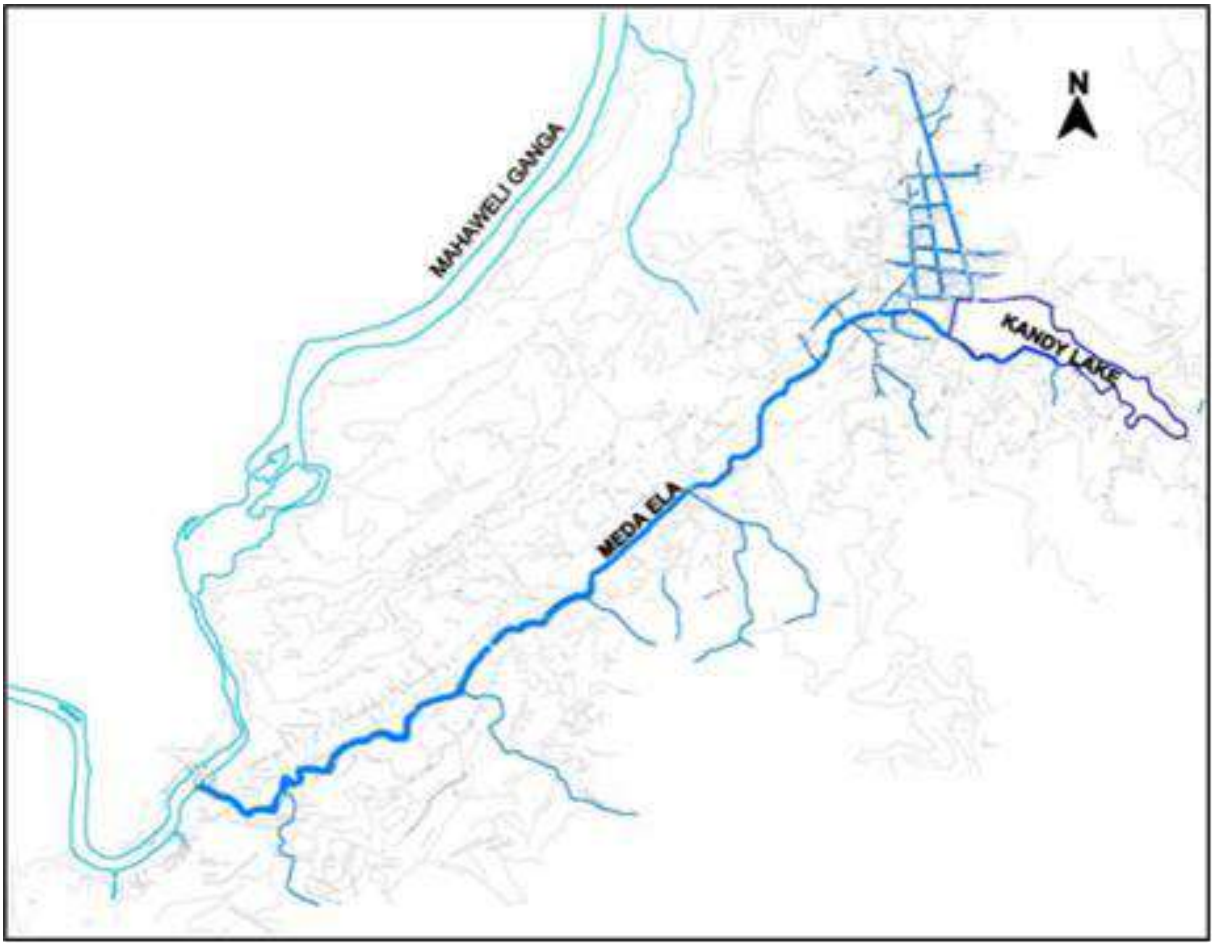


Figure C.4: Hydrological network in the project area

The Water is not been used for any purposes due to heavy loads of solid and liquid wastes disposals by the city dwellers. The excess rain water runoff in the railway land is naturally flowing to Meda Ela but there is no any drainage network within the site. Flooding can be anticipated in the downstream of Meda Ela due to the heavy flow of the existing Kandy lake spill way. That is being controlled and due to rehabilitation of the canal by the SCDP flooding will not be expected.

C.3.1.3. Ground water

Groundwater in Kandy exists mostly in the form of semi-confined Aquifers in the first 100 m of the bedrock. This groundwater exists both as small pockets of underground reservoirs and as fissure groundwater. The yields of these aquifers are not very well known and are limited as they recharge very slowly. In addition, there exist high-yielding groundwater resources along the alluvial flood plains of Mahaweli River that are mostly recharged by the river water.

The amount of groundwater use by the piped water supply schemes within the Kandy region is estimated at 8,567 m3/day (around 12 % of the total piped water supply). Further, the percentage of the population relying on groundwater in the district is almost 52% and individual domestic groundwater consumers are estimated to be using approximately 15 million m3 annually.

The project site is at a highly urbanized area and the pipe bone water is available for use.

Table C.2: Quality of Ground water Located near Project Sites

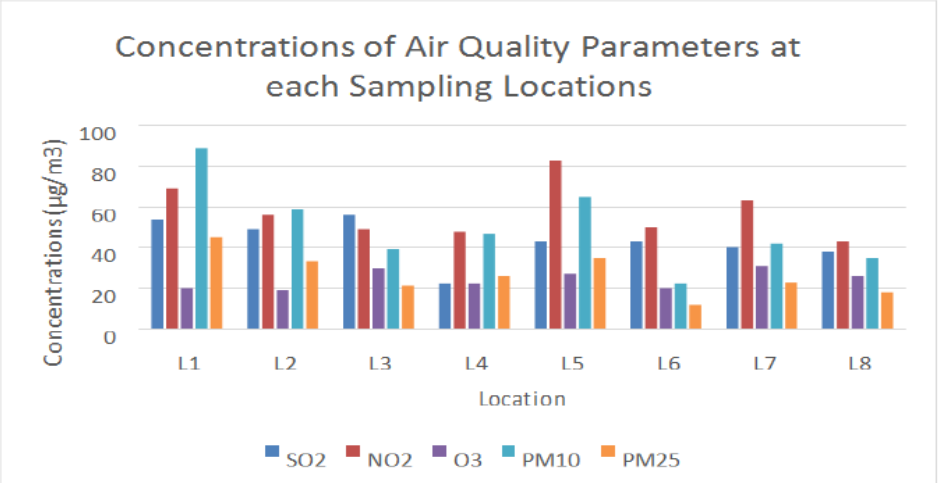
Waterbody	TDS (mg/L)	E Coli (cfu/100 ml)	COD (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)
Groundwater in the city	80-105	4-680	16-20	6-58	-	0.2-0.4	3.1-6.2

(source: http://wepa-db.net/activities/2014/20141127/pdf/2_3_WEPA%20Gemunu%20Herath%20Final%2028-11-14.pdf)

The quality of groundwater located near the project sites are provided in Table C.02. High levels of coliform found in the groundwater indicate that the groundwater is contaminated by fecal waste

C.3.1.4. Air quality

Air emissions by sources such as vehicular and commercial emissions are the major pollutant sources that contribute baseline ambient air quality levels in the area. Measured ambient air quality levels by NBRO with respect to SO2, NO2, CO, O3 and PM10 and PM25 were below the Ambient Air Quality Standards stipulated by the Ministry of Environment & Natural Resources of Sri Lanka (Extraordinary Gazette No. 1562/22 August 15, 2015)



Sampling location of the Kandy city for the above measurements.

L1 At The Good Shed area (In front of Post Office)
L2 At the Clock Tower Junction
L3 At the Queens Hotel Junction
L4 In Front of The District Secretariat
L5 At the Ampitiya Junction
L6 At the Mosque Close to Kandy City Centre
L7 At the Katugasthota Market
L8 At the Gatambe Junction

Figure C.5: Air Pollutant concentrations in the KMC area
(Source: Monitoring of Baseline Ambient Air Quality Levels measured by National Building Research Organization (NBRO)-2015 for the SCDP)

C.3.1.5. Ecological features – Eco-system components

a. Vegetation

Biogeographically, the proposed sub-project area lies within the wet zone, but it is closer to the boundary of the intermediate zone. Floristically it is under the Kandy and upper Mahaweli floristic zone. Tropical Wet Evergreen Forests and Humid Zone Dry Patana Grasslands are typical natural vegetation formations in the Kandy and Upper Mahaweli Floristic Zone.

The land in and around the proposed sub-project area are within the Kandy city centre and as such has been under human influence and cleared for human settlements and urban developments for a long time. Therefore, the area is devoid of any significant natural floral and faunal habitats, excepting a few large scattered trees which will be preserved and integrated to the proposed development.

Overgrown grass and shrubbery will be cleared to make space for additional parking space

b. Presence of wetlands

No wetlands are presence at the proposed site

c. Fish and fish habitats

Medaela runs through the KMTT site, however, no fish species have been recorded in the canal due to high pollution levels of its water

d. Birds

No waterfowls and migratory bird species encountered within the sub-project area. Few terrestrial bird species were identified in and surrounding area of the proposed project. Crows, Kingfisher and Minas were observed at the area during the field visits.

e. Presence of special habitat areas

There are no special habitats around the area as the area surrounding the proposed site is highly urbanized and built up area.

C.3.1.6. Other features

a. Residential / Sensitive Areas

Proposed project area is situated facing the Kandy Peradeniya road, which is one of the most congested roads in Kandy during School and office hours. Kandy General Hospital is located within 500m radius. Girls‟ High School and Swarnamali Girls‟ College are also situated very close to the proposed site. In addition to these government schools, private educational institutions, few residential places, commercial shopping complexes, hotels and private business places are situated around the proposed project area.

b. Traditional economic and cultural activities

The sacred Temple of Tooth Relic and associated activities take place once a year during the Kandy Esala Perahera Festival is the main cultural event happens in the area. The Kandyan art, paintings and hand crafts and Kandyan cultural dancing, Brass and wooden carvings are the most famous traditional economic activities found in and around the Kandy area

c. Archeological resources

The Department of Archaeology has investigated locations for artifacts of high historical and archaeological interest in the surrounding but not within the project location.

Proposed sub project involves on the interventions related to improvement of existing facilities in the site and hence, there will be no interference with the archeological objects.

C.3.1.7. Climate

The area has an average minimum and maximum monthly wind velocities of 0.5m/s (January) and 8.0m/s (May). The main prevailing wind directions are Westerly from January to March, South Westerly from April to October and North Westerly from November to December

The maximum and minimum average air temperatures are 26 degrees Centigrade (in April) and 23 degrees Centigrade (in January). Humidity varies in range of 63% (in January) and 90% (in September)

The annual average rainfall is 2000- 2300 mm. The barometric pressure in the area range from 900 to 1000 mbar.

The Proposer shall take into account the risk of any operation of forces of nature including but not limited to the 20 years maximum flood level, 10 years rain fall.

Contractor shall obtain relevant data from Meteorology Department of Sri Lanka, Disaster Management Center.

C.3.2. SOCIAL DATA

KMTT is expected to require acquisition of 3.6742 hectares of land, out of which 99.5% is public land under the ownership of various government agencies (i.e., SLR, SLTB and Kandy Teaching Hospital). While private acquisition is expected to be minimal, economic displacement will be significant with 841 businesses, mobile vendors, shop assistants, three- wheelers, etc., operating in the existing bus station and/or its immediate buffer zone, being affected.

The land earmarked for the construction of the Kandy Multimodal Transport Terminal (KMTT) is largely a crown land vested with a number of government agencies largely rail and bus operators. The land is currently used for public and private bus operations is known as Goods Shed Bus Stand (GSBS). Many business establishments catering to the needs of bus commuters have been established on this land with or without the consent or mediation of government agencies holding the land. In effect, the impacts of KMTT is not so much related to losses caused by acquisition of land but due to livelihood disturbances and economic displacement caused by clearance of the existing business enterprises from the site of KMTT and resulting loss of livelihoods for business operators and their employees, intermediaries between government agencies with land rights or rights over the buildings allocated to these intermediaries for business operations and/or tenants and actual business operators and, finally, persons making a living from mobile trade or three wheel taxi services catering to the commuters.

The social impact assessment (SIA) conducted as part of due diligence was based on preliminary

engineering design of October 2017. The SIA included inventorizing the project impact area, a census of all project affected persons, and preparation of an inventory of losses (IOL) for all APs.

The project will affect a total of 841 economic operators whom were operating in GSBS or its immediate buffer zone. The total household population among these economic operators is

3,688 as established through the census of APs conducted as part of the SIA related to KMTT. The project related economic damages include both permanent and temporary loss of livelihoods due to permanent demolition of all commercial and other structures located inside the technical boundary (ITB) of GSBS and temporary access difficulties and loss of their client base during the construction of KMTT that will be experienced by many of the commercial establishments in immediate buffer zone (IBZ). The largest number of APs were shop assistants working in GSBS or nearby shops (245), followed by rentiers who draw rent incomes from the business establishments in ITB or IBZ (213), business operators (161), mobile vendors (150) and three wheel operators serving bus commuters (65). Of these various categories of APs, shop assistants and mobile vendors may be considered as particularly vulnerable because they possess limited assets, limited reserves and limited skills that could be applied for the purpose of livelihood restoration. All these affected parties has been compensated and arranged for alternative livelihood through a compensation package. A system has been developed for monitoring and guiding them in the process of the livelihood restoration activity for a period of 3 years.

As such the site is clear from the occupant at present. However there are 5 families of Sri Lanka railway staff occupying 2 buildings belongs to Sri Lanka railways whom to be provided with temporary accommodation through Sri Lanka Railways by paying rental to Sri Lanka Railways until they are provided with permanent accommodation. The permanent accommodation is to be constructed by the project through separate contract which will be probably completed by Mid-2023.

C.4. GROUND INVESTIGATION DATA

Soil investigation of the site has been carried out at selected location of the land area identified for the construction. The soil investigation report is given in Annex C.2 for the reference of the Proposer.

C.5.UTILITY RECORDS

Plan showing the utility lines are given in Annex C.3. All these lines have been diverted to these

permanent or temporary locations to release the land for the construction of KMTT. These lines also shown on the Annex C1 – Topographical survey plan.

C.5.1. KMC WATER PUMPING MAIN LINE

The Plan showing in Annex C.4 is the permanent location of Kandy Municipal Council water main & DI pipes of this water main has been laid with a 1 m clearance from the ground level. This shall be considered in the design & construction of foundation & under pass levels.

C.5.2. TELECOMMUNICATION AND ELECTRICITY LINES

The Telecommunication lines and Electrical lines that were existed at the site have been relocated to temporary location mainly along the boundary of the site so that the construction of main building can be carried out without disturbance to them. Plan showing new temporary telecommunication and electricity line location are given in Annex C.3.

Permanent arrangement of these utility lines are to be included within the KMTT design as a utility duct or corridor with provision for outside connection. It is required to discuss with utility agencies for the location, arrangement, dimensions of these utility ducts

C.5.3. SEWERAGE LINE

Under the Kandy Waste Water Management Project, sewage lines have been laid recently in the vicinity of Goods Shed area and one main line & some peripheral lines have been planned through the KMTT site as well. The laying of that part within the site premises was delayed till the completion of foundations of the KMTT & laying of this section has to be done under the KMTT construction. (Refer Annexure C3)

C.6. LAND OWNERSHIP INFORMATION

KMTT is expected to require acquisition of 3.6742 hectares of land, out of which 99.5% is public land under the ownership of various government agencies (i.e., SLR, SLTB and Kandy Teaching Hospital). While private land acquisition is expected to be minimal, economic displacement will be significant with 841 businesses, mobile vendors, shop assistants, three- wheelers, etc., operating in the existing bus station and/or its immediate buffer zone, being affected.

The KMTT is being constructed on land that belongs to the State entities as per the Tracing number **Maha/MHN/2017/654 Prepared by Survey General** (Annex C.5)**.** Only small **private land of 2 Land lot (1.46Perchs**) to be acquired.

C.7. GROUND WATER, SURFACE WATER AND

HYDROLOGICAL INFORMATION

This information is given in Geotechnical Investigation Report given in Annex C.2

C.8. STATUARY PLANNING AND ZONING CONSTRAINTS

As per the UDA planning Zone classifications this area has been classified as commercial and transport zones in the city. Planning approval as the development permit has already been obtained from UDA.

C.9. ORDERS CONSENTS PERMITS, LICENSES AND COMPLIANCE REQUIREMENTS

The Central Environmental Authority (CEA) clearance has already been obtained for the proposed construction it is required to renew the clearance every year (Annex C.6). Urban Development Authority (UDA) development permit has already been obtained with the approval of National Building Research Organization (NBRO). All other permits licenses and compliance requirements have been addressed in the environmental requirement component of Employer‟s Requirement**.**

C.10. DEMOLITION OF EXISTING BUILDINGS

Few buildings & structures in the premises need to be demolished to make space for the project as given in Annexure C-7. Necessary actions shall be taken by the proposer.

C.11. CONSTRAINTS TO BE CONSIDERED IN THE DESIGN

- **Disruption at site due to Meda- Ela**

The Meda Ela is the water body that drains the storm water from city area and over flow of Kandy Lake. After the spillway, this runs underground for a major section and becomes an open channel from outfall and runs up to Goods Shed bus stand where the proposed KMTT will be constructed and crosses the existing bus stand as a covered underground section and exposes itself again as an open channel. When design and construction is carried out the Proposer is expected to take the location of the water body into consideration and plan out his proposal.

It also needs to be considered that with the rapid urbanization of the city the canal has been encroached at several places and poses a threat to flooding of the surrounding areas.

The section of the covered drain in the Project area is also in a poor state. Therefore, required

improvements to the Meda Ela for its existing path; or diversion of the Meda Ela as per the proposed design should be carried out by the Proposer. Further, canal improvement for 300m long section along the Meda-El towards upstream of the stream shall also be carried out with a suitable silt trap by the Proposer. (Refer Annexure C1)

- **Widening of William Gopallawa Mawatha**

There is a new proposal forwarded by the Road Development Authority of Sri Lanka to widen the William Gopallawa Mawatha road into a four lanes road. But this road has been indicated as a two lane road, as per the Conceptual drawings provided by the Employer. The Proposer is expected to consider this broadening in his design. Refer Annex C8 for further clarifications.

- **Location of Bo tree, Buddha Statue & Banyan Tree**

The Bo-tree and the Buddha Statue in the premises, have been worshipped by the people for some time. Further a vastly spread Banyan tree is also located within the proposed premises for a long time. The proposer is expected to preserve these features by incorporating these attributes into the design.

C.12. ANY OTHER PHYSICAL CONSTRAINTS

- **Limitation of space:**

As the construction site is located within the heart of the Kandy city, the land availability is very much limited. The Proposer is expected to schedule and manage his works, machine yards, material storage, labour camp, site office etc. within the limited space available.

- **Constructions near Rail Track:**

The construction activities of part of the Terminal & Parking building & the Sky walk have to be carried out very close to the existing rail track and over the rail track. As the rail tracks are in operation all the time, constructions near rail track have to be carried as per the guidelines issued by the Sri Lanka railways. Proposer shall address these situations while preparation of his construction methodologies.

D. CONTRACTOR'S REPRESENTATIVE AND KEY PERSONNEL

D.1 CONTRACTOR'S REPRESENTATIVE AND KEY PERSONNEL

Only the minimum Key Personnel required executing the Contract, taking into account the nature, scope, complexity and risks of the Contract have been specified here. If the Proposer/ Contractor feels that there are additional requirement those shall be considered and included while preparing the Proposal.

Key staff engaged shall meet the prevailing legal requirement and regulations of the Sri Lanka.

Chartered Engineer, Engineer, Chartered Architect, Chartered Quantity Surveyor shall have the following minimum qualifications in addition to the other qualifications and experience specified for respective key personnel.

Local Key Personnel

- Chartered Engineer referred in the RFP shall be registered under the Engineering Council of Sri Lanka (ECSL) as a chartered Engineer.
- Engineer referred in the RFP shall be registered under the Engineering Council of Sri Lanka (ECSL) as Associated Engineer.
- Chartered Architect referred in the RFP shall be an **Associate Member** of the Sri Lanka Institute of Architects (SLIA) or shall have the qualification accredited by SLIA to enter in to the class of **Associate Member.**
- Architect referred in the RFP shall be a **Graduate Member** of the Sri Lanka Institute of Architects (SLIA) or shall have the qualification accredited by SLIA to enter in to the class of **Graduate Member.**
- Chartered Quantity Surveyor referred in the RFP shall be an **Associate Member** of Institute of Quantity Surveyors Sri Lanka

Foreign Key Personnel

- Foreign Key Personnel shall have the provisional registration before practicing
- Foreign Key Personnel shall have the equivalent qualification similar to the respective local Key Personnel

D.2 KEY STAFF REQUIRED:

Position	Qualification	Total Working Experience	Specific Experience	No.
Project Manager	Chartered Engineer (Civil) or with an equivalent internationally recognized Professional Qualification.	20 years experience after graduation.	At least one previous project involved in similar nature & 15 years experience in Building projects	1
Team Leader-Design	Chartered Architect or with an equivalent internationally recognized Professional Qualification.	15 years experience after graduation	At least one previous projects involved in similar nature & 10 years experience in building projects.	1
Senior Passenger Terminal Design Engineer	Chartered Engineer (Civil) or with an equivalent internationally recognized Professional Qualification & Post Graduate qualification in transport engineering with minimum of 05 years of post- charter experience	15 years experience after graduation	At least one previous projects involved in similar nature.	1
Chief Engineer (Structural Design)	Chartered Engineer (Civil) with post graduate qualification in Structural Engineering and listed in directory of Structural Engineers prepared by IESL for middle rise buildings up to 08 storied.	15 years experience after graduation	10 years in Structural designs in building projects	1

Position	Qualification	Total Working Experience	Specific Experience	No.
Chief Engineer (Mechanical & Electrical)	Chartered Engineer (Mechanical / Electrical) with post graduate qualifications and listed in the directory of building services engineers prepared by IESL	15 years experience after graduation	10 years in Electrical/ Mechanical designs in building projects	1
Planning & Project Control Engineer	Chartered Engineer (Civil)	15 years experience after graduation	10 years in building projects	1
Senior Engineer (Building-Quality Assurance)	Chartered Engineer (Civil)	15 years experience after graduation	10 years in building projects	1
Senior Engineer (M & E- Quality Assurance)	Chartered Engineer (Mechanical/ Electrical)	15 years experience after graduation	10 years in building projects	1
Senior Engineer (Materials)	Chartered Engineer (Materials)	15 years experience after graduation	10 years in building projects	1

D.3 OTHER STAFF REQUIRED:

D.3.1 CONTRACT ADMINISTRATION

Table D.1: Contract Administration Staff

Position	Qualification	Total Working Experience	Specific Experience	No.
Deputy Project Manager	Chartered Engineer (Civil)	10 years experience after graduation.	8 years experience in building projects	2 (full time at site)
Chartered Quantity Surveyor	Chartered Quantity Surveyor	Minimum 10 years experience after graduation	6 years experience in building projects	1 (full time at site)

Position	Qualification	Total Working Experience	Specific Experience	No.
Green Consultant	Chartered Engineer (Electrical/ Mechanical/ Building services)	More than 10 years experience in energy efficiency and green building designs with recently completed buildings locally/ internationally		1 (Throughout the project period)
Safety Officer/ HSE officer	National institute of occupational safety and health certificate or diploma	3 years relevant experience		1 (full time at site)
QA/ QC Engineer	Chartered Engineer (Civil/ Materials)	5 years experience after graduation		1 (full time at site)
Assistant Quantity Surveyor	Qualified with NCT (QS)	5 years experience		2 (full time at site)

D.3.2. ARCHITECTURAL WORKS

D.3.2.1. DESIGN TEAM

Table D.2: Architectural Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Chartered Architect	Chartered Architect	10 years experience after graduation	8 years experience in the building projects.	1
Architect	Architect	5 years after graduation	3 years in building projects	2

D.3.2.2 CONSTRUCTION TEAM

Table D.3: Architectural Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Chartered Architect	Chartered Architect	10 years after graduation	8 years in building projects	1 (full time at site)
Architect	Architect	5 years after graduation	3 years in building projects	2 (full time at site)

D.3.3 STRUCTURAL & CIVIL WORKS

D.3.3.1. DESIGN TEAM

Table D.4: Structural Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Design Engineer (Structural Design)	Chartered Engineer (Civil) with Postgraduate qualification in Structural Engineering.	10 years experience after graduation	8 years in Structural designs in building projects	2
Design Engineer	Engineer	5 years after graduation	3 year experience in structural designs	2

D.3.3.2 CONSTRUCTION TEAM

Table D.5: Structural Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Civil Engineer	Chartered Engineer	10 years experience after graduation	8 years in building projects	2 (full time at site)
Civil Engineer	Engineer	8 years	5 years in building	2 (full time

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
		experience after graduation	projects	at site)
Technical Officer	NCT (Civil)	5 years	3 years in building projects	4 (full time at site)

D.3.4. ELECTRICAL WORKS

D.3.4.1. DESIGN TEAM

Table D.6: Electrical Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Electrical)	Chartered Engineer (Electrical)	10 years after graduation	8 years in Electrical designs in building projects	1
Engineer (Electrical)	Engineer	8 years after graduation	5 years in Electrical designs in multi storied building projects	1

D.3.4.2 CONSTRUCTION TEAM

Table D.7: Electrical Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Electrical)	Chartered Engineer (Electrical)	10 years after graduation	08 years in Electrical works of building construction projects	1 (Part time)
Electrical Engineer	Engineer (Electrical)	5 years after graduation	3 years in Electrical works of building construction	1 (full time at site)

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
			projects	
Engineer Assistant (Electrical)	NVQ Level 6 (Higher National Diploma in Electrical Engineering) or equivalent	10 years	5 years in Electrical works of building construction projects	1 (full time at site)
Technical Officers (Electrical)	NVQ level 4 (NCT) or equivalent	5 years	3 years in Electrical works of building construction projects	2 (full time at site)

D.3.5. WATER SUPPLY AND DRAINAGE WORKS

D.3.5.1. DESIGN TEAM

Table D.8: Water Supply and Drainage Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Water Supply and Drainage)	Chartered Engineer (Engineering Services)	10 years after graduation	08 years experience in building plumbing	1
Design Engineer	Engineer (Civil)	5 years after graduation	3 years in in building services field.	1

D.3.5.2. CONSTRUCTION TEAM

Table D.9: Water Supply and Drainage Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Water Supply and Drainage)	Chartered Engineer (Engineering Services/Mechanical) and listed in the directory of building services engineers	8 years after graduation	Minimum 5 years experience in building plumbing supervision and coordination of	1 (Part time at site)

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
	prepared by IESL		building plumbing & canal development	
Technical Officer (WSD)	NCT or equivalent	5 years	Minimum 3 years experience in building services	1 (full time at site)

D.3.6. MECHANICAL WORKS

D.3.6.1. DESIGN TEAM

Table D.10: Mechanical Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Mechanical Ventilation and Air conditioning (MVAC)				
Senior Design Engineer (Building Services - Mechanical)	Chartered Engineer (Mechanical) and listed in the directory of building services engineers prepared by IESL	10 years after graduation	7 years experience in designing MVAC systems for high-rise buildings	1
Design Engineer (Building Services - Mechanical)	Engineer (Mechanical)	5 years after graduation	3 years experience in designing MVAC systems for high-rise buildings	1
Fire Protection, Detection and Suppression System				
Senior Design Engineer (Building Services - Mechanical)	Chartered Engineer (Mechanical) &listed in the directory of building services engineers prepared by IESL	10 years after graduation	7 years experience in designing Fire protection, Detection & Suppression systems for high-rise buildings	1
Design Engineer (Building Services - Mechanical)	Engineer (Mechanical)	5 years after graduation	3 years experience in designing Fire protection, Detection & Suppression systems for high-rise buildings	1

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Building Management System (BMS)				
Senior Design Engineer (Building Services - Mechanical)	Chartered Engineer (Mechanical / Electrical) and listed in the directory of building services engineers prepared by IESL	10 years after graduation	7 years experience in designing Building Management System (BMS)	1
Design Engineer (Building Services - Mechanical)	Engineer (Mechanical/ Electrical)	5 years after graduation	3 years experience in designing Building Management Systems (BMS)	1
Elevator and Escalator System				
Senior Design Engineer (Building Services - Mechanical)	Chartered Engineer (Mechanical) &listed in the directory of building services engineers prepared by IESL	10 years after graduation	7 years experience in designing Elevator and Escalator Systems	1
Design Engineer (Building Services - Mechanical)	Engineer (Mechanical)	5 years after graduation	3 years experience in designing Elevator and Escalator Systems	1

D.3.6.2. CONSTRUCTION TEAM

Table D.11: Mechanical Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Mechanical Engineer	Chartered Engineer (Mechanical)	8 years after graduation	5 years experience in Mechanical designs and installation supervision in multi storied building projects	1 (Full time at Site)
Mechanical	Engineer (Mechanical)	5 years after	3 years	2

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Engineer		graduation	experience in Mechanical designs and installation supervision in multi storied building projects	(Full time at Site)
Technical Officers	With NCT or equivalent	7 years	5 years experience in building services field	4 (Full time at Site)

D.3.7. INFORMATION AND COMMUNICATION TECHNOLOGY WORK

D.3.7.1. DESIGN TEAM

Table D.12: ICT Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (ICT)	Chartered Engineer (Computer /Electronic/ Telecommunication)	10 years after graduation	8 years experience in ICT design/installation / supervision work at least one project in similar nature.	1
Design Engineer	Engineer(Computer/ Electronic /Telecommunication)	5 years after graduation	3 years experience in ICT design/installation / supervision work.	1
Site Engineer	BSc. in Computer or relevant field/ NDT/HNDE with necessary certifications.	5 years	3 years experience in ICT works.	1

D.3.7.2. CONSTRUCTION TEAM

Table D.13: ICT Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (ICT)	Chartered Engineer (Computer /Electronic / Telecommunication) and MSc or MBA or PMP/ PRINCE2	10 years after graduation	8 years experience in ICT in high-rise buildings.	1 (Part time at Site)
ICT Engineer	Engineer(Computer/ Electronic /Telecommunication)	5 years after graduation	3 years experience in ICT works	1 (Full time at Site)
Technical Officers	BSc. Computer or relevant field/ NDT/HNDE with necessary certifications.	2 years	2 years experience in ICT works	2 (Full time at Site)

D.3.8. ROADS AND PAVEMENTS WORKS

D.3.8.1.DESIGN TEAM

Table D.14: Road and Pavements Design Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Roads and Pavement	Chartered engineer (Civil) with post graduate qualification in Transport and Traffic Engineering	10 years after graduation	08 years' experience in road designs including pavement design	1
Design Engineer	Engineer (Civil)	8 years after graduation	6 years' experience in Pavement & Material designs	1

D.3.8.2. CONSTRUCTION TEAM

Table D.15: Road and Pavement Construction Team

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Senior Engineer (Roads Construction)	Chartered engineer (Civil)	10 years after graduation	8 years in road projects	1 (Part time at Site)

Position	Required Minimum Qualification	Total Work Experience	Specific Experience	No.
Quality Control and pavement material Engineer	Engineer (Civil)	10 years after graduation	6 years in road projects	1 (Full time at Site)
Technical Officer	NDT or equivalent and respective certifications	10 years	5 years in road projects	1 (Full time at Site)

E. SPECIFICATIONS

E.1. GENERAL SPECIFICATIONS

E.1.1 GENERAL REQUIREMENTS

General Requirements of Work will be specified as follows:

The general work of scope comprises but not limited to followings;

a) Design, Construction and Completion of all civil works specified under the Contract.

b) Design, supply, installation, testing and commissioning of all mechanical and electrical Plumbing and Information Technology (IT) equipment and plants; all other ancillary items necessary for a complete and functional project including furnishing of operation and maintenance manuals.

c) The testing and commissioning of the Works including Tests on Completion and Tests after Completion and furnishing of test reports.

d) Remedying of defects

e) Carrying out of all ancillary works necessary for the completion of the Works

f) Furnishing As-built drawings of the project.

g) Furnishing Operation and maintenance manuals of the project including those for installed equipment.

The Contractor shall be responsible for ensuring that his design complies with all relevant standards, codes of practices and by-laws. All plant, equipment and material items supplied and I or installed under the Contract shall be well-coordinated and be compatible with each other. In designing the Works, the Contractor shall plan for the layouts which will produce efficiency in operation.

E.1.2. EMPLOYER'S CONCEPTUAL DRAWINGS

The drawings provided with the Tender documents are intended to show the sites of the Works, illustrations of the Employer's Requirements and conceptual layouts and designs for the Works.

E.1.3. GEOTECHNICAL AND OTHER INFORMATION

Geological and / or geotechnical information, Survey and any other information given in this document or made available with the tender documents are only to assist the Tenderer for his preparation of the Tender. The Tenderer shall be responsible for the interpretation of the data.

The Contractor shall undertake at his own expense such further geological and / or geotechnical Investigations, Survey as may be necessary for him to design the works. He shall provide supporting information to validate his design assumptions. Copies of the results of all such investigations / reports shall be provided to the Employer and Engineer.

E.1.4. DESIGN RESPONSIBILITY

E.1.4.1. Tenderer's Design Approach

The Tenderer in his proposal shall submit his design approach which shall include the general layout of the project, improvements to the conceptual design (if any), standards and codes to be used, design criteria, outline specifications for materials, equipment and workmanship, technology to be used etc.

E.1.4.2.Criteria for Design Personnel

Contractor's Representative:

The Contractor's Representative shall have all the appropriate qualifications and experience acceptable to the Engineer and will undertake the coordination and progressing of all aspects of the Project from the commencement of the design through to final completion and commissioning of the Works. He shall be responsible for ensuring that the Works form a well engineered and integrated project complying with the Employer's Requirements.

Design Personnel:

The Contractor shall nominate suitably qualified and experienced personnel acceptable to the Engineer including personnel nominated in the Tender to be responsible for each assigned task. (Qualifications for Contractor's Personnel are given in xxx)

Once personnel nominated have been approved by the Engineer, no changes to these personnel shall be made until approval has been obtained in writing from the Engineer for the new nominee who is equally qualified or superior.

E.1.4.3. Contractor's Documents

The Contractor shall submit the following Contractors Documents for the Approval of the Engineer:

a) Design Submittals which include Construction Drawings, Fabrication Drawings, Lift and Placement Drawings, Layout Drawings of Temporary Works, Specifications and design calculations and other details if required by the Engineer.

(b) Shop Drawings, Manufacturers' Specifications, Engineering Data and Certificates of Compliance, other descriptive data for all materials and equipment

(c) Instruction Manuals for Assembly, Installation and Operation and Maintenance

(d) Test Procedure Instructions and reports

(e) Project Quality Plan and Quality Procedures

(f) Progress Reports

(g) Construction Schedule (Time Programme)

(h) Method Statements

(i) Other Schedules

(j) Other Submittals

(k) As-Built Documents

No separate payment will be made for the preparation and submission of the Contractor's Documents specified in this Section, and the costs thereof shall be included in the lump sum prices of the various items stated in the Activity Schedule.

E.1.4.4. Submission of Contractor's Documents

E.1.4.4.1 Document Format

The Contractor shall produce all design submittals in reproducible quality and clearly readable prints, photocopies and in soft copy form with all details to assure completion of construction of the Works. All Design Submittals shall be checked, signed and sealed by an authorized representative of the Contractor and the Design Engineer who is a registered Professional Engineer / Professionally Qualified Engineer. Size of the drawings / documents shall be unified as far as practicable and shall be as follows.

Al 594 mm x 841 mm

A2 420 mm x 594 mm

A3 297mm x 420 mm

A4 210 mm x 297 mm

- Contents list
- Summary
- References including specification requirements, design codes of practice, manuals and supporting documents used, numbers and titles of drawings which are based on the design
- Criteria, parameters, software and methods used
- Test procedures, analyses and results
- Calculations and schedules
- Qualitative description and comments on results
- Any other relevant information.

Designs and documents shall be presented on A4 size paper with every page numbered and bound in order between a transparent front cover and stiff back. The title of the submission shall be given on the front sheet beneath the title of Contract, Contractor‟s name, title of work location, author‟s reference, date, Contractor‟s signature, and any other relevant information.

The Contractor shall bind in as appendices to the designs and documents English language copies or photocopies of any standard, code of practice, manual or other reference referred to in the designs and documents which have not otherwise been submitted.

E.1.4.4.2 Drawing Format

Unless otherwise stated elsewhere in the Contract, the Contractor shall submit his drawings in time and in a logical order to the Engineer for approval. The drawings shall be submitted in sufficient time to permit modifications to be made if such are deemed necessary by the Engineer without delaying the delivery of the Contract Works.

All drawings and data submitted to the Engineer for review shall be stamped with "FOR APPROVAL" and submitted within times mentioned hereunder. The drawings which are required to be modified as required by the Engineer shall be re-submitted for approval.

Drawings submitted by the Contractor for review shall be based on previously submitted designs or documents. Interrelated drawings shall be submitted at the same time in a complete and self-sufficient set. Copies shall be collated into ordered bundles each with a list of contents.

All drawings provided by the Contractor shall be in the form of good quality reproductions and

shall conform to the requirements of relevant British Standards in respect of drawing size, presentation and use of symbols. Drawings shall be no smaller than A4 and no larger than A1. Drawings submitted as part of the design or document shall be presented on A1 size paper (unless otherwise requested by the Engineer to submit on A2 / A3 size paper) folded into pockets at the back.

All dimensions used on drawings shall be in metric units and all drawings shall be to scale and shall include a graphical scale to aid the use of photographic reproductions. Preferred scales are 1:1, 1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000, 1:2000, and 1:5000.

Drawings shall be complete with:

- Project cage approved by the Engineer.
- Drawing codification with revision number, revision clouds & related details.
- Legends with all details.
- Comprehensive notes describing all aspects, including revision, modifications made.
- Separate descriptive information for sub-assemblies, major components, foundation, fixing details etc.
- Separate drawings for sub areas.
- Sections, elevations, plan layout information.

E.1.4.4.3. Numbering and Titling

The Contractor shall use a reference numbering system for designs notes, report, drawings and documents so that each number used is unique. The numbering and title information on design notes, reports, drawings and documents shall be designed so that management, transmittal and communication of drawings can be carried out expeditiously using a computer aided data base system.

All drawings shall bear the following information in a standard cage:

- Engineer’s name, address and logo
- Contractor’s name, address and logo
- Engineer’s name, address and logo
- Contract Title

- Contract Number
- Drawing Title, including names of project
- Drawing Number
- Revision Schedule
- Scale
- Date

The Contractor shall maintain a document / drawing register listing all documents /drawings prepared as a part of the Contract.

The document / drawing register shall incorporate a revision number. Wherever a change is made to the document / drawing the revision number, the date of the change, full details of the change and person responsible for the change shall be recorded on the register. The first issue of a revised document / drawing shall indicate, by the use of "clouds", where on the document / drawing the revision has been made. The first revision of the document / drawing shall be designed as revision A. At monthly intervals until all design is complete the Contractor shall submit a copy of the current drawing register to the Engineer for his information. A final copy of the register shall be supplied to the Employer on completion of the Contract.

E.1.4.4.4. Design Submittals

The Contractor shall submit to the Engineer for review five hard copies as well as five electronic copies of all submissions – electronic copies shall be burned on DVD-ROM. Electronic copies shall include original (DWG, WORD, Excel, etc.) and PDF formats. Only one hard-copy will be returned to the Contractor.

Following acceptance of a note / document / drawing by all parties, the Contractor shall submit to the Engineer one original print on white paper and four paper print copies of all accepted drawings with the date of the Engineer‟s acceptance marked on the original.

E.1.4.4.5. Review Period

All design submittals after its receipt in the Engineer's Project Office will be reviewed within the specified time periods as follows with another 7 days allowance for return mail purposes to the Contractor.

No. of Drawings (N)	Maximum Time Period
N<5	15 days
N< 10	30 days
Specifications	30 days

The Contractor shall set a priority for the review of the submittals and re-submittals.

Design submittals shall be submitted as provided in the approved schedule of design submittal submission provided by the Contractor. Any deviation from the schedule may delay the Engineer's response. If multiple submittals and re-submittals are made within short periods of time, an extension of the above review period may be required.

E.1.4.4.6. Submittals Returned to the Contractor

Items submitted for review by the Contractor and returned by the Engineer will be categorized as follows:

(1) **Accepted**: Subject to its compliance with the Employer's Requirements and conformity with the overall design, the Engineer has no comment on the submission.

(2) **Accepted as Noted**: Subject to its compliance with Employer's Requirements and conformity with the overall design, the Engineer has some comments on the submission, but they are not such as to necessitate formal re-submission. Where the Contractor makes changes to an item an updated issue shall be provided to the Engineer for record purposes.

(3) **Rejected:** The Engineer will indicate the grounds for his not accepting the submission; the Contractor shall amend or revise the submission accordingly and re-submit the item for review.

Engineer shall review and / or approve the design submittals within the review period. If corrections are necessary, the Engineer shall send one copy with review comments to the Contractor. Acceptance by the Engineer of any drawing or revision, structural design, method of work or any information regarding materials and equipment the Contractor proposes to supply, shall not relieve the Contractor of his responsibility for any errors or omissions therein, and shall not be regarded as an assumption of risks or liability by the Employer. Such acceptance shall be considered to mean that the Employer has no objection to the Contractor using, upon his own full responsibility, the design, plan or method of work proposed or furnishing the materials and equipment proposed.

The Contractor shall respond to the instructions noted on the Drawings. Drawings shall not be used for construction unless marked with the notations 1 and 2 noted above. No drawing shall be considered valid unless signed by the Engineer as "ACCEPTED". The approval by the Engineer of such drawings shall not relieve the Contractor of his obligations and responsibilities under the Contract.

The Contractor shall be responsible for reproducing implementing the revisions noted, and distributing copies of the returned design submittal, if this is necessary, to provide this information to Subcontractors, Contractor's Design Engineer. The accuracy and completeness of

these additional copies of submittals are the sole responsibility of the Contractor. The Contractor shall have no claim under the Contract on account of the failure or partial failure, or inefficiency of any design, plan or method of work or material and equipment so accepted. The Contractor shall not be entitled to a time extension based upon the rejection of designs or detail drawings. No separate payment will be made for furnishing and submission of the drawings required.

E.1.4.4.7. Re-submittals

After review, the Engineer shall provide the Contractor a list of written comments on items requiring revision for compliance with the Contract Documents. The Contractor shall make corrections as necessary and the corrected drawings and specifications shall be resubmitted to the Engineer for review. When the returned drawings and documents are re-submitted for approval, the Engineer will try to complete his review and / or approval of the drawings and documents within fifteen (15) working days, however, this will depend on the number and complexity of the corrections / revisions which have to be checked. This procedure will continue until satisfactory response to all comments and re-submittal requirements have been received.

Coordination of design and construction requirements for the different design submittals shall be the responsibility of the Contractor. No reimbursement shall be made for revisions or design resulting from failure to adequately integrate the different design submittals within the overall plan of the Works.

E.1.4.4.8. Submission of Sub-Contractor's Drawings for Review

Before submission, the Contractor shall verify all drawings and documents prepared by the sub•contractors and manufacturers to ensure their compliance with the Employer's Requirements. Such drawings shall be clearly identified as being checked by the Contractor. All drawings not so checked and noted will be rejected by the Engineer and returned to the Contractor without further comment. Sub-Contractor's drawings and documents shall be numbered in accordance with the Contractor's system for which Engineer's consent has been obtained.

E.1.4.4.9 Checking

All submissions shall be checked first by the Contractor and shall be stamped and signed to confirm that the checking has been carried out. Checking shall be carried out by a Chartered Project Manager (or equivalent for other disciplines) experienced in the type of work involved. Any submissions not so marked will be returned to the Contractor immediately.

E.1.4.5. Other Submittals for Review

The Contractor shall submit the following to the Engineer for review and approval in accordance with the procedures specified for Shop Drawings:

(a) Lists of suppliers, manufactures and sources of Materials to be used for the Works.

(b) All relevant information and test data pertaining to representative samples from each supplier, manufacturer or source of Materials

E.1.4.6. Other Design Submittals Schedule

The Contractor is required to submit his design documents for approval of the Engineer.

No construction work may commence on site until the Contractor's design proposals have been approved by the Engineer for the relevant sections of the Works.

At the time the Construction Schedule (Time Programme) is submitted, the Contractor shall submit a Programme for submitting the Design Documents and this should conform to the overall Project Implementation Programme. The Design Programme shall be submitted to the Engineer for approval. The Design Programme shall be submitted to the Engineer for approval.

For each required design submittal, the submittal date to the Engineer for review shall be indicated, as well as the return date to avoid delay in any activities beyond the scheduled commencement date. The Contractor shall allow sufficient time for initial review, correction, and a second submittal, and final review and approval by the Engineer. In no case, will a schedule be acceptable which allows less than the review time specified for each review by the Engineer.

The Programme of Submissions shall clearly identify the dates of submission of the key elements of detail design and the final report. No designs, drawings and documents will be accepted by the Engineer for review until the Programme for their Submission has been approved by him.

E.1.4.7. As-Built Drawings & Documents

As-built record drawings shall cover the work as completed, incorporating all modifications carried out during construction or after testing at the Contractor‟s or sub-contractors‟ work and all modifications carried out in the course of the erection and construction of the Work. These drawings shall be submitted for review by the Engineer and may be produced by modifying drawings produced for construction or may be produced separately. Important notes and descriptive matter shall be in English.

The drawings shall include those provided by the Contractor during the design and construction period together with drawings submitted by him with his Proposal as appropriate.

The Contractor shall submit As-built drawings as follows;

Hard Copies	-The Contractor shall submit original and two copies of the relevant As- built drawings properly signed by the Contractor and the Engineer. The drawings shall be arranged insets of A1size (White Paper) or approved otherwise.
Soft Copies	-The Contractor shall submit electronically stored soft copies of As-built drawings through portable hard disc as follows;
	Scan copy of signed and approved As-built drawings
	PDF version of finalized As-built drawings
	AutoCAD 2014

Two copies of each detail shall be provided and each shall be duly signed and dated by the Engineer and Contractor. After signing off, the Contractor shall retain his copy in a purpose file until the Performance Certificate has been issued.

As-Built Documents such as As-Built Drawings, layout data, survey data, movie films, and photographs shall be submitted to the Engineer, for verification purposes. No separate payment will be made for furnishing "As-Built" Drawings as above and all cost thereof shall be included in the lump sum amounts in the price schedule.

The Contractor shall also supply any additional. copies that are required to be submitted as part of the Operation and Maintenance (0 & M) Manuals. As-Built Drawings shall be subject to an inspection at the Site by the Engineer's Representative, and if found unsatisfactory and not up-to-date, shall be re-checked within six (06) working days later. As each of the Works delineated on the Construction Drawings is completed, the Engineer and the Contractor or their representative shall mutually sign all As-Built Drawings, after approval by the Engineer.

E.1.4.8. Construction Photographs

The Contractor shall be responsible for the production of construction photographs in soft copy format for documenting construction work. Coloured photographs of the entire Site, or pertinent features thereof, shall be taken before the commencement of the work at the Site and promptly submitted to the Engineer. The same views shall be re-photographed throughout the Contract period as requested herein and shall be taken at the start, during stages and at completion of each major component of the work and at times as directed by the Engineer.

E.1.4.9. Progress Reports

The Contractor shall submit the Progress Reports in accordance with Sub-Clause 4.21 of the General Conditions of Contract.

E.1.4.10. Contractor's Quality Control Review

Before a design document is submitted, the Contractor shall perform a complete quality control review of all construction drawings and specifications, including design calculations, dimensions, loading conditions, materials, coordination between disciplines, and other items as required to ensure the design is complete, correct, and in conformity with the Contract Specifications, design criteria, and the approved preliminary design.

After the quality control review and implementation of all revisions necessitated by the review, the Documents shall be signed and sealed by a registered engineer. The Contractor shall certify that the design submittal meets all the requirements of the Contract and shall submit construction drawings and specifications to the Engineer for review and approval.

Each design submittal shall include a listing of the design criteria, standards and regulations to be met and used for design of the works. Except as requested by the Engineer, no design calculations shall be submitted with the design submittal. All calculations shall be kept by the Contractor for the entire operation and maintenance period and shall be made available to the Engineer if requested. No design submittal will be accepted for review without the Contractor's certification that he has reviewed and approved the submittal.

E.1.4.11. Construction Schedule (Time Programme)

The Contractor shall submit the Construction Schedule in accordance with Sub-Clause 8.3 of the General Conditions of Contract and within one (01) month from the date of the award of contract showing milestones and key dates.

The time program shall submit as coloured prints of readable version of initial programme and each revised programme to the Engineer for his acceptance in one paper copy, one electronic copy and additional four paper copies. This programme shall be prepared to show the sequence and interdependence of activities required for complete the performance of all items of Work under the Contract and meeting milestone dates as required. The programme shall be prepared by the Contractor using the latest version of “Primavera” or “Microsoft Project”.

E.1.4.11.1. Fortnight look ahead programme

The Contractor shall submit fortnight look ahead programme for the Works within the first two Days of each week, comparing actual progress of the preceding week.

E.1.4.11.2. Format and Details of the Construction Schedule

In preparing the Construction Programme, the Contractor shall make due allowances for possible delays, but not limiting to delays caused by frequently experiencing evening showers, all types of holiday periods, local working conditions, problems relating to maintaining equipment, problems relating to obtaining materials and supplies, and similar items etc. Under no circumstances shall the programme show a completion date in excess of the "Time for Completion" stated in the Appendix to Tender.

Further, within the specified time periods, the Contractor shall submit the Engineer the following documents in the form agreed and approved by the Engineer for the purpose of monitoring the progress of the Works:

(a) A detailed Programme, covering the activities for the first six (06) months, including mobilization, transport to the Site, and erection of construction facilities.

(b) Detailed statements of construction methods. (c) List of construction equipment to be used.

(d) Forecast of total labour requirements for the Works.

(e) Site management organization chart. (f) Histogram of staff requirements.

(g) (Work schedule showing the proposed weighted monthly percentage of work accomplished.

(h) List of those drawings, which the Contractor will submit and may require approvals from the Engineer during the first six (06) months of the construction period, and the priority order and the approximate date of issue of such drawings.

The Engineer reserves the right to permit the Contractor to commence the Works only after submission of the documents specified above.

During the construction period, the Contractor shall submit to the Engineer:

(1) A detailed Construction Programme for each consecutive six (06) months period at least two (02) months prior to the commencement of the relevant period, with a histogram of staff requirements for the period.

(2) A list of drawings (including the order and date of issue of such drawings) which the Contractor may require the Engineer to approve during each consecutive six (06) months period at least three (03) months prior to commencement of the relevant period.

All the documents to be submitted in accordance with this Clause shall contain the

information required by the Engineer. In addition to the documents and information as required above the Contractor shall supply to the Engineer at such times as the Engineer may direct during the progress of the Works such further or special written particulars and information as are required by the Engineer to enable a progress record to be maintained in respect of the Works.

E.1.5. TEMPORARY FACILITIES

E.1.5.1. Employer's/ Engineer's Facility

E.1.5.1.1. Office for Engineer/ Employer

The Contractor shall provide necessary air conditioned office space with separate sanitary facilities as specified hereinafter for the use of the Engineer and the Employer. The Contractor shall supply electricity and water (drinking water and general purpose) to office for the Employer/Engineer and shall maintain continuous supply of above facilities throughout the construction period. Further, the Contractor shall maintain sanitary, air conditioning, telephone, fax and internet facilities for the entire construction duration. Supplying and maintaining of above facilities shall be subject to the Engineer‟s approval. The Contractor shall employ an office attendant throughout the construction period for assisting at office and maintaining the office and make all payments and bear other expenses as required by the prevailing Labour Laws etc. Further, the Contractor shall provide continuous service of security for the Employer/Engineer office.

Contractor shall continuously supply stationery, tools for measurements, 3ply face masks, sanitizers with dispensers and light fittings to the Employer‟s/ Engineer‟s Office. Further, drinking water, tea/ coffee to the Engineer‟s/ Employer‟s staff including drivers and office assistants and refreshment for the site meetings shall be supplied by the Contractor throughout the construction period.

Cost of maintenance, cost of repairs, cost of replacement, cost of alteration, shifting offices and adopting same from time to time shall be borne by the Contractor.

All furniture and fittings provided by Contractor for use in Employer‟s /Engineer‟s office during construction period shall become Contractor‟s property on completion of Works.

Unless expressly specified otherwise by the Engineer, spaces and facilities required to the office of Employer/Engineer are as follows;

Table E.1: Employer/ Engineer's Facility

Description	Unit	Quantity
Approximate total area required for the office for Engineer / Employer is 200 Sq.m with relevant infrastructure facilities including attached toilets and bathrooms, separate area for a conference room (area not less than 10 Sq.m), full air conditioned with suitable illumination, adequate voice and data points as informed by the Engineer.		
Executive tables (approx. 6‟0‟‟‟ x 3‟0‟‟‟ with side return) and an executive chair with 2 nr visitor chairs.	Set	3
Executive tables (approx.. 6‟0‟‟‟ x 3‟0‟‟‟) and an executive chair with 01 nr visitor chairs	Set	6
Standard office table (approx.. 4‟0‟‟‟ x 6‟0‟‟‟) with 1 nr of office chair	Set	3
Office conference table with 6 seats	Set	1
Drawing racks of Aluminium or similar with clips to keep about 50 drawings	Set	2
Filling cabinet (4 drawers)	nr	4
Computer (core i7-RAM 8 GB-HDD 1 TB- Monitor: LED 560mm)	nr	3
Filing/Rack with a cupboard	nr	4
Printer (A3 sized, colour) Photocopier machines [Toshiba E-Studio 355 (Toshiba e-BRIDGE 3 technology or Equilent at 35/45 pages per minute with Colour, black and white print, copy, fax, Colour scan and internal toner recycling system)] including automatic document feeder and separate sizes of drawers and stand with necessary network connections.	nr	2
A4 Black and White printer (Laser) Printers [HP Laser Jet Pro MFP M227 fdw Printer (Print, Scan, Copy, Fax, Print Resolution: 1200 x 1200 dpi, Maximum Print Size: 8.5" x 14", Print Speed: 30 ppm)] with the stand.	nr	2
Supply and installation of Projectors [BENQ W 1700 Projector (4K UHD with Razor-Sharp True 8.3 Million Pixel Detail, Hyper- Realistic Video Quality with Projector-Optimized HDR, Rec. 709 HDTV)] with projector pen	nr	1
Projector Screens [Easy Fold Screen 10'*8' (120"*90")]	nr	1
Facsimile [Samsung SF-760P Laser Fax Machine with 4-in-1 functionality with 4-in-1 versatility]	nr	1

Description	Unit	Quantity
CDMA Phones [Panasonic Premium Digital Proprietary Telephone- kx-DT486 (6-line Graphical LCD with backlighting, 24 freely programmable function keys, EHS (Electronic Hook Switch), Speaker Phone, handset and headset with full duplex)]	nr	1
Waste paper basket	nr	8
Magi board	nr	1
Display board	nr	1
Electric kettle	nr	1
Water Dispensers [FUJI COD water dispenser FC-JX-C(Hot, Normal and Cold Water, Semi-Conductor Cooling, Storage cabinet, Stainless steel tank, Anti-Bacterial design)] with water.	nr	1
First Aid Box	nr	1
Refrigerator	nr	1
Digital thermometers	nr	3
Walk-in disinfection chamber with all required sanitizers and accessories	nr	1
Laptops	nr	4
Latest mobile phones	nr	4

E.1.5.2 Contractor's Facilities and Working Areas

As the construction site is located within the heart of the city and the land availability is very much limited, only the area indicated in Annex C.8 will be available for construction works and it is up to the Contractor to schedule and manage the Contractor‟s temporary facilities accordingly. Contractor‟s temporary facilities shall be arranged within or off the Site as approved by the Employer/Engineer.

E.1.5.2.1 Contractor's Temporary Site Office

The Contractor shall provide, maintain, dismantle and remove on completion of the Works, a temporary site office of adequate size within and/or outside the Site premises in the areas approved by the Employer/Engineer for the Contractor‟s use with necessary facilities such as water, electricity, safety and sanitary.

Cost for altering, modifying, or dismantling and re-erecting of temporary building for workshops and stores shall be borne by the Contractor.

E.1.5.2.2 Workshops and Stores

By considering the space available for construction works the Contractor shall make

necessary arrangements to provide and maintain, temporary workshops, machinery yards, bar bending yards and the like, and storage facilities by himself within and/or outside the Site premises. The Contractor shall obtain required insurance cover for Plant and Material which are stored outside the Site premises.

This is for erection of temporary shed for protection, storage of materials and temporary fabrication area and maintain for the duration of the construction period and remove on completion. Cost for altering, modifying, or dismantling and re-erecting of temporary building for workshops and stores shall be borne by the Contractor.

E.1.5.2.3 Sample Storage Room

By considering the space available for construction works, the Contractor shall provide two (02) numbers of 40 feet containers as sample storage room. The internal arrangement of the containers shall be in accordance with the plans prepared by the Contractor and approved by the Engineer.

E.1.5.2.4 Accommodation for Workmen

The Contractor shall make necessary arrangement to provide and maintain accommodation and other facilities, sanitation in connection with the accommodations for his workers during the construction period.

E.1.5.2.5 Facilities for Workmen

The Contractor shall make necessary arrangement to provide and maintain welfare facilities/ sanitary facilities for workers on Site, including rest room, mobile toilet arrangement (at least 7 numbers), drinking water and other relevant facilities including maintaining good hygienic conditions.

E.1.5.2.6 Samples

The Contractor shall provide specimens, samples for testing, making arrangements for testing of Materials, Goods etc, as stipulated in the Employer‟s Requirement and obtaining test reports by third party and submit same for Engineer‟s approval.

E.1.5.3 Bar schedules, Monthly Progress Report, Weekly Progress Report

Every month the Contractor shall submit to the Engineer a Progress Report for the previous month which shall be the detailed report including information stated in Contract.

Progress photographs

The contractor shall supply 175x125 mm colour prints of each "record photographs". The print shall bear the date of the photograph. Each set of prints shall be separately bound approximately A4 size, photographs albums.

E.1.5.4 Safety Measures

The Contractor shall provide and maintain the following safety measures (but not limiting to such) in accordance with the Contract and also as per the requirements stipulated by the relevant Statutory Authorities, ensuring safety of Employer‟s Personnel, Contractor‟s Personnel, visitors of Employer and Engineer and others engaged in the Works.

i. Safe working conditions.

ii. Full time service of safety officer.

iii. Safe means of access and exit.

iv. Safety systems for Plant, Machinery and Equipment.

v. Appropriate safety equipment required at the site and yards such as Helmets, Gum Boots, Masks, Welding Masks, Safety Belts, reflected jackets, rain coats etc.

vi. Safety signs, handrails, guardrail, platforms and other measures.

vii. Training, instructions, information and supervision as may be required to enable employees to avoid any potential dangers and hazards.

viii. All measures ensuring the health and workmen including satisfactory welfare facilities, working conditions and environment.

ix. Safety of the property of the Employer and the general public entering the premises. (vehicles, etc.)

x. Safety signs should be in the Sinhala, Tamil and English languages.

xi. A comprehensive first aid box and separate space room with beds, tables and chairs shall be made available at the Site by the Contractor and he shall ensure that at least three of his staffs are trained in first aid measures.

xii. Ambulance or a vehicle suitable for transporting injured workmen should be made available at the Site by the Contractor.

xiii. Health and welfare of work people.

E.1.5.5 Noise, Dust and Vibration Control

The Contractor shall take all possible measures necessary to protect and cover the adjacent properties against noise, dust and vibration. Contractor shall carry out the Works in accordance with the Employer‟s Requirement and rules and regulations of Central Environment Authority.

E.1.5.6 Daily Records

The Contractor shall supply by 12 noon on every working day, the following daily records as may be required by the Engineer.

• Daily weather condition (daily rainfall, temperature, humidity etc.) in a form approved by the Engineer.

• A list of the labour employed on the previous day specifying the number employed in each trade, including expatriate labour. (summaryof labour and plant required weekly)

• Particulars of all Materials and Goods delivered to Site, plant employed for the works

• Particulars of machinery and equipment brought to or taken out of site

• A list of works carried out with location

• Site test/ laboratory test

• Any other important records not listed above but required under the Contract.

• Following day scheduled work programme

E.1.5.7 Temporary Services

The Contractor shall provide and maintain temporary services necessary for the execution of the Works under the contract. The Contractor shall make applications and install such services in accordance with the regulations and requirements of the relevant local authorities.

The Contractor shall be responsible for all costs and charges in connection with the installation, alteration, shifting, adapting use and maintenance of such services. On completion of the Works, the Contractor shall disconnect such services, which are no longer required by him and or the Employer and clear away all traces.

E.1.5.7.1 Water

The Contractor shall apply for connection and pay for connection and settlement of monthly bills and pay for the continuation of uninterrupted temporary water supply to the Site and construct storage tanks with adequate capacity, together with the necessary internal temporary distribution system including an overhead tank at an adequate elevation, water pumps as may be required and providing taps, valves, etc. in order to provide water for the Works. In the case of any failure of existing water supply the Contractor shall provide alternative supply without any additional cost to the Employer.

E.1.5.7.2. Electricity

The Contractor shall apply for connection as per the loading requirement and pay for the provision and use of required power supply and maintain for the duration of the construction period. Contractor shall pay for temporary electrical connection, distribution system for the Works internal arrangements and all payments to the authorities for connections.

In the case of any failure of existing power supply the Contractor shall provide a stand-by Generator, with adequate capacity. The cost of supplying, installing, running and maintaining of the stand-by generator shall be borne by the Contractor.

E.1.5.8. Security Arrangements

The Contractor shall provide and maintain all necessary protective fencing, hoardings, gates and lighting for the security of Site and safeguarding the Works, Material, Plant, storage area and yards. The Contractor shall maintain properly the existing perimeter fence. The Contractor shall employ adequate number of security personnel & security systems on full time basis throughout the period of construction. The shelters, guard house and other facilities to be provided for the security personnel to do their duty in an efficient manner. Altering shifting and adapting same from time to time and maintain for the duration of the construction period and remove on completion shall also be the responsibility of the Contractor and all costs in connection with the above shall be borne by the Contractor.

E.1.5.9. Temporary works, Equipment and Methods of Hoisting

Contractor shall provide and maintain hoisting equipment including passenger/ material hoists, and other plant required for the proper execution of the Work.

Contractor shall pay special attention to the method of installation/erection of scaffoldings systems, location and installation/erection of tower cranes, hoists (passenger and material) with necessary temporary works and maintain for the duration of the construction period. It is the responsibility of the Contractor to ensure steady safe and uninterrupted service to the other works.

E.1.5.10. Traffic Management

The Contractor shall acquaint himself with the traffic flow on main roads and other roads leading to the site and the restrictions imposed by the Authorities in respect of certain types of vehicles permitted to use such roadways. The Contractor shall organize and plan movement of materials and equipment to the site taken into consideration the factors effecting such movements in order to minimize delays and disruptions to work caused by traffic congestion, restrictions etc.

The traffic management of adjoining public roads near the Site under the permission of the relevant authorities shall be carried out by the Contractor when required. The Contractor shall provide traffic controllers with necessary equipment (reflectable lights, sign boards, etc).

E.1.5.11. Maintaining the Site

The Contractor shall maintain the site in a clean and orderly manner at all times and during the entire construction period. Arrange for washing bay to clean the tires of vehicles leaving site during the process of construction and maintain for the duration of the construction period. The Contractor shall take due care to prevent water stagnation, eliminate mosquito breeding places at the Site and this is to be ensured through internal monitoring mechanism.

E.2. ARCHITECTURAL

E.2.1. FINISHES AND ALTERNATIVES:

The following table summarize the finishes and alternatives:

Table E.2: Finishes and Alternatives

Area	Type of Finishes	Specification
	Flooring	
B & A Platforms, Lobbies, Public Circulation Area	Flooring	Power trowel finished concrete. Architecturally matching color pigment to be used. Surface should be anti-skid & anti-glare type. Parking margins to be highlighted by an appropriate color. Compressive strength to be compatible with heavy vehicles.
Offices, Commercial Area	Flooring (Option-01)	Power trowel finished concrete. Architecturally matching color pigment to be used. Surface should be anti-skid & anti-glare type.

Area	Type of Finishes	Specification
	Flooring (Option-02)	600mm X 600mm Non-Skid homogenous tiled floor
Sensory pathways for people with visual impairments	Flooring	*Include Tactile Block of approved color conforming to BS 7997:2003 of size 300 mmx 300mm on pedestrian pathway to direct to people with visual impairments. To be matched with the architectural design*
Toilets	Flooring	300mm X 600mm Non-Skid, homogenous tiled floor
Pedestrian Pathways /Pavement	Flooring for the areas hasn't vehicle movement	100mmx100mm Interlocking concrete paving blocks laid on compacted ground soil Compacted sand base course or quarry dust course.(surface should be anti-skid & anti-glare type). *Keep appropriate drainage slope .Precast concrete curb of natural color. Keep provisions for drop curbs wherever necessary.* *Include Tactile Block of approved color conforming to BS 7997:2003 of size 300 x 300 on pedestrian pathway to direct people with visual impairments.*
Driveways	Flooring	Fine graded natural black color asphalt to BS EN 13108
First Floor Bus parking,	Flooring	Fine graded natural black color asphalt to BS EN 13108
Bus parking, B/A ,T n G areas in Ground Floor	Flooring	200mmx100mm Interlocking concrete paving blocks laid on compacted sand base course or quarry dust course layer on compacted ground soil. The compressive strength to be compatible with the heavy vehicles. (Surface should be anti-skid & anti-glare type). Keep appropriate drainage slope. Parking margins to be highlighted by an appropriate color. Compressive strength to be compatible with heavy vehicles.
Bus parking, B/A ,T n G areas in First Floor	Flooring	200mmx100mm Interlocking concrete paving blocks laid on compacted sand base course or quarry dust course layer on structural slab. The compressive strength to be compatible with the heavy vehicles. (Surface should be anti-skid & anti-glare type). Keep appropriate drainage slope. Parking margins to be highlighted by an appropriate color. Compressive strength to be compatible with heavy vehicles.
Car ,Three wheeler parking areas	Flooring	200mmx100mm Interlocking concrete paving blocks laid on compacted ground soil Compacted sand base course or quarry dust course. .The compressive strength to be compatible with the heavy vehicles. (Surface should be

Area	Type of Finishes	Specification
		anti-skid & anti-glare type).Keep appropriate drainage slope. Parking margins to be highlighted by an appropriate color. Compressive strength to be compatible with heavy vehicles.
Ramps	Flooring (Option 01)	Slip resistant power trowel concrete. Broom finished, Proper floor hardener to be used. Broom concrete surface with a steel or fiber broom to produce corrugations 5mm deep Broom perpendicular to nearest edge of pavement. Broom all areas of a panel in the same direction. Use the same type and manufacture of broom for all paved surfaces to provide a consistent appearance. Black pigment to be used.
	Flooring (Option 02)	Carborundum finished concrete floor.
	Walls	
Internal Wall	Walls – Brick/ Block) Wall Plaster	Walls plaster to Smooth with 2-3 skim coats, to be painted with 1 coat of primer/2 coats of filler and2 to 3 coats of approved internal paint as per manufacturer's specifications. Colors and textures to suit the overall architectural design.
	Walls - (Option-Selected areas of external walls)	FFC-Fine finish concrete wall
External Wall External Wall	Walls - Brick/ Block Wall Plaster (Option)	Rough plastered walls to be finished with 1 coat of external primer/2 coats of filler and to be painted with 2 to 3 coats of approved external weather resistant paint as per manufacturer's specifications(To be include Elastomeric weather, fungal and alkali resistant emulsion complete system with primer, top and protective coat system) . Minimum 5 year warranty. Colors and textures to suit the overall architectural design.
	Walls - (Option-Selected areas of external walls)	FFC-Fine finish concrete wall.

Area	Type of Finishes	Specification
	Walls (Option)	Correct combination of Aluminum cladding system, polished granite with stainless steel mechanical anchoring system to suit the overall architectural design.
Internal Office Partition (Finishes to be to be matched with architectural appearance and the function)	Walls	Toughen glass partition partitions comprising of necessary Al/ PVC U-channels, patch fittings, etc. and joints are sealed with silicon sealant.
	Walls	Glass & Aluminum Composite partitions- Al composite board (both side colored) from Finished Floor level to 900mm & powder coated Al glass partition with above from 900mm to 2100mm.
Internal Shop Partition	Walls	Plaster board partition up to slab level(plaster board both sides) ,GI box bar framework with necessary " L "angle, plywood biscuits and aluminum tape, voids filled with approved type glass wool for sound insulation, Prepare surface with skim coat, leveling with acrylic wall putty, one coat primer & minimum 2 coats emulsion paint.
Toilet Internal partition	Walls	1800 mm high Architect selected color (HPL) High pressure laminated partition system including 1 leg space complete with nylon plastic accessories including indicator lock, legs, cloth hanger, door knob & aluminum framework including swing door. (self-lubricating swing & gravity return movement)
Toilet Internal Wall	Walls	300mm X 600mm Ceramic/Porcelain tiled wall up to 2100mm level. Walls above to Smooth with 2-3 skim coats, to be painted with 1 coat of primer/2 coats of filler and 2 to 3 coats of approved internal paint as per manufacturer's specifications.
	Skirting	
B & A Platforms, Lobbies, Public Circulation Area	Skirting	Terrazzo skirting with chips up to 100mm. Slip resistant & stain and impact resistant properties to be achieved.
Offices, Commercial Area	Skirting for tiled floor areas	600mm Length homogenous tiled skirting up to 100mm. to be matched with floor tile layouts
	Skrting for terrazzo floor areas	Terrazzo skirting up to 100mm. Slip resistant & stain and impact resistant properties to be achieved.

Area	Type of Finishes	Specification
	Ceiling	
Store Room, Parking area, Technical Rooms	Ceiling	Slab soffit surface finish & painted. RCC slab to be finished with 1 coat of skim coat/ 2 coats of filler and 2 to 3 coats of approved paint color as per manufacturers specifications.
B&A Platforms, Lobbies, Public Circulation Area	Ceiling	(200mm/300mm) powder coated metal strip ceiling. Minimum strip panel length 6m
Offices, Control room	Ceiling	600mmx600mm demountable, concealed type powder coated metal ceiling
Waiting Lounge ,Commercial Area, Food court, restaurants	Ceiling	(200mm/300mm) powder coated metal strip ceiling. Minimum strip panel length 6m
conference room	Ceiling	Plaster board projected ceiling.
Toilets	Ceiling (Option-01)	Slab soffit surface finish & painted. RCC slab to be finished with 1 coat of skim coat/ 2 coats of filler and 2 to 3 coats of approved paint color as per manufacturers specifications.
	Ceiling (Option-02)	600mmx600mm Suspended Mineral fiber ceiling with adjustable GI hanging rods and concealed framework to detail.
	Handrail	
Staircase	Handrail (Option-01)	Marine painted M/s box iron handrail. M/s box iron balustrade & top rail, M/s flat iron verticals between balustrades. *Stainless steel tube side staircase handrails with 25mm dia wall supports to be include when necessary areas(when have wall side).Safety of the stairways shall not compromised for the purpose of architectural designs.*

Area	Type of Finishes	Specification
	Handrail (Option-02)	Stainless steel (vertical balustrade & top rail) with tempered glass panels. *Additional wall support handrails to be include when necessary areas (when have wall side). Safety of the stairways shall not compromised for the purpose of architectural designs.*
	Handrail (Option-03)	Stainless steel (vertical supports & timber top rail) with tempered glass panels. *Additional wall support handrails to be include when necessary areas (when have wall side). Safety of the stairways shall not compromised for the purpose of architectural designs.*
Ramp	Handrail	900 mm high disable handrail with steel top rail, steel box bar bottom rail, steel box bar verticals pass through stain less steel cables including all other accessories
Passenger queue handrails	Handrail	900 mm high with 50 mm dia 300mm high heavy duty GI vertical posts fixed to floor with GI floor fixing bracket and 50mm dia GI pipe frame (beveled edge square shaped frame) fixed above the vertical posts. Keep natural GI finish.
Pedestrian barriers	Handrail	50 mm dia 300mm high heavy duty GI vertical posts fixed to floor with GI floor fixing bracket and 50mm dia GI pipe frame (beveled edge square shaped frame) fixed above the vertical posts. Keep natural GI finish .m/s flat iron verticals between GI verticals.
Guardrails	Guardrails	Required RCC guardrails for upper floor areas has vehicle movement
	Roofing	
2nd floor roof	RCC Roof	RCC flat roofs with heat insulation and water proofing and finished with rustic porcelain tiling .Roof terrace to be landscaped as open to sky space.
	Roofing-Hip or gable roof areas (Option-01)	Cement tile roof including insulation layer, steel roof structure & Zn/Al aluminum gutters and down pipes. Cement roofing tile -Solar Reflective Index rating above 45 (min. 29). Also need to fulfill the WHO standards as safe for Rain water harvesting
	Roofing-Hip or gable roof areas (Option-02)	Zinc/Alum roof (AZ-200) system to approved profile including insulation layer, steel roof structure & Zn/Aluminum gutters and down pipes. Also need to fulfill the WHO standards as safe for Rain water harvesting.
Skywalk, Side Entrances & suitable	Roofing (Option-01)	Zinc/Alum roof (AZ-200) system to approved profile including insulation layer, steel roof structure & aluminum gutters and down pipes. *(Hidden roof type is*

Area	Type of Finishes	Specification
Vertical Cores		*encouraged)*
	Roofing (Option-02)	RCC flat roofs with heat insulation and water proofing.
Vendor Squares	Roofing (Option)	Water tight tempered glass roof with supporting Steel/ Cast Iron/Aluminum frame including flashings.
	Doors and Windows	
	Doors and Windows	Aluminum - Doors, windows and partitions shall be Powder Coated Aluminum. The Specification shall be -Raw material Aluminum. Should complying to: BS EN 515:1993, BS EN 573-Part1-4, BS EN 12020-1:2008, BS EN 12020-2:2008, BS EN 755-Part 1-9,SLS1410:2011. Raw material chemical composition to be according to alloy standard EN AW 6063. Powder coated film thickness 60-80 microns All doors to be fitted with Door Closers, Handles and Locks and the locks shall operate with a master key and individual keys. Low–E toughen glass for glass panels Proprietary system is required for all powder coated aluminum door windows

E.2.1.1. Performance characteristics for glass

Glass for all external doors and windows shall be reflective Low –E toughen glass having following performance characteristics:

i. U Factor: Not exceeding 0.53 Btu/hr.sq.ft.F

ii. Average visible light transmittance: 23%- 35%

iii. Solar heat gain coefficient: Not exceeding 0.35

E.2.1.2. Performance characteristics for aluminum doors, windows and curtain wall systems

The system shall be tested for compliance with the following performance standards in accordance with BS EN14351:

i. Air permeability: EN 1026:2000

ii. Water tightness: EN 1027:2000

iii. Wind resistance: EN 12211:2000

E.2.1.3. Structural glazed areas at lobbies/offices/food courts/restaurants:

It shall be designed for wind loads pertaining to the location and to satisfy the requirements of the structural engineer. The system shall be designed by a specialist glazing Design Company and supplied through them. The installer of the structural glass wall shall submit structural calculations and shop drawings for approval prior to the installation.

E.2.1.4. Doors:

Frameless toughened glass double swing/ revolving/ doors are recommended for the main lobbies. Proprietary system is required for all Powder coated aluminum door windows. All components shall be identified in the product catalogue. Fire doors shall be of steel finished with relevant to fire regulations. All doors shall satisfy the security and access control requirements specified under ICT services.

E.2.1.5. Windows:

All windows shall be of a proprietary system recommended for low-rise buildings of the scale of proposed building. Windows shall have Powder coated aluminum frames and sashes with Low-e glazing .These windows could be of different types such as fixed, sliding, tilt and turn etc., to suit the functional requirement of the activity areas. All windows shall be designed and installed to satisfy splash tests and wind pressure specified under structural requirements. Suitable gondola system or structural supports system also should be incorporated with the building structure itself for cleaning and easy maintenance of external windows. Shading devices also shall be incorporated wherever it is appropriate taking into consideration of the orientation of the building and sun path throughout the year.

E.2.1.6. Partitions:

Full height internal workplace partitions are required for cubicles and medium height partitions for general office areas. Full height partitions with toughened glass are recommended for the cubicles in public areas for various supportive services for the users of the building. Minimum 75 mm thick powder coated aluminum profiles with padded artificial leather or fabric is recommended for internal workplace partitioning in office areas. Partitions in office areas shall be able to accommodate power and telephone outlets within the thickness of the partition.

E.2.1.7. Furniture:

All furnishing items required for reception areas, lobbies, and passenger seating areas, office areas, conference rooms, control room, restaurants, rest rooms, food court, cafeterias and other indoor

habitable areas shall be supplied by the contractor and general guidelines are as follows:

Passenger seating areas- Shall be durable, easily cleanable, easy maintained.

Reception Counters – Shall be durable, easily cleanable, easy maintained.

Office areas, conference rooms, control room, Shall be durable, easily cleanable, easy maintained

Restaurants, Cafeterias – Chairs and tables for restaurants, cafeterias shall be heavy duty, stackable and easily cleanable

The all loose and fixed furniture required minimum 3 year comprehensive warranty for manufacturing defects. The furniture layout of the building to be incorporated in to the floor plans and submited with the design proposal.Contractor have to supply of curtains and blinds for office areas.Refer the reference for the specification guide for the furniture.**The given specifications are the minimum requirment to be followed and the furniture designs can be matched with the architectural concept.The nos of furniture items can be increased with the design proposal.**

Building	Amenities	Furniture item	Description	Nos	Reference image
Terminal building, Parking building, Arcade building	Shops for commercial activities, Mini banks		Furniture items to be supplied by the shop owners (Renter)		
Terminal building	Seating arrangement for the passenger at ground floor	Waiting chair	Stainless steel metal waiting area bench, Combined seats type **Seat and back-** perforated cold-rolled steel plate after anti rust detailing,electronic polishing,static coating, **Arms and legs-** 1.2mm thickness metal,die casting, deepdrawig steel plate, high strength jointing, polishing	Adequate numbers as per the standards	

Building	Amenities	Furniture item	Description	Nos	Reference image
			Beam-1.8mm Thk steel, required cutting, perforating, welding, anti-rust dealing, static coating		
	Reception	Reception desk with backdrop and celling, Mid back chair	**Reception desk**-- Dimension-as per the schematic design with standards height and width. All internal partitions to be finished with particle board with high pressure lamination. All external boards to be melamine particle boards. Thickness: Top board – 25mm thk All other side boards – 18mm thk. Except otherwise special stated. All hinges, handles and other accessories to be high quality stainless steel SS grade to be 304. Bottom should be supported with heavy duty PVC glides. **Mid back chair**- Ultra durable breathable and		

Building	Amenities	Furniture item	Description	Nos	Reference image
			flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene.		
	Passenger ticketing counters at 2nd floor	Tiketing counters	**Counters-** As per the standard sizes and heights, legth –Full periphary length , Quatrts top , Fit to purpose, consist with Internal drawers , CPU and UPS rack (made out of melamine boards) underneath of the top To be accommodate for the required service connections. Mid back chairs- Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene.	12 counters 12 mid back chairs	

Building	Amenities	Furniture item	Description	Nos	Reference image
	Passenger waiting areas at 2nd floor	Waiting chair	Stainless steel metal waiting area bench,Combined seats type Seat and back-perforated cold-rolled steel plate after anti rust detailing,electronic polishing,static coating, Arms and legs-1.2mm thicknes metal,die casting,deepdrawing steel plate,high strength jointing,polishing Beam-1.8mm Thk steel,required cutting,perforating,welding,anti rust dealing,static coating	*600 seats*	
	Food court at 2nd floor	Dining tables and chairs	**Table-** steel powder coated frame,high pressure laminated top.4 persons can be accomodated comfortably.Size- Chair-plastic chair with sturdy steel structure/frame.	Adequate numbers as per the reqirement ,standards	
	Baby care room	2 Single Beds,2 chairs, 1 table	**Beds-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Chairs- plastic chair	Adequate numbers as per the reqirement ,standards	

Building	Amenities	Furniture item	Description	Nos	Reference image
			with sturdy steel structure/frame. **Table-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size-1500mmx600mmx762mm(LxHxH)		
	First aid room	2 Single Beds,2 chairs, 1 table, Bed trolly	**Beds-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. **Chairs-** plastic chair with sturdy steel structure/frame. **Table-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size-1500mmx600mmx762mm(LxHxH)	Adequate numbers as per the reqirement ,standards	
	Pharmacy	Counter, 2chairs, Store	**Counter-** Partial board with Thermo fused melamine finish,		

Building	Amenities	Furniture item	Description	Nos	Reference image
		racks	with scratch resistant power coated steel base with necessary PVC glides **Chairs-** plastic chair with sturdy steel structure/frame **Store racks-** powder coated steel frame structure with melamine boards shelfs and Side panels 1800x600mmx2100 mm(LxHxH) **Store cupbords-** made out of melamine boards ,powder coated steel frame structure ,with openable two glass doors 1800x600mmx2100 mm(LxHxH)		
Parking building	Rest areas for 150(Minimum) nos of bus drivers	Bunker beds 10 chairs 7 Tables 3 Stools 3 Lokers	**Bunker beds-** - Single bed size ,bunker type(2beds),Partial board with Thermo fused melamine finish, with scratch resistant power coated steel structure Mettress-standard single size ,Triple layer 4''Thk foam	Minimum requirement; 75 Bunker beds 150 Mettress 10 chairs 7 Tables 3 Stools 3 Lockers	

Building	Amenities	Furniture item	Description	Nos	Reference image
			mattress **Chairs-** plastic chair with sturdy steel structure/frame. **Table-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size-1500mmx600mmx762mm(LxHxH) **Stools-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides **Lockers-** 6 Nos materiai,Powder coated metal 25 lokable partitions per each,Height –up to ceiling level		
	Food Court	Dining tables and chairs	**Table-** steel powder coated frame,high pressure laminated top.4 persons can be accomodated	Adequate numbers as per the standards	

Building	Amenities	Furniture item	Description	Nos	Reference image
			comfortably. **<u>Chair-</u>** plastic chair with sturdy steel structure/frame		
Operational and Management Amenities (Building /Floor as per the Table B3)	Office Space	Executive tables, Executive chairs, General office tables, General office chairs, Minor staf table, Minor staf chair Cupboards-type1 Cupboards-type2	**<u>Executive tables</u>-** made out of 25mm thick solid teak top (visible thickness 50mm) and 18mm thick solid teak wood base with Stain in matt finish ,Anti-scratch ,anti-dirty ,anti-water**.** Stain colour to be approved by architect. All accessories to be stainless steel with s/s screws. Drawers fixing to be With s/s sliders. Bottom should be supported with PVC glides. Technological requirement: Station should full fill the technological requirement as per the client requirement. (Flip open wire box with power & USB port). Combination - Main desk with pull out keyboard tray and drawer	Adequate numbers as per the standards	

Building	Amenities	Furniture item	Description	Nos	Reference image
			Side desk with lockable Drawers + moveable drawer for CPU. Thickness - Top board - 25mm thk Side - 18mm thk Drawers - 15mm thk All hinges, handles and other accessories to be high quality s/s. (s/s grade to be 304). Size: Main desk – L 2000 mm x W 900 mm x H 760 mm Side return – L 1200mm x W 500 mm X H 760 mm **Execative chairs**- High back Chair, Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **General office tables**- made out of melamine pasted board base with 1mm thick PVC edging table top (visible thickness		

Building	Amenities	Furniture item	Description	Nos	Reference image
			25mm).finish should be Anti-scratch, anti-dirty, anti-water and colour to be approved by architect. All accessories to be stainless steel with s/s screws. Drawers fixing to be with s/s sliders. Bottom should be supported with PVC glides. Combination - Main desk with pull out keyboard tray and drawer All hinges, handles and other accessories to be high quality s/s. (s/s grade to be 304) **<u>General office chairs</u>-** Mid back chairs,Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene.		 

Building	Amenities	Furniture item	Description	Nos	Reference image
			Minor staff table- Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size- 1500mmx600mmx762mm(LxHxH)		
			Minor staff chair- Mesh Backrest , Backrest color		
			Cupboards(type1)- 1200mmX600mmX2100mm made out of 25mm thk HDF board (laminated melamine) base with 1mm thick PVC edging Including Doors & shelves.		
			Cupboards(type2)- Floor cupboard (open + file)- 3930 mm x 450mm x 900 mm cupboard with 25mm thick HDF (laminated melamine) framework consist with 18mm thick HDF drawers fixed with standard drawers runners. All accessories to be stainless steel with s/s screws. Drawers fixing to be with s/s sliders.		

Building	Amenities	Furniture item	Description	Nos	Reference image
	Enquiry room (3 Counters)	Counter, 3chairs, 3Cupboards,	**Counter-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides.counter Size4500mmx600mmx762mm(LxHxH), Need counter seperations **Chairs-** 3 Nos,Mid back chairs,Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **Cupboards-** 3Nos ,Size 1200mmX600mmX2100mm made out of 25mm thk HDF board (laminated melamine) base with 1mm thick PVC edging Including Doors & shelves.	Adequate numbers as per the reqirement ,standards	 
	Defect Reporting	1Table, 2chairs,	**Table-** 2 Nos, Partial board with Thermo fused	Adequate numbers	

Building	Amenities	Furniture item	Description	Nos	Reference image
	Room and Repair room	3 Cupboards, 6 Racks	melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size-1500mmx600mmx762mm(LxHxH) **Chair –** Mid back chairs,Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **Chair-** Chair-plastic chair with sturdy steel structure/frame. **Cupboards-** 3nos,1200W x 450D x1800Hsteel cupboard with glass panels, made of cold Rolled carbon steel with Scratch Resistant Powder – Coat Finish with 2 metal Doors	as per the reqirement ,standards	   

Building	Amenities	Furniture item	Description	Nos	Reference image
			Racks- 6 Nos,Steel open shelves with slotted angle frames. All sections, Corner plates, nut and bolts feet and other necessary accessories should be 1.8mm thick nickel steel hot nickel dipped galvanized finished for durable. Size.: 940 mm x 300mm x 1800mm		
	Locker Room (for crew and staff)	Lockers, Benches	**Lockers-** materiai,Powder coated metal 25 lokable partitions per each,Height –up to ceiling level **Benches-** made out with hard wood timber planks. Size 600mmx1800mm	Adequate numbers as per the reqirement ,standards	 
	Cash Room	Lockers, Cupboard, Table,Chair	**Lockers-** materiai,Powder coated metal lokable partitions per each,Height –up to ceiling level	Adequate numbers as per the design	

Building	Amenities	Furniture item	Description	Nos	Reference image
	Training/ conference Room	High back chair ,20 mid back chairs, Conference table	**High back Chair-** Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **Mid back chair-** Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **Conference table-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides, consist with 2 or 3 parts, can be seated 10 persons around the table.	Adequate numbers as per the reqirement ,standards	  

Building	Amenities	Furniture item	Description	Nos	Reference image
	Control Centre for Terminal Operation System	Control Table , Mid back chairs, Floor cupboards	**Control Table-** Made out of Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides Size-as per the standards and requirment To be accommodate for the required service connections. **Mid back chair-** PU leather upholstery medium back Revolving chair with polypropylene arm rest, gas lift, heavy duty adjustment mechanism, wider five arms star base, Heavy duty dual wheel hooded caster wheels and tilt tension. **Floor cupboard-** (open + file)- 3930 mm x 450mm x 900 mm cupboard with 25mm thick HDF (laminated melamine) framework consist with 18mm thick HDF drawers fixed with standard drawers runners. All accessories to be stainless steel with	Adequate numbers as per the reqirement ,standards	 

Building	Amenities	Furniture item	Description	Nos	Reference image
			s/s screws. Drawers fixing to be with s/s sliders.		
	ETM Room for down loading & ETM charging racks	ETM charging racks		Adequate numbers as per the reqirement ,standards	
	Data storage-secured room for tapes and data, (near the control center)	Steel cupboards	1200W x 450D x 1800H steel cupboard with glass panels, made of cold Rolled carbon steel with Scratch Resistant Powder – Coat Finish with 2 metal Doors	Adequate numbers as per the reqirement ,standards	
	Security Posts (portable cabins as well as masonry)		Size-2100mmx2100mm,pertable type,powder coared steel structur and aluminium composite panel envelop.to be compatible with outdoor climate.	3 Nos	
	Environmental Quality Management Room	Tables, chairs, Cupboards	**Table-** made out of melamine pasted board base with 1mm thick PVC edging table top (visible thickness 25mm).finish should be Anti-scratch, anti-dirty, anti-water and colour to be approved by	Adequate numbers as per the reqirement ,standards	

Building	Amenities	Furniture item	Description	Nos	Reference image
			architect. All accessories to be stainless steel with s/s screws. Drawers fixing to be with s/s sliders. Bottom should be supported with PVC glides. Combination - Main desk with pull out keyboard tray and drawer All hinges, handles and other accessories to be high quality s/s. (s/s grade to be 304) **<u>Chairs</u>-** Mid back chairs,Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **<u>Cupboards-</u>** Size 1200mmX600mmX2100mm made out of 25mm thk HDF board (laminated melamine) base with 1mm thick PVC		 

Building	Amenities	Furniture item	Description	Nos	Reference image
			edging Including Doors & shelves.		
Arcade building	Guest rooms	Every room is consist with; 2 single beds , 2 matresses, Wall fixed work top,2 bed side Cupbords, 2 chairs, 2cupboards.	**Single beds** – 2Nos,Standard size, - made out with hard wood timber,box type ,coverd pheryphary **Matresses –** 2Nos,high quality spring metreess,150mm thk, classic type **Wall fixed work top-,** made out with hard wood timber,required comfortable working space for two users at one time. **Bed side Cupbords-** 2Nos, 325 mm x 400 mm bedhead cupboard finished with hard wood and should include 02 no's pull out drawers. Height should be bed height. **Chairs-** 2Nos, chair with upholstery fabric seat with hard wood timber base with legs.	16 rooms	 

Building	Amenities	Furniture item	Description	Nos	Reference image
			Cupboards- 2Nos,Size 1200mmx600mmx2100mm, made out with hard wood timber		
Re-fuel station	Operational office	Table, chair, cupboard steel drawer	**Tables-** Partial board with Thermo fused melamine finish, with scratch resistant power coated steel base with necessary PVC glides. Size-1500mmx600mmx762mm(LxHxH) **Mid back chair-** Ultra durable breathable and flexible mesh used in construction, height adjustable gas lift, contoured seat cushion with high density foam, polished chrome steel 5 star base with heavy duty casters, arm rest in polypropylene. **Cupboards-** 1200W x 450D x 2100H steel cupboard with glass panels, made of cold Rolled carbon steel with Scratch	Adequate numbers as per the reqirement ,standards	 

Building	Amenities	Furniture item	Description	Nos	Reference image
			Resistant Powder – Coat Finish with 2 metal Doors. Steel drawer-900W x 450D x 2100 H steel drawer made of cold rolled carbon steel with Scratch Resistant Powder – Coat Finish with Metal drawer		

E.2.1.8. Sanitary fittings and accessories:

Sanitary fittings shall be from reputed brands such as “Toto”, “American Standard”, “Rocel”or equivalent. After sale service (with local agent), reliability, availability and durability shall be the main consideration of the selection of items falling under this category. In addition, special consideration shall be given for the hierarchy and type of user category. All accessories shall be in chrome plated bronze. Preferred brands for accessories are “American Standard”, “Grohe” or equivalent (with local agent).

E.2.1.9. Lighting and light fittings:

Architectural lighting systems are strongly recommended for the exterior lighting and interior lighting in major areas such as entrances, parking areas, underpass area, entrance lobbies, general lobbies, terminal office rooms, etc., In general an energy efficient State of the Art lighting system is highly recommended in overall lighting arrangement. All light fittings shall be from preferred

brands specified under the Electrical section of this document.

E.2.1.10. Interior decoration items :

Interior decoration items including feature hanging items,statues and sculptures ,etc shall be supplied and installed by the contractor. Interior elements including decorative RCC elements,mouldings,engraving/carving works, etc to pe designed and constructed by the contractor.

E.2.1.11. Window blinds:

Adjustable vertical / horizontal blinds are recommended for all office areas and the contractor have to supply and fixing of curtains and blinds.

E.2.1.12. Vertical circulation systems:

Vertical transportation shall be designed with adequate number of passenger lifts, escalators, ramps and stairways to suit functional requirements and traffic patterns of the proposed building. All habitable spaces shall be accessible to all including differently abled persons. Fire escapes shall be provided to satisfy fire regulations and for the convenience of the users.

E.2.1.13. Signage:

Main name boards at the entrances of the building, on the body of the building, Signage for identification of spaces and directions for users are required. Modern standard signage system with a suitable lighting system is recommended.Have to follow a sutable theme for the internal signage boards . The signages shall be durable, easily cleanable, easy maintained.Below mentioned minimum requirment to be fullifilled by the contractor.

- Main name boards at the entrances –2 Nos, Size 4mx1.5m(length,height),stainless steel plate letters with suitable LED lighting system
- Sub name boards at the secondary entrances at Colombo Kandy road,William Gopallawa Mawatha –2 Nos, Size 2mx1m(length,height),stainless steel plate letters with suitable LED lighting system
- Layout map of the building (Wall fixed or free stand signage for identification of the location withinn the building ,“You are here” type) –size 2400mmx1200mm, to be located at the ground and second floor lobbies.
- Free standing KMTT photo backdrop made out of MDF / melamine boards (movable) .- 1Nos ,Size 2.5mx3m(length,height), to be located at the second floor lobby.

- Wall fixed signage for identification of the location withinn the building ("You are here") –size 841mmx594mm, to be located at every circulation cores
- Signage for identification of spaces- ticketing counters,offices,toilets,vendors square,food court,administrative and operational spaces,parking spaces etc
- Signage directions for users are required-(wall fixed way finding signages)at circulation cores.
- Signage boards (matching with the theme) for shops /eateries/food stalls
- Internal road signages as per the standards.
- Signages relavent to evacuation paths and other fire regulation requirments
- Other required signage for fit to the purpose of the building.

E.2.1.14. External work:

Appropriate landscaping design proposal shall be submitted showing with roads, paved areas, foliage, lighting systems and outdoor seating etc. for approval.The landscape works and other exterior works should be done by the contractor. Improvement of junctions and aproaches etc,integration of surrounding road network and facilities in line with the new facilities to be done by the contractor.

Note- A reasonable quantity of extra finishes materials (All finishes, item wise), loose furniture to be handed over to the employer (RDA) at the handing over the project

E.2.2. CONSTRUCTION STAGE

E.2.2.1. General

Main civil construction shall be carried out according to the standards, specifications described under the structural section and all supportive building services shall be done to satisfy specifications, standards and parameters given under respective engineering disciplines given in this document.

Contractor is responsible for obtaining all necessary approvals from relevant authorities before commencing any construction works at site.

E.2.2.2. Architectural Finishes

Architectural finishes shall be in accordance with the guidelines given under the "General Guidelines for selection of Material, Fittings and Finishes" of this document.

E.2.2.3. Selection of Finishing Materials and Fittings

In addition to the aesthetical acceptability, finishing material and fittings shall be selected taking into the consideration the functional requirements, durability, availability and after sale service(local agent).

E.2.2.4. Sample Approvals

Prior approval shall be obtained from the employer /consultant appointed by the employer for all finishing material, fittings and accessories. Submission shall be made with actual samples along with technical literature, production details, Brand names, prices etc., Test certificates and warranties shall be submitted along with the samples where it is applicable.

E.2.2.5. Mockups and Presentations

Detailed presentations shall be made by the contractor to obtain formal approval and consent from the employer for color schemes and finishing themes of the major areas of the building.

Financial provisions shall be made by the contractor to carry out “mockups” as requested by the employer.

E.2.2.6. Fabrications, Installations and Applications

Fabrication, installations and applications shall be done as per the specifications and guidelines given in this document and as per the specifications and recommendations of the manufactures.

E.2.2.7. Construction Drawings and Shop Drawings

Detailed architectural drawings and shop drawings required for the construction shall be made available for the approval of Employer/Engineer.

E.2.2.8. Spare material, Fittings and Accessories

A reasonable quantity of finishing materials, fittings and accessories shall be made available at the handing over of the building for repairs, replacements and maintenance works.

E.2.2.9. Product Information

A detailed document shall be prepared by the contractor and submitted to the Employer giving all the details related to finishing material, fittings and accessories such as brand names, model no, sources of supply ,local agent etc., for future reference.

E.2.2.10. Functional Tests

Contractor shall get all the functional tests performed by qualified persons to achieve the satisfactory levels and standards. All test certificates shall be handed over to the Employer at the

formal handing over of the project.

E.2.2.11. "As Built" Drawings.

Complete set of accurate "As Built" drawings shall be prepared by the contractor and submitted to the Employer along with softcopies in "auto cad" and "pdf" versions.

E.2.2.12. Certificate of conformity

At the completion of the project, Contractor shall be responsible for obtaining "Certificates of Conformities" for the building construction and installations from relevant local authorities which shall be handed over to the Employer.

E.2.2.13. Product Manuals and operating manuals.

Contractor shall be responsible for compiling all relevant product information and operating manuals, maintenance schedules etc., required for the smooth functioning of the building.

E.2.3. ADDITIONAL REQUIREMENTS

E.2.3.1. Local Authority Approvals

The Contractor is responsible for obtaining preliminary clearances and final approvals required for the proposed development from the relevant authorities. Further, the contractor is responsible

for making any amendments to the drawings if necessary to satisfy the comments and recommendations given by such authorities and to obtain final approvals. Contactor shall bear all the expenses incurred in this regard. Contractor shall be responsible to pay processing and all other fees incurred in obtaining approvals from the relevant authorities.

E.2.3.2. Certificate of Conformity

At the completion of the project, contractor shall prepare updated version of drawings incorporating all the amendments made during the construction and submit to KMC/UDA and any other relevant authorities in order to obtain all necessary certificates and "Certificates of Conformity" in respect of the building works and installations done.

E.2.3.3. Fire Approvals

The contractor shall obtain certificate of conformity from Fire Service Department of Kandy/Colombo Municipal Council on completion of the installation work of fire detection, fire protection and any other services which require fire service department approval.

E.2.3.1. Rainwater Harvesting

Finalizing the targeted use of harvested rainwater require obtaining of Client's decision as it has

bearing over the degree of treatment requirements.

In general any kind of rainwater harvesting system, in which collected water is destined for anything other than garden irrigation, it is essential that dust, debris, bird droppings, leaves, and other contaminants which accumulate on roofs are kept out when it starts to rain. Therefore it is necessary to define steps and relevant components in the cleansing process. It is required to highlight operation and maintenance procedure of the system.

However, as a pre-filtration process, first flush out system is recommended in the Rainwater Harvesting System to flush out initially contaminated water from the system.

E.2.3.2. Green building Certificate and green building category

Green Building Certificate issued by the Urban Development Authority shall be obtained by the design and build contractor. The proposed building shall comply with minimum **"**Green Gold Category" of the Green Building Rating of Urban Development Authority .

E.2.4. STANDARDS, REGULATIONS, GUIDELINES AND SPECIFICATIONS TO BE FOLLOWED

E.2.4.1. Standards

- Ernst and Peter Neufert,Architects' Data,Third edition,Black well science
- International plumbing code-2018, International Code Council, Inc.
- Design considerations on accessibility for persons with disabilities-2013,Ministry of Health,Sri Lanka.
- Other relevant standards from local stake holder institutes.(Especially standards followed by Sri Lanka Railways-SLR, Road development authority-RDA)
- Environmental and public Health standards, Construction Industry Development Authority(CIDA),publication no : CIDA/STD/01
- Ethical and Social responsibility standards, Construction Industry Development Authority(CIDA),publication no : CIDA/STD/02

E.2.4.2. Regulations

- Building regulations 2021-Urban Development Authority(UDA) Sri Lanka
- Kandy Development plan 2021-2030 –Kandy Municipal council ,Sri Lanka
- Fire regulations [3rd Edition (Revised) 2018], Construction Industry Development

Authority(CIDA),publication no :ICTAD/DEV/14

- Railway reservation lines established by Railway Department, Sri Lanka
- Other relevant reservation and clearances from local stake holder institutes, Sri Lanka (National Water Supply and Drainage Board, Central environment authority, Irrigation department, Sri Lanka Land Reclamation & Development Corporation (SLLRDC),Civil aviation authority etc..)

E.2.4.3. Guidelines

- Blue green Sri Lanka, Green building guidelines for Sri Lanka-2017, Urban Development Authority(UDA) Sri Lanka
- Other relevant guidelines from local stake holder institutes.
- World Bank Environmental Safeguard Policies and Environmental Health and Safety (EHS) Guidelines

E.2.4.4. Specifications

- Specifications for Building Works (Vol. I) – [3rd Edition (Revised) – July 2004], Construction Industry Development Authority(CIDA),publication no : SCA/4/I
- Specifications for Building Works (Vol. II) – [2nd Edition (Revised) – October 2001]. Construction Industry Development Authority(CIDA),publication no : SCA/4/II
- Specifications for Landscape Works – Volume I, Construction Industry Development Authority(CIDA),publication no : SCA/7

E.2.4.5. References

- Site survey plan .Plan No. Maha/MHN/2017/654P (Annexure 1)
- Updated Site survey plan with road expansion near arcade building .Plan No……. (Annexure 2)
- Conceptual design drawings (5.2, Deliverable No-5) by DIMTS in association with Uni consultants.–Addendam version, -(Annexure 3)
- Appendices to Integrated Strategic PT Plan, Public Transport Design & Operations Management Plan & Strategic Traffic Demand Management & Design Plan for Kandy, Sri Lanka by DIMTS in association with Uni consultants.–
- Integrated Strategic Public Transport Plan, ,Volume I of II ,Public Transport Design &

Operations Management Plan & Strategic Traffic Demand Management & Design Plan for Kandy by DIMTS in association with Uni consultants.

- Environment Impact Assessment (EIA) and Traffic Impact Assessment (TIA) done for the KMMIT Project

E.3. STRUCTURAL AND CIVIL WORK

E.3.1 STRUCTURAL

E.3.1.1 Standards

- BS 8110 Part I 1997 – Code of Practice for Design and Construction.
- BS 8110 Part II 1985 – Code of Practice for Special circumstances.
- BS 8110 Part III 1985 – Design Charts for Reinforcement elements.
- BS 5950 Structural Steel
- BS 5400 Bridges and related structures
- BS 5896 High tensile steel wire and strand for the pre-stressing of concrete
- BS 8007 Water retaining structures
- BS 5268 Structural use of timber
- BS 8004 Foundations
- BS 6399 Part 1 Design loading for building - Live Loads
- "Design of Buildings for High Winds –Sri Lanka –Ministry of Local Govt.
- Housing and Construction -1980" and BS CP 3 –Chapter V. Basic data for the design of buildings or any other standard approved by the Engineer- Wind Loads
- BS 4449 Specification for steel bars for reinforcement of concrete
- BS 4461 Rolled steel bars for reinforced concrete

- BS 5328 Specifying concrete including ready-mixed concrete
- BS 8007 1987 – Code of Practice for design of concrete structures for aqueous liquids.
- ICTAD/DEV/15 - Guidelines for Interpretation of Site Investigation Data for Estimating the Carrying Capacity of Single Piles for Design of Board & Cast In- Situ Reinforced Concrete Piles
- SCA/4 (Vol. I) - Specifications for Building Works Vol. (I), Sri Lanka. 3rd Edition (Revised), July 2004
- SCA/4 (Vol. II) - Specification for Building Works Second Edition (Revised), October 2001
- SCA/05(Vol. I) - Standard Specification for Construction and Maintenance of Roads and Bridges

The above standards or Eurocodes will be used as applicable; however, other British or other internationally recognized equivalent standards will be used for specific areas of design should be approved by the Engineer where necessary.

E.3.1.2 Special Loading

E.3.1.2.1. Earthquake Loads:

Sri Lanka is situated on the Indo-Australian Tectonic plate. Being located in the middle of Indian plate, Sri Lanka is well away from the plate tectonic boundaries & it has been considered an aseismic country in the past. The geological phenomena occurring in recent past in the Indian Ocean and formation of weak geological zones around the Sri Lanka, enhances the vulnerability of Sri Lanka to future hazards. Hence it is required to design the buildings & structures of KMTT for minor earthquake conditions and it is recommended to use the acceleration co- efficient of 0.1g (Peak Ground Acceleration): PGA value) for the

designs of buildings & structures in KMTT.

E.3.1.2.2. Wind Loads:

Wind speeds of Sri Lanka shall be obtained from the manual of "Design of Buildings for High Winds –Sri Lanka" published by the Ministry of Local Govt. Housing and Construction -1980.

With reference to the above document, Kandy is located in wind zone 3 of Sri Lankan map & Basic wind speed shall be taken as one of the follows.

a) 38 m/s for post- disaster structures (3 second guest speed for 50 year return period- CP3 Chapter V)

b) 23 m/s (10 min. average for 50 year return period- EN1991-1-4-2005)

c) 21 m/s (Mean hourly wind speed for BS 6399.2- 1997)

E.3.1.3. Minimum Live load Requirements:

All live loads for the design shall be obtained from the BS6399 & BS 5400 with following minimum requirements.

Bus parking and Terminal Building:7.5 kN/m^2(min) & HA & HB loading

Sky Walk	:7.5 kN/m^2 UDL with other code applicable conditions
Other Public Areas	:5.0 kN/m^2 UDL with other code applicable conditions

E.3.1.4 Guidance for design of retaining structures

E.3.1.4.1 Earth Retaining Structures

Retaining walls shall be designed according to the relevant standards. Type of retaining wall shall be selected based on the retaining height, ground conditions, applied loads, available space for construction, restrictions with the structures to be constructed, stability of the adjoining structures (existing structures), etc.

Retaining structures shall be design for "at rest" condition when they connected with any other structure/s or there is specific requirement to limit the lateral deflections. Otherwise earth retaining structures could be designed for active and passive earth pressure in addition to other loads. Stability against overturning, sliding, bearing, slope failures shall be checked in accordance with relevant standards specified herein. Deflections shall be controlled by limiting the allowable span to depth ratio in accordance with the relevant standards. The maximum crack with shall be limited to 0.2mm where there are water tightness requirements and it shall be limited to 0.3mm elsewhere.

E.3.1.4.2. Water Retaining Structures

Underground water sumps, overhead water tanks and fuel tanks should be designed according to relevant standards & specifications.

E.3.2 CIVIL WORK

E.3.2.1 Surveying

The Contractor shall render all services for topographical survey and field measurement required for the performance of the works. These services cover in general the verification of control points, the setting out for construction the accompanying control surveys for correct locations, dimensions, elevations as well as the necessary surveys for ground profile. Such surveys shall be based on and/or referred to a basic grid of datum points and benchmarks extended adjacent to the Works in the project area. This grid shall be the sole basis of reference for all survey work.

The Contractor shall provide, maintain and operate suitable and appropriate equipment, instruments, materials and auxiliary equipment, commensurate with the various tasks and precision requirements of the survey works.

E.3.2.2. Setting Out

The Contractor shall perform all setting out and check surveying of the Works in accordance with methods approved by the Engineer. The methods and program of checking shall be such, as to ensure the construction of every part of the Works to the correct line and level. The Engineer may at any time request the Contractor to submit proof that his own setting out has been satisfactorily checked. The number of points required for setting out as well as the spacing between these points shall be determined by the Contractor in accordance with the type of the work. The Engineer may require that some or all of the given points and datum levels be clearly marked during construction in such a way that the marks can be retained after completion of construction.

E.3.3 CLEARING, GRUBBING AND STRIPPING

E.3.3.1 Clearing

Clearing means the removal and disposal of materials above ground level including overhanging branches except those areas where the Engineer directs to be left undisturbed. The material to be cleared shall include, but not necessarily be limited to, trees, stumps, logs, brush, undergrowth, grass crops, loose vegetable matter, structures and other objectionable materials.

E.3.3.2 Grubbing

Grubbing means the removal and disposal of buried logs, stumps, roots and all unsuitable obstacles to a depth beneath the original ground surface as directed by the Engineer.

E.3.3.3 Stripping

Stripping means the removal and disposal of topsoil to a depth beneath the original ground surface as directed by the Engineer.

Clearing, grubbing and stripping operations shall be strictly limited to the area to be occupied by the indispensable works unless otherwise directed or approved by the Engineer. No trees shall be cut outside the areas mentioned above without prior approval. Clearing and grubbing shall extend to approximately five (05) meters beyond the limit of the works for permanent structures. As for Temporary Works, the extension shall be a minimum as required.

All materials obtained by the clearing, grubbing and stripping operations shall be remove and disposed of as specified or directed by the Engineer. All depressions below the ground surface by the removal of stumps or roots shall be refilled with suitable materials and compacted to the satisfaction of the Engineer. Care shall be taken to see that the burning of such material does not destroy or damage public or private property and adjacent vegetation, and the Contractor shall be fully responsible for destruction, damage, or nuisance caused therein.

E.3.4 OPEN EXCAVATION

Open excavation shall include all and every excavation work for foundations of all structures and any other excavation to be executed from the ground surface.

E.3.4.1 Common Excavation

The bottom and side slope of common excavations upon or against which structures are to be

Placed shall be finished accurately to the established lines and grades.

If, at any point in common excavation, the natural foundation material is disturbed or loosened, for any reason, it shall be consolidated by tamping or rolling, or where directed by the Engineer, It shall be removed and replaced with materials approved by the Engineer, which shall be thoroughly compacted. All water and other objectionable materials shall be either pumped out or removed.

E.3.4.2 Open Trench Excavation

Open trench excavation shall include excavation for all types of trenches and shall be performed by the use of hand tools and/or approved mechanical equipment, in such a manner as to prevent shattering of the sides and bottom of the excavation.

All planking, strutting and supports necessary to retain the sides of the open-cut trench excavation shall be provided, erected and maintained in a safe condition by the Contractor. Trench excavation

with surfaces too steep to be stable shall be supported to prevent soil movement. The Contractor shall furnish, place, and subsequently remove the supports.

E.3.4.3 Dewatering

The Contractor shall construct, operate and maintain drainage systems, including drainage trenches, pump sumps, pumps, pipelines, emergency generator etc., to sufficiently dewater all appearing water, service water and underground water encountered during excavation, in order to allow for the workman like execution of all underground excavation works. The selection of a pump (its type, capacity and location) for any specific task, requires the approval of the Engineer. Construction pits, galleries, and trenches shall be maintained and be protected according to regulations and as long as the progress of work demands such means." Underground drainage shall follow shortly after excavation at the face.

E.3.4.4 Slopes Support and Protection

The Contractor is responsible for all necessary safety measures for open excavation. From the Commencement of Works until issuance of Certificate of Completion, the Contractor shall strictly follow safety regulations in order to prevent accidents.

Proper strutting, including rearrangements of the struts when necessary, protection of slopes, methods of excavation to reduce risk of slides, etc. shall be deemed to be included in the lump sum prices. In the event of soil or rock slides occurring during earth excavation work, all damages shall be rectified by the Contractor. All additional work from such damage will not be paid for. Where the nature of the soil gives reason to fear of any movement, initial excavation operations shall be carried out with special care.

All planking, strutting and supports necessary to retain the sides of the excavations shall be provided, erected and maintained in a safe condition by the Contractor. Excavation shall not be carried out below foundations of any structure, until underpinning and shoring etc. to be performed by the Contractor, have been completed. All existing structures, pipes and foundations, if any, which are to be incorporated into the final work, shall be adequately protected or replaced by the Contractor. The Contractor shall provide soil support, gunite, and/or shotcrete support (with and without reinforcement) for open excavations or other methods as approved by the Engineer. These supporting measures shall be in accordance with the provision established in this document.

E.3.4.5 Seams, Cavities and Other Defects

The exploratory investigations of the foundations, slopes and other areas to be excavated cannot be so detailed as to disclose all seams, cavities and other defects that may exist in the areas to be

excavated. It is anticipated that there may be depressions, fissures, faults, seams and bands of soft disintegrating material running in various directions in the materials to be excavated and in the foundations and under passes, slopes and other areas.

E.3.4.6 Filling for Foundation and Structures

No filling operation shall be started by the Contractor for any part of the foundation, until the Engineer has inspected and accepted it. Where swamps, marshes, bogs or similar wet areas have to be crossed by the works, they shall be drained and unsuitable material shall be removed according to the materials and conditions encountered. When excavation operations are completed, the foundation surfaces shall be compacted to a depth of 30 cm with the density specified for the fill to be placed thereon unless otherwise instructed by the Engineer.

E.3.5. CONCRETE WORKS

E.3.5.1 General Requirements

All material shall be in accordance with the latest version of standards stated in Clause 2.11 of these specifications. It is deemed that the Proposer has allowed for all charges for obtaining materials in conformance to these standards in the Bill of Quantities.

E.3.5.2. Definitions

1. Fine Aggregate: Fine aggregate is defined as the aggregate substantially passing 4.75 mm sieve.
2. Coarse Aggregate: Coarse aggregate is defined as the aggregate substantially retained on the 4.75mm sieve and having maximum size of 80 mm.
3. Construction Joints: Concrete surfaces, upon or against which concrete is to be placed and to which new concrete is to adhere, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed are defined as construction joints.
4. Expansion or Contraction Joints: All joints allowing relative movement of concrete structures with respect to an adjacent one, due to expansion, shrinkage, settlement of foundations, etc. are to be considered expansion or contraction joints.

E.3.5.3. Submissions

(1) Ready mix concrete:

Ready-mix Concrete from a Central Mixing Plants (Batching plant) is only permitted for all reinforced concrete if approved batching plant is not installed at site by the Proposer. The details of the Mixing Plant and relevant Test Results should be submitted to the Engineer for the approval

before 56 days.

(2) Cement:

The Contractor shall submit at least twenty eight (28) days before the use of cement, a typical mill test report regarding the control tests performed at the factory, including the physical and chemical properties of the cement proposed for the Works. The Contractor shall indicate in writing to the Engineer the source of the cement at least fifty six (56) days in advance of his purchase order, indicating the shipping schedule and the estimated quantity to be obtained from each source. The Contractor shall submit a manufacturer's test certificate for each consignment and/or 1,000 tons cement received at site.

Having obtained the Engineer's approval of the source of supply, transport, storage and certification of the cement, the Proposer shall not modify or change the agreed arrangements without obtained the Engineer's permission.

(3) Aggregates:

At least ninety (90) days prior to placing any concrete, the Contractor shall submit to the Engineer for approval the confirmation of sources, processing procedures, gradation curves and quality assurance. Where this document requires specific types of materials or equipment to be used or specified procedures to be followed, such requirements are not to be construed as prohibiting use of alternative types of materials, equipment or procedures. Before giving approval for the use of alternatives, the Engineer may request the Contractor to submit proof that the use of such alternatives will not reduce the quality of concrete obtained. The Contractor shall not use such alternatives without the approval of the Engineer.

(4) Mix Proportion:

At least fifty six (56) days prior to placing any concrete the Contractor shall submit details of his proposed mix proportion of mix designs or the various classes of concrete specified as well as test results, for the approval of the Engineer.

(5) Conveyance Facilities:

Description of equipment and methods proposed for the transport of concrete from the batching plant to the works including placement equipment such as cranes, conveyors, concrete pumps and similar shall be subject to the Engineer's approval prior to the concrete work.

(6) Forms:

The Contractor shall submit to the Engineer for approval, prior to the start of any concrete work,

the detailed design he proposes to adopt for formwork, but approval of the drawings shall not relieve the Contractor from his responsibility for their adequacy.

(7) Drawings and Schedules:

The Contractor shall submit in advance the drawings showing the order, magnitude and construction joints proposed for the cast-in-place concrete. The Contractor shall submit in advance, a weekly placing schedule including layer thickness where applicable, giving the detailed locations of the placement, the approximate placement volume and the date on which the concrete will be placed.

(8) Placing Report:

The Contractor shall submit a daily placing report for each concrete pour duly signed by the Engineer, which include the detailed location of the placement, the volume, slump test result, concrete temperature and the date on which the concrete was placed.

E.3.5.4. Material Specifications

E.3.5.4.1 Cement

E.3.5.4.1.1 Types of Cement

The cement used for all reinforced concrete works shall be Ordinary Portland Cement complying with the requirements of the latest version of SLS 107(BS EN 197-1:2011). For thick concrete sections low heat cement or Portland cement with flyash or blended Hydraulic cements complying with the requirements of the latest version SLS 1247 (BS EN 15167) shall be used to reduce the heat of hydration of concrete with the approval of the Engineer.

E.3.5.4.1.2 Storage and Delivery of cement

The cement shall be delivered to the site or approved mixing plant in sound and properly sealed bags and while being loaded and during transit to the concrete mixers, whether conveyed in vehicles or by mechanical means must be protected from the weather by effective coverings. The cement shall be stored in approved weather proof and well ventilated sheds with a raised floor of timber or concrete.

All cement shall be used within six months of the date of manufacture.

E.3.5.4.2 Aggregates

E.3.5.4.2.1. Types of Aggregate

Aggregates shall consist of naturally occurring material unless otherwise specified or ordered. The Proposer shall inform to the Engineer about source of supply of the aggregates before commencement of work and provide evidence regarding their properties and consistency at the request of the Engineer.

Aggregates shall be in accordance with BS EN 12620-2002, 1192-2007 and

1200-2005 and tested in accordance with BSEN 932-1. All aggregates shall be hard, durable and clean, composed of inert material. All aggregate shall be free from clay, coal or other organic impurities, iron pyrites and soluble sulphate salts and other deleterious material which may cause corrosion of the reinforcement or may impair the strength and or durability of the concrete.

The use of aggregates derived from mica, shale or other naturally occurring laminated material will not be permitted. If the aggregates do not conform to the prescribed standards the Engineer may reject them or order that they be washed, screened and graded until they meet with his approval.

Manufactured coarse aggregates, containing more than fifteen 15% elongated or flat particles, shall not be used. An elongated particle is defined as a particle having a maximum length of more than five (5) times its maximum width. A flat particle is defined as a particle in which its maximum diameter or length is more than five (5) times its maximum thickness.

The content of chloride salt in the aggregate used in reinforced concrete work expressed as the equivalent anhydrous calcium chloride percentage by weight of the cement to be used in the concrete shall not exceed 1%.

Fine aggregate shall consist of river sand graded such that not more than 10% is retained on a 5 mm sieve and not more than 15 % passes a no. 100 sieve.

Coarse aggregate for reinforced concrete members of minimum thickness less than or equal to 100mm shall be graded such that not more than 5% is retained on a 12mm sieve and not more than 10% passes a 5mm sieve.

Coarse aggregate for mass concrete shall be graded such that not more than 5%

is retained on a 40mm sieve and not more than 5% passes a 5mm sieve.

E.3.5.4.2.2. Storage of aggregates

All aggregates brought to the Site shall be free and kept free from deleterious matter. Aggregates of different types and sizes shall be stored separately in different hoppers or different stockpiles.

E.3.5.4.3. Water

Water used in mixing concrete, mortar, or grout shall be free from lime, sulphates or other deleterious materials and from a source approved by the Engineer. The Engineer shall have the right to request samples of the water subjected to analysis from time to time.

E.3.5.4.4 Admixtures

Admixtures may be used if approved and when so required. The plasticizer shall be transported to the Site under cover in sound and properly sealed bags or in the manufacturer‟s containers, and shall be stored off the ground in a proper watertight shed of an approved design. The plasticizer shall be stored completely separated from all other materials to the approval of the Engineer.

E.3.5.4.5. Waterstops

The waterstops shall be extruded from an elastometric plastic compound, the basic resin of which shall be polyvinylchloride (PVC). The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, it is durable and resistant to any decomposition.

The plastic waterstops shall meet the following requirements:

Requirement	**Method of Test**
Tensile strength using die "C": not less than 150 kgf/cm2	ASTM D-412
Ultimate elongation using die "C": not less than 330%	ASTM D-412
Stiffness in flexure, 6 mm span: not less than 28 kgf/cm^2	ASTM D-747
Tear resistance : not less than 30 kgf/cm^2	ASTM D-624
Specific gravity: not less than 1.20	ASTM D-792

The corresponding British Standards are applicable subjected to the approval of the Engineer. The Contractor shall submit to the Engineer for approval the test results from a recognized institution showing that the material supplied meets the requirements specified. The Engineer may order to carry out additional tests, for which the Contractor shall supply specimens from the same material to be used in the Works. Test specimens, if required, shall be of the shape and dimensions required in the individual test methods. The extruded waterstops shall be dense, homogeneous, and free from holes, scratches and other imperfections.

E.3.5.4.6 Execution of Concrete Work

E.3.5.4.6.1. General

The concrete to be produced and placed shall be of highest quality and uniformity. In all phases of

his operations the Contractor will be subject to strict inspection to assure concrete of the best quality. Special emphasis will be placed on the uniformity of the concrete aggregates, water-cement ratio, consistency, air content and the temperature control of the concrete at the time of placement in the formwork, as well as the density and finishing when placed.

E.3.5.4.6.2 Tolerances for concrete structures

Construction tolerances for concrete structures shall be as follows unless otherwise specified elsewhere.

Table E.3: Tolerances for concrete structures

(a) Variation from vertical: -In the lines & surfaces of columns, piers, walls and towers - For exposed columns control joint grooves and other conspicuous lines	 In 3 m……..+/-5 mm In 6 m……..…+/-8 mm In 12 m or more……..…+/-16 mm In 6 m max……+/-5 mm In 12 m or more…… …+/-10 mm
(b) Variation from the level or from the grades indicated on the Drawing - In floor, inverts, ceilings, and beam so fits	In 3 m ……..+/-5 mm In any bay or 6 m max……..+/-8 mm In 12 m or more……..……+/-16 mm
(c) Variation of the linear structure lines from established position in plan and related position of walls	In any bay or 6 m max……..+/-12 mm In 12 m or more……+/-25 mm
(d) Variation in location of sleeves and sizes and locations of floor openings and wall openings	……..……+/-5 mm
(e) Variation in cross-sectional dimensions of columns, beams and in the thickness of slabs and walls	……..……..-5 mm ……..……...+10 mm
(f) Variation in steps: - In a flight of stairs - In consecutive steps	 Rise ……..+/-3mm Tread…….+/-5 1mm Rise……+/-2 mm

	Tread……..+/-3 mm
(g) Variation in lining concrete: - In design center line - In inner diameter -Tolerance in lining thickness	 ……+/-30 mm ……+/-30 mm ……+/-30 mm

E.3.5.5. Concrete Mixes

E.3.5.5.1 Grade designation

Grades of concrete shall be denoted by the 28 day test cube strength in Newton‟s per square millimetre (N/mm^2).

E.3.5.5.2 Mixing

Concrete mix shall be in accordance with clause E 3.5.5.3 (Designed mix) and the grades approved appropriate to the work. The various quantities of cement, aggregate and water for the concrete mix shall be measured by weight. A separate weighing device shall be provided for weighing concrete; alternatively cement may be measured by using a whole number of bags. The accuracy of weighing devices shall be within 3% tolerance.

The batching plant shall have an automatic control capable of ready adjustment, to compensate for the varying moisture content of the aggregates, and to change the weights of the materials being batched.

Volume batching for concrete mix is only approved for minor structures such as man holes, curbs, cover slabs and lean concrete works.

The Proposer will maintain on site cellular telephone link between site and the Concrete Mixing Plant and record times of Truck Mixer leaving Plant, arriving at the site and the Truck Mixer number. Copies of all records are to be delivered to the Engineer's Representative daily or more frequently, if requested.

E.3.5.5.3 Designed mix

All concrete mixes whether they are measured by weight or volume batching shall be according to the designed mixers approved by the Engineer. The Contractor shall be fully responsible for producing and maintaining the quality of concrete with especially compressive strength not inferior to the specified one, except if different instructions are given by the Engineer. After completion of tests, the Contractor shall inform the Engineer and get his approval on the

proportioning of mixtures to be adopted for the various classes of concrete.

The Proposer shall meet the requirements for the minimum cement content and other properties in his design mix. The Engineer may require ensuring durability etc. Designed mixes shall be in accordance with grades indicated in the drawings. Complete information on the mix and sources of aggregate for each grade of concrete and the water/cement ratio and the proposed degree of workability shall be approved before work commences.

No concreting will be permitted until the results of these tests are accepted by the Engineer.

E.3.5.5.4 Minimum and Maximum cement contents

The minimum cement content shall be not less than 300 kg/m^3 and the maximum cement content shall be not greater than 400 kg/m^3 for concrete used in reinforced concrete works.

E.3.5.6. Trial Mixes

E.3.5.6.1 General

Mix designs shall be prepared and submitted by the Proposer for approval of the Engineer. The Proposer shall submit result of trial mixes, grading curves and all other details to enable the Engineer to evaluate the proposed mix designs.

When designed mixes are specified, the trial mixes shall be prepared for each grade of concrete in accordance with the BS 1881-125:1986, BS1881-129:1992 unless there are existing data showing that the proposed mix proportions and manufacture will produce a concrete of the strength and quality required having adequate workability for compaction by the method to be used in placing.

E.3.5.6.2 Preliminary trial mixes

Before the commencement of concreting, Proposer shall have preliminary trial mixes prepared preferably under full-scale production conditions or if this is not possible in an approved laboratory using a sufficient number of samples to be representative of the aggregates and cement to be used. Unless otherwise approved for each grade of concrete, a set of six cubes shall be made from each of three batches in accordance with BS 5328 from each set of six cubes three shall be tested at an age of 7 days and three at 28 days.

E.3.5.6.3. Workability

The workability of each batch of the trial mixes shall be determined by the slump test as described in BS 1881-1998 or by an alternative approved method.

E.3.5.6.4. Variations in approved mix

When a mix has been approved, no variations shall be made in the proportions, the original source of the cement and aggregates or their type, size or grading zone without the consent of the Engineer.

E.3.5.7. Transportation

General Concrete shall be conveyed from the mixer to the place of final deposition, and finally poured as rapidly as practicable by approved methods, which will prevent segregation, loss of ingredients or damage by exposure to the atmospheric agents, and shall be deposited as nearly as is practicable to its final position. Concrete can be conveyed by truck mixers and agitators, buckets, trucks, chutes and pipes, belt conveyors, concrete pumps and other equipment approved by the Engineer. Conveying equipment shall be of such size, design and condition to ensure a practically continuous supply of concrete at the point of placement, and a concrete placing in approximate horizontal layers while the previous layer is still soft. The maximum height from which the concrete shall be dropped shall not exceed one and a half meters, except where the use of suitable equipment to confine and control the falling concrete is specifically authorized by the Engineer. All conveying equipment shall be supported independently of the forms. The conveying equipment shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals. Should the concrete show signs of segregation when it reaches the placing point, and provided that the maximum permissible time has not elapsed, it shall be remixed by mechanical means in the vicinity of the placing, otherwise it shall be rejected at Contractor's expense. In particular, the Contractor shall take appropriate measures to avoid excessive loss of moisture by evaporation, during the transportation and placing of the concrete. Addition of water in the mixture to make up for the evaporation losses shall not be permitted.

E.3.5.8. Forms

E.3.5.8.1. General

Forms shall be used whenever necessary to confine the concrete, and to shape it to the required lines, grades and dimensions shown on the Drawings. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall provide concrete surfaces conforming to the requirements of the finishes specified. Forms shall be sufficiently tight to prevent the loss of mortar from the concrete. Where re-usable forms are used, the original strength, rigidity, tightness and surface smoothness of the forms shall be maintained throughout their usage. The form surfaces in contact with the concrete shall be treated or protected to avoid chemical reactions or discolouring of the concrete surface. The use of forms with bruises, irregularities and incrustations shall not be permitted. Should displacement occur in

the position of the forms, with a consequent modification of the lines of the structure, as compared with the lines shown on the Drawings, the prescriptions set forth in the Clause "Tolerance of Concrete Structures" and "Repair of Concrete" shall be applied. Forms shall be placed so that the joint marks on concrete surfaces are, as much as possible, in alignment both horizontally and vertically. The support for forms shall be such that no deflection occurs under the weight of wet concrete and other loads. Forms shall not be tied, supported, rested or loaded on to any parts of the Works unless approved by the Engineer.

At the time of concrete placing, the inner surface of the forms, the contacts .and connections shall be free from any incrustations, mortar, grout or other foreign matter that may contaminate the concrete. Prior to pouring, the surface of the forms, with the sole exception of those made of rough wood, shall be smeared with a bond-breaking compound such as emulsified oil, or with refined mineral paraffin oil, designed to prevent sticking of concrete on the form. The treatment of the forms shall not cause harmful effects, or stains, on the concrete surface, or on the reinforcement system. Bond breaking compound shall be applied before reinforcement is placed if the method is feasible.

Forms made of timber which have been left in place for such a period that they have dried out, shall be wetted as directed by the Engineer. Furthermore, special care must be taken to prevent concrete adhering to the surface of the forms. Oil treatment shall be made in such a manner as to avoid spillage on previously placed concrete. All excess oil on the form surfaces, and any oil on the concrete, metal or other parts to be embedded in the concrete, shall be carefully removed.

E.3.5.8.2 Form Ties

The design of form ties shall be such that no metal shall be within 20 mm of any exposed surface except specified. Sufficient form ties and bolts shall be used on both sides, and within a few centimeters of construction joints, to ensure the forms fit snugly against the concrete previously placed, and shall remain in tight contact during placing operations. After removal of formwork, the Contractor shall withdraw the bolts and securely fill up the holes with cement mortar patch, as required by the Engineer. The terminal part of the wire ties, if their use is allowed, shall be shaped in such a manner that cutting and removal will not damage the concrete surfaces exposed to the sight. Possible damage to the concrete due to the aforementioned operations shall be repaired in accordance with Clause "Repair of Concrete".

E.3.5.9.3. Removal of Forms

The removal of the forms shall be carried out when the concrete has reached sufficient strength, so that no damage will be caused by removing. No forms shall be removed within the specified time

after the end of concrete placing, except for special cases where shorter time is approved by the Engineer. As a rule, the forms shall be kept in place at least for the time hereunder indicated after concrete has been placed:

Retaining Walls	48 hours
Columns and concrete walls	48 hours
Beams and slabs with a span less than 6 m	14 days
The same with a span larger than 6 m	21 days

The minimum time which shall elapse between the completion of concreting and removal of the forms for beams and slabs shall be established by the Engineer for any particular structure, according to the design calculations. After authorization for removal, the forms shall be removed as soon as practicable, to avoid delay in specified curing of concrete, and also to enable earliest practicable repair of surface imperfections. Methods of form removal likely to cause overstressing of the concrete, or injury to the concrete surface, shall not be used. Forms and their supports shall be removed in such a manner as to allow the concrete to take the stresses due to its own weight uniformly and gradually. Provisions shall be made by means of suitable wedges, sand boxes or other devices, for the gradual relaxation of the support given by false work and centering.

E.3.5.10. Placing

E.3.5.10.1. General

All concrete placing equipment and methods shall be subjected to the approval of the Engineer. Concrete placing shall not be started until all formworks, reinforcement, installation of embedded parts, and preparation of the surfaces of rock, and hardened concrete involved in the placement have been inspected and approved by the Engineer. The Contractor shall notify the Engineer at least 48 hours in advance and allow a reasonable time for inspection before placing begins. Placement schedules shall be submitted before the end of the last working day of each week and shall cover all concrete works planned for the following week. At least 48 hours before the start of concreting, the Contractor shall submit drawings and sketches showing embedded parts, shoring and scaffolding. Concreting of any part of the work will be authorized only after verification and acceptance of the following items:

a) The characteristics of the concrete mix to be used

b) The concreting program, type and quantity of equipment for placement and compaction, including the hourly placement rates

c) The availability at the site, of equipment and material necessary for finishing, curing

and protection of concrete

d) The condition and cleanliness of forms, adjacent concrete or other surfaces, reinforcement and embedded parts

e) Conformity of the installation, including shoring and scaffolding, with the formwork drawings

f) Concrete placed without prior knowledge and approval of the Engineer may be required to be removed and replaced at the Contractor's expense

E.3.5.10.2 Method of Placing

The concrete shall be deposited generally in horizontal layers in such a manner as to maintain, until completion of the pour, plastic surface approximate horizontal. The thickness of each layer shall range from 30 to 60 cm as approved by the Engineer and the placement shall be carried out at such a rate that no concrete surface can reach an initial set, before additional concrete is placed thereon. The lift thickness shall depend upon the ambient temperature, etc. at the time of placement and be based on temperature studies made by the contractor. However, the maximum lift of placing shall not exceed 2.00 m unless otherwise instructed or approved by the Engineer. The Engineer may authorize higher lifts or layers where concrete can be placed or consolidated in thick layers. Concrete shall be deposited as closely as possible, directly into its final position and in such as to avoid segregation or modification of other properties. Bouncing concrete off forms, reinforcing steel or any other obstruction is prohibited. Movement of concrete with vibrators, or by other means will not be permitted. For locations when direct placement is not possible, and in narrow forms, hoppers and trunks must be provided to a convenient size to allow a proper placing. Concrete that is of excessive slump, segregated, partially hardened, or unworkable, shall not be placed in forms or if placed, shall be removed and dumped as directed by the Engineer, at the Contractor's expense. Each layer of concrete which shall be placed and compacted with suitable types of equipment, until the concrete is consolidated to the maximum practicable density, shall be free of pockets of coarse aggregate, and fits tightly against all form surfaces and embedded materials. Construction equipment used for spreading, vibrating or other operation must absolutely not spatter loose oil, fuel and grease on the concrete. If a placement is stopped before completion, bulkheads shall be used to make a vertical joint. Any unconsolidated/ un-compacted concrete shall be removed before completing the placement. During placement, and until curing has been completed, the concrete shall be protected to the satisfaction of the Engineer, against the harmful effects of exposure to sunlight, wind and rain.

E.3.5.10.3 Placing restrictions

a) Reinforced structures and embedded parts

Where concrete has to be placed through reinforcement, care shall be taken so that no segregation of concrete or displacement of bars occurs. Closed chutes, elephant trunks, or tremies receiving hoppers, shall be used to place concrete in deep forms, around reinforcement, or other places not readily accessible for direct placing. Extreme care shall be devoted to placing the concrete around the various embedded parts, to ensure that unbalanced loading and impact from placing concrete, will not cause distortion or dislocation of parts. Both during and after placing of a lift, careful checks shall be made by the Contractor in the presence of the Engineer and Other Contractors to see that the parts requiring accurate setting have not been displaced. Where the embedded parts of Other Contractors are involved, check surveys shall be made jointly with Other Contractors before placing of concrete to confirm the original position of such embedded parts. No additional payment will be made for such work. The differential level of the fresh concrete shall not exceed 40 cm at any embedded parts and 30 cm around the spiral case. A minimum of seventy two (72) hours shall elapse between the placing of each successive lift. Any placing restriction deemed necessary by the Engineer, to maintain alignment of the embedded parts, shall be implemented promptly by the Contractor. Lifts may be terminated at any time, to allow implementation of any action necessary to maintain the accuracy requirements. Mechanical vibrators shall not be used for placing consolidating concrete around movable embedded parts, except as approved by the Engineer. In this case concrete shall be consolidated thoroughly by hand spading and tamping.

b) Rain

Outdoor concreting shall not be started during rains unless the Contractor has taken all protective measures including proper shelters so that during transport and placing. The concrete maintains the consistency tested at the mixing plant. Should concreting be already in process, the Contractor shall provide proper shelters in order to complete the pouring operation. In any case, placing operations shall be suspended if the rain affects the quality of concrete, if the Engineer directed.

c) Water

No concreting shall be carried out under water, unless it is foreseen or is approved by the Engineer. The "drop-bottom bucket" or "tremie" method shall be used to pour concrete under water. Concreting shall neither be conducted in running water, nor be exposed to the action of the same, before it is sufficiently set.

d) Blockouts, Recesses, etc.

The Contractor shall place concrete in blockouts, recesses, etc., constructed as designed or as directed by the Engineer, after e.g. the installation and adjustment of metal work has been completed. Before concrete is placed in the blockouts, recesses, etc. the surfaces of the concrete previously placed shall be roughened and cleaned. The roughening shall be performed by scrabbling or other methods so as not to crack or scatter any other part or me concrete surface. All concrete, which is not hard, dense and durable, as determined by the Engineer, shall be removed to the depth required to secure a surface to the satisfaction of the Engineer. The Contractor shall place the concrete in a way to ensure satisfactory bond with the existing concrete, to secure complete contact with e .g. metal work to be embedded and to avoid any displacement. Where directed by the Engineer, concrete placed in recesses shall contain an approved expanding agent or non-shrink grout. No force or load shall be applied before the concrete reaches its 28 days strength.

E.3.5.10.4 Temperature control

Hydration temperature of the concrete shall be controlled in shielding structure concrete as follows;

a) Concrete when placed shall have a temperature of not more than 30^0 C. b.) Maximum hydration temperature of concrete shall not exceed 70^0 C.

b) No temperature gradient within concrete shall be allowed to exceed 15^0 C, in a distance of 1 m and maximum temperature difference between two parts of the same pour shall not be allowed to exceed 20^0 C.

c) Portland cement with flyash or low-heat Portland or Blended Hydraulic cement complying with the requirements of SLS cement or equivalent BS/EN standards may be used to achieve the above requirements, in addition to other measures required for temperature controlling in concreting (i.e. use of ice or chilled water for concrete mixing special curing/insulation methods during hydration of concrete).

d) Proposer shall make a sample concrete block of 1m x1m x1m using the design mix for the concrete and shall demonstrate the temperature increase variation during the process of hydration to verify the suitability of the mix design and other temperature controlling measures for the use thick concrete sections.

e) Proposer shall submit a method statement detailing all the measures adopted to achieve above temperature control measures at least two months before the concrete work for the

Engineer approval.

All precautions needed for manufacture, transportation, placement, curing and protection shall be taken during extreme weather conditions as per standard practices and guidelines. For mass concreting, the Contractor shall also determine the layer and lift thicknesses during various weather conditions based on ambient temperature at site during different periods by making temperature studies. The proposed sequence of concreting including lifts/layer, time intervals along with the studies made shall be supplied in advance for the approval of the Engineer.

E.3.5.11. Compacting

Concrete shall be compacted with mechanical vibrating equipment, supplemented by hand spading and tamping, to a maximum practicable density so that it is in complete contact with the forms, reinforcement and other embedded parts. The vibration shall be carried out by means of immersion type high-frequency vibrators, of the electrically driven or compressed air types, or by means of engine driven vibrators. For the consolidation of concrete where immersion vibrations shall prove impracticable, vibrators rigidly attached to the forms shall be adopted subject to the approval of the Engineer. The size and number of vibrators, at each pour, shall be sufficient to thoroughly compact concrete, at the rate and conditions of placement. The total consolidating capacity, in cubic meter of concrete per hour, of all vibrators in effective operating condition, and employed on concrete consolidation in the Works, shall be based on a rated capacity of 80% of the manufacturer's recommendation for each type of vibrator. The total consolidating capacity so computed shall be not less than the maximum rate at which concrete is placed in the Works. For components of secondary importance the concrete may be deposited layer-by-layer with bottom-opening skips or traveling tremies on the foundation bed or on the surface of the individual layers of concrete. The tremies must be constantly and sufficiently far immersed in the concrete already placed for the concrete flowing out of the tremies to displace the earlier concrete.

For every four vibrators in use on the Works, an additional standby vibrator of similar consolidating capacity and in good working order shall be provided. When vibrating a layer of fresh concrete, the vibrator shall be held in a near-vertical position. The immersion of the vibrator shall be sufficiently deep to vibrate the entire depth of a new layer: the vibration should penetrate several centimeters into the layer below, to ensure thorough union of the layers. No new layer of concrete shall be placed, before the underlying one has been thoroughly vibrated. Immersion points for the vibrators shall be adequately spaced, so as to make sure that every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement

steel, especially that starting initial set. Vibrators shall not be allowed to come into contact with form or finish surfaces. Spreading concrete horizontally with vibrators is prohibited. Vibrators shall not be applied on reinforcing steel, embedded parts or formwork. Provisions shall be made to ensure that any entrapped air, formed during the placing of concrete, be allowed to escape, by leaving effective air vents in the formwork. Care shall be taken to provide a dense envelope of concrete surrounding the waterstops with no voids or honeycombing. Excessive vibration, causing segregation and laitance, and tending to bring water to the surface, shall be avoided.

E.3.5.12. Joints

E.3.5.12.1 Construction Joints

The shape and position of all construction joints shall be proposed by the Contractor and are subject to the approval by the Engineer, if not shown on the Drawings and/or not instructed by the Engineer. Construction joints shall be sealed by waterstops or other means if so shown on the Drawings or instructed by the Engineer. After the initial set, but before final hardening of the concrete, the unshuttered surface of the joint shall be washed with water and compressed air jets to thoroughly remove the top layer of mortar and all semi-detached parts from the surface, and to expose the upper half of the big-size aggregates, however, without loosening or undercutting them.

If the surface of a lift with reinforcing steel is congested and is relatively inaccessible, or if for any other reason disturbing an unhardened surface is considered undesirable, green cutting by air-water jets will not be permitted and the use of wet sand blasting will be required after hardening of the concrete. When employed in the preparation of construction joints, wet sand blasting shall be performed immediately before final cleaning for the following lift. The operation shall be continued until all unsatisfactory concrete and all laitance, coatings, stains, debris, and other foreign materials are removed. Immediately before pouring is resumed, air and water jet cleaning will be repeated, until the washing water remains quite clear; the Contractor shall deal in a controlled way with the water used in washing, carefully diverting it from the pouring zone, leaving the surface wet, but without water puddles. The air pressure used in the

jet shall be not less than 6 kgf/cm^2, and the water pressure shall be sufficient for thorough cleaning. When construction joints are not covered with concrete within twenty one (21) days after their formation, the Contractor shall apply wet sand blasting or roughen all surfaces by light jackhammering, when preparing for the next lift. The extent of concrete to be removed will be indicated by the Engineer. The

treatment described above shall also be carried out when construction joints have been covered by stagnant water for a period of more than seven (7) days or by foreign materials difficult to remove by normal cleaning operations.

Formed surfaces of construction joints shall be roughened prior to continuing concreting and shall be clean and free from oil, objectionable coatings and loose, semi-detached or unsound fragments. The period of moistening of concreted surface shall not be less than two days. Wherever possible, forms for construction joints shall be made of expanded metal. Formed surfaces of construction joints to be grouted shall be cleaned of all accretions of concrete or other foreign material by scraping, chiseling or other effective means. Whenever required by the length and type of structure the Engineer may instruct to carry out compulsory construction joints. At these joints no concrete shall be placed against the joint surface for at least 7 days for structures up to 1.00 m in thickness and for 10 days where the thickness exceeds 1.00 m.

E.3.5.12.2 Expansion and Contraction Joints

Joints shall be provided at the locations indicated on the Drawings prepared by the Contractor, or as directed or approved by the Engineer. In no case shall any fixed metal embedded in the concrete, continue across an expansion or contraction joint.

The expansion joints can be of the smooth and even or dented type to guarantee the contact of the structures. The opposite faces, which form the joint, shall be completely separate. Expansion or contraction joints shall be sealed by waterstops and/or joint sealants. The Contractor shall undertake the pouring of the second surface only after the first one has thoroughly hardened. When shown on the Drawings or ordered by the Engineer, a sheet of plain joint filler or other approved material may be placed in contact with the first pouring before starting the second pouring. The cost of the joint filler shall be included in the relevant concreting. Powerhouse sidewalls concrete around penstock shall be sealed by approved joint sealing compound to stop seepage water between penstock steel pipe and filling concrete as shown on the Drawings or ordered by the Engineer. The cost of the joint sealing compound shall be included in the relevant concreting.

E.3.5.13. Curing of Concrete

Curing provisions shall be made so that:

(a) Hydration of cement is developed gradually and completely

(b) Concrete does not quickly pass from plastic state to elastic state

(c) Concrete is not cracked or damaged by high differential temperatures or rapid changes in temperature

(d) Surfaces of concrete are not damaged by traffic, nor discoloured by chemical agents.

The methods and materials used in the curing process shall be at all times, subject to the approval of the Engineer. All equipment needed for adequate curing and protection of any concrete pour shall be ready to install before actual concrete placement begins.

Concrete shall be protected against harmful effects of weather, running water and drying out. One of the following methods appropriated to the particular situation shall be adopted.

A liquid curing compound shall be applied to the concrete surface by a low pressure spray until a continuous visible covering is achieved.

The concrete surface shall be covered with Hessian, sacking, canvas or other absorbent material agreed by the Engineer. The concrete surface shall be covered with polyethylene sheets. If concrete surfaces which have become dry shall be thoroughly wetted before the sheeting is placed. The minimum curing period shall be seven (07) days.

E.3.5.14. Testing of concrete

E.3.5.14.1 Sampling

Concrete shall be sampled in accordance with BS 1881-1993.

E.3.5.14.2 Slump

The workability of concrete shall be determined by the slump test as described in BS 1881-1993 or by an alternative approved method.

E.3.5.14.3 Works cube tests

For each grade of concrete, 4 cubes shall be made from a single batch when required for each 15m ^{3} of concrete of part thereof in each day's work. The cubes shall be made, cured and tested in accordance with BS 1881-1993 or as otherwise approved. One shall be tested at an age of 7 days and the other 3 at 28 days. The Contractor shall submit certified copies of the results of all tests to the Engineer.

E.3.5.14.4 Standard of acceptance

The standard of acceptance of the works cubes shall be in accordance with BS 8500-1-2002 or as otherwise approved.

E.3.5.14.5 Records of tests

The Contractor shall keep a detailed record of the results of all tests on concrete and concrete materials. Each test shall be clearly identified with the locations to which it relates.

E.3.5.15. Repairs of Concrete

E.3.5.15.1. General

Any indentation, irregularity and bulge occurring beyond the specified tolerance, or any voids and honeycombs, fractures or other damages, shall be repaired. Repairs shall be performed by skilled workmen and the Contractor shall inform the Engineer before starting the repair work. Materials, procedures and operations used in the repair of concrete, and also the finished work, shall be done in accordance with the orders and instructions of the Engineer. · In general the repair work shall be started within 24 hours after stripping of the formwork. Concrete damaged by any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which, because of excessive surface depressions must be cut back and rebuilt, shall be replaced with mortar, concrete or epoxy resin as specified hereafter or as otherwise directed by the Engineer. The repairs of tunnel lining shall be carried out with epoxy resin except different instructions are given by the Engineer.

E.3.5.15.2 Repairs with New Concrete or Mortar

Existing concrete of the portion to be repaired shall be cut back to sound concrete at least to a depth behind the reinforcement, sufficient to provide complete embedment of the reinforcement in the replacement concrete. Voids to be filled shall be provided with anchors, welded wire mesh, and/or dovetail slots whenever necessary to hold the new material securely in place. The edges of the cut shall be sawn normal to the concrete surface and the replacement concrete adequately doweled to the old concrete as directed by the Engineer. Cut out areas shall be thoroughly cleaned. Holes left by the removal of tie rods shall be thoroughly moistened and filled with dry-pack mortar thoroughly tamped into place. The colour of replacement concrete and patching mortar shall match the surrounding concrete. Concrete and mortar used for patching and repairs shall be cured in the same manner as specified for general concrete works. Where specifically authorized by the Engineer, bulges may be removed by grinding. Other methods to be followed in carrying out such repair works shall be those detailed in Chapter VII of the Concrete Manual USBR, 8th Edition

or equivalent Repair of concrete, whenever practicable, shall be completed within thirty six (36) hours after removal of forms.

E.3.5.15.3 Repairs with Epoxy Resin

(i) Repairs to depths of more than 6 cm

Where the depth of damage is more than 6 cm, the repair shall be made by first saw-cutting a grove 4 cm deep around the perimeter of the damaged area. Then the damaged concrete shall be removed by light-weight jackhammer and the resulting surface shall be cleaned by chisel and compressed air to receive the epoxy-bond coat. Damp or wet areas shall be dried with a propane torch immediately before applying the bonding agent to prepare a warm surface when touched. The applicable epoxy bonding agent shall be approved by the Engineer.

After the application on the clean and dry surface, and while still in a tacky stage, the bonding agent shall be overlaid with the repair concrete.

The repair concrete shall be of Class A with plastic to stiff consistency or as otherwise directed by the Engineer. If the bonding agent has set before applying the concrete, it shall be removed by sand blasting or additional chiselling.

(ii) Repair to depths of less than 6 cm

Where the depth of damage is less than 6 cm the repair shall be made by first saw-cutting a grove 3 cm deep around the perimeter of the damaged area. Then the damaged concrete shall be removed by chisel and the resulting surface shall be cleaned by compressed air to receive the epoxy mortar. The applicable epoxy mortar shall be approved by the Engineer. The material shall be applied on the clean and dry surface according to the manufacturer's instructions. Damp or wet areas shall be dried with a propane torch immediately before applying the epoxy mortar, to prepare a warm surface when touched.

E.3.5.16. Dental Concrete

Dental cavities shall be filled with concrete or shotcrete wherever possible prior to concrete lacement. Where dental concrete is used it shall have the same mix proportion as the concrete covering it, unless otherwise directed by the Engineer. Dental cavity side surfaces shall be cleaned of all loose and friable materials prior to concrete placement.

E.3.5.17. Second-Stage Concrete

The work shall be scheduled as shown on the Drawings and/or as directed by the Engineer, and;

(a) Special care shall be taken not so as to give effects on embedded items such as draft tube liner, stay ring, spiral casing, vertical guides for gates and trash racks.

(b) For encasement or mounting the air conditioner or other equipment as directed by the Engineer, the Contractor shall cooperate and coordinate the procedures with the relevant manufacturer.

E.3.5.18 Placing of WaterStops

Splices in the continuity or at the intersection of runs of waterstops shall be performed by heat sealing the adjacent surfaces, in accordance with the supplier's recommendations. The continuity of the characteristic corrugations of the cross-sections of the waterstops design shall be maintained across the splice.

The number of splices in the sealings shall be the minimum possible and all splices shall be approved by the Engineer; the equipment used for making splices in PVC sealings. and the splicing method shall also be approved.

A specimen as required by the Engineer shall be tested by the Contractor. The Contractor shall make the splices in such a manner as to ensure that the splices have a tensile strength not less than 80% of that of the unsliced material.

E.3.6. REINFORCEMENT

E.3.6.1. General

The type of reinforcement used in each part of the work shall as described on the drawings. All reinforcement used throughout the works shall be from one manufacturer.

Bars designated „R‟ shall be mild steel plain round bars having yield strength of 250N/mm^2 complying with BS 4449 and Bars designated „T‟ shall be high yield bars having yield strength of 460 N/mm^2.

All reinforcement shall be free from pitting due to corrosion and shall also be free from loose rust, mill scale, paint, oil, grease, adhering earth or other material that may in the opinion of the Engineer impart the strength or cause corrosion of the reinforcement or disintegration of the concrete.

Metal bar supports, ties, chairs, saddles ets., shall be of an approved design and shall be adequate to ensure that no displacement occurs during placing of wet concrete. All tying wire shall be 16

gauge soft annealed wire.

E.3.6.1.1 Storage

Steel reinforcement shall be stored in clean conditions such a way as to avoid distortion and rusting or coating by grease, oil, dirt and other objectionable materials. Storage shall be above ground in separate piles or racks so as to avoid confusion or loss of identification after the bundles are broken.

E.3.6.1.2. Placing of reinforcement

Reinforcement bending schedules shall be prepared and produced for Engineers approval by the Contractor. Bending and fixing of bars shall start only after the Contractor has convinced himself that no changes will be made to the concrete structure. Mill certificates of composition and strength tests on samples of steel purchased for use on this project and tested in an independent approved local laboratory should be furnished.

All intersecting bars shall be tied together with approved wire unless otherwise permitted by the Engineer.

Reinforcement in the form of a mast shall be assembled with additional support such as benches necessary to form a rigid mat. Reinforcement shall be placed and maintained in position. The cover to all reinforcement shall be according to the drawings. Cover blocks shall be approved and shall be as small as possible consistent with their purpose. They shall be made with 10 mm maximum aggregate size and shall have strength not less than that of the concrete to be placed.

E.3.6.1.3 Welding of reinforcement

Welded joints and welding procedures shall be carried out in accordance with BS 693 or BS 1856.

E.3.6.1.4 Expansion joints

Expansion joints shall be provided at every 6m intervals for in situ floor concrete work or as directed by the Engineer. The expansion joint shall be of 15mm and reinforcement should be discontinued. The joints should be filled with flexible bituminous material.

E.3.6.2 Drawings

The Contractor shall supply and fix all reinforcement of diameters and shapes as shown on the drawings. In case reinforcement is not shown but when the nature and / or purpose of the relevant element distinctly and obviously required the incorporation of reinforcement, then the Contractor shall be deemed to have included in his tender a quantity of 120kg reinforcement per cubic meter of concrete for such elements.

E.3.6.3 Cutting and Bending

If reinforcement already cast into concrete has to be bent, the internal radius of the bend shall be not less than twice the diameter of bars of mild steel or three times the diameter of bars of high-yield steel.

Unless shown to the contrary on the drawings, the cutting and bending of reinforcement shall be in accordance with the requirements of BS 8666. No steel which has been previously bent shall be re-shaped without the Engineer‟s approval.

Steel reinforcement shall be stored in clean conditions. It shall be clean and free from loose rust and loose mill scale at the time of fixing in position and subsequent concreting.

All steel reinforcement must be stacked on the site. All bars must be cut and bent cold in an approved bending machine. Welding of bars is not permitted. The Contractor shall prepare bending schedules. Bending and fixing of bars shall start only after the bending schedules have been submitted to the architect for approval and after the Contractor has convinced himself that no changes will be made to the concrete structure. Re-bending of reinforcement will not be permitted.

E.3.6.4 Conditions

All reinforcement shall when placed be free from rust, scale, grease, clay, salt deposits and other coatings or deleterious material that would destroy or reduce the bond with the concrete and all reinforcement in store on Site and in use shall be protected and/or cleaned as often as may be necessary.

E.3.6.5 Tying

All knots in tying wire shall be located within the reinforcement cage and shall not be located closer to the surface of finished concrete than the specified minimum cover.

Ensure that reinforcement cannot cause any rust staining to surfaces intended to be kept clean.

E.3.6.6 Supports

The Contractor shall supply and install chairs, ties, spacers, supports etc., as necessary to fix the reinforcement and maintain it in correct position during placing and vibration of concrete. Only precast concrete spacers shall be used in the formwork to maintain the required cover, their frequency and location shall be subject to the approval of the Engineer.

E.3.6.7 Laps and Joints

Laps and joints shall be in strict accordance with those specified on the Drawings. Relocation and additional laps shall be subject to the approval of the Engineer.

E.3.6.8 Testing Procedures

Reinforcement Steel Bars shall be hot rolled high yield steel bars either hot or cold worked for reinforcement purposes. Steel billets and reinforcement bars should comply with SLS 375:2009, *ASTM A706/A 706M* and BS 4449 – 2005 + A2 : 2009 as stipulated in the ICTAD Specification for Building Works – Volume 1 (SCA/4/1).

E.3.6.8.1 Billets

Steel billets shall be from sources which compliance with above standards. Chemical compositions marked as percentages by mass.

Table E.4: Chemical composition of bullets

Description	Value or description (value by mass (%))	Standard
Carbon, C	max.0.25	SLS 375: 2009 Table 2
Sulphur, S	max. 0.05	SLS 375: 2009 Table 2
Phosphorus, P	max. 0.05	SLS 375: 2009 Table 2
Copper, Cu	max. 0.80	SLS 375: 2009 Table 2
Nitrogen, N	max. 0.012	SLS 375: 2009 Table 2
Silicon, Si	max. 0.50	ASTM A706/A 706M -00 Cl. 6.2
Manganese, Mn	max. 1.50	ASTM A706/A 706M -00 Cl. 6.2

$$\textbf{C}\text{arbon }\textbf{E}\text{quivalent value} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

Table E.5: Carbon equivalent

Description	Value or Description (value by mass (%))	Standard
Carbon Equivalent (C.E)	≤ 0.50	SLS 375: 2009 Table 2

Mill certificates certified by the Billet Producer and Steel Manufacturer pertaining to billets imported/ purchased recently, confirming compliance with the above shall be submitted to the purchaser. The successful Steel Manufacturer shall, carry out tests in a laboratory directed by the

purchaser or certified laboratory, established for the testing quality of reinforcement if requested by the consultant/ purchaser. (1 test for every 1000 tonnes of steel production).

E.3.6.8.2 Traceability and Test Reports

Delivered batches of billets shall be identifiable and traceable. The manufacturer shall establish and maintain the records required and shall identify the products and their delivery documentation accordingly.

For each delivery, manufacturers shall supply the following information:

a) The cast number and cast analysis, including all specified elements and elements used for the calculation of the carbon equivalent value;

b) The carbon equivalent value;

c) The results of the tensile and rebend tests;

d) The mass per metre;

e) The manufacturing process route; and

f) The rolled on mill mark.

E.3.6.8.3 Reinforcement bars

The following tests which had been carried out on the Steel Manufacturers steel production during the past 6 months shall be submitted with his bid including documentary proof, ensuring his compliance with the given specifications. A minimum of 3 sets of tests carried in house together with 1 set carried out in an independent laboratory shall be submitted.

a) Tensile Testing

b) Bend / Re-bend Testing

c) Rib Geometry

d) Chemical Analysis

e) Nominal mass per meter & Cross sectional area

A successful Steel Manufacturers shall submit In house test certificates with the delivery of each major steel consignment of 100 Tonne to the site. The Steel Manufacturers shall carry out tests in an independent laboratory on specimen bars for 1 set of tests for every 1000 Tonne consignment.

The bars shall conform to the following;

E.3.6.8.4. Mechanical Properties of Reinforcement bars

Table E.6: Mechanical properties of reinforcement bars

Description	Standard/ Specification	
Yield Strength (MPa)	Absolute max. permissible value - 650	SLS 375:2009 Table 07
	Absolute min. permissible value - 500	SLS 375:2009 Table 07
Tensile Strength (MPa)	*Tensile / Yield Strength ratio ≥1.05*	SLS 375:2009 Table 07
Total elongation at maximum force, A_{gt}(%)	≥ 2.5	SLS 375:2009 Table 07
Total elongation at fracture, A_t(%)	≥ 14%	SLS 375:2009 Table 07
Re-bend Test	Should be pass	BS 4449: 2005

E.3.6.8.5. Chemical Properties of Reinforcement bars

Table E.7: Chemical properties of reinforcement bars

Description	Value or Description (value by mass (%))	Standard
Carbon, C	max.0.27	SLS 375: 2009 Table 2
Sulphur, S	max. 0.055	SLS 375: 2009 Table 2
Phosphorus, P	max. 0.055	SLS 375: 2009 Table 2
Copper, Cu	max. 0.85	SLS 375: 2009 Table 2
Nitrogen, N	max. 0.014	SLS 375: 2009 Table 2
Silicon, Si	max. 0.55	ASTM A706/A 706M -00 Cl.6.5
Manganese, Mn	max. 1.56	ASTM A706/A 706M -00 Cl.6.5
Carbon Equivalent (C.E)	≤ 0.52	SLS 375: 2009 Table 2

E.3.6.8.6 Surface Geometry of Reinforcement bars

Table E.8: Surface geometry of reinforcement bars

Description	Standard / Specification	
Transverse Rib Height(mm)	0.03d to 0.15d	BS 4449: 2005 + A2 : 2009 Table 8
Rib spacing (mm)	0.4d to 1.2d	
Rib Inclination (^{0})	35^0 - 75^0	

<table>
<tr><th>Description</th><th colspan="4">Standard / Specification</th></tr>
<tr><td>Longitudinal Rib Height (mm)</td><td colspan="3">≤0.10d</td><td>BS 4449: 2005 + A2 : 2009 cl.7.4.2.3</td></tr>
<tr><td colspan="5">Here "d" is nominal diameter of the product.</td></tr>
<tr><td rowspan="7">Cross sectional Area (mm^2)</td><td>Diameter</td><td>Area</td><td>Deviation</td><td rowspan="7">BS 4449: 2005 + A2: 2009 Table 7 & Cl. 7.3.2</td></tr>
<tr><td>10mm</td><td>78.5</td><td rowspan="6">Cross sectional area ±4.5%</td></tr>
<tr><td>12mm</td><td>113</td></tr>
<tr><td>16mm</td><td>201</td></tr>
<tr><td>20mm</td><td>314</td></tr>
<tr><td>25mm</td><td>491</td></tr>
<tr><td>32mm</td><td>804</td></tr>
<tr><td rowspan="7">Mass per meter (kg/m)</td><td>Diameter</td><td>Mass</td><td rowspan="7">Nominal Mass per meter ±4.5%</td><td rowspan="7">BS 4449: 2005 + A2: 2009 Table 7 & Cl. 7.3.2</td></tr>
<tr><td>10mm</td><td>0.617</td></tr>
<tr><td>12mm</td><td>0.888</td></tr>
<tr><td>16mm</td><td>1.58</td></tr>
<tr><td>20mm</td><td>2.47</td></tr>
<tr><td>25mm</td><td>3.85</td></tr>
<tr><td>32mm</td><td>6.31</td></tr>
</table>

E.3.6.8.7 Particular

In addition, the manufacturer's steel shall comply with the following requirements.

E.3.6.8.8 Quality Assurance Plan

The Steel Manufacturer shall submit the detail quality assurance plan followed and implemented within his steel mills. This shall include detail flow diagrams and schedules on the manner in which the **quality and process control** are integrated into the manufacturing process. Staff organization chart associated with the quality and process control together with CV's of key staff associated with the quality monitoring function shall be submitted.

Information in this submission shall include but not be limited to that given in the specimen table **Table E.9**. The specimen has been included to indicate the nature of the information being sought by the Purchaser.

E.3.6.8.9 In House Testing

The Steel Manufacturer shall submit with his bid his detail in-house testing regime for the production of steel reinforcement bars. The testing regime shall elaborate in detail the tests that shall be carried out as well as the frequency. The tests shall cover the mechanical properties as well as Rib geometry verification. The mechanical properties investigated shall include but not be limited to the following;

a) Profile (mm)

b) Weight per length (kg/m)

c) Yield Stress (MPa)

d) Ultimate Tensile Stress (MPa)

e) Elongation %

f) Bend /Rebend Test Results

E.3.6.8.10 Quality Controlling System

The Steel Manufacturer shall furnish details of the quality controlling system in place for his rolling mills covering the **Pre-Production, Production and Post-Production** stages of the plant. The Pre-production information should include but not be limited to Physical Properties of the steel billets; length deviations, twisting, concavity, camber, buckling & surface defects like cracks, shrinkage and scabs. The Chemical Composition of the steel billets (C, Mn, Si, S, *Cu*, *N* & P) should also be provided.

Checking and monitoring procedures associated with the production phase within the quenching area for hot worked bars (water purity, pressure, flow rate, finishing and tempering temperatures) shall be provided.

Checking and monitoring of Cold Worked bars shall include the process of twisting to achieve the required specifications (Measuring procedure of number of twists, measurement of the pitch of the spiral etc.). The frequency of the inspections, checks and tests in the cooling bed area (mass per unit length, Rib height, Rib width, Core diameter and Test for mechanical properties eg: YS, UTS, EL% & Bending) shall also be provided.

E 3.6.8.11 Inspection and Auditing

The successful Supplier shall allow the Purchaser's staff and/or their authorized staff (i.e. Consultant's staff etc.) to inspect and audit the all steps of manufacturing process including raw material yards, factory, storage yard etc.) without any hindrance during the supply period of

material. The Supplier shall also include in his bid his arrangements and facilities for such inspection and audit procedures.

E 3.6.8.12 Submission documents with the bid

The following documents shall be submitted with the bid.

a) Previous Mill Certificates (clause E.3.6.8.1)

b) Previous Test Certificates (clause E.3.6.8.3)

c) Quality Assurance Plan (clause E.3.6.8.8) – Typical example given in Appendix A

d) Details of the Quality Assurance staff with their CVs. (clause E.3.6.8.8)

e) In house testing regime (clause E.3.6.8.9)

f) Quality Controlling System (clause E.3.6.8.10)

g) Arrangements for Inspection and Auditing for the Purchaser and his representatives. (clause E.3.6.8.11)

Table E.9: Quality assurance plan

Process Name	Quality Character to be Checked	Process Control Method			Inspection/ Test Parameters
		Chart or Check Sheet Ref.	Person/s Responsible for Process Control	Sampling Frequency	
Receipt of raw material	Physical Dimensions, Heat Number		Store man/ Technical Assistant (Raw material & Furnace)	Per lorry load	Size, Weight, Count
Storage of raw materials	Physical Dimensions & Consignment		Technical Assistant (Raw material & Furnace)	Per lorry load	Consignment Length & Cross Section, Heat Number
Inspection of raw materials	Physical Dimensions , Appearance chemical Properties		Quality control Technologist, (Q.A. Dept.)		Bending, Twist Rhomboidity, Length end Curvature, Quality of steel, cross section, Chemical composition
Cutting & Stacking of billets	Length Perpendicularity of cut		Technical Assistant (Raw Materials &	Nos. of Billets	Visual, Length

Process Name	Quality Character to be Checked	Process Control Method			Inspection/ Test Parameters
		Chart or Check Sheet Ref.	Person/s Responsible for Process Control	Sampling Frequency	
			Furnace)		
Charging of billets to the Furnace	Physical Dimensions count & Consignment		Technical Assistant (Raw Materials & Furnace)	Nos. of Billets	Count Section Length Consignment, Heat Number
Heating of billets in the furnace	Heat		Technical Assistant (Raw Materials & Furnace)	Per Hour	Temperature
Discharging of billets	Physical Dimensions & Consignment		Technical Assistants (Furnace &Billet Yard)	Nos. of Billets	Length, Section & Consignment Temperature
(For Non Twisting bars) Rolling, Quenching & Tempering process control	Physical Dimensions & Appearance		Quality Control Technician (Process control) Technical Assistants Production & Pulpit		Tr. Rib height & width, Rib inclination Rib height, Rib width, Rib spacing unit weight & section surface finish & Roundness
Cutting, inspection & grading at cold shear			Quality Control Technologist (Q.A Dept.)/ Q.C Technician		Visual, Tr. Rib height & width, Unit weight, Rib height, Rib width Diameter & Section Yield Strength, Unit weight, Bendability Ultimate Tensile Strength, Elongation Diameter , Profile & Section
Bundling, labeling & sending to Ware House for weighing & stacking	Profile Identification No. Mechanical Properties		Quality control technician, (Q.A Dept.)		Weight, Profile, Length, Date &shift Consignment

Process Name	Quality Character to be Checked	Process Control Method			Inspection/ Test Parameters
		Chart or Check Sheet Ref.	Person/s Responsible for Process Control	Sampling Frequency	
Machining of rolls at Roll Preparation Shop	Groove Dimensions Roll Diameter		Technical Assistant (Roll Preparation Shop)		Depth of cut & Groove width, Roll diameter, core diameter, Surface Defects(visual)
TR.Rib cutting on Finishing Stand Rolls	Roll Diameter Tr.Rib Dimensions		Technical Assistant (Roll Preparation Shop)		Tr. Rib Height Tr. Rib Width Tr.Rib Spacing Tr.Rib Inclination
Supply of Roller Guides	Physical Dimensions of Guide rolls & passes		Technical Assistant (Guide Assembly & Maintenance shop)		Alignment (Visual) Pass height & width Roll height & diameter
Supply of Stripper passes	Physical Dimensions of Stripper guide & passes		Technical Assistants (Guide Assembly & Maintenance shop)		Stripper length & width (visual)
Supply of Friction guides	Physical Dimensions of guide pass		Technical Assistant (Guide Shop)		Surface finish (Visual) Diameter
For Twisting Bars Stacking semi-finished bars at finishing	Profile, identification No., Physical Dimensions		Technical Assistant (Finishing Area)	Every bundle	Visual, Weight, Profile, Grade, Length, Date & Shift
Twisting & Inspection at the twisting Area	Physical Dimensions, Pitch parameters & Mechanical Properties		Quality Control Technician		Pitch of twist, length, unit weight, Yield Strength, UTS, Elongation, Bendability

* Tr.Rib –Transverse Rib

E.3.6.8.13 Inspections and Tests

The following inspections and tests in whole or part as required by the Purchaser to be performed or proof documents shall be produced by the Bidder to establish his compliance with the given Specification.

a) Tensile Testing

b) Fatigue Testing (optional)

c) Re-bend Testing

d) Chemical Analysis

e) Rib Geometry

The quality of reinforcement steel shall be tested after the delivery of each *100 Tonne* by the Purchaser, using a test method acceptable to the purchaser for the above properties from an independent institute acceptable to the Purchaser at the Cost of the Steel Manufacturer.

E.3.7. DESIGN, SUPPLY AND INSTALLATION OF PRESTRESSING SYSTEMS

E.3.7.1. General

Prestressed Concrete Works shall consist of prestressing precast or cast-in-place concrete by furnishing, placing, and tensioning of prestressing steel in accordance with details shown on the approved drawings, and as specified in these specifications and the special provisions or as directed by the Engineer. It includes prestressing by either the pretensioning or posttensioning methods or by a combination of these methods.

This work shall include the furnishing and installation of any appurtenant items necessary for the particular prestressing system to be used, including but not limited to ducts, anchorage assemblies and grout used for pressure grouting ducts.

Post-tensioning work shall consist of designing, supply and installation of post-tensioning materials for the post-tensioned slabs/beams. The work shall be carried out in accordance with the forms, shapes and dimensions shown on the approved Drawings and these Specifications or as directed by the Engineer.

When structural members are to be constructed with part of the reinforcement pretensioned and part post-tensioned, the applicable requirement of this Specification shall apply to each method.

E.3.7.2. References

- Standards

    1. BS 5896:1980 -High tensile steel wire and strand for the pre-stressing of concrete.

2. BS 8110:1997 -Structural use of Concrete.
3. BS 5896 High tensile steel wire and strand for the pre-stressing of concrete.

- Where more than one applicable Standard are specified or in case of differences with this Specification, use the most restrictive provisions and recommendation or as directed by the Engineer.

E.3.7.3. Submittals

Prior to starting Pre tensioning/ Post-tensioning work, the Successful Proposer/ Contractor shall submit the Drawings, Reports and Procedures for review and approval of the Engineer. These submittals shall include the following;

1. Design information.
2. General notes, specifically for Prestressed / post-tensioned structural system.
3. Shop drawings including Tendon layout, dimensions, location of the tendons in the horizontal plane. Openings and anchorages and show all openings in slabs and beams. Clearly designate each tendon.
4. Method Statement.
5. Material Submission.
6. Quality Manual
7. Inspection and Test Plan.
8. Programme in line with the Contractor's Programme.
9. As built drawings after completion of the work.

- **Manufacturer's Data: Submit for review and approval.**

1. Sample hardware, including but not limited to Anchorage system, strand, wedges, pocket formers, and other sub-assemblies required for complete installation including all accessories required to complete the system.
2. Mill Certificates: Submitting certified mill reports of post-tensioning steel (strand) immediately upon shipment indicating compliance with specified requirements for all material that is to be delivered to the project.
3. Equipment Calibration: Submitting certification of the calibration of jack and gauge sets.

4. Certifications and other data as may be further required to demonstrate compliance with other items in this section.

- **Calculations:**

1. Design calculations and all the relevant supporting documents including the computer analysis models shall be submitted to the Engineer of the project for his review and approval.

2. Elongation calculations shall be submitted for every floor level before stressing for review and approval of the Engineer.

- **Checklists: The Successful Proposer/ Contactor shall provide their own check lists for the following operations before execute the same.**

1. Checklist for installation operation.

2. Checklist for stressing operation.

3. Checklist for grouting operation.

- **Stressing Reports: The Successful Proposer/ Contactor shall provide the information described below for review and approval of the Engineer.**

a. Floor pour and tendon identification numbers. Calculated elongation and actual measured elongation for each jacking point, and total for each tendon.

b. Stressing jack serial number, pressure gauge serial number and required gauge pressure to be applied to tendon.

c. Date of stressing operation and signature of the Subcontractor's engineer / supervisor and Contractor's / Engineer's inspector witnessing the operation.

- **Further submissions shall be made for any change of material quality or source and the Engineer's approval to be obtained before the new materials are used.**

E.3.7.4. Materials

E.3.7.4.1. Pre-stressing Steel and Anchorages

Pre-stressing reinforcement shall be high-strength seven-wire strand, high strength steel wire of the grade and type called for on the plans or in the special provisions and shall conform to the

requirements of the following specifications.

- **Strands**

Strands shall be stress relived seven wire low relaxation super stabilised strands complying with BS 5896 or uncoated seven wire strands complying with the requirements of AASHTO M203 (ASTM A416) Supplement S1 (low relaxation) and as approved by the Engineer. To ensure that the strand pays off straight, the pre-stressing strand, however manufactured, shall be in coils of sufficiently large diameter.

- **Steel Wire**

Steel wire shall be uncoated stress-relieved steel wire complying with the requirements of AASHTO M204 (ASTM A421) or BS 5896. Unless otherwise agreed by the Engineer low relaxation and normal relaxation wire shall be in coils of sufficiently large diameter to ensure that the wire pays off straight.

- **Post-tensioning Anchorages and Coupler**

Anchorages shall be cast units and assemblies that are standard with the pre-stressing manufacturer's system and to the review by the Engineer.

Anchorages shall be tested in accordance with BS 4447 or equivalent code and construction specification. Proprietary anchorages shall be handled and used strictly in accordance with the manufacturer's instructions and recommendations.

All anchorages and couplers shall develop at least 95% of the minimum specified ultimate strength of the pre-stressing steel, when tested in an unbonded state, without exceeding anticipated set. The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself. Couplers and/or coupler components shall be enclosed in housing long enough to permit the necessary movements. Couplers for tendons shall be used only at locations specifically required and/or approved by the Engineer and couplers shall not be used at points of sharp tendon curvature.

- **Identification and Testing**

All wire, strand to be transferred to the site shall be numbered and tagged for identification purposes. Each cable shall be tagged with its number from which the coil numbers of the steel used can be identified.

Cables shall not be kinked or twisted. Individual wires and strands of which extensions are to be measured shall be readily identifiable at each end of the member. The strand that has come unraveled shall not be used.

Each lot of wire and each reel of strand reinforcement shall be accompanied by a manufacturer's certificate of compliance, a mill certificate, and a test report. The mill certificate and test report shall include the chemical composition for wires, cross- sectional area, yield and ultimate strengths, elongation at rupture, modulus or elasticity and the stress strain curve for the actual pre-stressing steel intended for use. All values certified shall be based on test values and nominal sectional area of the material being certified.

The Contractor shall furnish to the Engineer for verification testing the sample described here. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the Inspector.

All samples submitted shall be representative of the lot to be furnished and in the case of wire or strand, shall be taken from the same master roll.

The actual strength of the pre-stressing steel shall not be less than specified by the applicable British or ASTM Standard, and shall be determined by tests of representative samples of the tendon material in conformance with the appropriate Standards.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

- **Pre-tensioning & post tensioning Tendon Samples**

Selection of samples shall be done as per the standards.

- **Anchorage Assemblies and Couplers**

The Contractor shall perform the testing and shall furnish certified copies of test results that indicate conformance with the specified requirements prior to installation of anchorages or couplers when dynamic testing is required. The Contractor shall furnish for testing, one specimen of each size of pre-stressing tendon, including couplings, of the selected type, with end fittings and anchorage assembly attached, for strength tests only.

- **Protection of Pre-stressing Steel**

All pre-stressing steel shall be protected against physical damage work hardening or heating and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Pre-stressing steel shall also be free of deleterious material such as grease, oil, wax or paint. Pre-stressing steel that has sustained physical damage at any time shall be rejected and the development of pitting or other results of corrosion, other than rust stain, shall be cause for rejection.

All pre-stressing steel shall be stored clear of the ground and be protected from the weather, from

splashes from any other materials and from splashes from the cutting operation of an oxy-acetylene torch, or arc welding activity in the vicinity. In no circumstances shall pre-stressing steel after manufacture be subjected to any welding operation, or heat treatment or metallic coating such as galvanizing.

All anchorages, end fittings, couplers, and exposed tendons, which will not be encased in concrete or grout in the completed work, shall be permanently protected against corrosion.

E.3.7.4.2. Corrosion Protection

All the pre-stressing bars shall be protected against corrosion. Water-soluble oil may be used on tendons as a corrosion protection when approved.

E.3.7.4.3. Ducts

The system of ducts, duct connectors, grouting connections, vents, vent connectors, drains, transition to anchorages and caps for anchors shall form a complete encapsulation for the tendon which is resistant to ingress of air and water. Ducts shall be a corrosion resistant durable material. Ducting which may degrade or corrode during the expected life of the structure shall not be permitted.

Where ducts are non-conductive, metal parts of the anchorages shall be electrically bonded to the adjacent reinforcement at each end of the tendon and electrical continuity of the structure over the length of the tendon shall be confirmed by testing.

For duct fitting, coupling and transition fittings for ducts formed by sheathing shall be of a material compatible with the ducts and corrosion resistant, and shall be cement paste intrusion proof and of sufficient strength to prevent distortion or displacement of the ducts during concrete placement. All ducts or anchorage assemblies shall be provided with pipes or other suitable connections at each end of the duct for the injection of grout after pre-stressing.

E.3.7.5. Placement of ducts and steel

The Contractor shall submit method Statements with full details of placement of steel and ducts and get approval by the Engineer.

E.3.7.5.1. Placement of Ducts

Ducts shall be rigidly supported at the proper locations by ties to reinforcing steel that are adequate to prevent displacement during concreting and supplementary support bars shall be used where

needed to maintain proper alignment of the duct. The tolerance in location of the centerline of the duct shall be 5mm. Joints between sections of duct shall be coupled with positive connections that not to be changed the angle and will prevent the intrusion of cement paste. All unintentional holes or openings in the duct must be repaired prior to concrete placing and grout openings and vents must be securely anchored to the duct and to either the forms or to reinforcing steel. Internal and external surfaces of ducts shall be cleaned and free from pitting at the time of incorporation in the work. After installation in the forms, the ends of ducts shall be covered.

E.3.7.5.2. Vents and Drains

All ducts for continuous structures shall be vented at the high points of the duct profile, except where the curvature is small, as in continuous slabs and at additional locations where necessary. At low point in ducts where needed to prevent the accumulation of water, drains shall be installed and shall remain open until grouting is started. The ends of vents and drains shall be removed 25mm below the surface of the concrete after grouting has been completed, and the void filled with flowable non-shrink mortar to a level flush with the adjacent concrete surface.

E.3.7.5.3. Placement of Pre-stressing Steel

- **Placement for Pre-tensioning**

Pre-stressing steel shall be accurately installed in the forms and held in place by the stressing jack or temporary anchors. When tendons are to be draped shall be done by hold-down devices which used at all points of change in slope of tendon trajectory shall be of an approved low-friction type.

- **Placement for Post-Tensioning**

All pre-stressing steel pre-assembled in ducts and installed prior to the placement of concrete shall be accurately placed and held in position during concrete placement. Pre-installing of tendons shall be permitted only when the total length of tendons does not exceed 35m so that during concrete initial setting period the tendon can be moved to ensure that there is no concrete blockage inside the duct and tendons will be free to move when stressing.

When the pre-stressing steel is installed after the concrete has been placed, the Contractor shall demonstrate to the satisfaction of the Engineer that the ducts are free of water and debris immediately prior to installation of the steel. The total number of strands in an individual tendon may be pulled into the duct as a unit, or the individual strand may be pulled or pushed through the duct.

Method of protection of steel after installation shall be included in the method statement which is to be submitted by the contractor for the Engineers approval.

E.3.7.6. Tensioning

E.3.7.6.1. General Tensioning Requirements

- Pre-stressing steel shall be tensioned by hydraulic jacks so as to produce the forces shown in the approved working drawing with appropriate allowances for all losses. For post-tensioned work the losses shall also include the anchor set loss appropriate for the anchorage system employed.
- For pre-tensioned and post-tensioned members, the strand jacking stress shall be as specified in the design.
- The method of tensioning shall be one of the following as specified or approved:
    - In pre-tensioning; which the pre-stressing strand or tendons are stressed prior to being embedded in the concrete placed for the member. After the concrete has attained the required strength, the pre-stressing force is released from the external anchorages and transferred, by bond, into the concrete.
    - In post-tensioning; which the reinforcing tendons are installed in voids or ducts within the concrete and are stressed and anchored against the concrete after the development of the required concrete strength. The voids or ducts are pressure-grouted shall be done as a final operation under this method.
- Concrete Strength
    - Until the concrete has reached the strength specified for initial stressing, pre-stressing forces shall not be applied or transferred to the concrete. The Contractor shall cast and test sufficient cubes to demonstrate this to the Engineer.
- Pre-stressing Equipment
    - Hydraulic jacks which shall be capable of imposing a controlled total force gradually, are used to stress tendons and they shall be capable of providing and sustaining the necessary forces and shall be equipped with either a pressure gauge or a load cell for determining the jacking stress.
    - During the pre-stressing operations of the project for verifying pressure gauge readings, master gauges shall be supplied on site.
    - Re-calibration of gauges shall be repeated at least annually and whenever gauge

pressures and elongations indicate materially different stresses.

- All cutting of wire, strand shall be carried out using either:
- A high-speed abrasive cutting wheel or friction saw at not less than one diameter from the anchor, or any other mechanical method approved by the Engineer; or
- An oxy-acetylene cutting flame, using excess oxygen to ensure a cutting rather than a melting action, not less than 75mm from the anchor. The temperature of the tendon adjacent to the anchor shall not be greater than 200°C. Care shall be taken that neither the flame nor splashes come into contact with the anchorages or tendons.

- Sequence of Stressing
  - The stressing of post-tensioning tendons and the release of pre-tensioned tendons shall be done in a sequence that produces a minimum of eccentric force in the member when the sequence of stressing individual tendons is not otherwise specified.
- Measurement of Stress
  - Contractor shall provide a record of gauge pressures and tendon elongations for each tendon Engineer's review. Elongations shall be measured to an accuracy of 1mm. Stressing tails of post-tensioned tendons shall not be cut off until the stressing records have been approved. A facility shall also be provided to measure any movement of the tendon in the gripping devices.
- Before elongation readings are started all tendons shall be tensioned to a preliminary force, which is to be in between 5 and 25 percent of the final jacking force, as necessary to eliminate any take-up in the tensioning system. The initial force shall be measured by a dynamometer or by other approved method, so that its amount can be used as a check against elongation as computed and as measured. Each strand shall be marked prior to final stressing to permit measurement of elongation and to ensure that all anchor wedges set properly.

E.3.7.6.2. Pre-tensioning Method Requirements

- Stressing shall be accomplished by either single strand stressing or multiple strand stressing. The amount of stress to be given each strand shall be as shown in the approved working drawings.
- All strand to be stressed in a group (multiple strand stressing) shall be brought to a uniform

initial tension prior to being given their full pre-tensioning. The amount of the initial tensioning force shall be within the range specified in General tensioning requirement section and shall be the minimum required to eliminate all slack and to equalize the stresses in the tendons as determined by the Engineer.

- To ensure that the wires or strands are maintained in their proper position during concreting, sufficient locator plates shall be distributed throughout the length of the bed, when straight tendons are used in the long-line method of pre-tensioning. Where a number of units are made in line, they shall be free to slide in the direction of their length and thus permit transfer of the pre-stressing force to the concrete along the whole line.
- In the individual mould system, the moulds shall be sufficiently rigid to provide the reaction to the pre-stressing force without distortion.
- Approved low-friction devices shall be used at all points of change in slope of tendon trajectory when tensioning draped pre-tensioned strands, regardless of the tensioning method used. For single tendons, the deflector in contact with the tendon shall have a radius of not less than 5 times the tendon diameter for wire or 10 times the tendon diameter for strand, and the total angle of deflection shall not exceed 15°.
- If the load for a draped strand, as determined by elongation measurements, is more than 5 percent less than that indicated by the jack gauges, the strand shall be tensioned from both ends of the bed and the load as computed from the sum of elongation at both ends shall agree within 5 percent of that indicated by the jack gauges.
- Pre-stressing steel strands in pre-tensioned members, if tensioned individually, shall be checked by the Contractor for loss of pre-stress not more than 3 hours prior to placing concrete f`or the members, when ordered by the Engineer. The method and equipment for checking the loss of pre-stress shall be subject to the review by the Engineer. All strands that show a loss of pre-stress in excess of 3 percent shall be re-tensioned to the original computed jacking stress.
- Until the concrete has reached the compressive strength required at time of transfer of stress to concrete, stress on all strands including hold down/hold up forces shall be maintained between anchorages and transfer of stress shall take place slowly to minimize shock.
- When pre-stressing steel in pre-tensioned members is tensioned at a temperature more than 14°C lower than the estimated temperature of the concrete and the pre-stressing steel at the time of initial set of the concrete, the calculated elongation of the pre-stressing steel shall

be increased to compensate for the loss in stress, due to the change in temperature, but in no case shall the jacking stress exceed 80% of the specified minimum ultimate tensile strength of the pre-stressing steel.

- Strand splicing methods and devices shall be approved by the Engineer. Only one splice per strand will be permitted, when single strand jacking is used. When multi-strand jacking is used, either all strands shall be spliced or no more than 10 percent of the strands shall be spliced.

E.3.7.6.3. Post-Tensioning Method Requirements.

- Prior to post-tensioning any member, the Contractor shall demonstrate to the satisfaction of the Engineer that the pre-stressing steel is free and unbonded in the duct.
- All strands in each tendon, except for those in flat ducts with not more than four strands, shall be stressed simultaneously with a multi-strand jack. Tensioning shall be accomplished so as to provide the forces and elongations specified in Section General tensioning requirement except as provided herein or when shown in the approved working drawings, tendons in continuous post-tensioned members shall be tensioned by jacking at each end of the tendon.
- All post-tensioning shall be by means of hydraulic jacks equipped with accurate reading calibrated hydraulic pressure gauges to permit the stress in the pre-stressing steel to be computed at any time. A certified calibration curve shall be submitted for each jacking system. In the event inconsistencies occur between the measured elongation and the jack gauge reading, the jack gauge shall be immediately be recalibrated. In the event still further discrepancies occur, the cause shall be determined and reported to the Engineer.

- Deflectors in contact with tendons shall have a radius of not less than 50 times the diameter of the tendon, and unless otherwise agreed by the Engineer, the total angle of deflection shall not exceed 15°.
- Stressing shall continue until the required extension and tendon load are reached or are approved by the Engineer. Elongation is the preferred method of stress determination wherever possible. The tendons shall be tensioned to the total forces as specified in the design.

- Elongation shall be measured to an accuracy of 1mm. Elongation tolerances for individual tendons, based on agreed and approved friction coefficients (established through Friction Tests) and material properties determined from laboratory tests, shall be within + 7% of the theoretical value. Prior to commencing pre-stressing work, the Contractor shall submit elongation calculations to the Engineer for review. These elongations should be based on actual area and elastic modulus values of the strands making a single tendon which in case of a single tendon made-up of more than one pre-stressing steel coil, weighted average values of strand areas and Elastic modulus shall be used in the calculations.
- After the tendons have been anchored, the force exerted by the tensioning apparatus shall be decreased gradually and steadily so as to avoid shock to the tendon or the anchorage. Full records shall be kept of all tensioning operations, including the measured extensions, pressure-gauge or load-cell readings, and the amount of draw-in at each anchorage. Copies of these records shall be supplied to the Engineer within 24 hours of each tensioning operation.
- Unless otherwise agreed by the Engineer tendons shall not be cut less than 3 days after grouting.
- Friction Test
- Friction losses estimated on the basis of friction and wobble coefficients as in the design. Total friction losses shall be estimated by carrying out Friction Test on one tendon for each tendon configuration at the very start of the post-tensioning to check and compare with that obtained using theoretical coefficient values from the Contract drawings. In case the friction losses in tests exceed the computed losses, all wires shall be relieved and lubricated using water-soluble oil and re-tensioned. For the calculation of theoretical elongations, values of friction and wobble coefficients obtained in Friction Test shall be used.

Sequence of pre-tensioning and posttensioning shall be included in the method statements to be approved by the Engineer prior to commence work.

E.3.7.7. Grouting

E.3.7.7.1. General

The Contractor shall undertake grout trials in accordance with the details described here. The grouting methods and procedures proposed by the Contractor will ensure that grout completely fills the ducts and surrounds the pre-stressing steel.

The Contractor shall submit at least 4 weeks before on-site trials a detailed method statement covering proposed materials, duct, anchorage and vent arrangements, personnel, equipment grouting procedures and quality control for Engineer's review.

E.3.7.7.2. Grout Materials

- The properties of the grout, shall be assessed for suitability for the intended purpose sufficiently in advance of grouting operations. All retrials shall be at the Contractor's expense.
- The materials assessment shall consist of the preparation of the grout, made with the materials and using the plant and personnel proposed for use on site, and the testing of it in accordance with this section. The preparation shall be carried out under conditions of temperature expected on site. If grouting operations are likely to cover different seasons, the assessment shall include the range of expected temperatures.
- The sources of materials and procedures approved as a result of satisfactory trials shall not be changed without the written review of the Engineer.
- Unless otherwise instructed or agreed by the Engineer as a result of grouting trials, the grout shall consist only of Portland cement complying with BS12 Class 42.5 N, admixtures complying with this Section and water complying with BS3148.
- The materials used shall be such that the chloride ion content of the grout shall not exceed 0.1% chlorides by mass of the cement.

E.3.7.7.3. Ducts

The system of ducts, duct connectors grouting connections, vents, vent connections, drains, transitions to anchorage and caps for anchorages shall form a complete air and water tight encapsulation for the tendons. Each ducting assembly complete shall be pressure tested for leaks using air prior to concreting. The wall thickness of ducts after tensioning is not less than 1.5mm and the duct shall transmit full bond strength from the tendons to the surrounding concrete over a length no greater than 40 duct diameters.

Air vents of at least 25mm internal diameter shall be provided at the anchorages and in the ducts at troughs and crests and 400mm beyond each intermediate crest in the direction of grout flow, and elsewhere as required by the Engineer. All ducts shall be kept free from standing water at all times and shall be thoroughly clean before grouting. All anchorages shall be sealed by caps and fitted with grouting connections and vents. Air vents on each tendon shall be identified by labelling and shall be protected against damage at all times.

Air vents at high points shall extend to a minimum of 500mm above the highest point on the duct profile.

E.3.7.7.4. Grouting Equipment

Grouting equipment shall consist of mixer, a storage reservoir and a pump with all the necessary connection hoses, valves, measuring devices for water, cement and admixtures and testing equipment. The mixing equipment shall be capable of producing a grout of homogeneous consistency and shall be capable of providing a continuous supply to the injection equipment. The equipment shall have a constant delivery pressure of less than 1 N/mm2, it shall be equipped with a pressure gauge and shall prevent pressures above 2 N/mm2. All piping to the grout pump shall have a minimum number of bends, valves and changes in diameter and shall incorporate a sampling Tee with stop cock. The equipment shall be capable of maintaining pressure on completely grouted ducts and shall be fitted with a valve that can be locked off without loss of pressure in the duct.

E.3.7.7.5. Batching and Mixing of Grout

All materials shall be batched by mass except the mixing water and liquid admixtures, which may be batched, by mass or volume. The accuracy of batching shall be ± 2% for cement and admixtures and ± 1% of mixing water of the quantities specified. The mixing water shall include the water content of liquid admixtures. The w/c ratio shall be kept as low as possible having regard to the required plastic properties of the grout. The maximum w/c ratio shall be 0.40. The temperature of freshly mixed grout shall be between 5°C and 25°C.

E.3.7.7.6. Injecting Grout

A check shall be done by blowing through the system with dry, oil-free air and proving each vent in turn to ensure the ducts, vents, inlets and outlets are capable of accepting injection of the grout. Grouting of the ducts shall be carried out as soon as is practicable after the tendons have been stressed and the Engineer’s written agreement to commence has been obtained. Injection shall be continuous, and slow enough to avoid producing segregation of the grout. Grout shall be allowed to flow from each vent and the free end of the duct until its consistency is equivalent to that of the grout injected. The injection tubes shall be sealed off under pressure of 0.5N/mm2 which shall be maintained for at least one minute.

The filled ducts shall not be subjected to shock or vibration within 24 hours of grouting.

If, in the opinion of the Engineer, there is cause for doubt that the ducts are completely filled with grout, the Engineer may require non-destructive testing to be carried out.

The Contractor shall keep full records of grouting for each duct including the date each duct was

grouted, the proportion of the grout and any admixtures used, the pressure, details of any interruptions and topping up required. Grout vents shall be positively sealed to be waterproof on completion of grouting.

E.3.7.7.7. Properties of Grout

The fluidity of the grout during the injection period shall be high enough for it to be pumped effectively and adequately to fill the duct, but low enough to expel the air and any water in the sheath.

The material used shall comply with the standard and shall be taken the prior approval from the Engineer.

The bleeding of the grout shall be sufficiently low to prevent excessive segregation and settlement of the grout materials. The volume change of the grout shall be within the range 0% to +5%. For grouts with expanding agents there shall be no decrease in volume.

The compressive strength of 100mm cubes made of the grout shall be in accordance with BS 1881.

E.3.7.7.8. The Testing of Grout

The testing of grout shall be done accordance with the standards of BS 1881.

Procedures of tests shall be submitted by the Contractor for review shall include but not limited to.

- Fluidity Test
- Bleeding Test
- Sieve Test

E.3.7.7.9. Admixtures

Admixtures shall be used to achieve a low water/cement ratio and impart good fluidity, minimum bleed and volume stability or expansion to the grout. They should be added on site during the mixing process and used in accordance with manufacturer's recommendations. Admixtures may be used singly or in combination to obtain the required grout performance and which used in combination shall be checked for compatibility. Admixtures shall not contain substances in quantities, which will adversely affect the grout or the corrosion protection of the pre-stressing steel. Thiocyante, nitrates, formate and sulphides shall not be used in admixtures. Admixture shall not segregate and shall be uniform in colour. The Contractor shall submit and get approved of trial mixers which are done to determine the optimum dosage of admixture. The method of measuring dosage and checking weights of pre-packed dry materials shall be agreed with the Engineer.

E.3.7.7.10. Grouting Trials

The Contractor shall provide full documentary evidence, to the satisfaction of the Engineer, of successful grouting trials on a similar project, using similar grout and similar equipment. All relevant details of ducts, vents, duct supports, pre-stressing anchorages, pre-stressing strands, grout inlets and outlets shall be incorporated.

All system methods and materials are to be those proposed for the permanent works and shall have been submitted to the Engineer as part of the detailed method statement required in this Section.

Grouting and testing shall be carried out in accordance with the Specification.

After 3 days the Contractor shall carefully cut and expose cross-sections and longitudinal sections of the duct and anchorages where directed by the Engineer to demonstrate that the duct is fully grouted. Where polyethylene ducts are used, the Contractor may propose proven non-destructive imaging procedures as an alternative method of verification of full filling of the duct with grout subject to the approval of the Engineer. A report shall be prepared by the Contractor including full details of the trial, testing results and photographs of the cut sections. Pre-stressing for the permanent works will not be permitted without the written review by the Engineer to the grouting procedures and formal acceptance of the results of the grouting trial or the documentary evidence of previous grouting trials.

E.3.7.7.11. Protection of Tendons

The pre-stressing tendons shall be protected by cement grout within a pressure tested completely sealed encapsulation. Metal parts of anchorages shall be electrically bonded to the adjacent reinforcement at each end of the tendon. Electrical continuity of the structure over the length of the tendon shall be tested.

E.3.7.8. Quality Assurance

Successful Proposer/ Contactor shall maintain the quality of work according to the approved Quality Manual. It shall contain the following details to maintain the quality.

1. Introduction.
2. Materials.
3. Material Tests.
4. Work Procedures.
5. Acceptable Tolerances for each operation.

6. Check list for each operation.
7. Study guidelines prior to the relevant operation.
8. Actions to be taken on site to rectification.
9. Further investigations.

E.3.8. STRUCTURAL STEEL

E.3.8.1. Standards

E.3.8.1.1.

For the structural steelwork the following codes and standards will be applicable.

BS 449 : Specification for the use of structural steel in building.

BS 4360 : Specification for weldable structural steels,1986

E.3.8.1.2.

Unless otherwise specified the structural steel to be used shall be mild steel grade 43.

E.3.8.1.3

All weld metal shall be suitable steel relative to the parent metal of the structure and all electrodes used for manual welding shall conform with B.S 639. Continuous electrodes for machine welding shall be to the approval of the Engineer. All welding must conform to B.S. 5135.

E.3.8.1.4

Site-bolted joints will normally be made using general grade high strength friction grip (H.S.F.G.) bolts conform with BS 4395, and conform with BS 4190.

E.3.8.2.General

E.3.8.2.1

In general, shop joints shall be made by welding and site joints by bolting. Site welding will not be permitted without the express approval of the Engineer.

E.3.8.2.2

Contact between galvanized steel members and aluminium surfaces is to be prevented by means of a layer of P.V.C self adhesive plastic tape “Densochrome” tape or similar approved material.

E.3.8.3. Drawings and calculations

E.3.8.3.1

The Contractor shall check dimensions on all shop drawings with the dimensions on the Contract drawings before start of manufacturing of the relevant items.

E.3.8.3.2

Should and discrepancies occur between the Contract drawings and the Specification, the matter is to be referred immediately to the Engineer for decision.

E.3.8.3.3

All steel members shown on the Contract drawings are based on West European Standards, Dimensions, weights and strengths. In case the specified sizes are not available, the Contractor shall submit alternatives which shall be to the approval of the Engineer in all respects.

E.3.8.3.4

The Contractor shall prepare and submit detailed working drawings for the structural steelwork for the Engineer‟s approval if an alternative is to be offered to the Architect‟s design. Detailed design, fabrication, erection etc. shall comply with all requirements of B.S 449 including amendments.

E.3.8.3.5

The Contractor shall prepare and submit all calculations and shop drawings for all parts of the steel structures and all detail drawings of all connections in welded, bolted or riveted constructions for the Engineer‟s approval before manufacturing, The Engineer‟s approval does not release the Contractor from his responsibilities for the structure and the dimensions on such shop drawings.

E.3.8.3.6

At the Contractor‟s request, the Engineer will supply design calculations for information only.

E.3.8.3.7

The Contractor shall prepare assembly drawings showing the location, position and reference numbers of all components including fixing materials and sequences of erection and installation to the approval of the Engineer.

E.3.8.3.8

Any damage to materials on the site or other storage areas due to inadequate precautions being taken during the erection of steelwork shall be made good as required by the Engineer at the

Contractor‟s expense.

E.3.8.4. Scope of work

E.3.8.4.1

Steel work to be supplied and delivered according to the drawings and specifications comprises all structural steel works including the necessary anchors, base plates, head plates, connection plates, stiffening plates, bolts, nuts, washers, temporary bracing and additional rails required for the fixing of the roofing and cladding etc.

E.3.8.4.2

The Contractor shall supply and fix all mild steel profiles such as mild steel angles to be welded to various structural steel frame members to receive block work, mild steel plates at columns at corners etc. According to the structural and Architectural drawings.

E.3.8.4.3

All structural steel to be hot-dip galvanized. Damages to the layer to be touched – up immediately upon discovery or infliction. All excess to be removed carefully. The finished surfaces shall be clean.

E.3.8.4.4

The Contractor shall supply the Engineer with test certificates obtained from the rolling mills with each delivery of structural steel and reinforcement steel.

E.3.8.5. Welding

E.3.8.5.1

Machine welding shall be carried out using approved machines sufficiently supervised by qualified operators and hand welding shall be executed in an efficient manner by fully qualified workmen equipped with plant suitable for the purpose. All welding tests shall comply with B.S 4870 and 4871 so far as applicable and except as modified in this Specification.

E.3.8.5.2

The manipulators and the sequence of welding shall be suitable for the work, and

shall be subject to the Engineer‟s approval before welding is commenced.

E.3.8.5.3

Welding procedure shall be such that distortion is reduced to a minimum and local distortion is rendered negligible in the final structure.

E.3.8.5.4

Surfaces to be welded shall be properly prepared in accordance with accepted standards and during welding shall be kept clean and free from all extraneous matter.

E.3.8.5.6

All welds shall be finished full and made with the proper number of runs, the welds being kept free of slag instrusions and all adhering slag being carefully removed from the exposed surfaces immediately after each run.

E.3.8.5.7

Approval of any welding procedure shall not relieve the Contractor of his responsibility for correct welding and for the minimising of distortion in the finished structure.

E. 3.8.5.8

Only skilled welding operators who satisfy the appropriate welding tests specified in the relevant Standards shall be employed on welding.

E.3.8.5.9

Notwithstanding any routine testing of operators by the Contractor the Engineer reserves the right to have any welding operator re-tested at any time.

E.3.8.5.10

In addition to the Contractor‟s normal supervision and testing procedure, radiographic and other non-destructive examination shall be carried out as and when required by the Engineer, on butt or fillet welded joints and/or on test specimens. Prepared etched sections of welds may be required for examination. The Contractor shall at his own cost, provide all equipment necessary for such tests and shall cut out and remove any portion of the steelwork which the Engineer shall decide is defective.

E.3.8.5.11

The acceptance of the welding work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the examination and testing of the joints and the test specimens, soundness of the welds, and upon general good workmanship.

E.3.8.5.12

Welding other than in properly equipped fabrication shops will normally be limited to non-structural

members except where specifically permitted by the Engineer and designated beam seatings and cleats to be welded to the structural steelwork for receiving the small steelwork.

E.3.8.6. Bolted fixings

E.3.8.6.1

All bolts and nuts shall be complete with washers and shall be galvanized where specified, If washers are not shown on the Drawings, they shall be provided in accordance with best current practice to the approval of the Engineer.

E.3.8.6.2

Where H.S.F.G. bolts are used, the holes shall be drilled full size to a diameter not more than 2 mm greater than the shank diameter of the bolt and all gurrs shall be removed.

E.3.8.6.3

Any type of H.S.F.G bolts which the Contractor may wish to supply and use shall be submitted to the Engineer for approval and must comply with BS 4395.

E.3.8.7. Erection of steelwork

E.3.8.7.1

The Contractor shall ensure that all component parts of the structures will fit correctly and that the holes of adjoining members correctly register with one another. The Contractor shall temporarily erect at his works such proportion of the component parts as is necessary to verify to the satisfaction of the architect the accuracy of fabrication.

The verification will not however relieve the Contractor of his responsibility in ensuring correct fit etc.

E.3.8.7.2

The Contractor shall include in his rates all costs in respect of temporarily erecting components, the provision of all necessary scaffolding, flooring, staging, bolts and everything else necessary for erection.

E.3.8.7.3

The steelwork shall be lined, levelled and plumbed as the erection proceeds and no cladding or doors shall be fixed to the framework until the bolting up, lining, levelling and plumbing is complete and to the satisfaction of the Engineer.

E.3.8.7.4

After steelwork has been plumbed, lined and levelled, all bases shall be grouted with neat non-shrink grout of as dry a consistency as possible compatible with the requirement as regards pouring, raking and ramming of the grout under and through the steel bases The grout shall be from an approved manufacturer and shall be applied in strict accordance with his instructions.

E.3.8.8 Correction of work

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered as a legitimate part of erection. Any error that may occur in shop work which prevent the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall immediately be called to the attention of the Engineer and approval of the method or procedure of correction shall be obtained or such method or procedure shall not be employed. The use of cutting torches to enlarge or alter bolt or rivet holes shall be prohibited.

E.3.8.9 Purlins

Purlins are cold formed from hot dipped zinc coated high strength steel strip which has minimum yield stress of 450 MPa. The standard galvanized coating is 450g/m to BS 2989 on all sides. Minimum thickness of purlins shall be 2.0 mm. "C" sections shall be used for simple span construction with the purlin butted at internal support.

E.3.8.10 Insulation

Insulation shall be 100 mm thick glass fibre of 24 kg/m3 density having thermal conductivity of less than 0.035W/mK at mean temperature 25 C0, thermal resistance (R value) shall be greater than 2.857 m2/WC0 laid on two way reinforced double sided aluminium foil. All joints shall be sealed with aluminium vapour sealed tape and thermal insulation system shall be supported with a 3"x3" 17 gauge BRC welded roofing galvanized mesh fixed to the purlins.

E.3.8.11. Painting and Galvanizing

E.3.8.11.1 Galvanized steel work (internal and external)

E.3.8.11.1.1 Cleaning

After the shop works have been completed and accepted, all material to be galvanized according to the Specifications shall be cleaned of rust, loose scale, dirt, oil, grease and other foreign substances in accordance with the provisions stipulated under Chapter , 'Painting and Corrosion Protection of these Specifications. Particular care shall be taken to clean slag from welded areas. Execution of galvanizing shall conform to ASTM A 123, ASTM A153 and ASTM A384.

E.3.8.11.1.2 Galvanizing of Plates and Shapes

After being cleaned, the material shall be zinc coated (galvanized) in accordance with applicable Standards. Where members are of such lengths that they cannot be dipped on one operation great care shall be exercised to prevent warping. Finished compression members shall not have lateral variations greater than one-thousandth of the axial lengths between the points which are to be supported laterally. Finished tension members shall not have lateral variations exceeding 3 mm for each 1.50 m of length. Sharp kinks or bends will be cause for rejection of the material. All holes in material shall be free of excess spelter after galvanizing.

E.3.8.11.1.3 Galvanizing of Hardware

Bolts, nuts, washers, locknuts and similar hardware shall be galvanized in accordance with the relevant Standards. Excess spelter shall be removed by centrifugal spinning.

E.3.8.11.1.4 Straightening after Galvanizing

All plates and shapes which have been warped by the galvanizing process shall be straightened by being rerolled or pressed. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If the material has been harmfully bent or warped in the process of fabrication or galvanizing, such defects shall be cause for rejection.

E.3.8.11.1.5 Repair of Galvanizing

Materials of which galvanizing has been damaged shall be re-dipped unless the damage is local and can be repaired by soldering or by applying a galvanizing repair compound, in which case the compound shall be applied in accordance with the manufacturer's instructions.

Soldering shall be done with a soldering-iron using 50/50 bar solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanized coating becomes damaged after having been dipped twice shall be rejected.

E.3.8.11.2 Painting

E.3.8.11.2.1 Shop Painting

Paint shall be delivered to the shop and the site in original sealed containers, which shall be clearly marked with the manufacturer's name and the identifying brand number or name. The paint shall be used as prepared by the manufacturer without thinning or other admixtures.

Steel to be encased in concrete shall not be painted. All steel parts such as steel structures, girders,

frames, chequered plates, grids, railings, latticed members, gratings, bars and plates of any kind, etc. shall be sand blasted down to white metal according to the provisions of Chapter "Painting and Corrosion Protection".

Before assembly of the different structural parts, surfaces shall be coated as specified.

E.3.8.11.2.2 Surface Preparation

White metal sandblast cleaning in accordance with steel structures. Painting Council Specification SP 5 latest edition.

E.3.8.11.2.3 Shop Priming

As specified in Chapter "Painting and Corrosion Protection". Mating surfaces of friction connections shall be prepared as specified.

No paint which prevents proper welding shall be used within 5 cm (2 inches) of indicated field welds.

E.3.8.11.2.4 Field Painting

After assembly welding spots shall be ground smooth, the first coat shall be repaired and a second coat similar to the above mentioned shall be provided. Isolation of non-compatible metals shall be provided in all installation by giving the metal a coat of asphalt and an isolation barrier (i.e. asphalt impregnate felt) to prevent contact with dissimilar metals, masonry, concrete or plaster. Galvanized structural steel parts except girders and gratings shall also be provided as mentioned above.

All field rivets, bolt and welds, and all serious abrasions to the shop coat shall be spot painted with the same material used for the shop coat or an equivalent, and all mud, grime and other firmly attached foreign and objectionable materials shall be removed. Then, a through coat of approved field paint shall be applied to all steel work, except when steel comes in contact with concrete. After erection, the finish coat of painting on Site shall be carried out in accordance with the painting specifications and any damaged restored.

E.3.9. MASONRY WORKS

The work under this Section shall comprise the supply of all labour, materials and equipment

and the performance of all works required for the masonry works for the buildings as specified herein.

E.3.9.1 Material and Execution

E.3.9.1.1 Brick Masonry

(1) Materials

The bricks shall be uniform in size and shape and shall be deep red in colour and must be well burnt. The bricks shall be wholly clean and free from flaws, cracks and under burnt lumps of any kind. They shall have sharp edges and angles and even surfaces. The Contractor shall submit to the Engineer sample bricks for his approval before the bricks are supplied, and all bricks used on the works shall be equal to the approved samples. The bricks shall be sampled and tested for dimensions, general requirements, compressive strength, water absorption and efflorescence as per SLS 39.

(2) Brick Laying

The bricks shall be thoroughly soaked with water before their use and they shall be laid end and side in one operation in close compact mortar joints. The cement mortar to be used shall have cement to sand ratio of 1 : 5 .

E. 3.9.1.2 Concrete Block Masonry

(1) Materials

The concrete blocks shall have a compressive strength of not less than 2.8 N I mm2 and an apparent specific gravity, air dried of not less than 1 . 7 . Sampling and testing shall be as per BS 6073 Part-1.

(2) Concrete Block Laying

The concrete blocks shall be laid in straight and struck joints of about one (1) cm thick with

1:5 cement mortar. The concrete block walls shall be reinforced with steel reinforcement deformed bars of a diameter of 12 mm at 60 cm intervals in horizontal and 40 crn intervals in vertical directions. Steel anchor bars shall be pre-installed to the surrounding floor, columns, walls and ceiling at intervals and locations to enable connection to the reinforcement bars. All splices shall be taken 40 times the bar diameter.

The hollows through which the reinforcement bars run shall be thoroughly filled with 1 :3 cement mortar. A bay wall shall, when large in height and width, be divided into sections with reinforced concrete frames. The Contractor shall design the reinforced concrete frames and obtain the approval of the Engineer. Where required to install doors, windows and any other opening in walls, reinforced concrete lintels shall be provided. The Contractor shall design the reinforced

concrete lintels and shall obtain the approval of the Engineer.

Laying of the concrete blocks shall not exceed 1. 2 m in height per day.

E. 3.9.1.3 Random Rubble Masonry (R. R. Masonry)

Random rubble Masonry is to be built with stones from quarries approved by the Engineer. The stones shall be hard, free from decay, weathering and defects like cavities, cracks, flaws, sand holes, veins etc. Stones with rounded surfaces shall not be used. The stones used shall be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height. The breath of stone on base shall not be greater than three-fourth of the thickness of the wall (except for through stones) nor be less than l 50mm. The height of the stones may not exceed 300mm.

Stones shall be hammer dressed to enable it to come into close proximity with the neighboring stones. The bushing in the face shall not project more than 40mm on an exposed face, and 10mm on a face to be plastered. Unless otherwise stated 1 :3 cement sand mortar may be used for jointing the stones in the masonry.

All stones shall be cleaned and watered before use and shall be laid on natural bed on a full even bed of mortar and hammered down in to position. Every stone shall be carefully fitted to the adjacent stones leaving a minimum space of 15mm between stones to provide mortar bond between them. Chips and spalls of stones may be used to avoid thick mortar beds or joints, and to ensure that no hollow spaces are left anywhere in the masonry.

In building RR Masonry walls up to 600mm thickness at least one through stone shall be used at intervals of l.8m horizontally and 0.6m vertically. Such stones shall be at least l 50mm square at the face (rough shape). For walls exceeding 600mm in thickness more than one stone may be used to run through the full thickness with overlaps of not less than l 50mm, and such stones are called "bond stones". If suitable bond stones are not available they may be cast out of 1 :3:6 (20mm) concrete. Face joints shall not be more than 20mm thick.

Any holes left in the masonry for supporting scaffolding as approved by the Engineer shall be completely filled with proper sized stones and mortar. The masonry shall be kept constantly moist for a period of seven days.

E.3.10. PAINTING

The works under this Section shall comprise the supply of labour, materials and equipment and performance of all works necessary for applying painting finishes to the interior and exterior surfaces of the buildings and facilities. The works shall be performed as shown on the Drawings

prepared by the Contractor or as directed by the Engineer arid as specified herein.

E.3.10.1 Materials

Paints shall be of the best quality of their kind. Colour of paints shall be in accordance with the colour schemes accepted by the Engineer. Exact tone of the colour selected shall be in accordance with the samples supplied and applied on test areas in the Works approved by the Engineer. The Contractor shall submit color samples and catalogues of all paints to be used to the Engineer for his approval.

All paint materials shall be delivered to the Site in their original containers with labels intact and seals unbroken. All paints shall be of reputed registered brands, with the exception of ready mixed materials in original containers and all mixing shall be done at the Site.

E.3.10.2 Execution

All metal components other than galvanized steel shall be prepared and primed in the shop

and final paint coat applied after erection. Metal cabinets and machinery shall be prepared, primed and given two coats of rust resistant paint in the shop, and all damaged places shall be cleaned and touched-up after installation is completed.

Metal surfaces shall be cleaned with mechanical methods by metal scrapers and wire brushed to remove all mill scale, weld spatter, rust and any other deleterious materials. Oil and grease shall be removed by an approved solvent. The surfaces shall be wiped clean of any dust prior to priming. Priming shall be done immediately after cleaning to prevent new rust. Any primed surfaces that show rusting, flaking, powdering or peeling shall be re-cleaned and repainted.

All wood surfaces to receive paint shall be cleaned of all dirt, grease, dust or any other deleterious matters. All surfaces shall be thoroughly sanded and all nail holes, cracks and any other defects shall be puttied, and re-sanded to a smooth and flush finish. The painted surface shall show a smooth, level and uniform finish, free from any stains and shall be uniform in colour and shade.

All concrete, masonry and plastered surfaces to be painted shall be smooth, dry, and free from dirt or other deleterious material and stopped up holes. All rubbish waste or surplus material shall be removed from time to time, walls/floors or other adjacent work shall be cleaned. The mortar and concrete shall be left to dry for a minimum period of 3 weeks after application. Spray painting equipment shall be adequate for the work to be performed and shall have suitable air pressure and paint flow controls. Air lines shall be equipped with moisture and dirt traps. The paint shall be continuously stirred during the painting process. The paint shall be mixed and applied in accordance with the manufacturer's recommendations. and painting process shall be subjected to

the approval of the Engineer.

All painting works shall conform to the manufacturer's specifications and instructions. Painting shall not be done in rain, fog or mist, or at any other time considered unsuitable by the Engineer. All the surrounding works shall be protected in a suitable manner from paint drops and overspray. All smeared and damaged surfaces shall be cleaned or repaired to the Engineer's satisfaction. Sufficient quantities of all types and colour paints shall be supplied in unopened cans to the Employer for touch up paints.

E.3.10.2.1Vinyl Paint and Oil Paint to Metal Surfaces

Steel surfaces except galvanized areas shall be applied with two shop coats of rust resistant paint prior to its delivery to the Site, then touch up painting of rust resistant paint shall be applied after erection of the steel structure at the Site. Exposed surfaces shall be applied with two finishing coats of viny I paint.

Galvanized metal surfaces to be painted such as steel doors shall be first etched with a 5% Acetic acid solution and washed clean before applied with two finishing coats of oil paint.

E.3.10.2.2Vinyl Paint to Wooden Surfaces

Wooden doors and all other wooden surfaces except wooden handrails to receive paint shall be thoroughly dry and free from foreign substances. Paints shall be applied in 3 coats including one coat of primer paint. Sufficient time shall be allowed for drying between each new coat in accordance with the paint manufactures recommendations.

E.3.10.2.3 Vinyl Emulsion Paint to Mortar, Concrete Surfaces and Flexible Boards

The mortar and concrete shall be left to dry for a minimum period of 3 weeks before application. The vinyl emulsion paint shall be applied in 3 coats including a primer coat. Minimum 1 2 hours or a period recommended by the manufactures, whichever is higher, shall be allowed before application of each successive coat. Outside and the other areas liable for wetting shall be applied a weather proof type paint.

E.3.10.2.4 Clear Lacquer Finish

Wooden surfaces shall be properly smoothened with sandpapers. Clear lacquer finish shall be applied in 3 coats to a clear and uniform finish in shade and to reveal the grain of the wood.

E.3.10.2.5 Floor Paints

Floor paints shall be of epoxy-resin type which has high durability against rubbing.

E.3.10.2.6 Acid-resistant Paints

Acid-resistant paints shall be emulsion/epoxy type synthetic resin paint which has a proven quality of acid-resistance. Battery rooms shall be painted with acid-resistant paints.

E.3.11.WATERPROOFING

E.3.11.1 General

E.3.11.1.1 Warranty

- Insulation, water proofing and tanking shall be applied in accordance with the directions of the manufacturer of the materials and components, and the complete systems shall be fitted in the works by experienced specialist crew.
- Notwithstanding maintenance requirements for the works, the Contractor shall warrant the Owner with the assurance of a reputable local insurance company that roofs and tanks shall remain waterproof, vapour proof and damp-proof in respect of workmanship and materials for a minimum period of 10 years calculated from the time that the works are certified as substantially completed.
- The form of guarantee offered by the specialist, applicator shall be submitted for the Consultant's approval prior to commencement of waterproofing. This guarantee shall in no way indemnify the against the improper performance of the waterproofing system.
- All structural components that retained or exclude water or any other liquid should be applied with approved water proofing material.
- Roof slab should be externally water proofed and insulated by an agent approved by the Engineer.

E.3.11.1.2 Structure

- It shall be the Contractor's responsibility to ensure that the specialist applicator takes note of the type of the structure, nature and the location of waterproofing to be applied, including any movement joints provided, when designing his water proofing system.
- The laying of a water proofing system on a concrete surface will be taken as signifying the acceptance of that surface, both in terms of surface quality, spacing and arrangement of movement joints and the construction joints by the Contractor and his specialist applicator.

E.3.11.1.3 Application

- Where applicable, aprons and other sections for roof/tank penetrations, trims, side laps, bends and corners shall be incorporated, corrected finished and uniformly lined.
- The water proofing system shall be dressed up all pipes and other penetrations to a minimum height of 250 above the top of the concrete slab.
- Sharp corners are to be filled with screed or other fillets and water proofing should be laid with generous overlap as per manufacturer's instructions.
- When water proofing is to be applied on exposed areas, colours have to be approved by the Engineer.
- Where finishes such as concrete paving or tiles are specified and to be laid over water proofing membranes, of concrete floor. The floor shall be tested for water - tightness prior to laying of these tiles/paving. The structures such as Sumps and tanks shall also be tested after the application of water proofing systems. The cost of carrying out these tests including that of blocking any outlets shall be borne by the Contractor. Where it is seen that water tightness has not been achieved, the Contractor shall take whatever remedial measures as are ordered by the Consultant and the cost of all such measures shall be borne by the Contractor.

E.3.11.1.4 Joints with abutting walls, columns, piping etc.

- Joints with abutting structures shall be carried out with materials as specified in the relevant Clause of other trades, such as weather sealant all as generally shown in typical details on the drawings.
- Special joints which are not shown on drawings or particular sections there of requiring a special attention, are deemed to be included in the Contractor's drawings and are to be executed in a workman like manner and in consent with and to the satisfaction of the Engineer.

E.3.11.2. Distinction of waterproofing - Systems

In order to distinguish between the various systems of water proofing in relation to the Finishing Schedules and / or drawings; the following denomination shall be adhered to:

WP 1 : For roof slab and machine floor areas.

WP 2 : For basement floor slabs, beams, pile caps.

WP 3 : For basement floor walls.

WP 4 : For concrete slabs before finishing (heavy duty), comprising toilet floors, balconies, gutters etc.

WP 5 : For sumps, tanks and ponds

WP 6 : For pits, gulleys etc., comprising but not limited to all pits, inspection pits, pumps-pits etc., inside and outside the building, for drainage, waste water, sewerage and rainwater assembly and/or transport.

WP 7 : Special Flooring and Wall Coatings

E.3.11.2.1. Waterproofing system to roof slabs and machine floor areas – (WP1)

Material Specification – Torch-On Waterproofing Membrane

- The following specification is for a built-up Waterproofing system of non-metallic roofing compound of laminar bituminised construction, intended for this project. The Contractor may submit alternative reputable constructions together with the relevant specification and method statement to the approval of the Consultant; such constructions should in any case conform to the insurance requirement specified under "Warranty" requirement.
- Waterproofing membrane shall be 4.0mm thick with sand finish on top, UV resistant;
- Atactic Polypropylene (APP) modified bituminous membrane reinforced with 160g/m2 polyester fabric, with approximate weight 4.6 kg/m2 and torch-applied over the substrate after application of the approved primer.
- An interruption of work the edges of the sheets have to be finished in such a manner that rain water and dust cannot penetrate underneath.
- A Prefabricated multi-layer sandwich type membrance should conform to the manufacturer‟s Specifications.
- Mechanically batch mixed cement; sand (1:3) protective screed shall be laid over the waterproofing membrane having a minimum layer thickness of 15mm.

Insulation

- On top of the Waterproofing membrane, polyurethane or equivalent extruded polystyrene boards 25-50mm thick with Thermal conductivity of not more than 0.03W/Mk (as per ASTM C5 18) shall be laid.
- Method should comply with the following standards ASTM D-1622, ASTM C-518, ASTMD2842 and ASTM D1621-95.

- The boards shall have rebated / ship lap edges all round for interlocked laying in sizes of 600x1200mm, tightly laid in stretcher bond.
- The compressive strength of the insulation boards shall be not less than 40kPa according to ASTMC165 procedure B.
- Insulation boards shall be protected against rain and humidity.

Separation Layer

- On top of the Insulation / Waterproofing membrane, non-woven geo-textile polyester mat or equivalent shall be laid as the separation layer.
- It should conform to the manufacturer's specifications.

Concrete covering screed

- Concrete covering screed of grade 20-25mm thick shall be laid over the gauge 1000 polythene sheet (Separation sheet) as shown on the drawing. 50 x 50mm (3mm dia.) galvanized steel wire-mesh shall be incorporated in the concrete screed layer. 10mm thick expansion joints shall be provided in covering screed to limit the concrete screed panel size approximately to 4.0 Sq.m. Expansion joints shall be coincided with the joints of the tile layer (if any) above and later filled by the approved joint sealant.
- Floor tiles with approved colour and quality shall be laid over the screed as the finishing layer,
- Alternatively, reinforced concrete floating slab shall be constructed instead of concrete screed if there is any possibility of installation of mechanical plants or equipment.

E.3.11.2.2. Waterproofing system for Basement floor slabs, beams, pile caps– (WP2)

Material Specification – Torch-On Waterproofing Membrane

- The prepared concrete surface shall be waterproofed by means APP bituminous polyester sheet or equivalent 4.0mm thick sand finish, UV resistant, APP modified bituminous. Torch-applied membrane reinforced with 160gms/sqm. polyester fabric over the substrate after application of the approved primer.
- Application of the Waterproofing membrane shall strictly be in accordance with the manufacturer's instruction maintaining sufficient over lap at joints.
- At interruption of work the edges of the sheets have to be finished in such a manner that rain water or duct shall not penetrate underneath.

- The Contractor shall ensure timely submission to the Consultant of details, type, make and composition of the Waterproofing systems together with certified proof from the manufacturer of the proposed system.
- Prefabricated multi-layer sandwiched type membrane conforming to the manufacturer's specifications.
- Mechanically batch mixed cement; sand (1:3) protective screed shall be laid over the waterproofing membrane having a minimum layer thickness of 15mm.

E.3.11.2.3. Waterproofing system to Basement walls – (WP3)

Material Specification – Sheet Membrane

- The prepared concrete surface shall be waterproofed by means of a 1.5mm thick (minimum thickness) P.V.C. film/self- adhesive bitumen laminated, supplied in roll form or other approved system. The laminate or other approved system shall be applied in strict accordance with the manufacturer‟s instructions, including the necessary prime coats, tact coats etc.
- Application of the Waterproofing membrane shall strictly be in accordance with the manufacturer's instruction maintaining sufficient over lap at joints.
- At interruption of work the edges of the sheets have to be finished in such a manner that rain water or duct shall not penetrate underneath.
- The Contractor shall ensure timely submission to the Consultant of details, type, make and composition of the Waterproofing systems together with certified proof from the manufacturer of the proposed system.
- Mechanically batch mixed cement; sand (1:3) protective screed shall be laid over the waterproofing membrane having a minimum layer thickness of 15mm.

E.3.11.2.4 Waterproofing system to concrete slabs before finishing (heavy duty), comprising toilet floors, balconies, gutters, etc. – (WP4)

Material Specification- Flexible Cementitious Coating System

- The material used shall 2-part polymer (acrylic), flexible cementations waterproofing slurry or equivalent to 1.5mm minimum thickness with sound bond properties to cement screed/mortar surfaces.
- Water proofing of concrete slabs before receiving the ultimate finish shall be carried

out as detailed below.

- In these areas, the prepared concrete floor and abutting up- stands/fillets shall be water proofed by means of application of Polymer modified cementations water proofing coatings or other approved method in accordance with the manufacturers‟ instruction.
- The water proofing system shall be applied in strict accordance with the manufacturer's instructions, including primers etc. The system shall be suitable to receive the screed.
- The Contractor shall ensure that all penetrations of the relevant floors/slabs shall be water proofed in a workmanlike manner and as per instructions by the manufacturers or, lacking that, by the Engineer.
- The Contractor shall ensure timely submission to the Engineer of details, type, make and composition of the systems, together with certified proof from the manufacturer in respect of the suitability of his system.
- Mechanically batch mixed cement; sand (1:3) protective screed shall be laid over the waterproofing membrane having a minimum layer thickness of 15mm.

E.3.11.2.5.Waterproofing system to sumps, tanks and ponds-(WP5)

Material Specification- Cementitious Crystalline type Coating System

- The water proofing shall consist of application of Cementitious Crystalline type approved water proofing coating according to the manufacturer‟s recommendations.
- The Contractors shall ensure that all penetrations for piping, gulleys etc., shall be water proofed in a workmanlike manner.
- The Contractor shall satisfy the Engineer that the waterproof coating is not of a toxic nature, giving no elements toxic to drinking water.
- If the latter should occur, the shall provide and apply extra coat(s) of non- toxic sealant to walls and floors of drinking water sumps, all in accordance with the manufacturers' instructions.
- The water proofed areas shall be filled with water for 3 days to check any seepage of water or dampness.
- After testing of water proofing, 1:3 cement and sand screed shall be laid as a protective screed.

E.3.11.2.6. Waterproofing system to pits, gulleys, etc. - (WP6)

Material Specification-Flexible Cementitious Coating System

- All pits, gulleys, gutters and such other structures as the Consultant shall designate, shall be internally treated with two coats of black tar paint, in accordance with BS 1070.
- Concrete or masonry, whether plastered or not, which is to be coated with tar paint shall be well cleaned, and free from damp, dust and dirt. The paint shall be applied to bottoms of pits, benching therein and sides over full height.
- Mechanically batch mixed cement; sand (1:3) protective screed shall be laid over the waterproofing membrane having a minimum layer thickness of 15mm.

E.3.11.2.7 Waterproofing system to special flooring and wall coatings - (WP7)

E.3.11.2.7.1 Wall Coating to Emergency Stair Ways, Service Duct and Lobby Wall

- Material Specification – Water Based Two Part Epoxy Coating
- Apply 2 coats of Epoxy Coating with approved colour as per the specification and instruction of Manufacturer's representative.

E.3.11.2.7.2 Dust Proofing to Lift Shaft Walls

- Material Specification – Single pack colorless, penetrating Synthetic Acrylic coating.
- Dust Proof coating shall be semi-gloss finish.
- Apply 2 coats of dust Proof coating as per his specification and instruction of Manufacturer's representative.

E.3.11.2.7.3 Waterproofing system to concrete decks/slabs and areas overlaid by asphalt

- Concrete deck waterproofing shall be continuous and cover the entire deck between parapet up stands.
- The waterproofing system shall provide a watertight seal at edges and around interruptions, such as gulleys.
- Arises shall be chamfered or rounded and fillets formed in internal angles.
- The waterproofing system shall be compiled with BS Standards and it shall be approved by the engineer.
- A permitted waterproofing system shall have a valid and current certification at

the time of use.

- The waterproofing system specified for use on concrete decks shall be compatible with the concrete and the concrete surfacing.

E.3.11.3. Product Characteristics

- The tolerance does not have to be declared by manufacturer where it is defined by the standards.
- The product shall be free of visible defects, as determined in accordance with relevant British Standards
- The length, width and straightness shall be determined in accordance with relevant British Standards
- Water tightness shall be checked as per the relevant British Standards or local standards.
- Waterproofing systems shall be installed in accordance with the manufacturer's specified procedures.

E.3.12. PLASTERING

The works under this Section shall comprise the supply of all labour, materials and equipment and performance of all works for the plastering work to floors, walls, and ceilings in the buildings. The work shall be performed as shown on the Drawings prepared by the Contractor or as directed by .the Engineer and as specified herein.

E.3.12.1 Materials and Execution

E.3.12.1.1 Material

The sand to be used in the mortar shall be clean, hard, solid and durable and shall not contain harmful amounts of dust, mud, organic materials or other objectionable matter. The grading of the sand shall be within the following limits:

Table E.10: Grading of sand for Plastering

Classification	Screen Size	Percentage by Weight Passing Screen
Rendering Coat	5mm	100%
	0.15mm	10% or below
Finishing Coat	2.5mm	100%
	0.15mm	10% or below

The mix proportions of the cement mortar shall be as follows:

Table E.11: Mix Proportions for Plastering

Applying Bed	Place of Application	Rendering Coat Cement: Sand	Finish Coat Cement: Sand or
Concrete	Floor	-	1: 2
	Interior wall	1: 2	1: 3 : 0.3
	Ceiling	1: 2	1: 3 : 0.3
	Exterior wall	1: 2	1: 3
Brick & Concrete Block masonry	Interior wall	1: 3	1: 3 : 0.3
	Exterior wall	1: 3	1: 3

E.3.12.1.2 Execution

The surfaces which are to receive a rendering coat shall be roughened, brushed or washed clean, free from all laitance, scum, loose carbonate scale, loose aggregate, dirt and other foreign matters. In the case of concrete block or brick surfaces, they shall be sufficiently and uniformly dampened before the application of mortar.

Concrete surfaces shall be roughened and kept thoroughly dampened for 24 hours prior to application of mortar.

Mortar shall be used within 30 minutes from the time of mixing. Retempering will not be permitted. The rendering for tile work shall be made with 1 8 mm thick, and its surface shall be cross scratched. In the case of mortar finish, the total thickness of rendering and-finishing coat shall be 30 mm for the floors, and 20 mm for walls and other places. When the finishing coat is applied, the entire surface of wall or ceiling shall be finished in one operation in order to minimize joint marks. Where expansion and control joints exist in the base structure, provision shall be made to prevent cracking of the mortar by inserting galvanized steel expansion beads within the coating thickness in a manner approved by the Engineer. The finished surface shall be perfectly plumb or level as the case may be without any bulging, runs, bruises of stains.

After application of the finishing coat, the surfaces shall be kept continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently to prevent displacement or damage. Where shown on the Drawings or directed by the Engineer, metal wire lath shall be fixed to concrete block wall surfaces and into waterproof mortar on roofs before applying mortar plaster. The metal wire lath shall be galvanized expanded metal sheet with reinforcing ribs and shall be fixed with staples.

E.3.12.2 Waterproof Mortar

Waterproof mortar shall be applied to roofs, balconies, parapets, eaves, external walls and other required places. Mortar shall conform to the technical requirements as provided for in this Section. Waterproof admixture shall be used in the mortar in accordance with the manufacturer's recommendations to effect waterproofing. Catalogues of waterproofing admixture shall be submitted to the Engineer for his approval.

E.3.12.3 Expanding Grout

An expanding grout shall be used around any pipe passing through a concrete or masonry wall where water may stand on one or both sides of the wall and where the pipe is not embedded in the initially constructed structure. Such grout shall expand upon setting to effect bonding to the concrete and the pipe. An approved expanding agent shall be used and the grout composition shall conform to the manufacturer's instructions.

E.4. ELECTRICAL WORK

E.4.1. TECHNICAL REQUIREMENT

E.4.1.1. General Requirements

E.4.1.1.1. Site Environmental Conditions

Altitude of site above sea level	: 500 m
Maximum ambient air temperature	: 28 ^{0}C
Minimum ambient air temperature	: 20 ^{0}C

Relative humidity	- Maximum	: 95%
	-Annual average	: 76%

E.4.1.1.2. Electrical System

	MV	LV
Nominal system voltage between phases	11kV	400V
Wiring system	Three phase, Three wire	Three phase, Four wire
Earthing of system	Solid earthing	Solid earthing TT/TN system
System frequency	50 Hz	50 Hz
Symmetrical short-circuit RMS current	Verified by CEB	To be calculated

E.4.1.1.3. Standards

As a rule, the electrical systems are to be in accordance with the relevant British Standards (BS) and International Electro technical Commission (IEC) publications. All the regulations of Ceylon Electricity Board (regular power supply authority of Sri Lanka) and other relevant authorities are to be strictly followed.

- Electrical Installations within buildings to be according to BS 7671 : 2018: IET Wiring Regulations, 18th edition
- Building lightning protection systems to be as per IEC 62305: 2010-12, Protection
- Against Lightning -Part 1, Part 2, Part 3 & Part 4
- Code for Lighting 2002 by CIBSE (Chartered Institution of Building Services Engineers) / The Lighting Handbook by IESNA (Illuminating Engineering Society North America)
- Green Building Guildlines issued by UDA (Blue Green Sri Lanka First Print, January 2017).
- Electrical Equipment – Relevant IEC / British Standards (BS)
- Energy Efficiency Building Code of Sri Lanka 2020 published by Sri Lanka
- Sustainable Energy Authority

E.4.1.1.4. Selection of Equipment

When determining the type of equipment to be specified /used for the electrical systems,

following parameters are to be considered:

- Functional suitability for the application
- Reliability and durability
- Efficiency
- Ease of maintenance
- Suitability for ambient conditions
- Suitability in appearance
- Cost
- Country of Origin and Manufacture
- Availability of a local agent
- Warranty

The following types of equipment are therefore being advised to choose in the scheme design:

MV Power cables	: XLPE insulated copper cables, armoured
LV Power cables	: XLPE insulated copper cables
LV Wiring cables	: PVC insulated copper cables
MV Switchgear	: Metal-enclosed, Gas Insulated Switchgear (GIS) with vacuum circuit breakers
LV Switchgear	: Air Circuit Breakers (ACB), Moulded Case Circuit Breakers (MCCB), Miniature Circuit Breakers (MCB), Residual Current Devices (RCD), monitoring devices, protection relays and contactors
Transformers	: Cast resin dry transformers (11kV/400V)
Standby Generators	: Sound attenuated canopy type, imported
Solar PV Modules	: Mono crystalline, 320-350 Wp, high efficiency
Lighting fixtures	Energy efficient LED luminaires for all areas depending on functional and architectural requirements for each area

E.4.1.1.5. Conductor Size Selection

Conductor size has to be determined considering the following:

- Maximum load to be fed by the cable
- Voltage drop at the load

- Short-circuit fault level at the feeding point of the cable

The maximum permissible voltage drop at the load would be as per the latest IET Wiring Regulation. Typical calculation for conductor selection shall be submitted with the proposal.

E.4.1.1.6. Electric1al Loads

The electrical load of the building premises comprises the following:

i. Electrical lighting (indoor, outdoor, street lighting & emergency lighting)

ii. Air conditioning and Ventilation

iii. Computers and other office equipment

iv. Pumps and motors

v. Lifts and escalators

vi. Kitchen/Restaurant equipment

vii. Telephone system, fire detection system, BMS, PA, CCTV, Parking/terminal management systems and other ELV system loads

viii. Electrical vehicle charging bays

ix. ETM charging racks

x. Small power requirements for commercial and common areas

xi. Any other loads identified by the Proposer

Out of the above, all loads except air-conditioning load shall be considered as essential loads.

E.4.1.1.7. Spare/Future Expansion Capacity

All equipment including feeder cables, Switchgears and Distribution Boards shall be sized / designed to allow for sufficient spare capacity (at least 20 %) for any unforeseen future loads.

E.4.2 SCOPE OF WORKS

The Proposer shall carry out the design, supply, delivery, erection, connection, testing and commissioning of all the equipment and material for complete electrical works of the entire KMTT building complex. Work to be carried out under this contract shall include, but not necessarily be limited to the following major work/equipment and systems.

- Medium Voltage (MV) distribution system including 11kV cables, MV switchgears & transformers

- Standby power supply system including diesel generators, synchronization panels, Auto Transfer Switch (ATS) panels, power cables, fuel tanks, fuel transfer system
- Low Voltage (LV) distribution system including LV cables, all type of LV switchgears and power factor correction capacitor banks etc.
- Final circuit (point) wirings
- Luminaires, socket outlets, industrial sockets and fans
- Lighting control systems
- Lightning Protection System
- Uninterruptible Power Supply (UPS) systems
- Solar Photo Voltaic (PV) system

Lighting and socket outlet layout design shall meet the functional requirements, architectural requirements and the energy efficient aspects.

Diesel generators shall be provided as standby power source to provide power supply to the total load in the event of utility power failure.

Considering all the circumstances and after visiting the site, it is the Proposer's responsibility to design and submit a proposal to achieve the Employer‟s requirements as described herein. After making detail calculations, equipment and panel boards, cables cable management system etc shall be selected sized appropriately.

Spaces for main equipment such as Transformers, Generators, fuel tanks, Main MV & LV Switchgears, Distribution Boards, Consumer Units, vertical and horizontal power distribution system and Solar PV system shall be provided by the Proposer considering safety, accessibility and maintenance aspects. Cable trenches inside and outside of buildings and electrical service ducts shall also be provided as per the requirement. Proposer shall plan and consider mounting structures and any related civil works for the installation of the above mentioned electrical equipment. The detailed calculation for selection of equipment shall be submitted and obtained the Engineer‟s approval before purchasing the equipment.

The Employer expect to integrate green building features in the building complex as per UDA green building guidelines. Hence the electrical design shall be carried out to maximize the green features and energy efficiency within the premises.

The given format for the BOQ shall be followed by the Proposer in submitting the price proposal.

Proposer shall include the cost for all other necessary work (which has not been specified in the given BOQ format/ER and the necessity of those items have been identified by the proposer) under the "Miscellaneous" item. Rate breakdowns with detailed descriptions shall be provided for all items included under the "Miscellaneous" item.

E.4.3 POWER SUPPLY SYSTEM

E.4.3.1 Regular Power Supply System

Regular power supply to the building shall be obtained from Ceylon Electricity Board (CEB) within the premises and an appropriate location shall be proposed for the CEB substation by the Proposer and agree with CEB.

Proposer shall have the sole responsibility to select the appropriate capacity of transformers and number of required transformers as per their calculations. Transformers shall be selected so that in the event of failure of one transformer, others can take the essential loads of the building. Loads considered as essential loads is given under the previous chapter "Electrical Loads". Transformers and other equipment proposed for the installation has to be standardised as economically as possible. The preliminar y design with sufficient calculations, schematic diagrams and room arrangements shall be submitted along with the Proposal.

Prior to start cost ructions, detail design calculations and drawings shall be submit ted to the Engineer for approval.

The total power requirement as estimated by the contractor shall be submitted to the employer for obtaining the utility power supply from Ceylon Electricity Board. Contractor shall co- ordinate with Ceylon Electricity Board for obtaining the utility connection. Total CEB supply to the building will be metered at one point.

If the estimated pow er demand exceeds 1000 kVA, C EB will provide a HT connection and underground 11kV cables from the CEB substation to the receiving 11kV switchgear in the transformer room shall be installed by the contractor. Also, the civil construction of the CEB

substati on shall be carrie d out by the Contractor. Employer"s receiving 11kV switchgear panel shall be provided by the contractor to control the MV power supply and to feed the individual power transformers with 11kV power supply. This 11kV switchgear panel is not belonging to CEB but is a Client"s property. 11kV supply (MV) has to be stepped down to low voltage (LV) 400V to feed lighting, small power and other loads.

If the estimated power demand less than 1000 kVA, CEB will provide a 400V, LV bulk supply connection with CEB own transformer and meter panel. The Contractor is responsible for the

internal LV power distribution system within the premises from the CEB meters. Also, the civil works of CEB transformer and meter room shall be carried out by the Contractor.

E.4.3.2 Standby Power Supply System

Diesel generators shall be provided as a standby backup power supply source to the load in the event of a regular power failure. Total generator capacity shall be sufficient to cater the full load of the building complex. Careful attention has to be drawn to noise controlling to meet the Central Environmental Authority (CEA) regulations and the exhaust disposal of the generators away from the buildings.

E.4.3.3 Emergency Power Supply System

Emergency power shall be provided for the escape route lighting, selected lighting in other areas (toilet areas, stair cases, ramps, lift lobbies) and specified essential loads of the building.

Emergency power shall be provided using direct on-line type Uninterruptible Power Supply (UPS) System. Minimum back-up time shall be provided as per the fire protection requirements.

E.4.4 MEDIUM VOLTAGE (MV) DISTRIBUTION SYSTEM

If the estimated power demand ex ceeds 1000 kVA, C EB will provide a HT connection and the proposer shall design the MV distribution system. Therefore, specifications in this section will apply only if the estimated power demand exceeds 1000 kVA.

Medium voltage distribution system shall contain incoming MV cables, MV switchgears and

11kV/400V transformers. Contractor shall design, supply, delivery, erection, connection, testing and commissioning of all the equipment and materials. Contractors shall incorporate required provisions for the installations (trenches or any other cable management system, plinths) in the designs and drawings (architectural and structural).

The calculations for selection of major equipment shall be submitted with the proposal and Engineer‟s approval shall be obtained before purchasing the equipment.

E.4.4.1 Gas Insulated Switchgear (GIS) Panels

Scope of work includes design, manufacture, test at manufacturer‟s factory (FAT), supply to the site, install, test at site, commission and maintain during defect liability period of 11kV Gas Insulated Switchboard as specified here with necessary measuring, control & protection equipment. All equipment supplied shall be brand new and best of their respective kinds and shall be of the class most suitable for the purpose for which they are intended. The scope of contractor includes

all associated items / sensors / interlocks required for smooth and efficient working of system and required during installation, testing & commissioning. All such items are deemed to have been included in the contractor‟s scope.

Safety interlocks, necessary to ensure maintenance operation shall be provided. Design shall be type tested for Seismic conditions. Type test certificates shall be in the name of the panel builder.

ISO 9001 Quality Assurance System shall be followed in the manufacture of Gas Insulated Switchgear. Contractor shall furnish documentary evidence (Complete Document) that he has obtained ISO 9001 Certification for the manufacturing plant. Proposals without the proof of ISO 9001 Certification will be rejected.

E.4.4.1.1. Type Test Certificates

Type tests shall have been carried out on the similar switchgear components in accordance with the relevant IEC standards preferably in an independent test laboratory during currently accepted time duration for corresponding type tests.

The performance of the components of the switchgear shall be substantiated by test data relevant to the particular designs offered.

E.4.4.1.2. Routine Tests

All the routine tests as specified in relevant IEC shall be carried out at the manufacturer's Workshops on 11kV GIS panel, witnessed by the Employer‟s representative and Engineer‟s representatives.

Contractor shall notify the engineer thirty (30) calendar days in advance to witness the factory performance test. All the costs of Employer‟s representative and Engineer‟s representatives for witnessing the tests shall be borne by the Contractor. All the test shall be carried out as per the following standards.

Complete Bay	IEC 62271-200
Circuit Breaker	IEC 62271-100
Disconnector & Earth Switch	IEC 62271-102
Current Transformers	IEC 61869-2, 61869-6
Voltage Transformers	IEC 60186 & 61869-3

E.4.4.2 Dry Type Transformers

Proposer shall design, manufacture, test at manufacturers factory (FAT), supply to the site, install, test and commission 11/0.4 kV, cast resin insulated dry type distribution transformer(s)

with required spares, tools and accessories. Transformer(s) shall be provided with an enclosure for indoor installation.

The HV windings will be connected to 11kV switch gears through 11kV XLPE cables. LV winding will be connected to Automatic Transfer Switches (ATS) through 600/1000V XLPE cables.

Design shall be type tested for Seismic conditions with following characteristics.

Type	: Cast resin encapsulated winding, 3 phase units
Enclosure	: Sheet steel or other approved metal (Natural ventilated)
Degree of protection	: IP21
Type of cooling	: AN
Rated frequency	: 50Hz
Rated voltages	
o Higher voltage winding	: 11 kV
o Lower voltage winding	: 400 V
Tapings (in HV winding)	
o Range	: + 5.0 % to -5.0 %
o Steps	: 2.5 %
o Type	: Manual, off circuit links
Vector group	: Dyn 11
Impedance	: As specified by the manufacturer
Sound pressure level	≤ 62 dB(A) at 1m from the enclosure

The transformers/accessories shall be designed, manufactured and tested in accordance with IEC 60076 part 11, other relevant parts of IEC 60076 and other publications quoted in these Standards. Also, ISO 9001 Quality Assurance System shall be followed by the manufacturer. Proposer shall furnish documentary evidence (Complete Document) that he has obtained ISO

9001 Certification for the manufacturing plant.

E.4.4.2.1. Testing

Contractor shall notify the engineer in advance to witness the Factory Acceptance Tests (FAT). All the costs of the Employer‟s representative and Engineer‟s representatives for witnessing the tests shall be borne by the Contractor. All the routine tests as specified in IEC

60726 shall be carried out at the manufacturer's workshops on each transformer witnessed by the Engineer and Employer.

E.4.4.3 Medium Voltage (MV) Power Cables

Scope of work includes design, supply, installation, testing and commissioning at site of 11kV XLPE insulated power cables from CEB substation to the MV receiving panel (11kV switchgear) of the KMTT premises and from 11kV MV switchgear to power transformers including cable termination using heat shrinks terminations.

Underground feeder shall be installed from CEB substation to the MV receiving panel and outgoing feeders from the MV switchgear to the transformers shall be installed in a cable trench. Location of the CEB substation shall be decided by the Proposer. Appropriate cable sizes shall be selected by the Proposer and it shall be clearly mentioned in the schematic diagrams to be submitted with Proposal. Cable selection calculations shall also be submitted with the Proposal.

ISO 9001 Quality Assurance System shall be followed in manufacturing the XLPE insulated underground cables. Contractor shall furnish documentary evidence (Complete Document) ISO 9001 Certification is available for the manufacturing plant. Proposals of contractors without the proof of ISO 9001 Certification will be rejected.

The cables shall be designed and manufactured in accordance with IEC 60502 and the specific requirements set out below. The Cables shall be designed to operate at the rated voltage (System highest voltage) of 12kV. The conductors shall be screened in accordance with IEC 60502. The conductor screen shall be Extruded layer of Semi-conducting cross- linkable compound type (taped conductor screening not acceptable). The extruded layer shall be continuous and shall cover the surface of the conductor completely. The nominal insulation thickness as per BS 6622:2007 is 3.4mm and maximum resistivity of the conductor screen shall not exceed 500 Ω.m at 90^0C.

Maximum design electrical stress shall be such that purity of raw materials, manufacturing conditions and ageing of cables has been taken into account. Maximum design stress shall not be more than 5kV/mm.

The conductors shall be stranded (Class 2) circular compacted Plain Annealed Copper Conductors in accordance with BS EN / IEC 60228.

E.4.4.3.1. Type Test Certificates

Certified copies of type test reports shall be submitted for the approval of Engineer/Consultant on tests conducted previously on similar 11kV cables. Type tests shall have been carried out on the similar cables in accordance with the relevant BS / IEC standards preferably in an independent test laboratory during currently accepted time duration for corresponding type tests. If acceptable type test reports are not available, contractor shall carry out the type test in

accordance with the applicable standards and show acceptable results.

E.4.4.3.2. Inspection and Factory Acceptance Test (FAT)

The selected contractor shall make necessary arrangements for inspection by the Employer‟s representative and Engineer‟s representatives and to carry out in his presence necessary Sample/Acceptance tests of the cables offered in compliance with the standard specified.

All the routine tests as specified in relevant IEC shall be carried out at the manufacturer's workshops on 11kV cables and submitted to Engineer/Consultant who visits for the factory tests.

Contractor shall notify the Engineer thirty (30) calendar days in advance to witness the factory performance test. All the costs of the Employer‟s representative and Engineer‟s representatives for witnessing the tests shall be borne by the Contractor.

E.4.5 LOW VOLTAGE (LV) DISTRIBUTION SYSTEM

LV distribution system shall include premises Main Distribution Board (MDB), Sub Main Distribution Boards (SMDBs) for each individual building and major services, Floor Distribution Boards (FDBs) for each floor of the buildings, Distribution Boards (DBs) / Consumer Units (CUs), low voltage cables, and final circuit wirings.

In the design, all required protections (against over current, short circuit current, earth leakage current & surge protection etc.) shall be provided up to the final circuits in the distribution system as per the latest IET wiring regulations. Selected contractor shall submit the detailed design including calculations and drawings for the prior approval after the awarding of the contract.

Proposer shall submit the schematic diagram of the entire LV power distribution system with the Proposal.

E.4.5.1 Main Distribution Board (MDB) and Sub Main Distribution Boards (SMDBs)

A Main Distribution Board (MDB) shall be provided for the entire premises in the Main Electrical Panel Room for control and distribution of low voltage electrical power to the individual building loads. Suitable location / space for the MDB shall be proposed by the Proposers and the MDB shall be designed as per their calculations. Sub Main Distribution Board (SMDBs) shall be provided for each of the separate buildings in the premises and for the larger individual loads.

The **MDB** and SMDBs shall be of the rigid, freestanding, metal cubicle type, totally enclosed, dust and vermin protected and factory fabricated in compliance with BS 5486 (IEC

60439) and this specification where applicable. Form of internal separation shall be Form 4b as specified in IEC 60439-1. The Panels shall be of type tested design. Design shall be type tested for Seismic conditions. Type test certificates shall be in the name of the panel builder.

MDB and SMDBs shall include Air Circuit Breakers (ACBs)/Moulded Case Circuit Breaker (MCCBs), power analysers, indicator lamps, bus bars, current transformers, auxiliary fuses, protection relays, surge protective devices small wiring, interconnections and other accessories. Sufficient space shall be provided in the panels for future expansions.

Connection facilities for all incoming and outgoing cables shall be designed appropriately by the Contractor. Those details shall be provided in the single line diagrams/schematic diagrams/general arrangements. Bus bars shall be of tin plated copper, and purity of copper shall be 99.99%. The rating of main bus bar and fault current rating at the main bus bar shall be selected as per the contractor‟s calculations.

All the outgoing feeders shall be metered using digital power analyzers and shall be able to integrate to with the proposed Building Management System (BMS).

Proposer shall approximately size the MDB and SMDBs. Drawings shall be submitted with the Proposal along with the main panel room equipment arrangement, incoming and outgoing feeder details etc.

E.4.5.2 Floor Distribution Board (FDB)

Floor Distribution Boards shall be provided for each floor in each building to distribute power to each floor via cables or other way (i.e. bus risers) from the respective SMDB. FDB shall be located in an electrical panel room provided in each floor.

FDB shall include incoming and outgoing Moulded Case Circuit Breaker (MCCBs), power analysers, indicator lamps, bus bars, current transformers, auxiliary fuses, protection relays, surge protective devices, small wiring, interconnections and other accessories. Sufficient space (spare breakers and free space for spare breakers) shall be provided in the FDB for future expansions.

The **FDB** shall be of the rigid, freestanding or wall mounted, metal cubicle type, totally enclosed, dust and vermin protected and factory fabricated in compliance with BS 5486 (IEC

60439) and this specification where applicable. Form of internal separation shall be Form 3b as

specified in IEC 60439-1.

Critical outgoing feeders shall be metered using digital power analyzers and shall be able to integrate to with the proposed Building Management System (BMS).

E.4.5.3 Distribution Board (SDB) / Consumer Units (CUs)

Distribution Boards (DBs)/Consumer Units (CUs) shall be wall surface mounted/ freestanding, metal cubicle type, totally enclosed, dust and vermin protected and factory fabricated in compliance with BS 5486 (IEC 60439). DBs/CUs shall be fed via the FDBs in each floor and separate units shall be provided for each individual section. All the final point wirings shall be connected to the DBs/CUs.

DBs/CUs shall include incoming MCCBs/MCBs, outgoing MCBs, RCCBs, indicator lamps, bus bars, current transformers, auxiliary fuses, protection relays, surge protective devices, small wiring, interconnections and other accessories. Sufficient space 40% (spare breakers and free space for spare breakers) shall be provided for future expansions.

E.4.5.4 Low Voltage (LV) Switchgear Accessories

E.4.5.4.1. Air Circuit Breakers (ACB)

ACBs shall comply with standards IEC 60947-1 and IEC 60947-2 and be of type tested (test certificates shall be submitted) and reputable make. Utilization category of ACB shall be Category B. Air circuit breakers shall have a rated operational voltage of 690V AC (50Hz). All circuit breakers shall be fully tropicalized as standard. Air circuit breakers shall be suitable for isolation according to IEC 60947-1 and –2 for the rated insulation voltage.

Circuit breakers shall be of the automatic, metal clad, withdrawable isolating, removable type having provision for safe maintenance. Provision shall be made to padlock the circuit breaker in the isolated/ withdrawn position and to padlock the automatic shutters covering the live contacts when the circuit breaker is removed from its housing. Interlocks shall be provided to prevent movement of the circuit breaker within the housing when it is in the 'closed' or 'service' condition and automatic shutters shall be provided to cover all live contacts when the circuit breaker is isolated or withdrawn or is removed from its housing.

The operating mechanism shall be of the Open / Closed /Open stored-energy spring type and shall be of the trip-free, spring assisted motorized closing and opening design. Interlocking mechanism shall be built in as a standard feature to prevent the breaker from closing when the spring is not fully charged. Mechanical indicators shall be incorporated to indicate breaker OPEN, CLOSED and TRIPPED status, and spring CHARGED and DISCHARGED.

Shunt trips and other required accessories shall be provided for the breaker. Auxiliary switches shall be fitted to provide illuminated indication of circuit breaker ON/OFF status.

The ACB control unit shall offer the following protection functions as standard:

- Long-time (LT) protection with an adjustable current setting and time delay
- Short-time (ST) protection with an adjustable pick-up and time delay
- Instantaneous (INST) protection with an adjustable pick-up and an OFF
- Current and time-delay settings shall be indicated in ampere respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay

Current rating and the rated short circuit capacity shall be selected by the Contractor. Calculations shall be submitted after the award of contract under the "Schedule for Selection of Circuit Breakers".

E.4.5.4.2. Moulded Case Circuit Breakers (MCCB)

MCCB shall comply with IEC 60947-2 and be of type tested and reputable make. MCCB shall be of current limiting type and shall have a rated operational voltage of 690V AC (50Hz). All circuit breakers shall be fully tropicalized as standard. MCCBs shall suitable for isolation according to IEC 60947-1 and –2 for the rated insulation voltage.

The operating mechanism shall be of the quick-made, quick-break, trip-free type with the speed of operation independent of the operator. The mechanism shall be designed to operate all poles simultaneously during opening, closing and tripping conditions. The breaker shall be operated by a toggle unless otherwise specified in the schedules, drawings or bill of quantities.

The breaker shall be provided with thermal bi-metallic elements for an inverse time-current trip characteristic to protect against sustained overloads and instantaneous magnetic trip elements for short circuits protection. Thermal trips and magnetic trips shall be adjustable. A single adjustment shall ensure the setting of all poles in a multi-pole breaker simultaneously.

MCCBs above 800A shall be provided with a micro-processor control unit for tripping. The CB control unit shall offer the following protection functions as standard:

- Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay;
- Instantaneous (INST) protection with an adjustable pick-up and an OFF position.

- Current and time-delay settings shall be indicated in amperes and seconds respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay

Current rating and the rated short circuit capacity shall be selected by the Contractor and the calculations shall be submitted with the Proposal under the "Schedule for Selection of Circuit Breakers".

E.4.5.4.3. Miniature Circuit Breakers (MCB)

The Miniature Circuit Breaker shall be a compact electro-mechanical device for making, breaking and disconnecting a circuit in normal conditions and protecting circuit in abnormal conditions such as over-current and short circuit. The circuit breaker time current operating characteristics shall conform to type C, table 7 of IEC 60898-1 (shall apply for all office areas).

The Miniature Circuit Breaker shall be of wire in, wire out type and basically comprise the following features.

- Independent Manually operated latched switching mechanism with trip free release
- Arc-quenching chamber
- Overload protection
- Instantaneous Short circuit protection
- Safe Disconnection of load from the source

The single phase MCB shall be of Single or two pole type suitable for operating on 230V supply and three phase Miniature Circuit Breaker shall be of three or four pole type suitable for operating on 400 V supply. Minimum short circuit capacity of all type of MCBs shall not be less than 10kA.

The manufacturer shall possess ISO 9001:2015 Quality Assurance Certification valid throughout the delivery period of this Proposal, for the manufacture of Miniature Circuit Breakers for the plant where the Miniature Circuit Breaker is being manufactured. The Proposer shall furnish a copy of the ISO certificate certified as true copy of the original by the manufacturer, along with the offer.

Type Test Certificates conforming to IEC 60898-1 shall be provided for the Engineer‟s approval.

E.4.5.4.4. Residual Current Devices (RCD) & Earth Leakage/Fault Protection Devices

RCD shall disconnect a circuit whenever it detects that the electric current is not balanced between

the energized conductor and the return neutral conductor. They shall provide protection against earth leakage currents and earth fault currents. The tripping current shall be

30 mA/100mA as specified. RCD shall be super immunized type.

RCD shall be conforming to IEC 60755. Each RCD shall consist of a current transformer, a tripping coil with contact assembly, main supply contacts, ON/OFF switch, a test button and a trip-free mechanism, all mounted on robust body of all insulated material. RCD shall be suitable for operation on a single phase/three phase, 50 Hz supply and shall give trouble-free service in the locally prevailing climatic conditions.

Earth Leakage, Fault Protection Devices (ELRs/EFRs) shall be provided in the up-stream distribution boards (MDB, SMDB/FDB levels) and the co-ordination between protection devices shall be considered in the design.

E.4.5.4.5. Power Analyzers

Digital power analyzers shall be provided in the SMDBs and/or three phase DBs with current transformers, potential transformers and all required accessories to monitor the following parameters.

- Active power (kW) and reactive power (kVAR) - total and per phase
- Current (A) – 3 phases and neutral
- Voltage (V) – phase to phase and phase to neutral
- Frequency (Hz)
- Apparent power (kVA)
- Power factor
- Active energy (kWh)
- Reactive energy (kVAR)
- Maximum active power demand (kW)

Accuracy of multi-function power meter shall be not less than the following.

- Energy and power accuracy: 2%
- Current and voltage accuracy : 0.5%

All s required for Power Analyzers shall be provided.

E.4.5.4.6. Communication

Communication facility all power analyzers shall be compatible with the proposed Building Management System (BMS).

E.4.5.5 Power Factor Correction Capacitor Banks

Power Factor Correction Capacitor Banks shall be provided to the system to reduce the Reactive Power fed to the system by the utility. Capacitor Banks shall be connected to the MDB, SMDBs as well as for each large individual and/or group of electrical equipment to acquire an additional credit which is to enhance the active power handling capacity of the long-run sub-main distributions cables.

The PFC shall be assembled in an independent cubicle. A number of capacitor units shall be combined to capacitor banks. The PFC shall be designed to correct the total power factor in between 0.98 lag and unity and the calculations for the selection of capacitor banks shall be submitted.

Capacitors with suitable harmonic suppression detuned series reactors shall be offered. PFC shall be automatically operating type. The PFC shall be microprocessor controlled type based on solid state switching. The power factor shall be always lagging.

The power factor control panel enclosures shall be floor mounted type made of 1.5mm sheet steel with a minimum degree of protection of IP 54 and shall include all necessary internal connections and bus bars, insulators and other fittings.

Capacitor bank shall provide communication facility to integrate with proposed BMS.

E.4.5.6 Low Voltage (LV) Power Cables

Cables shall be installed in properly designed/planned cable management system (cable tray/ladder, PVC compartment trunkings etc.). If cables are supposed to lay underground, cables shall be armoured cables and laying shall be as per the standard practice. Concrete cable trenches shall be provided as specified under cable management systems.

Feeder cables shall be of four (4) core, copper conductor, XLPE or PVC insulated, PVC sheathed, 600/1000V grade complying with BS 5467 or IEC 60502.

Conductor size of the cable shall be decided by considering the total allowable voltage drop in the cable and current rating considering all correction factors and future expansions.

End terminations of all feeder cables shall be properly installed (tightly fixed to the circuit breaker terminals) including sleeves (with standard colour code to identify the three phases & neutral), copper cable lugs and cable glands. Cable joints are not be allowed in between.

Suitably selected Fire Resistance (FR) cables complying with BS 6387:2013, BS 8519:2020 & BS 8491:2008 shall be used to feed power to emergency lighting systems, fire pumps, fire lifts and any other essential critical load which are to be in operation under fire conditions.

E.4.5.7 Low Voltage (LV) Small Power System

Power socket outlets of single phase 230V, 13A switched shuttered flush mounting type complying with BS 1363 shall be provided. The final locations of all socket outlets shall be agreed with the Interior Designer/Architect/Engineer, during the detail design stage. Power outlets (industrial sockets) shall also be provided for electric vehicle charging bays in the parking areas and all other necessary locations.

Office areas shall be provided with a suitable method to get the connectivity for power, data and communication to the working tables in the middle of the office. Number of socket outlets provided in the office areas shall be sufficient for intended occupancy of the particular area. (At least 2 Nos. 13A socket outlets shall be provided for a one workstation with a computer. Only 6-8 computers shall be connected to a single Residual Current Device (RCD) to prevent from nuisance tripping.

For the other areas, sufficient amount of socket outlets shall be provided considering the occupancy and the power requirement of equipment to be installed. Also the final arrangement shall be designed considering the requirements of other building services such as fire protection & detection system, IT services, air conditioning system and building management system etc.

The wiring for 13A socket outlets shall be carried out using PVC insulated, PVC sheathed, copper conductor single core cables. Type of circuit shall be radial or ring as per the Proposer"s design. The minimum conductor size to be used for socket outlet circuits shall be 2.5 mm^2 and 1.5 mm^2 for lighting circuits and all lighting circuits shall be provided with 2.5 mm^2 earth conductor.

E.4.5.8 Electrical Lighting System

The lighting design has to provide a good general ambient level of lighting as well as special task and effect lighting. Proposer shall have the sole responsibility to design the lighting systems in the entire building premises as per their calculations and software simulations. All the calculations and software simulation details shall be submitted along with the proposal.

For the lighting design, international standards and design guidelines for public transport terminals and CPTED methods (Crime Prevention through Environmental Design) shall be followed. Also the design shall be complied with the CIBSE standards & Sri Lanka Standard Code of Practice for the Energy Efficient Buildings. Required illumination levels given below shall be referred for the

lighting design and the appropriate type of energy efficient luminaires shall be proposed accordingly.

Table E.12: Design Illumination Levels

Area	Illumination Level (Lux)
Terminal Entrance and Exits	250
Driving Lanes	75
Driving Lanes – at Ramps	150
Public Roads & Streets (outside the terminal)	30
Bus/Car Park (Indoor)	100
Bus/Car Park (Outdoor)	50
Passenger Entrances	150
Passenger Concourses	150
Passenger waiting area & waiting rooms	150
Lounges	300
Ticketing counters	500
Offices	400-500
Public Canteens	150
Restaurants	200
Food preparation/Cooking	500
Lifts	150
Escalators	200
Lift Lobbies	200
Staircases	150
Corridors	200
Toilets	200
Store rooms	200
Pump rooms, AC plant rooms, Generator and transformer rooms, Electrical panel rooms	200
Canopied Areas	150
Commercial areas	300

Energy efficient type LED luminaries shall be provided for lighting at all indoor and outdoor area. The luminaires at each area shall be selected to match with the architectural features of the location

where the lighting fixture is intended to be used. A schedule of proposed light fitting types shall also be submitted with the Proposal.

Each individual component of luminaire such as LED chip, driver, optics and heat sink shall be properly selected and placed within the system. There shall be good convective air flow around the heat sink and LED chip. The driver or the control gear shall be constant current integrated type. Life time of lamps shall be greater than 30,000 burning hours. All type of luminaries shall be in accordance with SLS 1639 Part 1 & 2.

All the lamps/fittings must be reputed & proven European or equivalent brands, with minimum efficacy of 90 lm/W (If it is not specified), must be supplied from their original manufacturer through the authorized local agents with a comprehensive warrantee of minimum 02 years. 10 % spares of each type of luminaire shall be handed over with the building handing over.

Engineer"s approval shall be obtained for light fitting samples before purchasing them by submitting technical and architectural catalogues. After obtaining the approval, one sample of each type of luminaire shall be subjected to test at any of following local test laboratories by the contractor and test reports shall be submitted to the Engineer"s approval before purchasing. In case the test reports do not meet the specifications of the manufacturer, the particular samples will not be accepted and contractor shall submit alternative light fittings for the replacement.

- Regional Centre for Lighting (RCL) under Ceylon Electricity Board (CEB)
- National Engineering Research and Development Centre of Sri Lanka

E.4.5.8.1. (NERDC) Applicable Standards

- IEC 62031:2018 LED Modules for General Lighting - Safety Specifications
- IEC 62717:2019 LED Modules for General Lighting - Performance Requirements
- SLS 1639 Part 1 Specification for LED Modules for General Lighting – Safety Requirements
- SLS 1639 Part 2 Specification for LED Modules for General Lighting – Performance Requirements
- IESNA LM-79-08 Approved Method : Electrical and Photometric Measurement of Solid State Lighting Products
- IESNA LM-80-08 Approved Method for Lumen Maintenance Testing of LED Light Sources

- IEC 62384- DC or AC Supplied Electronic Control Gear of LED Modules – Performance Requirements

The wiring for electrical lighting fixtures and ceiling fans shall be carried out using PVC insulated, PVC sheathed, copper conductor single core cables. The minimum conductor size to be used for lighting circuits shall be 1.5 mm^2 and all lighting circuits shall be provided with 2.5 mm^2 earth conductor.

E.4.5.8.2. Lighting Control System

The proposed lighting system shall be able to control (dimmable, on & off) with the day light gain through glass walls at all possible areas for the maximum energy efficiency. Also, the entire indoor lighting system (including all terminals, underpasses etc.) shall be day light sensor and 24 hrs timer operated type. Those lighting circuits shall be integrated to the Building Management System (BMS).

It is Contractor's responsibility to suitably select a control strategy/ strategies based on the areas and the usage of each area. And also Contractor shall select and supply all the required components to control the lighting systems such as light fittings, sensors, switches, controllers, cabling ect. A facility to by-pass the controller system shall also be provided to use when it is required.

Documents incorporating the details of proposed lighting control strategy, Electrical Power Wiring diagrams, Control Wiring Diagrams, data sheets of all the components of the lighting control systems with other documents prepared for the green aspects of the building shall be submitted for the review.

ON/OFF switches for lighting/controlling devices shall be provided at appropriate convenient locations and number of switches shall be selected to meet Green guidelines.

E.4.5.8.3. Emergency Lighting

Adequate emergency lighting circuits shall be provided as per the fire regulations to cover the escape route lighting under the emergency conditions. Those circuits shall be originated from the separate Distribution Board (DB)/Consumer Unit (CU) for emergency power fed via a UPS system. At the locations where the UPS can‟t be provided maintained type emergency luminaires shall be provided. All emergency wirings from each respective CU/DB shall be carried out using properly sized fire rated (FR) cables complying with BS 6387.

Design of this system shall coordinated with the fire protection & detection system design team. Back-up time shall also be decided as per the fire requirements. Contractor shall clearly indicate the lights to be controlled via emergency power supplies (via UPSs and maintained type) in the

lighting layout and wiring drawings.

E.4.5.8.4. Outdoor Lighting

Street lighting and security lighting system shall be provided for the building complex considering architectural and functional requirements. Light fittings shall be weather proof and made of non-corrosive materials (die-cast aluminium/Stainless Steel). Their mounting accessories shall be properly protected against corrosion (Galvanized Iron/Stainless Steel). Special attention shall be taken in selecting outdoor equipment considering the building environmental conditions.

The entire outdoor lighting system shall be photo sensor and/or timer operated type. Also, shall be able to integrate with the BMS system. LED fittings with inbuilt Surge Protective Devices (SPDs) are recommended. Lighting design shall be carried out using a simulation software and the simulation details shall be submitted.

Possibilities of introducing renewable energy sources (solar) to power up the street lighting are encouraged and shall be proposed wherever it is appropriate.

- **Street Light Pole** - The Octagonal Poles shall be designed to withstand the maximum wind speed as per BS EN 875. The top loading i.e. area and the weight of fixtures are
- to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.
- Octagonal Poles HT Steel Conforming to grade S355JO. Foundation Bolts EN.8 grade welding the welding shall be carried out confirming to approve procedures duly qualified by third party inspection agency. Pole sections The Octagonal Poles shall be in single section. There shall not be any circumferential weld joint.
- Pole shaft shall be adequately strengthened at the location of the door to compensate
- for the loss in section. Door opening the octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking. 20A, 4P MCCB with connectors and earthing terminals shall be provided inside the pole.
- **Galvanization** - The poles shall be hot dip galvanized as per BS EN ISO 1461
- standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

- **Installation Method** - All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This baseplate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency. The Octagonal Poles shall be bolted on a foundation with a set of four foundation bolts for greater rigidity.
- **Bracket for street light fittings** - The brackets shall be made of specified size heavy duty pipe approx. 1.4 M long, bent at the center at an angle of 120 degree, with necessary holding brackets, hold fasts etc. with special reducer at end to accommodate type of street light fitting to be fixed. The bracket shall have one coat of anti-corrosion paint before dispatch to site and two coats of approved make and shade of enamel paint.
- **Earthing Arrangement** - Suitable earthing arrangement shall be provide for the street lighting poles and at least earth electrodes shall be installed one after the other pole.

Apart from the street lighting landscaping lighting system within the premises shall be provided as per the Architectural requirements. All the outdoor wirings shall be carried out via a separate Distribution Board using underground armoured power cables direct buried and through GI conduits for mechanical protection as per the requirement and all the termination points shall be water-proofed. Outdoor type Feeder Pillar units shall also be used if required.

E.4.5.9 Electricity Metering

E.4.5.9.1. Utility Metering

CEB Electricity supply to the building complex is metered at medium voltage (11kV). Only one electricity bill will be issued by CEB for the electricity consumption of each month. Tariff that will be applied is Bulk Supply Tariff which comprises of charges for electrical energy (kWh) consumption and maximum demand (kVA). Electricity service connection charges are not included to the Contractor‟s scope. However, the contractor shall provide all the facilities/provisions as per the requirements of the utility provider and shall coordinate with them until the bulk supply connection is obtained.

E.4.5.9.2. Sub Metering

Within the building complex power distribution, electricity metering (internal) facility shall be

provided for each separate buildings (at SMDBs), every floor of the each building (in FDB levels), at large individual loads and all rentable commercial spaces. Facility for remote monitoring/reading of electricity meters from a single place shall also be provided. Thus these electricity meters shall be of electronic type capable of metering multi functions and shall be essentially connected with the Building Management System (BMS).

E.4.5.10 Earthing System

A complete and effective system earthing has to be provided for the building, in accordance with the IET Wiring Regulations. The exposed metal parts of all electrical equipment shall be bonded to earth.

All metallic components of services including water mains, water treatment systems, fire and sprinkler mains etc. entering or leaving the respective building shall be effectively bonded to the main earth bar.

All equipotential bonding conductors shall be insulated, the insulation being coloured green/yellow. The electrical earthing system has to be interconnected with the lightning protection earth termination system.

E.4.5.11 Cable Management System

Cable Management System shall include cable trenches, heavy duty GI pipes for road crossings, vertical cable ladders, horizontal cable trays, PVC/GI conduits, multi-compartment PVC trunkings and raised floor systems (if any). Size of the systems shall be designed providing the 60% of free space inside the system after installing the cables.

Layout drawings shall be submitted after the tender awarding and shop drawings shall be submitted for the prior approval in the construction stage.

E.4.5.11.1. Cable Trenches

Concrete cable trenches with concrete cover slabs shall be provided for following cable installations.

- 11kV Utility Cables within the entire premises and crossing the premises (if any)
- 11kV incoming cables from utility substation to the Transformer room
- From the Transformer room to Main Electrical Panel Room
- From the Generator room to Main Electrical Panel Room

- Main Electrical Panel Room to all the buildings/zones of the premises as per design of the proposer
- For outdoor lighting and street lighting
- For any other service or to any location as per the design

The structural design of cable trenches shall be suitable for handling heavy vehicle movements. At the locations where the trench crosses canals or bridges, suitable size of GI pipes shall be provided. Cable trench layout shall also be submitted with the proposal.

E.4.5.11.2. Cable Trays and Ladders

Metallic systems shall be made of hot dipped Galvanized Iron (GI) or epoxy powder coated zinc coated sheet metal depending on the location to be installed and shall comply with BS EN 61537:2007 Cable Management – Cable Tray and Cable Ladder Systems/NEC Article 318, NEMA VE 1, and NEMA FG 1 and follow safe work practices as described in NFPA 70E. Samples of each item with fixing accessories shall be subjected to the prior approval.

E.4.5.12 Testing of the Installation

After completing the installation work, Testing of the entire electrical installation of the building shall be carried out by the Contractor. Test report/certificate as required by latest IET Wiring Regulations and requirements of IEC 62305 and certified by a Chartered Electrical Engineer (CEB registered) shall be submitted. Test reports/certificates shall be submitted per each building separately and for the total electrical installation. Test reports shall be acceptable to Ceylon Electricity Board (CEB).

Contractor shall energize the building after testing and make arrangements to commission of the electrical installation. Contractor shall co-ordinate with CEB for obtaining the incoming power connection to the building complex. Commissioning of main equipment such as transformers, generators, main panels, UPS systems, lightning protection system and solar PV systems shall be arranged to witness by the Employer and the Engineer.

E.4.6 STANDBY POWER SYSTEM

Scope of work includes design, supply, delivery to the site install, testing and commissioning of prime rated brand new diesel generators (canopy type) and accessories as an alternative (Stand-by) power supply for the building complex. If it is proposed open type generators due to some restricted spacing issue, then the generator room shall be sound proofed.

The standby power supply shall be designed by the Proposer to cater the total power requirement

of the premises (as per the calculations of the Proposer). Night time loads and weekend/holiday loads (minimum possible load) shall also be considered in the design. Number of generators and their capacities shall be decided accordingly. Minimum possible load for any generator shall be more than 1/3rd of the prime rating.

In addition, a separate stand-by diesel generator (canopy type) shall be provided for the

Refueling Station. This system shall be complete with an inbuilt fuel tank and a separate Auto Transfer Switch (ATS) panel and a proper exhaust system. Capacity of the referred stand-by system shall be selected to cater the total demand of the refueling station (as per the calculations of the Proposer) during a utility power failure.

Following works shall be included in the scope of the work.

- Selection of adequate capacity of the Generators
- Design of Standby Power Distribution Systems including Generator Distribution Board/Synchronize Panel (GDB), Auto Transfer Switch (ATS) panels, power cables and cable management systems (trenches, cable trays/ladders etc.)
- Design of underground fuel sump, day tanks and fuel pumps, pump controlling system and piping system
- Design of structural arrangements of the generator rooms (considering the vibration reduction and room sound proofing requirements.)
- Design of ~~a~~ proper exhaust systems as per the requirements of Central Environmental
- Authority (CEA) and the architectural aspects.
- Obtaining the necessary approval for the designs and shop drawings.
- Arranging the Factory Acceptance Test (FAT) at the manufacturers workshops before importing the Generator sets.
- Supply, installation, testing and commissioning of diesel Generator sets (canopy type) with GDB, ATS panels, power cables, cable management systems, additional room sound proofing (if required), fuel sumps/tanks, fuel pump system and all other necessary accessories.
- Training of the Employer‟s staff about the operation of the system.
- Maintenance of the system/Handing over the maintenance to the local agent of
- Generator Manufacturer (after the defect liability period if required by the Employer).

E.4.6.1 Qualification Information

- **Engine Manufacturer**: Shall be a renowned company specialized in manufacture of diesel engines with minimum 10 years documented experience. Manufacturing plant where the proposed engine would be built shall have minimum 5 years documented experience in the production of diesel engines. Quality assurance system of the manufacturer shall have ISO 9001 certificate.
- **Alternator Manufacturer**: Shall be a renowned company specialized in manufacture of alternators with minimum 10 years documented experience. Manufacturing plant where the proposed alternator would be built shall have minimum 5 years documented experience in the production of alternators for diesel gen sets. Quality assurance system of the manufacturer shall have ISO 9001 certificate.
- **Assembly of Generator Set**: If the assembly of engine-alternator set is carried out neither by engine manufacturer nor alternator manufacturer, then the assembling party shall be a reputable company with a minimum of 5 years‟ experience in the assembly of generating sets. The quality assurance system of the assembling company shall have ISO 9001 and/or ISO 9002 certification.
- **Local Agent:** There shall be an accredited agency in Sri Lanka for the make of generator set offered and also the agent shall have proven record of providing after sales services including maintenance services at least during last five years. The local agent shall have adequate stock of spare parts at all the time, qualified maintenance staff and repair facilities.

E.4.6.2 Diesel Generators

Each Generator set shall consist of one diesel engine complete with radiator, exhaust system, electronic governing one alternator with exciter and one flywheel with flywheel housing, mounted on a steel base. The automatic voltage regulator may be mounted on the alternator. Generator control, protection, monitoring systems and accessories shall be mounted on a control panel. Each generator set shall be factory assembled and aligned accurately on the steel base which shall be strong and rigid enough to ensure permanent alignment of all rotating units and prevent vibration build up and shall permit skidding in any direction during installation.

The generator sets shall be capable of delivering the rated output for continuous period of not less than 12 hours at a time. It shall have overload capacity of 110% of the rated output for one hour during a period of 12 continuous hour‟s operation.

Generator set shall have the following features:

- Factory-mounted on a common, rigid, welded, structural steel base.
- Sound attenuated type canopy to meet with recommended sound levels or room sound proofing for open type generators
- Automatic start, accelerate to the rated speed and deliver the specified kW/kVA
- output at 50 Hz within 10 seconds.
- Recover rapidly from instantaneous changes between no load and the specified kW/kVA rating, and the reverse changes of load, without damage.
- Engine-generator set shall be statically and dynamically balanced at the factory.

E.4.6.3 Sound Attenuating Type Canopy

The canopy shall be sound attenuating type and manufactured from high quality Zinc coated steel sheeting or other approved material. The canopy shall be base frame mounted and lined with sound absorbing materials retained by steel perforated sheet or other suitable arrangement. Entering of air to the enclosure shall be via acoustic intake louvers at the generator end and discharge shall be acoustic louvers at the engine end. Access to the generator set shall be provided by side opening doors with lockable recessed handles. The acoustic lining shall be applied to the doors, discharge and inlet louvers and roof.

Noise level should be less than 70 dB at 1m distance from the walls of the generator room with doors closed, when operating at full load.

E.4.6.4 Generator Distribution Board (GDB)

The Synchronizing Panel/ Generator Distribution Board (GDB) shall be of the rigid, freestanding, metal cubicle type, totally enclosed, dust and vermin protected and factory fabricated in compliance with BS 5486 (IEC 60439) and this specification where applicable. Form of internal separation shall be Form 4b as specified in IEC 60439-1. The Panel shall be of type tested design. Type test certificates shall be in the name of the panel builder.

Synchronizing panel shall contain separate incoming breakers for all generator incomings and separate outgoing breakers for the outgoings up to the Auto Transfer Switch (ATS) units and all the indicating instruments, contactors indicator lamps, current transformers, auxiliary fuses, protection relays, surge arrestors, small wiring, interconnections and other accessories of that circuit. Busbars shall be of tin plated copper, and purity of copper shall be 99.99%. The rating of main bus bar and fault current rating at the main bus bar shall be selected as per the contractor‟s

calculations.

Moulded Case Circuit Breakers (MCCB) in Synchronizing panel shall be furnished with normally closed auxiliary contacts for circuit breaker on/off and tripped signals for connectivity with Master Control Panel and Supervisory Control and Data Acquisition System (SCADA).

Enclosure protection class shall be IP 54 as a minimum. The Synchronizing Panel shall be flush fronted with front and rear access, and suitable for indoor use. Access doors and covers shall incorporate sealing gaskets. Synchronizing Panel shall be provided with a metal plinth of minimum 200mm high. All metal work (other than current carrying parts) shall be bonded to the earthing bar.

E.4.6.5 Auto Transfer Switch (ATS) Panels

The ATS panels shall be of the rigid, freestanding, metal cubicle type, totally enclosed, dust and vermin protected and factory fabricated in compliance with BS 5486 (IEC 60439) and this specification where applicable. Form of internal separation shall be Form 4b as specified in IEC 60439-1. The Panel shall be of type tested design. Type test certificates shall be in the name of the panel builder.

Connection facilities for all incoming and outgoing cables shall be designed by the Contractor. Those details shall be provided in the single line diagrams/schematic diagrams/general arrangements.

E.4.6.6 Cables & Cable Management Systems

Requirements under 5.5.6-Low Voltage (LV) Power Cables and 5.5.11-Cable Management

Systems shall be applied for cabling under generator scope.

E.4.6.7 Fuel Delivery system

E.4.6.7.1. Fuel Storage (Bulk Tanks)

Proposer shall determine the required capacity of the underground fuel storage which shall be sufficient for operation of continuous 3 days (with 12 hours operation cycle @ full load) of all the generators. A suitable location shall also be proposed. Delivery system shall be consists of underground pipeline from the storage tanks to day tanks, fuel transfer pumps for pumping diesel from main storage tanks to day tanks and manual pumps.

Calculations for the capacity selection and shop drawings for the underground fuel storage including, fuel transfer pump arrangement and piping system shall be submitted for the approval prior to the construction.

E.4.6.7.2. Day Tanks

Day tanks capacity shall be sufficient for 12 hour operation of all the generators. The tanks shall be provided with all necessary fittings including fill, vent, drain and overflow line, level indication, Level switches and access for inspection and maintenance. Fuel transfer from day tank

to diesel engine shall be by gravity.

E.4.6.7.3. Fuel Pump Control Panel

A pump control panel complete with all required starters, relays, switches, push buttons etc., shall be provided. The pump control panel shall contain a selector each so that each pump may be either started or stopped by hand or automatically on receipt of signal from the level switches in the service tank. All required wiring between pumps, day tanks and pump control panel shall be provided.

E.4.6.8 Generator Room Sound Proofing

It is expected to provide the Generators with sound attenuated canopies for the sound reduction. Noise level of the generator sets shall be not more than 70 dB(A), when running at full load, at outside of the generator room 1m away from the walls of the generator room with doors closed.

If it is proposed open type generators due to some restricted spacing issue, then the generator room shall be sound proofed. The sound attenuation design shall include layers of sound absorbing materials for the fresh air intake attenuators and hot air discharge attenuators. A proper exhaust silencer shall be provided so that the noise level will be minimized.

Noise level outside the generator room shall meet the Central Environmental Authority (CEA) requirements. CEA requirements with regard to the generator sets are as follows.

- *"The in-plant generator planned to be used during power failures should be installed in such a manner that the noise generated from the operation of the in-plant generator shall be maintained at or below 63dB (A) during day time (0600 hrs to 1800hrs) and 50dB (A) during night time (1800hrs to 0600hrs). The generator shall be installed on resilient foundations in an enclosed sound proof chamber".*

The above CEA requirements may apply at the boundary of the building premises where the generators are installed.

E.4.6.9 Generator Room Vibration reduction

The engine-generator set shall be provided with proper vibration dampers fitted to the base mountings. Vibration isolators of spring/pad type shall be provided as recommended by the

generator set manufacturer. Isolators shall include seismic restraints as per the employer‟s requirement.

Flexible connections shall be provided to all exhaust, water, air, fuel and oil piping that leave the engine to prevent the transmission of vibration and the fracture of the piping due to movement of the set. The choice of connections and their installation is to be such as to give long life under normal operating condition of the set.

E.4.6.10 Tests

The following tests and checks shall be carried out in the manufacturer's workshops and test certificates shall be submitted. All tests as required by the manufacturer's practice or by applicable standards during the manufacture stage.

E.4.6.10.1. Factory Acceptance Test (FAT):

Manufacturer shall furnish load banks, testing instruments and all other equipment as necessary to perform these tests to be witnessed by representatives of the Engineer and Employer. All the costs of the witnessing representatives (travelling, lodging etc.) for witnessing the tests shall be borne by the Contractor.

- Load Test: During this test record the following data at 15-minute intervals.

Time	Engine RPM	Oil Temperature Out
kW	Water Temperature In	Fuel Pressure
Voltage	Water Temperature Out	Oil Pressure
Amperes	Oil Temperature In	Ambient Temperature

- Quick Start Test: Record time required for the engine generator set to develop specified voltage, frequency and kW load from a standstill condition.
- Performance tests on the assembled diesel generating set (with voltage regulator)
  - Check of fuel consumption at different loads
  - Dielectric or insulation tests

E.4.6.10.2. Site Tests

The following tests shall be carried out after installation at the Site:

- Operational tests (including instantaneous loading and load rejection)
- Measurement of the output
- Functional testing of all alarm and control devices

- Checking of the starting time and of the time up to taking-over full load.
- Testing of noise levels. Measurement of sound level at 1m and 7 m distances.

E.4.7 EMERGENCY POWER SUPPLY

Emergency power shall be provided for the escape route lighting in all areas (Terminal areas, parking areas, connecting bridge, office areas, corridors, stair cases, fire lift lobbies etc.) as per the fire regulations and the following specific power requirements of the building.

- Servers and server room equipment
- Parking management and terminal management systems
- Electronic security system head end equipment,
- CCTV system
- Data & Telephone Network
- BMS Network
- Any other special loads

Emergency power shall be provided using direct on-line type Uninterruptible Power Supply (UPS) System compliance with IEC 62040-1, IEC 62040-2 & IEC 62040-3. Separate UPS shall be provided for above specific systems. Minimum back-up time for all UPSs shall be provided as per the fire protection requirements.

Separate Distribution Board (DB)/Consumer Unit (CU) shall be allocated for emergency power and lighting circuits in a floor. Required capacities (rating of UPS, single phase or three phase, battery capacity, cable sizes etc.) of UPS for a typical floor shall be proposed by the contractor with the calculations.

E.4.7.1. Experience of the UPS manufacturer

Shall be a renowned company specialized in manufacture of UPSs with minimum 10 years documented experience. Manufacturing plant where the proposed UPS would be built shall have minimum 5 years documented experience in the production of UPS units. Quality assurance system of the manufacturer shall have ISO 9001 certificate.

E.4.7.2. Experience of the battery manufacturer

Shall be a renowned company specialized in manufacture of Sealed AGM VRLA or Gel type Batteries with minimum 10 years documented experience. Manufacturing plant where the proposed batteries would be built shall have minimum 5 years documented experience in the production of

batteries. Quality assurance system of the manufacturer shall have ISO 9001 certificate.

E.4.7.3.Experience of the local agent

There shall be an accredited agency in Sri Lanka for the make of UPS system offered and also the agent shall have proven record of providing after sales services including maintenance services at least during last 05 years. The local agent shall have adequate stocks of spare parts at all the time, qualified maintenance staff and repair facilities.

E.4.8 LIGHTNING PROTECTION SYSTEM (LPS)

All buildings within the premises shall be protected against Lightning. Lightning protection system shall comply with the requirements of IEC 62305:2010-12 Part 1, Part 2, and Part 3 & Part 4 for protection against lightning. The direct protection system includes, but not be limited to, an air termination network, down conductors, joints and bonds, test joints, earth terminations and earth electrodes. The indirect lightning protection shall be provided by incorporating coordinated Surge Protective Devices (SPDs) in Distribution Boards.

The risk assessment shall be carried out to find the class of the protection needed for the building against lightning. Contractor shall submit the detailed drawings for the proposed Lightning Protection System with detailed calculations including risk analysis for the approval prior to the construction.

E.4.8.1.Air Termination System

Air termination components shall be positioned in a way to cover up all exposed points and edges. The air termination network shall comprise bare copper strips and solid copper air termination rods (finials).

E.4.8.2. Down Conductors

Dedicated circular mild steel conductors running through the structure columns and en-cased in concrete or exposed bare copper strips shall be used as down conductors. Distance between two adjacent down conductors shall be determined as per the class of LPS required. Down conductors shall be provided for each edges and corners of the building perimeter.

All down conductors shall be continued from pile cap reinforcement of the structure up to the air termination network in the roof level. At the ground level a connection shall be provided to the column surface mounted test box. At the roof levels all down conductors shall be connected to the to the air termination network with 25mm x 3mm solid copper tapes. (Solid bond form MS rod to a 25mm x 3mm solid copper tape). Surface mounted down conductors (25mm x 3mm solid copper tapes) shall be used in some locations if it is required.

E.4.8.3. Earth Termination System

Earthing arrangement with vertical solid copper earth electrodes properly bonded to the reinforcement of the pile caps has been proposed. Earth electrodes will be positioned near to all down conductor locations (near to columns) and the down conductor will be connected to the electrode through test joints installed on columns above the ground level. The earth resistance of the earth termination network shall not exceed 10 (ten) ohms.

E.4.8.4. Equipotential Bonding

All exposed metalwork such as steel handrails, cooling towers, chillers, pump arrangements, cladding structures, metal structures of glass walls, metal roofs, etc shall be bonded to the lightning protection system as specified in the standards, using bonds and clamps appropriate to the location. Equipotential bonding terminals (which have been connected to the down conductor system) shall be provided in all plant rooms and machine rooms.

E.4.8.5. Selection of Surge Protective Devices (SPDs)

IEC 62305-4 (Edition 2.0 2010-12): Protection against lightning – Part 4: Electrical and electronic systems within structures; and IET Wiring Regulations shall be referred to design the indirect Lightning Protection System using surge protective devices (SPDs). Coordinated Surge Protective Devices (SPDs) arrangement with appropriate protection levels and capacities have to be installed in the main and other distribution boards up to the sensitive equipment levels to protect electrical and electronic systems within the buildings. The Cost for SPDs shall be included to the respective switchgear items in the BOQ.

E.4.9 SOLAR PHOTO VOLTAIC (PV) SYSTEM

Scope of work include design, supply, installation and commissioning of grid connected, net metered, solar PV plant with all relevant accessories at most suitable locations at the premises (roof tops areas) as per the guidelines of Public Utility Commission of Sri Lanka (PUCSL).

Contractor shall responsible for the coordination with Ceylon Electricity Board (CEB) until the solar PV system is connected to the grid. The solar PV system shall include solar PV modules, mounting structure, grid-tie inverters, junction boxes, isolators, DC cables, AC cables, Surge Protective Devices (DC/AC), LV panels and import/export meters, etc.

Number of solar panels shall be selected as per the shadow free space available in the premises (shall be coordinated with the other services) and the total solar PV system shall be designed accordingly. Proposers must consider shading losses as per the relevant Industry Standard & Practice which designing the proposed power plant. Schematic diagram for the complete system

with all calculations are required to submit with the Proposal.

E.4.9.1. PV Module

PV module shall contain mono crystalline high power silicon solar cells. The solar cells shall have surface anti-reflective coating to heal to absorb more light in all weather conditions.

Proposer shall submit the details of the following performances under standard test conditions (with the Proposal)

(STC: 1000 W/m2, 25 ^{0}C & AM 1.5)

- Maximum power
- Open circuit voltage
- Maximum power point voltage
- Maximum power point current
- Short circuit current
- Maximum allowed system voltage (Open circuit voltage of PV strings)
- Module efficiency at STC (>17 %)
- Fill factor of the modules (> 0.7)

The rated power output of any supplied module shall not vary by more than 5% from the average power rating of all ratings. Test certificate confirming the rating shall be submitted with the offer.

Solar modules offered shall be certified as per latest edition of IEC 61215-2, IEC 61730-1, and IEC 61730-2 for safety qualification testing. Also, it shall meet the ISO 9001:2008, ISO 14001:2004 and ISO 17025:2005 international standards. Copies of the certification should be submitted with the offer.

E.4.9.2. Grid Tie Inverters

Total Rating of the Inverters shall be selected by the Proposer considering the availability and

the efficiency. Inverter units shall convert DC produced by SPV array and adjust the voltage and frequency levels to suit the Grid.

- Nominal AC voltage shall be 03 Phase, 30V/400V
- AC Grid Frequency shall be 50Hz. ±2.5Hz Allowed

All the Inverters shall be housed in a suitable switch cabinet, with minimum IP65 degree of Ingress

Protection, weatherproof, Rodents & Insect proof and Components and Circuit Boards mounted inside the enclosures clearly identified with appropriate permanent designations.

The grid supervision must comply with relevant local regulations. Maximum Power point Tracker (MPPT) has to be integrated in the Inverter Unit to maximize energy drawn from the array. The MPPT shall be microprocessor based to minimize power losses. The MPPT shall have provision (manual setting) for constant voltage Operation.

- DC voltage ripple content shall not be more than 3%.
- Efficiency of inverter shall not be less than 97%.
- Operating temperature range shall be 5°C to 60°C
- Islanding Protection. Facility to reconnect the inverter automatically to the grid following restoration of grid, subsequent to grid failure condition.
- Inverter generated harmonics shall not exceed a total harmonic distortion of 5%, a single frequency current distortion of 3% and single frequency current distortion of
- 1% when the 1^{st} through the 5^{th} integer harmonics of 50Hz are considered.
- Inverter shall not produce Electromagnetic interface (EMI)
- Code & Standards: VDE 0126, G83/1, IEC 61727, IEC62116

E.4.9.3.Module Mounting Structure

The Array Structure shall also be designed to occupy minimum space without wasting the output from SPV Panels. The Structure shall be designed such that there is adequate heat dissipation from solar panels under maximum solar radiation and to allow easy replacement of any module.

The PV array & support structure shall be designed to withstand wind speed as per relevant wind load codes and the details shall be included in the design calculations and shall also be connected to lightning protection system.

Structure shall be fabricated out of steel channels and hot dipped galvanized. Nut & bolts should be non-corrosive. The contractor shall submit detailed drawings of the mounting structure for approval of the structural engineer (shall be enclosed in structural drawings).

E.4.9.4.Warranty

Solar PV modules shall have more than 10 years product warranty (materials and workmanship) and 25 years power output warranty.

- All the inverters shall be covered under the warranty period of 10 years from the date of commissioning of the system.

E.4.9.5. System Monitoring, Remote Diagnosis & Data Storage

Meter to log the actual amount of AC energy generated/consumed by the PV System shall have to be provided. An integrated measuring device to be provided with the sensor mounted in the plane of the array.

Suitable Mechanism shall be provided to monitor the plant performance, to log plant data, to access current values, previous values up to one month & average values at any time. Provisions shall be provided to connect that system directly to the proposed Building Management system (BMS).

E.4.9.6. Site Testing and Commissioning

Proposer should submit a complete proposal with time schedule for testing and commissioning of the Grid Connected Solar Power System at site. The Program should include a trial operation of all main equipment with any necessary adjustments to ensure that system is working correctly. The Contractor should provide all instruments and equipment together with commissioning engineers and adequate assistance for carrying out the commissioning and testing activity which should be done in accordance with the recommendations of relevant Standards.

If any portion of the works fails to pass the tests, the Contractor should, at his own expense carry out such alterations or replacements as are required to the satisfaction of the Engineer. The Engineer should be at liberty to call for further commissioning when such alterations have been completed to their satisfactory. The Contractor should provide commissioning spares at his own expense.

E.4.10 GREEN ASPECTS

The Employer expect to integrate green building features as much as possible in the building complex as per recommended green building guidelines. Hence the electrical design shall be carried out to maximize the green features and energy efficiency within the premises.

The design shall comply with the minimum Green Building Guild lines issued by UDA (Blue Green Sri Lanka First Print, January 2017). If the Employer needs to apply for the UDA or any other green building certification in future, Contractor shall coordinate that process. Proposer shall refer the relevant green building guidelines of UDA and the maximum points which can be claimed for the design proposal shall be submitted with the calculations with the proposal.

E.4.11 REMOTE MONITORING AND CONTROLLING

Provisions shall be made to centrally monitor the low voltage electrical power distribution system at the each SMDB and FDB levels via Building Management System (BMS). Hence main components such as breakers, power analyzers, etc. shall be compatible and complete with required access ports.

Medium voltage system shall also be centrally monitored via BMS. Outdoor lighting and common area/special feature lighting shall also be able to control via BMS.

E.4.12 PREFERRED LIST OF MANUFACTURERS / MAKES

Preferred list of manufacturers/makes of equipment in electrical system is given in the E.4.17.

It has been provided for the sole purpose of defining and establishing standards of quality and performance and not with the intention of restricting the procurement of materials or fittings to a particular manufacture. Proposer shall ensure that all products, even though they are from the above list, meet the specification requirement.

E.4.13 TRAINING OF EMPLOYER'S STAFF

It is required to provide training of Employer‟s personnel for the following major electrical systems before the handing over of the project.

- Dry type transformers
- MV Switchgears
- Standby Generator System
- LV Power Distribution system
- Emergency Power (UPS) systems
- Lighting control systems
- Solar PV System
- Any other system requested by the Employer

E.4.14 SPARE PARTS, TOOLS AND CONSUMABLES

Spare parts for the following items/systems are required to be submitted at the handing over.

- Light fittings, ballasts/LED drivers, batteries, sensors and lamps (10% of each category)
- Switches and power socket outlets
- LV switchgear accessories (MCB & RCCB, fuses, indicator lamps, relays, timers etc.)
- Spare parts for generator system (lubricating oil filters, primary and secondary fuel oil filters and air filters)

E.4.15 MAINTENANCE STRATEGY

Maintenance strategy for the electrical distribution system of the building after the Contractor‟s defects liability period shall be furnished with the Proposal. For main equipment / components of the electrical distribution system, local agent‟s confirmation on maintenance ability (draft maintenance agreements for major equipment and systems) and spare parts availability shall be submitted. Contractor shall coordinate with their sub-contractors and the Employer for entering into the maintenance agreements after the defect liability period.

E.4.16. MINIMUM QUALIFICATION REQUIREMENTS OF EXECUTION OF SPECIALIZED ELECTRIC WORK

Electrical work shall be carried out by an experienced electrical contractor who has previous experience in similar scale projects (at least one project) during last 05 years and shall have necessary tools, equipment and experienced staff for medium/low voltage electrical installation and testing. The contractor or the sub-contractor selected for electrical works shall have the following experiences sub specialties.

Medium Voltage Electrical Installations - Experience in successfully completion of at least one (1) MV installations of similar capacity or larger within last 5 years

Low Voltage Electrical Installations - Experience in successfully completion of at least two (2) LV installations of similar capacity or larger within last 5 years

Standby Generator System - Experience in successfully completion of at least three (3) Generator installations of similar capacity or larger within last 5 years

Lightning protection System - Experience in successfully completion of at least one (1) Lightning protection system installations of similar nature/capacity or larger within last 5 years

Solar Photo Voltaic (PV) System - Experience in successfully completion of at least five (5) Solar Photo Voltic (PV) Systems installations of similar nature/capacity or larger within last 5 years and shall be a registered supplier/contractor of Sri Lanka Sustainable Energy Authority (SLSEA).

E.4.17. LIST OF PREFERRED MANUFACTURES – ELECTRICAL WORKS

Table E.13: List of Preferred Manufactures

	Item	Manufacture/ Brand Name	Country of Origin & Manufacture
1.	Air Circuit Breakers	ABB Siemens Schneider Terasaki Moller	Italy Germany France Japan Germany
2.	Moulded Case Circuit Breakers	ABB Siemens Schneider Terasaki Moller	Italy Germany France Japan Germany
3.	Miniature Circuit Breakers	ABB Siemens Schneider Terasaki Moller Hager	Italy Germany France Japan Germany Europe
4.	Residual Current Devices	ABB Siemens Schneider Terasaki Moller Hager	Italy Germany France Japan Germany Europe
5.	Surge Protection Devices	OBO Bettermann Eaton Soule Furse Novaris *J.Propster*	Germany Europe France United Kingdom Australia Germany
6.	Power Factor Correction Capacitor Banks	ABB Legrand Epcos	Switzerland France Germany

	Item	Manufacture/ Brand Name	Country of Origin & Manufacture
		Eaton	Europe
7.	Uninterruptible Power Supply	APC Eaton MGE	Europe Europe Europe
8.	Power Cables	ACL Kelani Sierra	Sri Lanka Sri Lanka Sri Lanka
9.	Light Fittings	Philips RZB Thorn Davis Osram	Holland Germany UK Australia Germany
10.	GIS Panels	ABB Siemens Schneider	Germany Germany France
11.	AIS Panels	ABB Siemens Schneider Tamco	India India India Malaysia
12.	Dry type Transformers	TRAFO Electro TRIHAL ABB	Italy France Switzerland
13.	Diesel Generators	FG Wilson Cummins Caterpillar	United Kingdom United Kingdom USA

Note:

Reference made here to certain manufacturers products and items identified by registered trademarks. This has been done for the sole purpose of defining and establishing standards of quality and performance and not with the intention of restricting the procurement of materials or fittings to a particular manufacture. Proposer shall ensure that all products, even though they are

from the above list, meet the specification requirement.

E.5. WATER SUPPLY, DRAINAGE & SEWERAGE WORKS

E.5.1. SCOPE OF WORKS

Contractor shall undertake design, construction, installations, testing, commissioning and also operation and maintenance during defect liability period for following major activities and requirements, without limiting to the same, under the development of KMTT.

a) It require utmost care to minimize disturbances and to ensure safety to the public and common activities going on the city, during execution of construction activities including underground construction,

b) Construction of the entire potable water and harvested rainwater storage and conveyance infrastructure,

c) Construction of the entire storm & foul water conveyance infrastructure,

d) Indoor & outdoor building plumbing,

e) Installation of sanitary fittings & fixtures,

f) Installation of necessary pumps, machineries and control devices,

g) Necessary control and safety systems in water conveyance infrastructures, for both temporary (during construction) and permanent uses,

h) Diversion of center canal (Meda Ela), including capacity improvements,

i) Waterproofing to suit different conditions such as; indoor wet-floor, outdoor terraces, under vegetation etc.,

j) Irrigation system for roof top gardening and landscaping area,

k) Green building design as per UDA green building guide, in Sri Lanka.

l) Potable cold water supply to all the individual buildings and amenities.

m) Non-Potable water supply to flushing cisterns after proper filtration.

n) Sanitary plumbing and drainage connections from individual buildings to sanitary drainage

system.

o) Trade waste connection such as commercial kitchen to the building greasy waste drainage system.

p) Installation of sanitary fixtures, tap ware and outlets.

q) Rain water harvesting system with necessary first flushing and storage.

r) Irrigation system for roof top gardening and landscaping.

E.5.2. GENERAL REQUIREMENTS

E.5.2.1. General Specification

All pipes, fittings, valves, appliances, joints and materials shall be;

a) Selected to operate effectively under all normal conditions likely to be experienced in the specific installation for the anticipated life of such installation, and used in strict accordance with the manufacturer's recommendations.

b) Where reference is made to certain manufacturers' products and items identified by registered trademarks, shall considered to be for the sole purpose of defining and establishing standards of quality and performance and not with the intention of restricting the procurement of material or fitting to a particular manufacturer.

c) All materials, fittings and equipment shall be supplied by a local supplier who is in operation for more than five years. All shall be manufactured by reputed manufacturer who is manufacturing the same material or equipment for more than ten years.

d) All testing shall be done according to BS EN standards unless otherwise specified.

e) Factory acceptance/ performance test shall be carried out for water supply and drainage pipes and other materials, pumps, sanitary fittings, treatment systems etc. and contractor shall arrange and facilitate for the engineers and Employers representatives (one from each) to witness each factory acceptance/ performance tests. Cost of these shall be borne by the contractor.

f) The contractor shall arrange and facilitate training of staff, demonstration.

g) All types of fittings, materials, painting and finishes shall be approved by the Engineer prior to installation.

h) Canal improvements and diversion require systematical approaches with cofferdams, bypass conduits, submersible pumps for storm water Lifting up etc.,

i) The contractor is responsible to obtain necessary authority approvals for the design, equipment and installation, relocation etc.,

j) The contractor shall submit shop drawings for the approval of the Engineer where required, prior to commencing work.

k) Contractor shall prepare and submit As Built drawings as per the Contract.

l) All samples shall be provided for approval by the Engineer prior to purchase of material.

E.5.2.2. Standards for both 'water supply and Drainage'

Water supply work shall be conforming to **BS EN 806-1 to 5** new series on Specifications for installations inside buildings conveying water for human consumption. Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilage specification shall conform to **BS 8558**. The water supply and distribution system shall be designed in accordance with Plumbing Engineering Services Design Guide by the Institute of Plumbing, UK **(ISBN 1871956404)**.

Wastewater drainage work shall be conforming to **BS EN 752** - Drain and sewer systems outside buildings. Sewer system management and **BS EN 12056-1 to 5**- Gravity drainage systems inside buildings.

All uPVC pipes shall be conforming to requirements **by SLS 147: 2013** and new series of British Standards **BS EN 1452- 1 to 5. BS EN 1329-1** Plastic piping system for soil and waste discharge (low and high temperature) within the building structure shall be referred to design the uPVC pipes.

Hot and cold water supply pipes with any other material such as polyethylene, Polypropylene, ductile iron, C- PVC etc. shall conform to new version of relevant European Standards.

American Water Works Association (AWWA) standards shall be applied for 'Disinfection Practices, Storage tanks, and Pipes and Fittings' as well as 'performance testing of pressure pipelines'.

ICTAD publication No. SCA/3/1 – specification for irrigation and land Drainage (2nd edition – Revised – November 1999) shall be used to design waste water drainage and rainwater discharge system.

ICTAD publication No. SCA/3/2 – specification for water supply, Sewerage and Stormwater drainage works (2nd edition – Revised – November 1999) shall be used to design water supply, Sewerage and Stormwater drainage works.

Water supply pipes, fittings shall be conforming to following standards.

- BS EN 12201 – 1 - Plastic piping systems for water supply – Polyethylene (PE) – Part 1: General
- BS EN 12201 – 2 - Plastic piping systems for water supply – Polyethylene (PE) – Part 2: Pipes
- BS EN 12201 – 3 - Plastic piping systems for water supply – Polyethylene (PE) – Part 3: Fittings
- BS EN 545 - Ductile Iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods
- BS EN 1092 - Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges
- BS EN 1074 – 4 - Valves for water supply – Fitness for purpose requirements and appropriate verification tests – Part 4: Air Valves
- ISO 4427:1:2007 - Plastic Piping System - Polyethylene (PE) pipes and fittings Part 1- General for water supply.
- ISO 4427:2:2007 - Plastic Piping System - Polyethylene (PE) pipes and fittings Part 2- Pipes for water supply
- ISO 4427:3:2007 - Plastic Piping System - Polyethylene (PE) pipes and fittings Part 3- Fittings for water supply
- ISO 4427:5:2007 - Plastic Piping System - Polyethylene (PE) pipes and fittings Part 5- Fitness for water supply
- ISO 1167-1:2006 - Thermoplastics pipes for the conveyance of liquids - Determination of the resistance to internal pressures – General method
- ASTM D 2774 - Standard Practice for Underground Installation of thermoplastic Pressure Piping
- ASTM D 3350 - Standard Practice for Polyethylene Plastic Pipes and Fitting Materials
- ASTM F 2389 - Standard Specification for Pressure-Rate Piping System

American Water Works Association (AWWA) standards for testing pipelines and disinfection

- AWWA C651 - Procedures for the Disinfection of Water mains

- AWWA C651 - Procedures for Pressure and Leakages testing of water mains
- AWWA C652 - Disinfection of water storage facilities

Sanitary appliances/ fitting shall be conforming to following standards.

- BS 6465 – 1:2006+A1:2009 – Code of practice for the design of sanitary facilities and scales of provision of sanitary and associated appliances.
- BS 3402:1969 – Code of practice for Quality of vitreous china sanitary fittings.
- BS EN 12288 - Industrial valves. Copper alloy gate valves
- SLS 377 – Wash Basins.
- SLS 832 – Ceramic Sinks.
- SLS 568 – Ceramic Squatting pans and traps.
- SLS 1459 – Stainless Steel Kitchen Sinks.
- SLS 792 – Ceramic pedestal wash down water closet pans and traps.
- BS 316S16 – Stainless Steel for External Application
- BS 304S16 – Stainless Steel for Internal Application
- SLS 1174 – Polyethylene water storage tanks.
- SLS 596 – Bib taps and stop valves for water services.

E.5.3. BUILDING WATER SUPPLY

E.5.3.1. Capacity Calculation

It is required to indicate clearly parameters and conditions that are to be follow for design stage. Following requirement shall be addressed during conceptual design stage, and shall not be limited to purview of the same.

1. Assessment of ‘per day total water demand in compliance with the following.
    - Water demand per capita per day (for different categories) including kitchen and cafeteria (Sri Lankan standards shall be followed)
    - Requirement for makeup water for cooling towers & A/C system
    - Recreational needs
    - Security needs

- Gardening and landscaping
- Washing and cleaning
- Requirement for fire protection.

2. Overhead water tank and sump capacities based on per day total water demand.

E.5.3.2. System Description for building Water Supply

The portable water supply and distribution system shall be suitably developed in harmony with building structural form. Concern is drawn over following requirements.

1. Above ground or underground water storage sumps.
2. Adopting of zoning method for efficient water distribution system considering energy conservation and reliable supply.
3. Reuse of treated rainwater to reduce clean water consumption.
4. Provisions for uninterrupted vertical and horizontal clean water supply.
5. Water service facilities for all the remote user-point with stipulated residual pressure.
6. Supply connections for ancillary facilities, AHU rooms, flower troughs.

E.5.3.3. Water Storage

The total in house potable water storage capacity (both ground and overhead) shall be designed to suit minimum of 1 1/2 days and maximum of 2 days requirements (sump is to be for 1 1/2 days with an overhead tank of 1/3 days storage). The governing factors in determining the capacity of storage tanks are based on security/ safety aspects, category of building importance, reliability of the city water supply, possible shut-downs and the length of such shut downs.

Potable water supply system starts from the NWS&DB water meter chamber, and then collects to ground sump for enable pumping to overhead tanks, which spearhead distributing clean water via the main distribution system to each user point. Design considerations include the sizing of pumps, pump protection, control requirements, pipe sizing for the entire feeder and distribution network.

The location of water meter chamber, diameter of water supply service connection pipe line and pipe route up to the water meter chamber will be designed and laid by the National Water Supply and Drainage Board (NWS&DB) on client's request. The extending of city water supply beyond the water-meter is requited under the contract to reach up to the sump. Line laid up to bulk meter point including bulk water meter chamber shall be constructed as per NWS&DB's requirement. Bulk meter and sub meters are to be provided to monitor the water consumption in different

department.

Further, there will be different categories of water usages (apart from human consumption) such as; landscape usage, cooling tower usage and fire fighting requirements. As such, separate sumps might become necessary for storage of different qualities of water, for enable economical accommodation of various category water supply needs.

Location of sumps, pump room and overhead water tanks shall be clearly marked on layout plans.

Decision for requirement of space for overhead tank shall be arrived based on in-house water supply demand (human consumption) and any other category of water supply need. Arrangement of overhead water storage, aiming of zoning distribution pattern, may require spaces at different locations of the building. Despite the fact of scarification of habitable space for deploying storage tanks in various places, it might be advantageous in energy saving during long term running of the system.

It is preferable to have overhead water tank and reinforced concrete sump with adequate capacities. Tank as well as sump structures shall be designed, constructed and tested to cater the entire requirement of the building water supply need. Automated water pumping mechanism would be preferable for pumping water from sump to overhead tank. Adequate capacity pumps with all necessary accessories should be supplied, installed, tested and commissioned in a suitable pump house constructed to suit with the purposes.

Firefighting water requirements should also be made available in a ground sump with all necessary utilities. Storage water in any of these sumps requires refreshing to maintain water qualities at favourable limits. Economical as well as effective methodologies shall be adopted to refresh various quality water bodies inside sumps.

Waterproofing is an aspect requires careful intervention to accomplish water storage tank structural works. Those should be assigned to a reputed specialist supplier/ company/ agent with at least 10 year guarantee in compliance with the requirements stipulated under Chapter E.6 of this document.

Prior approval of the client & consultant/engineer should be obtained for all the installations including pumps, pipes and accessories/ fittings such as taps, shower and valves etc. Proper ventilation and maintenance access for the water tanks and sump shall be provided and that shall be esthetically acceptable with the elevation. Precautions shall to be taken to prevent mosquito breeding and entering of insects to water storage or distribution system.

Hot water supply shall be provided for kitchen and bathrooms as per employer’s requirement and specialist kitchen designer’s requirement.

E.5.3.4. Water Supply Pumps

Water pumps are mainly centrifugal for transfer pump work for feeding water to overhead storage tanks. Booster pumps might be necessary to lift up pressure in low pressure areas in the distribution system. Water supply pumps are required to operate in duty and standby configuration, and as such minimum 2 pumps are needed at each pumping points. All water supply pumps shall be factory tested to determine the capacity, specific power consumption, efficiency, MEI level etc. The overall efficiency of the pumps shall not be less than 60% at the duty point and Minimum Efficiency Index (MEI) shall be not less than 0.4. The hydraulic performance acceptance test of water supply pumps shall be done according to ANSI/HI 14.6. Degree of protection shall be IP 54 and insulation class shall be F. Pumps shall be European make and shall have a reputed local agent, having minimum 5 years continuous business operation.

Pumps shall be of the non-overloading, centrifugal, back pull-out type. Pumps shall generally be of the horizontal end suction type or equivalent.

Casings of horizontal end suction pumps shall be designed for a working pressure of 10 kg per square cm or 1½ times the actual discharge pressure, whichever is greater. Casings of Vertical Inline pumps shall be designed for working pressure of 5 kg per square cm or 1½ times the actual discharge pressure, whichever is greater. Pressure classification of flange connection shall correspond to casing working pressures.

Pumps having discharge connections larger than 75mm and operating at more than 20 metres total dynamic head shall be provided with casing wearing rings. Rings shall be of bronze, chrome iron, nickel iron or the composition suitable for the individual application.

High points of pump casings shall be provided with air vent cocks. Cocks shall be extended outside of any insulation. Low points of casings shall be provided with valved drains and inlet and outlet connections shall be provided with properly located gauge tapings. Each removable casing part weighing over 10kg shall be provided with a lifting eye or lugs of ample strength. Casing brackets of vertically-split pumps equipped with stuffing boxes shall be arranged to form drip pockets. A drip pipe shall be run from each drip pocket and terminated with an approved air gap over the nearest drip funnel or floor drain.

Impellers shall be bronze and shall be dynamically balanced. Impellers of pumps having 40mm and larger discharge connection shall be fully enclosed and hydraulically balanced.

Shafts for pumps with stuffing boxes shall be stainless steel, monel alloy or shall be carbon steel with sleeves of bronze, chrome iron or nickel iron extending through the stuffing boxes. Shafts

shall be provided with water slingers where stuffing boxes are used.

Bearings for close coupled pumps shall be of the ball or roller type. Bearings for all other pumps shall be either ball or roller bearings, or ring oiled or wool packed sleeve bearings with ample oil reservoirs. Thrust bearings shall be of either the ball or roller type. Bearings shall be effectively sealed to prevent loss of oil and entrance of dirt or water.

Stuffing boxes shall be deep enough for not less than 4 rings of packing and shall be have bronze glands. Glands for horizontally-split case pumps shall be split. Pumps of 40mm size and larger operating with a suction lift shall be equipped with bronze lantern rings and external or internal water seal connection with needle valves.

Packing shall be suitable in all cases for the service required with proper consideration of water pressure, temperature, temperature changes and sediment carried in the water. Mechanical seals may be provided in lieu of stuffing boxes where recommended and guaranteed by the pump manufacturer for the particular service involved.

All pumps, other than close coupled pumps, shall be provided with suitable flexible couplings. Couplings shall impose no restriction on normal end play or expansion. Suitable coupling guards shall be provided.

Each flexible coupled pump shall be provided with a cast iron or fabricated steel bedplate of ample size to hold both pump and motor in correct alignment. Pump and motor shall be accurately aligned when running at normal temperature. Bed plates of horizontally split pumps shall have raised lips and drain connections. A drain pipe shall be run from each drain connection and terminated with an approved air gap over the nearest drip funnel or floor drain.

The bedplate shall be mounted on a reinforced concrete foundation block of a weight at least equal to the weight of the pump. These concrete foundation blocks shall be poured in a steel pan of a shape conforming to the shape of the bedplate.

The concrete foundation block shall be supported in neoprene vibration isolating pads, sized for 2 mm static deflection. Each isolation pad shall be sized correctly for its share of the load.

The isolation pads shall be mounted on concrete sub-bases. These sub-bases will be made by the Contractor according to details to be supplied by the pump manufacturer.

All pumps are to be supplied by one manufacturer.

Manufacturer shall provide pump characteristic curves including Head (H) curve, Efficiency (η) curve, Horse Power (HP) curve and Net Positive Suction Head (NPSH-R) curve. It should mention the shut-off head of the pump in the Head curve itself. Difference between shut-off head and the

head at Duty Point shall be greater than the 10 % of the head at duty point. Otherwise pump shall be rejected.

Difference of flow rates between Duty Point (DP) and Best efficiency Point (BEP) shall be lesser than 10 % of the flow rate at Duty Point. Otherwise pump shall be rejected.

Pumps shall be selected for an overall efficiency of not less than 60%.

General frequency of pump shall be 50 Hz and frequency of inlet power supply shall be kept within the range of 40- 60 Hz.

Test for pumps shall be done accordance with the standard of ISO 9906:1999 and tests shall be done for each and every pump.

E.5.3.5. Water Distribution Pipe Network

Efficient distribution system is required with ensuring stipulated residual pressure at the each and every user points. Pipe material, pipe joining system, installation techniques, water hammer arresters and pressure controlling devices shall be in accordance with the standards and those shall be installed as per the manufacturer's specification.

Suitable identification method with signs and colours shall be assigned to enable identify different category of water distribution pipes (e.g.; portable water supply), during operation and maintenance phase.

All pumping pipe lines & vertical water supply stacks shall be made from durable pipe material (PE, PPR, HDPE etc.) to sustain in aggressive environmental situations.

E.5.3.6. Testing and Commissioning

Before conceal any pipe installation, it is necessary to carryout hydrostatic pressure testing to confirm the engineer compliances with relevant ICTAD, BS and AWWA standards.

Further system is requiring disinfection prior to commissioning as per the procedure illustrated in BS and AWWA standards.

E.5.3.7. Air Circulation and Ventilation inside Toilets

Sufficient mechanical/ natural ventilation should be provided to achieve a pleasing atmosphere inside toilets and also necessary to minimize energy usage by adopting natural as well as environmentally friendly concept.

Smooth air circulation inside the toilets shall be ensured by efficient space during the design of architectural lay out. due to wind flow.

E.5.4. BUILDING DRAINAGE WORKS

E.5.4.1. Conceptual Development

It requireS arrive on optimum system design for ‘Sanitary plumbing and drainage system design under the prevailing circumstances. Following requirements are worth to consider during the process of evaluating possible options.

a. Underground disposal pipe network, including manholes and catch-pits, pump pits shall be designed in harmony with landscape.

b. Multiple stacks (vertical pipes) system shall be adopted for building drainage inside vertical ducts. Waste water stacks, urinal stack and sewer stacks shall be totally differentiated until reach manhole or water-seal catch pit in the ground.

c. Suitable venting shall be introduced for back vent, branch vent, trap vent, cross vent etc.,

d. Efficient arrangement of floor drains and branch discharge pipes are required. It require clearly illustrate sewers installation & slopes inside the toilet i.e., embedded into the floor (with second stage concrete) or hung under the soffit of toilet floor slab.

E.5.4.2. Drainage System Description

Sewage and Wastewater Disposal system includes:

1. Pipe network inside the building (building drainage)
2. External sewer network including manholes, silt traps, oil/ grease traps, ‘water sealed catch pits’ and ‘urinal catch pits’.

During the design of building drainage, it is compulsory to differentiate sewage (black water) disposal arrangement and wastewater (gray water) disposal arrangement inside buildings. Further, it is preferable to have separate vertical stack for urinal waste disposal until connect to a dedicated water-sealed catch-pit in the ground. More importantly, it require methodology to cut-off entering of foul smell back into building through user-points such as wash basins and floor gullies. Care shall be exercised to avoid potential blockages from hair, grit or any other fiberous and/ or oily matters clogged inside pipe lines, catch-pits or manholes.

In line with this requirement vertical stacks shall be provided inside ducts to drain sewage, urinal waste and wastewater separately from upper floor toilets of the building upto the ground. Suitable

venting arrangement is required at upper floor for lateral disposal branch confections and stacks.

Vertical ducts shall be of suitable size to have space for accommodate vertical pipes, horizontal branch connections and also attending for maintenance.

Solid particles and oils discharged from kitchens & cafeterias shall be thrashed prior to entering into combined sewer network.

Water supply and drainage system for flower troughs, AHU rooms and chillers in buildings, rooftop garden and landscape area shall be considered in the design and to be provided.

It is expected that the Kandy City Wastewater Management Project (KCWMP) will be completed by the time the KMTT will be in operation. Therefore the KMTT sewers shall be connected to the Kandy sewerage system. All external pipe lines should be underground as appropriate to satisfy the relevant standards & regulations. All internal pipe systems including necessary accessories and fittings etc. should be fixed and tighten to satisfy the employer's requirements and as in accordance with the relevant standards/ regulations. Prior approval of the engineer should be obtained for pipes and accessories/ fittings etc. in installation works.

E.5.4.3. Construction of the Drainage line belonging to Kandy Waste Water Management Project

The proposed sewer service line of the Kandy Waste Water Management Project also runs through KMTT and it is required to be done under the same contract of KMTT construction to meet with the operational conditions of waste water management of Kandy city as per the drawings and instructions issued by Kandy Waste Water Management PD. Presently the water Trunk Main is running under the existing road and needs to be relocated outside the KMTT site or a suitable alternate arrangement as it is in conflict with the proposed main storm water drainage canal and peripheral drain trace, before construction commences. Since the proposed location is in a highly built-up area in an undulating terrain the space management without disturbing the city functions is challenging.

E.5.5. RAINWATER HARVESTING

E.5.5.1. Standards

Rainwater Harvesting system shall conform to Code of Practice BS 8515: 2009.

Rainwater harvesting system will be designed in accordance with requirements stipulated by Sri Lanka Gazette Notification dated 17 April 2009 on 'The Urban Development Authority Law, No. 414 of 1978' , Green building rating system in urban development authority and guidelines of relevant local administrative authorities.

E.5.5.2. Preliminary Planning

It is required to indicate clearly intended usage, parameters and conditions that are to be applied in conceptual design stage. The following requirements shall be addressed during the conceptual design stage backed by detailed calculations.

- Assessment of Metrological department data for the recorded rainfall in the vicinity of the site.
- Roof surfaces will be suitably selected as the rainwater catchment.
- Rainwater harvesting tank / sump volume shall be adequate to meet requirements stipulated in UDA regulations and the green rating system in urban development authority.
- Harvested rain water shall be used for toilet flushing after proper filtration and irrigation

E.5.5.3. Filtration system

In general any kind of rainwater harvesting system, in which collected water is destined for anything other than garden irrigation, is essential that dust, debris, bird droppings, leaves and other contaminants accumulated on roofs are kept out when it starts to rain. Therefore it is necessary to define steps and relevant components in the cleansing process. It is required to highlight operation and maintenance procedure of the system.

However, as a pre-filtration process, first flush out system is recommended in the rainwater harvesting system to flush out initially contaminated water from the system. Approved filtration system with lesser operational and maintenance cost, prior supplying water to toilet flushing shall be installed.

E.5.5.4. System Description for Rainwater Harvesting

It is required to indicate important basic components that are to be used in developing the system. Considering the adoptability of above main components, it is required to indicate necessary provisions for installation of components. These details shall be finalized at the design development and arranged to incorporate those in the architectural drawings too.

Rainwater storage tank/ sump is required to be installed/ constructed so as enable to fill with a gravity fed system from the roof catchment. This tank can be coupled with a reserve of any other category of usage for effective system design. Methodologies to minimize capital as well as operational and maintenance costs shall be encouraged during components design stage.

E.5.5.5. Backup water supply for Rainwater Storage Tank

It is essential to choose a source of water supply to look after supplementary water supply need as

well as entire water demand, under particular category of water usage, for the duration absence of natural rain. This source for backup water supply for the rainwater supply tank shall be equal or superior quality water compared to usual rainwater collected to the tank. Backup water supply source has to be a reliable continuous supply to be enabling relies on.

E.5.6. STORM WATER DISPOSAL SYSTEM

E.5.6.1. Preliminary Planning

Following requirements shall be fulfilled at the conceptual design stage for storm water drainage in the site limit while accommodating flow from the upstream catchment.

1. The Metrological department data for the recorded rainfall in the vicinity of the site will be made available (Preferably recent 10 years period).
2. contour survey map to indicate ground topography
3. Building finish floor and external ground formation levels shall be finalized in line with landscape design planning.
4. Ensure that surface drainage of abutting properties will not be adversely affected by the development
5. Limit the extend of impervious surface
6. Reuse storm water for irrigation or any other suitable purposes (where possible)
7. Undergo preliminary treatment system to improve the quality of storm water before it exists the site (thrush racks, silt traps etc.)
8. The excess rainwater falling on the ground within the KMTT footprint shall be discharged via the storm water drains into the main canal (Meda Ela)

E.5.6.2. System Description for Storm water Drainage

Storm water disposal system includes:

1. Gutters and Rainwater down pipes
2. Rain water collecting tanks/sump inside the building including filtration systems and pipe network on the ground outside buildings
3. Side drains of internal roads
4. Drains along the periphery of the site boundary.

Disposal of rain water from the roof of buildings and open areas are the concern under this topic.

Methodologies on developing the Storm water disposal system should be clearly defined and indicated in the proposal. The system development is required to be in harmony with landscape, retaining structures, topography, internal road network etc. Storm water disposal route should be planned in such a manner avoiding disturbances for vehicular and human circulation, while ensuring cleared from spot pooling within the premises.

Peripheral drains join the main canal (Meda Ela) from the Peradeniya Road side. During the tail end of the realignment of the main canal (Meda Ela), the peripheral drains will still drain into the existing main canal (Meda Ela). However, there will be a switch from the existing main canal (Meda Ela) to the new alignment. Household drains currently run into the main canal (Meda Ela) inside the KMTT footprint. These lines shall be taken into consideration when designing the peripheral drains so that all these lines will run into the peripheral drains which will then run into the realigned main canal (Meda Ela).

Finally storm water is required to be discharged via the storm water drains into the main canal (Meda Ela), after meeting the requirements of relevant authorities.

E.5.6.3. Main Canal Development

The drain that runs east to the dividing ridge near Ampitiya in which the Kandy lake is situated, is known as Meda Ela (Main Canal). It carries overflow from storm water from Kandy Lake. It was originally an open natural stream and was converted into a stone/brick masonry drain in about 1920. It runs in West direction as a tunnel of about 461m, thereafter runs in a south-westerly direction as a tunnel for another 70m and becomes an open channel at about 531m from the spillway.

It runs as an open channel up to goods shed bus stand where the proposed KMTT will be constructed and crosses the existing bus stand as covered underground section before it becomes an open channel on the other side of the bus stand. Meda Ela (Main Canal) is considered a major conveyance for Storm water discharge in the Kandy city and discharges its waters in to the Mahaveli River at Getambe.

With the rapid urbanization of the city the main canal has been encroached at several places and poses a threat to flooding of the surrounding areas. The section of the covered drain in the Project area is in a poor state with the remaining masonry drain which has deteriorated requiring reconstruction and rehabilitation.

Construction of new canal diversion & connect to the existing main canal (Meda Ela) at the upstream & downstream ends at the designated locations. Canal diversion works include:

- Setting out and trial pits and testing.
- Temporary sheet piling or any other forms of piling/shoring and shoring works.
- Construction of main canal including manholes, silt traps, trash screen.
- Construction of peripheral canal/drain and associated structures.
- Diversions, over pumping and cofferdams.
- Construction of merging sections at inlet and outlet.
- Demolish/clear the existing main canal in section where it becomes redundant after the construction of the diverted new canal and fill where necessary.
- Until the completion & commissioning of the new canal diversion the piles located on the trace of existing main canal should be delayed.

Drainage capacity in main canal (Meda Ela) has to be improved, within the limit of site premises, to cater for development related to KMTT project. It requires diversion of the main canal in harmony with proposed KMTT development in a safe and orderly manner, for the affected stretch of the canal. Household drains currently run into the main canal (Meda Ela) inside the KMTT footprint. These lines shall be taken into consideration when designing the peripheral drains. Canal shall lead the spill water from the Kandy city lake, while accommodating storm water in the downstream catchment of the lake. Design shall consider maximum spill flow from the lake for a 100 year flood, while storm water flow in downstream catchment for a 10 years return period.

Conveyance system and necessary hydraulic structures shall be designed using updated meteorological data and catchment pattern. Further, design shall foresee potential future changes in the catchment as well as upstream water bodies.

E.5.7. SANITARY INSTALLATIONS

E.5.7.1. General

Sanitary installation shall be carried out as per approved drawings/samples and in accordance with the BS EN (British standards) & SLS (Sri Lanka standards) standards. Associated appliances and fittings shall be compatible. Relevant tests to be done at such time and in such manner as the Engineer/Consultant shall direct and to his satisfaction.

All toilet fittings selection, installation and requirements of appliances shall conform to relevant BS EN & SLS standards or to be as specified in specification of ICTAD SCA/4/II and subjected to engineers' approval and the supplied by a reputed supplier having minimum of 5 years continuous

business for the product.

Luxury type fittings shall be supplied to individual toilets based on employer's requirement.

All taps, shower appliances, cocks and floor waste covers used in the plumping installation shall be chromium plated brass or stainless steel. 5 year warranty period shall be provided for these shall be in working order.

Special facilities for disable persons to be provided with grab rail set, stainless steel studs & other necessary accessories shall be provided in disable toilets.

As per the green rating system recommendations, target performance to reduce water usage for various fixtures are as below.

Table E.14: Target performance of fixtures

Fixture Type	Recommended values
Shower heads	1.32 GPM
Basin taps and mixers (public)	0.52 GPM
WC flush valves (per flush)	0.95 GPF
Urinal flush valves (per flush)	0.13 GPF

a. All sanitary fittings shall be subjected to approval of the client.

b. All sanitary fittings shall be local or European make.

c. All taps and valves shall be Japanese or European make.

d. Water closets shall be provided with cisterns and bidet showers and urinals shall be provided with automatic sensor type flush valves.

e. Wash basins shall be provided with mirrors.

f. All toilets (individual or toilet blocks) shall be provided with at least one bib tap.

g. All Squatting pans shall be provided with bib taps and bidet showers.

E.5.7.2. Appliances

E.5.7.2.1. Water closet & cistern

Low level close coupled back to wall water closet in white vitreous china, 100 mm dia. 'P/S' trap, symphonic system, hinged acrylic soft closing seat and lid complete with dual flush 6/4.5 liter capacity cistern with chromium plated flexible hose and other necessary fixtures.

E.5.7.2.2. Squatting pan

Approved colour ceramic squatting pan with high/ medium level cistern, consisting with 100mm diameter 'P/S' trap, symphonic system with chromium plated flexible hose and other necessary fixtures.

E.5.7.2.3. Wall mounted type wash basin

510mm x 420mm wall mounted type wash basin in overall white vitreous china including 40mm (1 ¼") dia. plastic bottle trap, 20mm (1/2") dia. 01 no. lever type handled pillar tap of approved quality, 40mm (1 ¼") dia. waste plug and chain, chromium plated flexible hose and other necessary fixtures.

E.5.7.2.4. Vanity type wash basin

Vanity type wash basin in overall white vitreous china including 40mm (1 ¼") dia. plastic bottle trap, 20mm (1/2") dia. 01 no. lever type handled pillar tap of approved quality, 40mm (1 ¼") dia. waste plug and chain, chromium plated flexible hose and other necessary fixtures.

E.5.7.2.5. Stainless steel sink

Stainless steel sink including chromium plated swan neck tap of approved quality, plastic bottle trap, 1 ½" dia. waste plugs and chains, chromium plated flexible hose, semi concealed brackets with all necessary accessories. Grade 316 stainless steel shall be used.

E.5.7.2.6. Hand spray unit, shower roses, taps & traps

These shall be stainless steel based on employer's requirement (grade 316). Traps shall be of such designs that do not allow accumulation of deposits.

E.5.8. SOLID WASTE MANAGEMENT

Planning of Solid Waste Management techniques shall follow the guidelines of Central Environmental Authority (CEA) of Sri Lanka and relevant Kandy Municipal Council (KMC) requirements and also shall be in compliance with any other stakeholder authority requirements. During the development of the Management system, National and International 'colour codes' for waste collection bins should be considered.

In-house 'solid wastes' shall be handled by 'Waste Management Team (WMT)' appointed by employer or his authority. All the solid waste generated in the building complex shall be transferred to final collection chamber in a segregated form, as assign with colour codes.

Garbage collection points (room) shall be allocated at each floor levels of the building. Solid waste generated in a floor shall be collected in segregated pattern and store in this room, until transferring those by WMT to the final collection chamber as sooner possible.

Storage capacity, for short-term biodegradable wastes, shall be made available in a cool-room, with temperature below 10 ^{0}C at the final waste collection chamber. This final solid waste collection chamber shall be located in a convenient place having trouble free access path to reach local authority garbage collection truck.

Proper solid waste management proposal shall be included describing solid waste load calculation and methodologies for reducing, reuse and garbage floor wise.

Table E.15: Recommended Products, Materials and Equipment

No.	Description	Recommended Products	
		Manufacture/Brand Name	**Country of Origin**
01	Cold Water Supply Pipes (UPVC PNT 11 pipes with fittings)	S-loan / National/ Anton	Sri Lanka
02	Hot Water Pipes (Polypropylene PN20 and fittings are Polypropylene PN 20)	Wavinpilsa or equitant	Turkey
03	Cold Water Supply Pipes (Polypropylene PN16/20 and fittings are Polypropylene PN 16/20)	Wavinpilsa or equitant	Turkey
04	Sewer and Waste Water Pipes (UPVC PNT 7 pipes)	S-loan / National/ Anton	Sri Lanka
05	UPVC Drainage fittings (Compatibility to be recommended by the pipe supplier)	Shanko/Era/Sloan/ National/Anton	India / China / Sri Lanka
06	Gate Valves	"Kitz/Peglar" or equivalent	Japan/UK
07	Stop Valves	"Kitz/Peglar" or equivalent	Japan/UK
08	Ball Float Valves	"Peglar"	UK
09	Foot Valves	"Z-tide"	Thaiwan
10	Transfer Pump	MAS DAF/ Grundfos or equivalent	Turkey/Europe
11	Booster Pump	MAS DAF/ Grundfos or equivalent	Turkey/Europe
12	Water Closet	DURAVIT Durastyle/ Rocel Riviera or equivalent	Germany/Sri Lanka
13	Wash Basin	DURAVIT D-CODE / Rocel Riviera or equivalent	Germany/Sri Lanka

No.	Description	Recommended Products	
		Manufacture/Brand Name	**Country of Origin**
14	Urinals	DURAVIT Durastyle CODE / Rocel Flo or equivalent	Germany/Sri Lanka
15	Taps	Euro Bath/ Grohe or equivalent	Europe

E.6. MECHANICAL WORKS

E.6.1. GENERAL

Table E.16: Site Environmental Conditions

Altitude, reference to the mean sea level (m)	465
Maximum ambient temperature	33 ^{0} C
Minimum ambient air temperature	20 ^{0} C
Relative humidity – Maximum	95%
Relative humidity – Annual average	76%

E.6.2. SCOPE OF WORKS

The contractor shall carry out the design, supply, delivery, erection, connection, testing and commissioning and maintenance during detect liability period of all the equipment and material for following mechanical works.

- Fire detection and Protection system
- Air Conditioning and Mechanical Ventilation System
- Lifts and Escalators
- Building Management System
- Cold Room – Garbage Collection
- Fuel Pumping System
- Centralized Gas Distribution and Detection System

The design information developed by the Engineer are enclosed here with for information purposes

(only as guidance) of the bidders and aiming the complete design developments/improvements by the bidder. Spaces for main equipment chillers, chilled water and condenser pumps, cooling towers, air handling units, primary air handling units, fire pumps, fire command center, lift and escalators, and mechanical service ducts have been incorporated in the Architectural drawings for information only. The detailed calculation for selection of equipment shall be submitted and obtained the engineer's approval before purchasing the equipment.

However, contractors shall not be expected to make major changes/deviations for the spaces provided for major equipment and general arrangements of equipment since the Architectural drawings have already been almost finalized.

Considering all the circumstances it is the contractor's responsibility to review the adequacy of the existing design information drawings and submit contractors proposal to achieve the employers requirements as described herein.

If the contractor is not capable of handling all the mechanical services directly, the contractor has to select sub-contractors having experience and qualifications in relevant specialty to carry out all the mechanical systems stipulated above. The main contractor shall corporate and coordinate all the specialist contractors' works.

The contractor shall be obtained certificate of conformity relevant to fire protection system from Fire Services Department on completion of work. Furthermore, complete detailed drawing of the all above fire detection and protection system including floor plans and schematic diagrams shall be certified by Authorized Person prior to submit the same to the Fire Services Department on completion.

All equipment and components shall be brand new, and of manufacturer's current models. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protected premises protective signaling (fire alarm) system. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Samples and manufacturer's technical literature shall be submitted for Engineer's approval before the installation. All samples shall be supplied by the Contractor at his own expenses.

E.6.3. APPLICABLE STANDARDS

E.6.3.1. Fire Detection and Protection System

All equipment and material used and Fire Detection and Protection shall meet the requirements of the relevant standards / publications.

E.6.3.1.1. Fire Detection System

a. British Standards Institution

BS 5445 Components of automatic fire detection systems

Part 5 : Heat sensitive detectors

Part 7 :Specifications for point type smoke detectors using scattered light transmitted light or ionization

Part 8 : Specifications for high temperature heat detectors

BS 5839 Fire detection and alarm systems for buildings

Part 1 :Code of practice for system design, installation and servicing.

Part 2 : Specifications for manual call points.

Part 4 : Specifications for control and indicating equipment.

BS 5499 Safety signs including fire safety signs

Part 1 : Code of practice for escape route signing

Part 10 : Guidance for the selection and use of safety signs and fire safety notices

BS 7629 Electrical Cables

Part 1 : Specification for 300/500V fire resistance screened cables having low emission of smoke and corrosive gases when affected by fire

b. Fire regulations of Institute for Construction Training and Development of the Ministry of Housing, Construction and Public Utilities, Sri Lanka

c. All requirements of the Fire Services Department of Colombo Municipality.

d. National Fire Protection Association (NFPA) of America

e. ICTAD/DEV/14 Fire Regulation (Rev. 2018)

E.6.3.1.2. Fire Protection System

a. British Standards Institution

BS 5306 Part 1 - Hydrant Systems, Hose Reels and Foam Inlets (formally CP 402)

Part 2 - Sprinkler System

Part 3 - Portable Fire Extinguishers

BS 334 - Fire Hose Couplings and Ancillary equipment

Part 1 - Specifications for landing valves for wet risers

BS EN 12845:2004+A2:2009 - Fixed Fire Fighting System, Design, Installation and maintenance

BS 5274 - Fire hose reels (water) for fixed installation

BS EN 3 - Fire extinguishing System

BS EN 671 - Fire hose reel system

BS EN 15004 – Fixed firefighting system, Gas extinguishing system

ISO 14520 – Gaseous fire –extinguishing system

b. National Fire Protection Association (NFPA) of America

NFPA 2001 : Standard on Clean Agent Fire Extinguishing Systems

NFPA 750 : Standard on Water Mist Fire Protection Systems

NFPA 17A : Standards on Wet Chemical Extinguishing System

NFPA15 : Standard for Water Spray Fixed Systems for Fire Protection

NFPA 20 : Standard for the Installation of Stationary Pumps for Fire Protection

NFPA 25 : Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

NFPA 96 :Ventilation Control and Fire Protection of Commercial Cooking Operation

BS EN 15004 : Fixed firefighting systems. Gas extinguishing system

ISO 14520 : Gaseous fire-extinguishing systems

c. All requirements of the Fire Services Department of Colombo Municipality.

d. ICTAD/DEV/14 Fire Regulation (Rev. 2018)

E.6.3.2. Air Conditioning & Ventilation System and Refrigeration (Cold Rooms)

Code of practice for Energy Efficient Buildings in Sri Lanka 2008.

ASHRAE 90.1 (2013): Energy Standard for Buildings except Low-Rise Residential Buildings I-P Edition

ASHRAE 62.1-2007 : Ventilation for Acceptable Indoor Air Quality

ASHRAE 55-2004 : Thermal Environmental Conditions for Human Occupancy

ASHRAE whether data

CIBSE Guide A : Environmental Design January 2006 (7th edition). Chartered Institution of Building Services Engineers, London.

SMACNA : Sheet Metal and Air Conditioning Contractor's National Association

BS 5588 Part 4 : Fire precautions in the design, construction and use of buildings Part 4: Code of practice for smoke control using pressure differentials Department of Meteorology, Sri Lanka.

ASHRAE 150: 2019 : Method of Testing the Performance of Cool-Storage Systems

ASHRAE : Refrigeration Handbook

ANSI/AHRI 540 : Performance Rating of Positive Displacement Refrigerant Compressors and Compressor Units

AHRI 1250 : Performance Rating of Walk In Coolers and Freezers

EN 14509:2013 : Self-supporting Double Skin Metal Faced Insulating Panels

BS EN 16855-1:2017 : Walk In Cold Rooms - Definition, thermal insulation performance and test methods

BS EN 13771-1:2016 : Compressors and condensing units for refrigeration. Performance testing and test methods Refrigerant compressors

EN 10143:2006 : Continuously Hot-Dip Coated Steel Sheet and Strip

EN 12900 : Refrigerant Compressors – Rating conditions, tolerances and presentation of manufacturer’s performance data

BS EN 378 : Refrigeration and Heat Pumps (all parts of the standard)

BS EN ISO 4126 : Safety devices for pressure relief

BS 1012-2 : 2010: Compressors and Vacuum Pumps

BS 1306 : 1975:Specifications for copper and copper piping

BS 2502 :Specification for manufacture of sectional cold rooms

BS 7671 :IEE Wiring Regulation

BS 5266-1:2011 :Emergency Lighting

E.6.3.3. Elevators and Escalators

Relevant part of BS. EN 81-1, EN-72 and EN-70:2003

IEE Regulations for Electrical Equipment in Buildings

Regulations and Recommendations of the Ceylon Electricity Board and the Sri Lanka Standards Institution

Other recognized national or international specifications, not less exacting than those above may be used, provided that the latest edition of such specification (in English) had been furnished with the tender and accepted.

E.6.3.4. Fuel Pumping System

a. American National Standards Institute

ANSI - NFPA 30 : Flammable and combustible liquid code

ANSI- UL 87 : Power operated dispensing devices for petroleum products.

ANSI - UL 57 : Steel underground tanks for flammable and combustible liquids

ANSI- UL 79 : Power Operated pumps for petroleum product dispensing system

b. British Standards Institution

BS 2594 : Horizontal mild steel welded storage tanks.

BS 799 (Part 5) : Oil burning equipment – Specification for oil storage tanks.

E.6.3.5. LP gas distribution system

a. British Standards Institution

BS 5482 : Code of practice for domestic butane- and propane-gas-burning installation.

BS EN 50073:1999 : Guide for selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases or oxygen.

b. National Fire Protection Association (NFPA) of America

NFPA 58 : Liquefied Petroleum Gas Code

c. ICTAD/DEV/14 Fire Regulation (Rev. 2018)

d. SLS 1196; Part 3 : LPG piping system – Design and Installation

E.6.4. SELECTION OF EQUIPMENT

When determine the type of equipment, to be specified/ used for mechanical systems, following parameters shall be considered;

- Complying with stipulated standards
- Functional suitability for the application
- Reliability and durability
- Efficiency
- Ease of maintenance
- Suitability for ambient conditions
- Suitability in appearance

Since this proposed building to be located at high humid environment, special attentions/ precautions shall be made during selecting the equipment and execution.

Further, following requirements shall be fulfilled while supplying the equipment

Table E.17: Air Conditioning and Ventilation System

	Item	Requirement
1.	Chillers	The manufacturer of the equipment shall have at least fifteen (15) years experience in the Design and Manufacture of similar type air conditioners and make of offered equipment shall have at least five (05) years proven service record in Sri Lanka.
2.	Air Handling Unit	
3.	Fan Coil Unit	
4.	Pumps	
5.	Cooling Tower	
6.	Exhaust Fan	

Table E.18: Elevators and Escalators

	Item	Manufacturer/Brand Name
1.	Lifts	The manufacturer of the equipment shall have at least fifteen (15) years experience in the Design and Manufacture of similar type air conditioners and make of offered equipment shall have at least five (05) years proven service record in Sri Lanka.
2.	Escalators	

Table E.19: Fire Detection and Protection System

	Item	Manufacturer / Brand Name
1.	Fire Pumps	The manufacturer of the equipment shall have at least fifteen (15) years experience in the Design and Manufacture of similar type air conditioners and make of offered equipment shall have at least five (05) years proven service record in Sri Lanka
2.	Landing Valves, Hose Reels, Pillar Hydrants, Valves etc.	
3.	Detection system – Initiating Devices, Alarm Devices, Fire Detection Cables	

Note:

The reference made here to certain manufacturers` products and items identified by registered trade marks, this has been done for the sole purpose of defining and establishing standards of quality and performance and not with the intention of restricting the procurement of materials or fittings to a particular manufacturer.

E.6.5. GREEN ASPECTS

The employer expect to apply for the "Silver or above" grade under "Blue-Green Sri Lanka", the green building guideline published by Urban Development Authority (UDA). The contractor shall refer the guideline and the design shall be carried out in order to achieve the maximum points to be obtained.

Maximum points which can be attained by the contractor's design shall be submitted with the calculations and any other documents as evidence and proofs.

E.6.6. PRODUCT REVIEW AND FACTORY INSPECTION AT MANUFACTURE'S FACILITIES

Factory Acceptance Test (FATs), Pre-Dispatch Inspection, Product Review and Awareness Programs on major plants and equipment of mechanical systems as specified in below (Sub-section 5.6.1 to 5.6.4) followed by factory inspection for witnessing the manufacturing process and quality control process shall be conducted at the Manufacture's Overseas Facility for two representatives of Employer and two representatives of Engineer

All costs (Air Tickets, Travelling, and Lodging etc.) for the representatives of Employer and representatives of Engineer (04 persons) participating for the above program at the manufacture's facility shall be borne by the Contractor.

Those programs shall cover the main topics and procedures as mentioned below (Sub-section 5.6.1

to 5.6.4).

E.6.6.1. Factory Acceptance Tests - Chillers

The Following tests and checks shall be carried out in the manufacturer's works and test certificates issued by an approved Testing Authority shall be submitted.

- All tests as required by the manufacturer's practice or applicable standards during manufacturing stage.
- Chiller Performance Test in accordance with ARI 550/590 to achieve ASHRAE standard 90.1 requirements at ARI 550/590 stipulated testing procedure at following load points.
    - At 100% load point
    - At 75% load point
    - At 50% load point
    - At 25% load point

During the above factory test the manufacturer shall be able to satisfactorily prove to the Engineer that the efficiencies of water cooled packaged chillers shall meet the stipulated minimum efficiencies as per ASHRAE Standard 90.1 at ARI 550/590 specified conditions. In addition to the above all other functional tests required by the Engineer shall be performed by the manufacturer at the manufacturer's works.

In the event of not performing above factory acceptance tests to achieve the required rating to the satisfaction of the Engineer then chiller plant under consideration will not be accepted for incorporation in the work.

E.6.6.2. BMS Product Review and Factory Inspection at Manufacture's Facility

BMS System Product Review and Familiarization Program including Factory Inspection shall be conducted at the Manufacture's Facility. This program shall cover the following main topics with regards to the BMS System.

- Basic techniques of control engineering
- BMS introduction and best practices
- Brief introduction on various components of a BMS
- DDC controllers
- BMS related sensors

- Method of interfacing with auxiliary devices including their limitations
- I/O configuration
- Trends, schedules, alarms and report generation
- Graphics generations
- Limitation of BMS
- Backup and restore plan
- Factory visit to obtain first hand information on the standards manufacturing process of BMS controllers, performance testing, quality control procedure.

E.6.6.3. Chilled Water Pumps / Condensed Water Pumps

All chilled water pumps & condensed water pumps shall be factory tested to determine the capacity, specific power consumption, efficiency, MEI level etc. the efficiency of the pumps shall not be less than 70% and Minimum Efficiency Index (MEI) shall be not less than 0.4. The hydraulic performance acceptance test of chilled water pumps/ condensed water pumps shall be done according to ANSI/HI 14.6.

E.6.6.4. Lift & Escalators

The Engineer / Engineer's representative shall inspect the manufacturer's premises for manufacturing process and testing procedures of the lift & escalators for ensuring proper quality and standards to be maintained.

During the above factory tests the manufacturer shall be able to satisfactorily prove to the Engineer that the equipment is in line with requirements stipulated in relevant standards and modern engineering practice.

E.6.6.5. Cold Room

The Engineer / Engineer's representative shall inspect the manufacturer's premises for manufacturing process and testing procedures of the refrigeration unit for ensuring proper quality and standards to be maintained.

During the above factory tests the manufacturer shall be able to satisfactorily prove to the Engineer that the equipment is in line with requirements stipulated in AHRI standards and modern engineering practice.

E.6.6.6. Fire Pumps

All the fire pumps shall be factory tested to determine the operating point, churn head (no flow

head), NPSHR and the discharge water flow rate of the pump at 65% of the rated pressure. The hydraulic performance acceptance test of fire pumps shall be done according to ANSI/HI 14.6 and NFPA 20.

E.6.7. WARRANTY

All equipment & accessories shall be given minimum one year warranty from the date of handing over the project to owner after substantial completion unless specifically mention in the relevant sections of the specifications. The warranty shall include plant/equipment/parts and labor costs for the repair or replacement of defects in material or workmanship.

Warranty for chiller compressors, chilled water pumps, condenser water pumps, fire pumps, motors and control panels of elevators and escalators shall be provided for a period of ten years.

E.6.8. MAINTENANCE STRATEGY

Maintenance strategy for the all mechanical works carried out under the scope of mechanical works of the building after the Contractor's defects notification period shall be furnished with the Proposal. Local agent's confirmation on maintenance ability and spare parts availability for following major equipment shall be submitted. But shall not be limited to the same.

Table E.20: Major Equipment for Mechanical System

Mechanical System	Major Equipment
Air Conditioning System	Chillers
	Compressor units of chillers
	Chilled water/ condenser water pumps
	Cooling towers
	Motorized valve
	Air Handling Units (AHUs)
	Variable Speed Drive Units
Fire Protection and Detection System	Fire Pumps
	Fire Alarm Control panel
Building Management System	Supervisory Control Panel
	Direct Digital Controllers
Fuel Pumping System	Dispenser Units/ Pumps
Cold Storage for Wet Garbage, Kitchen etc.	Cold Rooms

E.6.9. SYSTEMS

E.6.9.1. Fire Detection System

E.6.9.1.1. General

The type of the system required for the building shall be decided based on the class of fire as per the classification given in BS 5839. Furthermore the system shall be complied with the Local Fire Regulation (CIDA/DEV/14, 2018) and relevant standards. The contractor shall obtain the Fire Approval for the project from the Fire Service Department.

The building complex shall be provided with addressable fire detection system. Main Fire Alarm control panel, two way communication system equipment, personal computer and printer shall to be provided in the Fire Command Centre provided in the building. Repeater panel shall be be installed in the Monitor & Control Room (24 hours monitoring facility) that can monitor the detection systems. The system shall be an addressable type system which shall have the capability to detect and identify exact location of the fault. Unique identification which is known as "address" can be assigned to each and every points. With the help of this address once any point is activated, the system shall have the capability to indicate the details such as location, type of device, the response at the panel.

As building complex is consists with 03 nos of multi storied buildings (i.e. Parking Building, Terminal Building and Railway side Building) and a Sky Walk, zoning system is identified. Sub Fire Alarm Control Panels shall be installed at the each building and same shall be interconnected with Main Fire Alarm Control Panel, which shall be installed at the Fire Command center. Location of the Fire Command Centre (FCC) shall be decided by the Contractor and the same shall be incorporated in to the architectural drawings. The minimum area of the FCC shall be 10m2.

A software tool shall be installed to the personal computer and which shall compatible with the fire alarm control panel. All the features of FACP shall be virtually displayed on the PC via the software tool with continuous data logging and storing.

Main components of the system shall be as follows.

E.6.9.1.2. Main/Sub Control panel

Control panels shall be located at the Fire Command Center and dedicated room at each building. The panel shall have the capability to communicate with the Building Manage System.

E.6.9.1.3. Repeater panels

Repeater panel shall be located at a place where 24 hr monitoring designated by the employer. (i.e. Entrance Lobbies, Maintenance Rooms etc.)

E.6.9.1.4. Smoke detectors

Smoke detectors shall be provided on the ceilings at lobbies, office areas, auditoriums, conference rooms, inside the air conditioning ducts, lift shafts, plant rooms, generator rooms, panel rooms, electrical ducts, etc.

E.6.9.1.5. Ducted Smoke detectors

Ducted smoke detectors shall be installed at the main rerun air duct of each Air handling Unit (AHU) and where appropriate.

E.6.9.1.6. Heat detectors

Heat detectors shall be placed on the ceilings at pantry, cafeteria, car park area etc.

E.6.9.1.7. Audible alarms

Alarm sounders shall be placed at every lobby and all the enclosed areas to maintain the minimum decibel level of 65dB at office and common spaces and 10dB than the surrounding sound level at car parks, service areas etc (if the sound level is higher than 65dB and less than 90dB).

E.6.9.1.8. Combined Audible & Visual alarms

Combined Audible & Visual alarms shall be placed at each lobby levels where the disable lift is landed, every disable toilets, auditorium, plant rooms and other areas where the surrounding sound level is more than 90dB.

E.6.9.1.9. Manual call points

Manual call points shall be provided at the start and end of escape routes in the building and any location to maintain the maximum travelling distance to nearest call point less than 45m.

E.6.9.1.10. Short Circuit modules

Short Circuits modules shall be placed between each floor level to isolate the circuit.

E.6.9.1.11. Interface with other systems

Further the system shall be interfaced with the Air conditioning and ventilation system. In a situation of fire smoke control system shall be operated to prevent spreading of smoke. This shall be achieved by actuating the staircase & lobby pressurization fans, by shutting down all the fire dampers and air handlers etc. Integrated Fire-fighting Smoke Control Panel shall be introduced for

remote controlling of fans and dampers for pressurization system and smoke extraction system.

The elevators and the fire detection system shall be interfaced with automatic recall system in order to bring the elevator to the ground floor in case of fire.

Basement ventilation system and fire detection system shall be integrated to increase the speed of exhaust and supply fans to maintain 10 ACH at fire situation.

Fire detection system shall interface with Emergency Voice Evacuation System (EVES) and Public Address System to make alert or evacuation announcements during a fire by EVES while overriding any music or tuner distributed via Public Address System.

The system shall interface with Door Access Control System for controlling and monitoring of access-controlled doors required under security aspects, Smoke Control system and evaluation purposes of the building.

The system shall interface with CCTV System in order to focus the relevant camera towards the active fire detector or manual call point for identifying actual fire condition if any through building management system (BMS).

The detection system shall interface with fire protection system to monitor the on/off status of the fire pumps (sprinkler & hydrants), open/closed status of the zone control valves, activation of sprinkler at each floor level and water level of the fire sump

The system shall interface with water mist systems, inert gas system and kitchen wet chemical suppression system for monitoring the status of the systems.

Make provision in Fire Alarm Control Panel to transmit an alarm signal to the Fire Services Department, Colombo.

All above interfaces shall be completed in order to facilitate the phase evacuation of the building at fire and emergency situations. Hence all sounder output shall be programmed as Alert tone (intermittent pulsed tone) and Evacuate tone (continuous tone).

E.6.9.1.12. Exit/Fire Exit sign boards

EXIT sign board shall be installed to define the exit route and FIRE EXIT sign board s shall be installed to define the evacuation path at a fire situation. Contractor shall decide the location and mounting method of Exit/Fire Exit sign board by examine the exit/ escape routes and same shall be placed to assist an occupant to leave the building or premises without any other disturbances. All the configuration and installation of Exit/ Fire Exit sign board shall comply to BS 5499 and Exit/Fire Exit sign boards shall be internally illuminated type with LED lamps and battery backup.

Other safety sign boards and fire safety notices shall be displayed at appropriate locations as per BS 5499.

E.6.9.1.13. Fire resistant cable, conduits

The wiring and conduit system for Fire Detection System shall be completely segregated from all other wiring systems and shall be in accordance with the IEE Regulations.

All wirings shall be enclosed in conduit run in the following manner,

- Wiring within false ceiling spaces and all other areas shall be PVC concealed conduits to be chased in wall cast in columns/ concrete slabs or clipped soffit as directed by the engineer.
- Wiring within riser ducts, electrical switch-rooms, substations and mechanical pant rooms shall be in surface mounted or hanged in G.I. conduits.
    - All wiring/ cable dropping from the concrete slab to the false ceiling shall be drawn in flexible steel conduits not more than 1m in length.

The wiring shall be carried out with fire resistant cables complied with **BS 6387, CWZ** and **BS 7629.**

Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 1.5mm2 for initiating device circuits and signal line circuits, and 2.5 mm2 for notification appliances circuits.

Cable Construction

Fire resistant cable shall be consisting of conductors, insulation, screen, earth wiring and sheath. The insulated conductors shall be plain or tinned annealed copper. Minimum insulation thickness of conductors shall be 0.7 mm for 1.5 mm2 conductor and 0.8 mm for 2.5 mm2. The earth wire shall comprise one or more tinned annealed copper wires with total nominal cross section area not less than 0.5 mm2. Sheath shall be LSZH (Low Smoke Zero Halogen) and radial thickness of sheath shall not be less than 0.9 mm for 1.5 mm2 and 1.0 mm for 2.5 mm2. Screen shall be made from one or more metallic or laminated metallic tape(s) and applied longitudinal or helically or a combination of both. The minimum thickness of the metallic element of the screen shall be 0.008.

E.6.9.1.14. Two way fireman's communication system

Two way fireman's communication system shall be provided to communicate with fire fighters in a situation of fire and interfaced with public address system in order to send warning massagers at

the affected areas. The system shall comply with BS 5839-9 and ICTAD/DEV/14 Fire Regulation (Rev. 2018).

The master station of two way fireman's communication system shall be installed at the fire command. The master station may inbuilt in the fire alarm control panel or the same may be installed as a separate panel with a provision to communicate the fire alarm control panel. Outstations points of fireman's two way communication system shall be installed in following locations

- Each Fire Fighter's Lobby
- Fire Pump Room
- Lift Machine Room
- Generator Room
- Chillier Plant Rooms

The fire alarm control panel, repeater panels, initiative devices, alarm devices, fire resistant cables shall be UL listed, FM approved or LPCB approved. Relevant documents as a proof of certifications shall be submitted with the bid.

E.6.9.2. Fire Protection System

a. General

Centralized fire protection system shall be provided for the building. Pump room shall be provided at ground level to house all the hydrant pumps, sprinkler pumps, main vales, control panels etc.

The water requirement for the fire hydrant system and sprinklers system shall be fulfilled by the main water sump closer to the fire pump room.

Fire protection of a building consists with following sub systems:

- Wet Riser system with Hydrants and Hose Reels
- Sprinkler System
- Inert Gas Fire Suppression System
- Water Mist System
- Portable Fire Extinguishers
- Wet Chemical System for Kitchen

For the wet riser fire hydrant system, duty pump, standby pump and jockey pump shall be provided at the fire pump room and the contractor shall decide a suitable location for fire pump room and the same shall be incorporated in to the architectural drawings.

b. Design Conditions

Fire Hydrant System

- Water quantity at furthest hydrant connection - 25 l/s
- Pressure required at furthest hydrant - 5 bar (max)
- Connection valve fully open - 4 bar (min)
- Water quantity at furthest hose reel connection- 0.5 l/s
- Minimum pressure required at hose reel nozzle- 1.25 bar

Sprinkler System

- Hazard classification - Ordinary Group II or as per the CIDA Regulations
- Sprinkler head - 15 mm (nominal size)
- Area coverage of sprinkler head - 12 m^2
- Design discharge density - 5 mm/min
- Assumed maximum area of operation - 144 m^2

Inert gas system

- Type of System - Triple Layer System (Protected ceiling void, room space and under raised floor)
- Hazard classification - Class C Fire
- Design concentration - Below 43%
- Discharge time - 95% of the total quantity of extinguishing agent in 120 seconds

Water mist system

- Type of System - Pre-engineered system with self-contained water supply (Pulse mist system)
- Hazard classification - Class B & C Fire
- Pressure Rating - High Pressure Application (> 500Psi)

E.6.9.2.1. Wet Riser system with Hydrants and Hose Reels

Landing vales and hose reels shall be provided inside the building at the fire-fighting lobbies and Main lobbies as required. External hydrants shall be located outside the building in such a way that distance from any entry is not more than 70 m, the minimum distance between any hydrant and the building shall be 6 m and distance between two hydrants shall not be more than 90 m if required. External fire hydrants shall be connected with the fire system through an underground ring main.

E.6.9.2.2. Fire Pumps

All the Pumps shall be vertical turbine type and the flow rates and the operating pressures shall be selected according to the number of risers to be served and the habitable height of the building and those selections shall be make according to the ICTAD/DEV/14 Fire Regulation (Rev. 2018). The contractor shall not to be restricted on the Architectural design and contractor shall re-calculate the number of risers required for complete installation. **The fire pumps shall delivery water at a rate of 150% of rated flow at a pressure of 65% of rated pressure.**

Main fire pump shall be electrically driven and a continuous supply shall provide to the pump while the standby pump shall be driven by an auxiliary power source or electrical power according to the ICTAD/DEV/14 Fire Regulation (Rev. 2018).

All the fire pumps shall be UL listed, FM approved or LPCB approved. Relevant documents as a proof of certifications shall be submitted with the bid.

E.6.9.2.3. Pipes

Above ground

All above ground pipes shall be seamless and complied to ASTM A53 (Hot Dipped Galvanized), Grade B, Schedule 40, Type S (Seamless). All the precautions shall me made to prevent corrosions.

All above ground pipe shall be supported or bracketed with required distance as specified in the standards stipulated in clause C.1.2.

All the pipe joints shall be made with Victaulic grooved couplings or similar approved mechanical pipe couplings.

Underground ground

All underground pipes shall be HDPE pipe or ASTM A53 (Hot Dipped Galvanized), Grade B, Schedule 40, Type S (Seamless) pipes (including all the joints) wrapping with grease impregnated jute wrappings (Denso or equivalent) having minimum 50% overlap.

Before backfilling, pipes shall be pressure tested to 1.5 times the working pressure and maintain

that pressure 24 hours. The pipe shall be laid on 100mm thick fined sand layer. Soil around the pipe shall be plain and free of stones, well compacted and back filled up to minimum height of 150 mm from the top surface of the pipe and the rest shall be filled with Aggregate Base Coat (ABC) or sand as per drawings.

If water fills in to the trench at the construction level, contractor shall dewater and shall take the precaution such as shoveling the trench wall etc.

As a safety precaution, warning tape shall be buried at the half of the ABC backfilling.

At paved and turf areas, minimum depth of 750 mm shall be maintained to the Centre of Pipe (COP) from the ground level and at vehicle moving areas that minimum depth shall be maintained as 900 mm.

E.6.9.3. Automatic Sprinkler System

Parking Areas of the building shall be protected with automatic sprinkler system. Number of sprinklers risers required shall be decided by the contractor by considering the total building height and the total floor area of the building.

Appropriate sprinkler type shall be decided by the contractor to match with the each serving area (i.e. upright sprinklers, pendant sprinklers, side wall sprinklers, open sprinklers etc.).

Table E.21: Type of Sprinklers

Location/ System	Type of Sprinklers
Parking Floors , floor height is less than 3000m	Upright Sprinklers
Parking Floors, floor height is more than 3000m	Pendent Sprinklers with sprinkler guard
Other areas (except parking) without a ceiling	Side wall sprinklers
Other areas (except parking) with a ceiling	Pendent Sprinkler with ceiling concealed type rosettes
Auditorium Drencher system	Open type sprinklers

Above table is provided as a design reference but the design shall not be limited on the given data except all the rosettes of pendant sprinklers installed at any area covered by a ceiling shall be ceiling concealed type.

The screen of the auditorium shall be protected by manually operated drencher system including position indication butterfly wall with enclosure box (break glass type) and open type sprinklers. And the system shall connect with the sprinkler system at the relevant floor.

Sprinkler risers of building shall be tapped from the main sprinkler header. Branching and zoning of sprinkler system shall be carried out in accordance with the BS Standards. Depending on the zoning system numbers of sprinkler valve sets shall be provided at each floor and the same shall be placed inside sprinkler valve room.

Zone control valve sets shall be installed where it appropriate and the same shall include zone subsidiary stop valve with temper switch, flow switch, isolations valves, sight glass etc. the zone subsidiary stop valve and the flow switch shall be connected with the fire alarm control panel though a monitor module.

All the pumps, pipes and pipe installation shall be complied with the details stipulated in the **clause 5.9.2.2.**

All the fire pumps shall be UL listed, FM approved or LPCB approved. Relevant documents as a proof of certifications shall be submitted with the Proposal.

E.6.9.3.1. Portable Fire Extinguishers

Water/CO2, and CO2, ABC Dry Power portable fire extinguishers shall be provided throughout the building as per the minimum requirements stipulated in the below table.

Table E.22: Types of portable extinguishers

Location	Types of portable extinguishers
Parking Floors	ABC Dry Powder, CO2
Generator Room, Fire Command Centre	ABC Dry Powder, CO2
Office Areas	CO2/ Water, CO2

The design shall not be limited to the above minimum requirement, but shall be based on BS 5306 Part3.

E.6.9.3.2. Inert Gas Fire Suppression System:

Triple layer inert gas fire suppression systems comply with NFPA 2001- Clean agent fire extinguishing systems shall be provided for Server Room. The Inert Gas Agent installation shall be an engineered fixed full flooding system which is suitable for Class C energized electrical equipment fires.

The contractor shall decide the system size, discharge times, discharge pressure etc. by a detailed design and the appropriate location for the cylinder bank shall be decided by the contractor upon the size and number of required cylinders. The system shall comprise with following items, but shall not be limited to stipulated items.

- Control panel, Manifold, Pressure reducing unit, Nozzle, Smoke/heat detector, Alarm bell, Strobe Light, Manual call point, Pressure gauges, Pressure relief flap, cylinder manifold with master and slave cylinders

The system shall be incorporated with dedicated early warning detection and alarm to facilitate confirmation of an incipient fire before release of agent.

The dedicated detection system shall act separately from the central detection system of the building except status of the system shall be indicated through the main detection panel of the central system.

Control panel shall be capable of communicate with Integrated Building Management System (IBMS) regarding the system updates of the inert gas system. The control panel shall be a releasing panel and shall be UL/LPCB listed and shall contain release circuits for activation of a fire suppression system.

The fire suppression system shall be designed in such a way to capable of providing homogenous concentration of inert gas throughout the covered spaces, within the required time period.

Additionally all the equipment's including initiative devices, alarms devices shall be UL listed, FM approved or LPCB approved. Relevant documents as a proof of certifications shall be submitted with the bid.

All distribution piping shall be Schedule 40 seamless galvanized carbon steel pipe to ASTM A106 Grade B (latest edition). All pipe fittings such as elbows, tees, etc. shall be forged steel fittings to ANSI B16.11 Class 3000lb (latest edition). All pipe flanges shall be steel flanges to ANSI B16.5 Class 600lb (latest edition). All threaded connections shall confirm to ANSI B1.20.1 (latest edition).

E.6.9.3.3. Water Mist System

Wet chemical suppression system shall be provided for the generator room at ground floor and the same shall comply with NFPA 750 - Standard on Water Mist Fire Protection Systems and the pressure rating shall be in accordance with the listing requirement (UL300) or LPCB certified.

The system shall comprise with following items, but shall not be limited to stipulated items.

- Pressurized water container, pressurized air container, automatic spray nozzles, etc.

The system pressure and the cylinder sizes shall be decided by the contactor via detailed calculations

An audible or visible indicator shall be provided to show that the system has operated and provision

to be provided to connect with the central fire detection panel to indicate the system activation. In advance the main panel if the system shall be capable of communicate with Integrated Building Management System (IBMS) regarding the system updates of the water mist system.

All the equipment in suppression system shall be UL listed or LPCB certified. Relevant documents as a proof of certifications shall be submitted with the Proposal.

The pipe materials shall be non-corroded and stainless steel pipes are mostly recommended.

E.6.9.3.4. Wet Chemical Suppression System

Wet chemical suppression system (pre-engineered) shall be provided for Kitchen at Second floor and the same shall comply with NFPA 17A – Wet Chemical Extinguishing System, UL300 - Fire Testing of Fire Extinguishing System for Protection of Restaurant Cooking Areas and relevant LPCB standards.

The contractor shall decide the system size, discharge times, discharge pressure etc. by a detailed design and the appropriate location for the cylinder/s shall be decided by the contractor upon the size and number of required cylinders.

The system shall comprise with following items, but shall not be limited to stipulated items.

- Wet Chemical Cylinders, cylinder brackets, cylinder enclosure, Mechanical Control box, nozzles (appliance, duct and plenum), remote manual actuators (pull station), corner & three way pulleys, fusible link detectors, liquid seal devices etc.

An audible or visible indicator shall be provided to show that the system has operated and provision to be provided to connect with the central fire detection panel to indicate the system activation. In advance controller box shall be capable of communicate with Integrated Building Management System (IBMS) regarding the system updates of the wet chemical suppression system.

All the equipment in suppression system shall be UL listed or LPCB certified. Relevant documents as a proof of certifications shall be submitted with the bid.

All the pipes and fitting shall be noncombustible type and shall have the chemical and mechanical characteristic to compatible with the chemical used in the suppression system.

Chrome-plated or stainless steel pipes and fittings are recommended for appropriate installation and hot dipped galvanized is not allowed.

E.6.9.4. Air Conditioning System

E.6.9.4.1. General Details

a. Design Criteria/Conditions

Table E.23: Average Outdoor conditions

Description	Temperature °C	Relative Humidity (RH)/%
Day time	29 - 33	70-90
Night time	24 - 26	70-90

Table E.24: Indoor conditions

Space	Usage/Activity level	DB / °C	RH % (maximum)
Office area	Office/office work	24±1	55 -65
Shops	Light Work	24±1	55 -65
Reception and Lobbies	Light Work	25±2	55 -65

b. Humidity control

Precious Humidity control- only for Server room

c. Occupancy load

For cooling load calculations, following occupancy density for each area shall be considered as follows,

Table E.25: Occupancy Density

Area	Description
Occupancy loads in office area	Total occupancy density is considered as the higher value of 8m2/person or based on the number of seats indicated on the Furniture lay out drawings.

d. Building envelop characteristics

Overall Heat Transfer coefficients of Roof (Non-tiled area), external walls, and internal walls shall be selected by the contractor to match with the architectural drawings.

The performance data of glasses shall be comply with the following table

Table E.26: Performance data of glasses

Glass Type	Parameter	Value

Single Glazing	U Value (Max.)	2.5 W/m2.°C
	Shading Coefficient – SC (Max.)	0.3
	Visible Transmissivity (VT) (Max.)	40 %
Low E Glazing	U Value (Max.)	5.0 W/m2.°C
	Shading Coefficient – SC (Max.)	0.8
	Visible Transmissivity (VT) (Max.)	70%

e. Lighting Criteria

The maximum Light Power Density shall not be more than 10W/m2.

f. Ventilation criteria

Table E.27: Air changes per hour (ACH)

Description	Air changes per hour (ACH)
Toilet exhausting flow rate	8.0 -10.0
Car park areas	6.0
Fire Pump room	6.0

g. Ventilation criteria

Table E.28: Infiltration rate

Description	Infiltration rate (when supply fan on)
Entrance lobby	0.50 ACH

h. Acoustic criteria

Table E.29: Acoustic criteria

Space	NC
Open plan office (except where adjacent to plant room)	35 - 40
Small office (except where adjacent to plant room)	30 - 35
Corridors	45 - 50

Space	NC
Café	40 - 45
IT rooms	35 - 40
Auditorium	25 - 30
Meeting room / board rooms	30 - 35
Changing room	35 - 40

Design Margins

Table E.30: Design Margins

Description	Margin
AHU selection	
Safety margin for sensible load	Add 10% for design sensible load
Safety margin for latent load	Add 10% for design latent load
Pump selection	
Primary Chilled water Pumps Design flow	10% design flow against the system design pressure
Fan selection	
Design flow	10% design flow against 15% system pressure
Chillers-Total Cooling load	10-15 %
Cooling Towers	25%

E.6.9.4.2. Specific Details

A Centralized Air Conditioning system shall be provided for the complex consists of Water Cooled Chillers, AHUs, FCUs, Primary-secondary chilled water distribution system and Condenser water system.

The capacities of the equipment shall be selected by the contractor using the computer simulation licensed soft-ware “Trace”/ “Carrier HAP”. And the contractor shall decide the proper locations for the chiller plants including chillers, pumps, control panels etc. and cooling tower locations.

All areas mentioned in the following schedule shall be air conditioned but shall not be limited to that schedule.

Table E.31: Areas need to be air-conditioned

	Building	Floor	Sample areas to be air-conditioned
1	Parking Building, Terminal Building	Mezzanine Floor, Ground floor, First Floor, Second Floor…etc, Roof Terrace	Food Courts
2			Operator Office 1
3			Operator Office 2
4			Female Staff Rest Room
5			Pantry
6			UPS/ Data Room
7			Maintenance Office
8			Meeting Room
9			Control Room
10			Asst. Manager Office
11			Manager's Office
12			Operator Office 3
13			Management Facilities Room
14			Wet Garbage Store
15			Wet Garbage Store
16			Waiting Area
17			Super Market
18			Shops
19			Reception
20			Baby Care Room
21			First-Aid Room
22			Operators' Admin Office
23			Police Post
24			Police Post Lobby
25			Security Control Center with CCTV
26			ATM Room
27			Mini Bank
28			Ticketing Area
29			Vaults Area
30			Pharmacy

	Building	Floor	Sample areas to be air-conditioned
31			Food Courts
32			Wet Garbage Store
33			Preparation Area
34			Restaurant
35			Wet Garbage Store

Additionally, areas in basement level, all toilets, and all parking areas shall be provided with mechanical ventilation system.

The MVAC system shall be controlled via BMS (Intelligent Building Management System) and shall circulate chilled and Condenser water through the piping network connected to Fan Coil Units, AHUs and CTs in building.

Rentable spaces which are to be air conditioned, shall be only provided with chilled water distribution pipes with Energy Meter by the AC contractor and the buyer shall have the responsibility to install the air-side equipment (ducting, AC units etc.). The Energy Meter shall compatible to communicate with BMS. Area to be rented are mentioned in the below table,

Some spaces mentioned under the section of **"DETAILED MISCELLANEOUS FEATURES TO BE INCORPORATED IN THE TERMINAL AND PARKING BUILDINGS"** will be considered as rentable spaces and air conditioning and ventilation system shall be provided as suitably.

All plant location piping and the chiller plant room piping shall be supported on combination **rubber spring vibration isolators** which shall be attached as close as possible to beams.

For the design, if additional space is required for AC plants, Contractor shall decide the required size and location of the space and shall incorporate the same in the architectural drawings.

E.6.9.4.3. Chilled water Distribution system

Variable Secondary/ Primary pumping system shall be used for chilled water supply. Chilled water flow rate shall be varied by varying the speed of the primary pumps with VSD according to building load. Pressure independent valve shall be used to maintain the minimum chilled water flow through the chillers.

E.6.9.4.3.1. Chillers

Contractor shall decide the chiller sizing and configuration base on total cooling load of the

building and building operation based on N+1 configuration. All the chillers shall be water called type and the minimum COP valves and IPLV shall comply with ASHRAE 90.1-2013). All the chillers shall be packaged type chillers and the same shall be deemed to include inbuilt restrained spring isolators (double spring) or equivalent for vibration control. All chillers shall be water cooled and the same shall be complied with ANSI/AHRI 551/591-2011 Standard for Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle.

The refrigerant used in the chiller will be R-410a or R134a concerning the environmental regulations.

E.6.9.4.3.2. Chilled Water Pumps

All chilled water pumps shall be VSD driven and the same shall be selected for an average efficiency of not less than 70% and the minimum efficiency index (MEI) shall be not less than 0.40. The pumps shall be installed on rectangular concrete inertia bases.

The pump motors shall be comply with IEC 60034-30 (2008) efficiency classes and comparable efficiency level shall be IE3.

E.6.9.4.3.3.Chilled Water Pipes

Chilled water piping shall be seamless black steel to ASTM 53A; Grade B; Type S or ASTM 106 Schedule 40.

All chilled water pipe work shall be suitably insulated with **flexible elastomeric closed cell thermal insulation** (complying with ASTM C534 standard) with a thermal conductivity (K) value not greater than 0.04 W/m°C and vapour-sealed, including all valves, flanges, expansion vessels etc.

For the support of all insulated piping 80 mm long machine cut timber support blocks shall be fitted all round the pipe to suit the insulation thickness. Wooden blocks shall not be fitted at anchor points

E.6.9.4.3.4. Condensate Drain Water Pipes

Condensate drain water piping shall be rigid PVC type 1000.

Furthermore, the system shall include with expansion tanks, headers, pressure gauges, thermo meters, motorized valve (IP55 for indoor installation and IP65 for outdoor installation), Pressure Independent Control Valve for AHUs, electromagnetic 2 way FCU valves, balancing valves,

strainers and all necessary accessories required for the complete installation of the system.

E.6.9.4.4. Condenser Water Distribution System

Condenser water distribution system is a constant flow water distribution system, which uses a set of constant speed pumps to deliver the required flow to the Cooling Towers, based on the amount of heat rejected by the Condenser.

The cooling towers shall be installed at 18th level (Cooling tower level) and the condenser pumps shall be installed Chiller room level – 17th level.

E.6.9.4.4.1. Cooling Towers

The cooling capacities and configuration of the cooling towers shall be selected to match with chillers and for the election cooling capacities, following parameters shall be considered.

- Condensed Water Flow rate – to be decided based on chiller configurations
- Entering temperature - 35°C
- Leaving temperature - 30°C
- Operating air wet bulb temperature - 27°C

The minimum total cooling capacity of the cooling towers shall be not less than 130% of total cooling capacity of the chillers.

All cooling type shall be induced draft cross flow type and manufactured from fiber reinforced plastic and shall have CTI Certification.

Fan shall be of Aluminium blades type driven with IP65 class motor shall be compatible to VFD.

Note-: it is recommended to operate the all cooling towers in Duty Mode.

E.6.9.4.4.2. Condenser Water Pumps

All condenser water pumps shall be constant speed pumps and the same shall be selected for an average efficiency of not less than 70% and the minimum efficiency index (MEI) shall be not less than 0.40. The pumps shall be installed on rectangular concrete inertia bases.

The pump motors shall be comply with IEC 60034-30 (2008) efficiency classes and comparable efficiency level shall be IE3.

E.6.9.4.4.3. Condenser Water Pipes

Condenser water piping shall be seamless black steel to ASTM 53A; Grade B; Type S or ASTM 106 Schedule 40.

Marine grade paints shall be applied on all pipes and fittings in condenser water system to prevent the corrosion due to coastal conditions.

Furthermore, the system shall include with makeup water tank, chemical water treatment plant, headers, pressure gauges, thermo meters, motorized valves (IP55 for indoor installation and IP65 for outdoor installation), strainers, supports and all necessary accessories required for the complete installation of the system.

Makeup Water Tank

The contractor shall calculate the capacity of the makeup water tank by considering the evaporation rate for 3 hours. The tank/s material shall be PVC of FRP.

The makeup water tank shall be located at the same area where the cooling is to be located.

E.6.9.4.5. Air Distribution System

No of zones on each floor level shall be selected based on nature of occupancy type. Supply air will be provided for each Zone by using AHU and variable air volume air distribution system. Amount of Air Supplied to each zone and its temperature will be controlled using VAV units.

The system shall include with Localized Air Handling Units (AHUs), Fan Coil Units (FCUs), supply and return air duct works, Variable Air Volume (VAV) boxes, sound attenuator, air terminals etc.

E.6.9.4.5.1. Air Handling Units (AHUs)

Modular type AHUs shall be installed at each AHU rooms with selected cooling capacities, the AHUs shall include with return air mixing box pre-filter module, Bag filter module, Cooling Coil Module, fan module, drain pads etc. (not to be limited stipulated items). The fans shall be compatible with VSD (if necessary). The configuration and the blow type of AHUs shall be decided based on the cooling capacity and space allocation. Air handling units shall conform to AHRI Standard 430-2014.

E.6.9.4.5.2. Fan Coil Units

Fan coil units shall be installed at appropriate locations (Kitchen areas, chiller plant rooms, lift machine rooms etc.) and the same shall consist with filters, cooling coils, supply air fans, drain pads etc. (not to be limited stipulated items). Units shall bear AHRI labels certifying conformance to ANSI/AHRI Standard 440-2008 or Eurovent certification.

E.6.9.4.5.3. Supply/ Return ducts

All the duct work shall be fabricated with GI sheet metals and shall be insulated with **flexible elastomeric closed cell thermal insulation** (complying with ASTM C534 standard) with thermal conductivity not more than 0.04 W/m.°C at 25 °C. Supply ducts shall be insulated to thickness of 50mm and return duct 25 mm thickness with density of 450kg/m3.

Duct works shall include for supports, hangers, acoustic lining where necessary, balancing dampers, volume control dampers, fire dampers, flexible connectors etc. for completion of installations.

E.6.9.4.5.4.Air terminals

Air terminals (supply/return) shall be fabricated with powder coated sheet steel and shall be selected to match with the ceiling type.

E.6.9.4.5.5. Sound Attenuators

Sounder attenuators shall be installed at main supply and return air ducts. The size of the attenuators shall be decided on noise level generated by the AHU and the required noise level of the served space.

E.6.9.4.5.6. Variable Air Volume (VAV) Boxes

VAV boxes shall be installed at any spaces where individual controlling shall be required, especially for conference rooms, director's rooms, etc. VAV boxes shall be consists with following items but not to limited to the same,

- thermostat, silencer, tubular type air flow meter

The minimum flow rate for the VAV boxes shall be decide based on " minimum ventilation rates in breathing zones" stipulated in ASHRAR 16.2.

Unit shall be consisting with factory mounted standalone DDC with actuator to control and monitor the VAV unit. The controller shall be fully BACnet compliant to integrate the building automation system (BAS) through the BACnet MS/TP protocol.

E.6.9.4.6. Toilet exhausts air system

All toilets shall be provided with ducted type exhaust systems except for the ground floor toilets at periphery wall. The system shall consist with ducted exhaust fans, G.I. ducts, disk valves, weather resistant lovers, inset nets etc.

Ground floor periphery wall shall be provided with wall mounted type exhaust fans with gravity operated lover shutters, inset net etc.

E.6.9.4.7. Ventilation system for Parking Areas

Separate ducted ventilation system including jet fans (where appropriate) shall be installed at the parking areas at ground floor and mezzanine level. The system shall ensure adequate ventilation inside the parking area and also to limit harmful CO inside the parking area.

The system shall include following items but not to be limited the same,

- Soffit mounted ducted exhaust Fans, soffit mounted jet fans, G.I. ducts, grills, lovers, Carbon Monoxide (CO) sensors etc.

The exhaust fan shall be VFD driven and compactible to connect with the building management system.

CO sensors will be supplied and installed under BMS system.

Any duct work pertaining to car park ventilation system shall be of galvanized sheet steel designed, fabricated and installed in accordance with relevant ASHRAE standard or approved equivalent.

E.6.9.4.8. Split type air conditioning system

Split type air conditioners shall be installed at required locations. (i.e. Electrical Panel room, transformer room, fire command center and lift machine room etc.)

It is essential to provide precision AC system for server room areas.

E.6.9.4.9. Active Harmonic Filter

Active Harmonic Filter Panels shall be provided to the chiller plant room and the locations where the variable frequency driven motors and fan installed such as AHU rooms, etc.

E.6.9.4.10. Kitchen ventilation system

The separate ventilation system at shall be provided for the kitchen areas at second floor. The system shall incorporate with kitchen hood ventilation system and fresh air supply system.

All the ducting material of kitchen ventilation system shall be of Stainless Steel (S.S) and the total system shall comply with the ASHRAE standards (Application – Handbook and ASHRAE 154).

Total system shall include items listed below but not to be limited for the same,

- Supply air duct, supply air fans, exhaust hoods with S.S baffle filters/ grease arresting filters, hood gutters, hood lamps (incandescent of CFL are recommended), lamp guard (S.S) exhaust air duct, belt driven exhaust fans, chimney etc.

The lux level at the burner height shall be not less than 500 Lux and the hood lamp shall be selected

to in order to maintenance that required lux level.

E.6.9.5. Building Management System

Building Automation System (BAS) will be provided incorporating an open protocol system technology (Lonworks/ Bacnet) in the network methodology and management, programming tools and data exchange to control the specified HVAC system and the following sub-systems.

- Chiller Management System
- AHU System
- CO2 level Control System for AHU
- Monitoring and Control of Access control system, CCTV system, Potable Water System, Rain Water Harvesting system, access control system etc.
- Monitoring and control of car park ventilation System.
- Monitoring of Standby Generators
- Zone Lighting Control and Power Monitoring
- Maintenance scheduling
- Monitoring of fire protection and detection System.
- Monitoring and control rain water harvesting system and irrigation system
- Monitoring of Lift Installation

The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (SUPERVISORY CONTROLLER), Graphical User Interface through standard Web browsers, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other systems.

The supervisory panel and the workstation shall be installed at fire command center at ground floor.

Point List

Sample point list is annexed [Annex E.8 (Mech) – *attached separately as Volume 3.2 of Employer's Requirement*] with the document for each system controller.

E.6.9.6. Elevators and Escalators

Number of lifts provided per building shall depend on the population density of the building above the ground floor. The calculation and selection of elevators shall be done in accordance with the

standards stipulated in the (c.3). The elevator schedule is given bellow.

Table E.32: Schedule of Elevators

Elements	Terminal Building Area	Railway Track Area
Elevators	14	5
Escalators	2	6

Note: Number of lifts and elevators may be increased as per the detailed design with the passenger flow, standards and building regulations. The Proposer is anticipated to take necessary actions

Submit a detailed traffic calculation for the building complex and if there is any changes, the Contractor shall incorporate the same in the design. (i.e. capacities, speed, shaft sizes, car size etc.) and shall take necessary actions to update the architectural drawings with revised shaft sizes.

Two number of Car Operating Panels (COP) – at left side & right side of door entrance, shall be installed at each lift car.

The whole work shall confirm to the following standards stipulated in (c.3) Elevators and Escalators.

Elevators at a common lobby shall equipped with group controlling system. Emergency backup facility shall be provided for each elevator for emergency operation in case of power failure.

Escalators (for up and down purposes) shall be installed inside the premises as per the schedule provided in below.

Furthermore, minimum capacities of the all escalators shall be 1050 persons/min, step width shall be 1000mm and the speed shall be 0.65.

Energy efficient regenerative type lifts shall be selected with latest code of practices. Lifts and/or escalators should be with AC Variable Voltage and Variable Frequency (VVVF) motor drive with sleep mode features.

Central control panel shall be provided for elevator system and the same shall connects with the Building Management System.

E.6.9.7.Fuel Pumping System

Fuel pump system shall be provided for the location indicated in the architectural drawings and the

system shall be compromised with the following items,

- Four (04) Nos underground cylindrical steel storage tanks of 5000 galons capacity suitable for storing diesel. – Contractor shall verify the given capacity with a proper calculations and if there is any changes in the capacity, the contractor shall proceed the design with the revised value.
- Four (04) nos heavy duty type dispensing units installed at the ground level for pumping diesel
- Inter-connecting pipe lines of galvanized steel, manifolds, valves and fittings for fuel pumping system.
- Associated electrical cabling and control gear.

E.6.9.7.1. Fuel Storage tanks

Storage tanks shall be designed, fabricated, installed and tested to BS 2594 (1975) or superior standard for horizontal mild steel welded storage tanks. Flat ended tanks may be supplied, provided the design conform to ANSI – UL 58. Tank shall be installed inside a reinforced concrete cell. The space between cell and tank shall be filled with dry sand prior to placing the concrete of the cover slab. The tanks should be equipped with reliable measures to detect any fuel leakage instantaneously from the tank. Tank shall have two manholes and be provided with a dial-type float operated oil level indicator, opening for inserting a dip-stick, air vent, one draw-off pipe with non-return valve and two filling connections (one for filling from bowser and other for transfer from large naval craft).

The tank shall be tested for leaks according to the referred standards and according to Engineer's approval. On successful completion of the tests, the outer surface shall be blast cleaned to SA 2.5 and two coats of hot bitumen applied, followed by the application of one layer of roofing felt. Roofing felt joints shall be given a further coat of hot bitumen.

E.6.9.7.2. Fuel piping system

The design, construction and testing of the piping system shall conform to ANSI B 31 (American National Standard for pressure Piping). Pipe joints shall be either flanged or threaded.

Fuel piping system should have adequate capacity to supply the required flow from storage tanks to the dispensers. The contractor should submit the corrosion treatment measures for above ground and underground piping. Flexible joints should be used where necessary.

The pipe line shall be provided with a surge arresting device at no extra cost if found necessary by

the Engineer.

E.6.9.7.3. Dispensing Units/Pumps

Dispensing units/pumps shall be of heavy duty type conforming to ANSI – UL 87. The pumps shall be capable of delivering 3,900 litters / hour. The dispensing pump shall be provided with re-settable digital type nine-digit register and a non-resettable totalizer running up to at least seven digits. The dispensing pump shall include an air, duel filter and a pressure regulator at the inlet to ensure proper operation of the air eliminator. The pump cabinet shall be of stainless steel. The pumping unit shall be consist with inbuilt printer.

Sufficient length of flexible hose shall be provided with the small pump to be able to reach the filling point of a small craft berthed alongside. The hose shall be provided with an automatic nozzle.

For larger dispensing pumps, facility shall be provided to connect to the universal coupling of the ships and sufficient hose length shall be provided.

The inlet to each dispensing pump shall be provided with a gate valve.

Fuel dispenser unit shall be comply with the specifications published by the Ceylon Petroleum Corporation. *(Link - http://ceypetco.gov.lk/fuel-dispensers/)*

Table E.33: Parameters of dispensing units/pumps

	Parameters	**Value/ Description**
1.	Fuel to be pumped	Heavy Duty - Diesel
2.	Flow Rate	Heavy Duty – 65 l/min
3.	Volume Preset – Main Display	Heavy Duty - > 1 – 999 Litres
4.	Capacity of the Electric Motor	Heavy Duty - 1 Hp/.75 kW
5.	Nozzle	Automatic Shut off Nozzle (1” BSPT female thread preferred) Spout Diameter 24 mm
6.	Hose 1.Diameter 2.Wall Thickness 3. Minimum Length 4. Couplings	 25mm (1”) Minimum 6.0 mm 4m 1” BSPT (preferred) chrome plated brass swivel couplings, male thread at one end and female thread at the other end.

E.6.9.8. Centralized LP Gas Distribution and Detection system

A centralized LP gas distribution system shall be provided for kitchen areas. The cylinder manifold shall be located at lower ground level and with well-ventilated location. The manifold shall be

covered with a cage, fabricated with steel. A dedicated LP gas detection system shall be installed for the above system.

Cylinder Manifold

The capacity of the bank/ number of LP gas cylinders shall be calculated based on the LP gas requirement of the kitchen appliance for 14 days. The manifold shall have 02 number of gas banks (duty/standby), isolation valves, pressure gauges, pig tails, automatic/manual change over, non-return valves etc.

LP Gas Cylinders

All the cylinders shall be industrial type cylinders with the capacity of 37.5 kg.

Piping system

The pipes shall be of Galvanized Iron and shall be painted with yellow color by indicating the flow direction. Before the paining, precautions shall be taken to minimize the corrosions.

Pressure Regulation Valves (1st stage & 2nd stage), pressure gauges, isolations valves, no- return valves etc. shall be installed where necessary. The kitchen appliances shall be connected with piped system with flexible hose and flexible hose connectors.

Automatic shutoff valves shall be installed inside the cylinder bank area to shut off the LP Gas supply to the building in case of a fire or detection of leakage of flammable gas.

LP gas detection system

A dedicated conventional panel shall be installed at the security office. The panel shall be compatible to communicate with Fire Alarm Control Panel and Building Management System (BMS). Detector and alarm shall be placed according to the standards stipulated in c.4. (i.e the maximum height of the LP gas detectors shall be 300 mm from finished floor level).

Detectors shall communicate with the main gas panel through monitor modules. The number of monitor modules shall depend on the number of detection zones and the number of output of each module.

All the wiring shall be fire rated and the total wiring system shall be complying with Clause 5.9.1.12.

The detection system shall compromise with backup Ups to energize the detectors and alarms in case of power failure

E.6.9.9. Cold Room – Garbage Collection

A cold room shall be provided to store wet garbage and same shall be at lower ground level. The total volume/ dimension shall be calculated based on the requirements of the local authorities.

The cold room shall be prefabricated walk in type and the same shall maintain the temperature of 4^0C - 10^0C and 55% - 65% RH of inside the conditioned space.

A dedicated control penal shall be provided to operate the cold room and the panel shall compatible to connect with the BMS.

The compressor assembly shall have minimum of 02 nos of compressors (duty/standby) to facilitate the redundancy of the system. The minimum lux level inside the cold room shall be 250

E.6.10. MECHANICAL WORKS

E.6.10.1. Mechanical Ventilation and Air Conditioning System

- Specialist MVAC contractor shall have at least ten (10) years experience in Supplying, Installing, Testing, Commissioning and Maintenance of similar type of Air Conditioning systems in Sri Lanka and having qualified technical staff trained at Chiller plant manufacturing facility for installation, operation, maintenance & trouble shooting of modern multi compressor screw type chillers.
- Experience in performing at least one contract of a nature, complexity and value equivalent to the proposed works over the last 5 years.
- The manufacturer of the equipment shall have at least fifteen (15) years experience in the Design and Manufacture of similar type air conditioners and make of offered equipment shall have at least five (05) years proven service record in Sri Lanka.

E.6.10.2. Fire Protection and Detection System

- Specialist FDPS contractor shall have at least ten (10) years experience in Supplying, Installing, Testing, Commissioning and Maintenance of similar type of Fire Detection and Protection Systems in Sri Lanka.
- Experience in performing at least one contract of a similar nature, complexity and value equivalent to the proposed works over the last five (05) years.
- The manufacturer of major equipment shall have at least ten (10) years experience in the Design and Manufacture of similar type equipment and make of offered equipment shall have at least five (05) years proven service record in Sri Lanka.

E.6.10.3. Lift

- Specialist Lift contractor shall be a reputed local company having experience in planning, engineering, supplying, installing, testing, commissioning and maintenance of passenger lifts at least for last five (05) years.
- The manufacturer of the Lifts shall have at least fifteen (15) years experience in the design and manufacture of similar type Lifts.
- The make of Lifts offered shall have satisfactory service record in Sri Lanka at least for last ten (10) years.
- At least 10 nos of lifts of similar model shall be in service at present in Sri Lanka

E.6.10.4. IBMS (Integrated Building Management / Automation System)

- Specialist BMS contractor shall have at least ten (10) years experience in Supplying, Installing, Testing, Commissioning and Maintenance of similar type of BMS systems in Sri Lanka and having qualified technical staff trained at manufacturing facility for installation, operation, maintenance & trouble shooting of the proposed BMS system.
- Experience in performing at least one contract of a nature, complexity and value equivalent to the proposed works over the last 5 years.

Hardware and Software Component Manufacturer Qualifications

- The manufacturer of the hardware and software components must be primarily engaged in the manufacture of LONWORKS/BACNET based systems and must have been so for a minimum of fifteen (15) years.
- The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- A copy of certified and Valid Contact Agreement as local agent for Supply, Engineering, Testing and Commission on behalf of Manufacture shall be furnished with the bidding documents.
- Specialist BMS contractor (Who is the local representative for the proposed BMS) shall have experience in Installation, Testing and Commissioning of similar type and magnitude of BMS/BAS.
- The system shall be installed by competent mechanics regularly employed by the

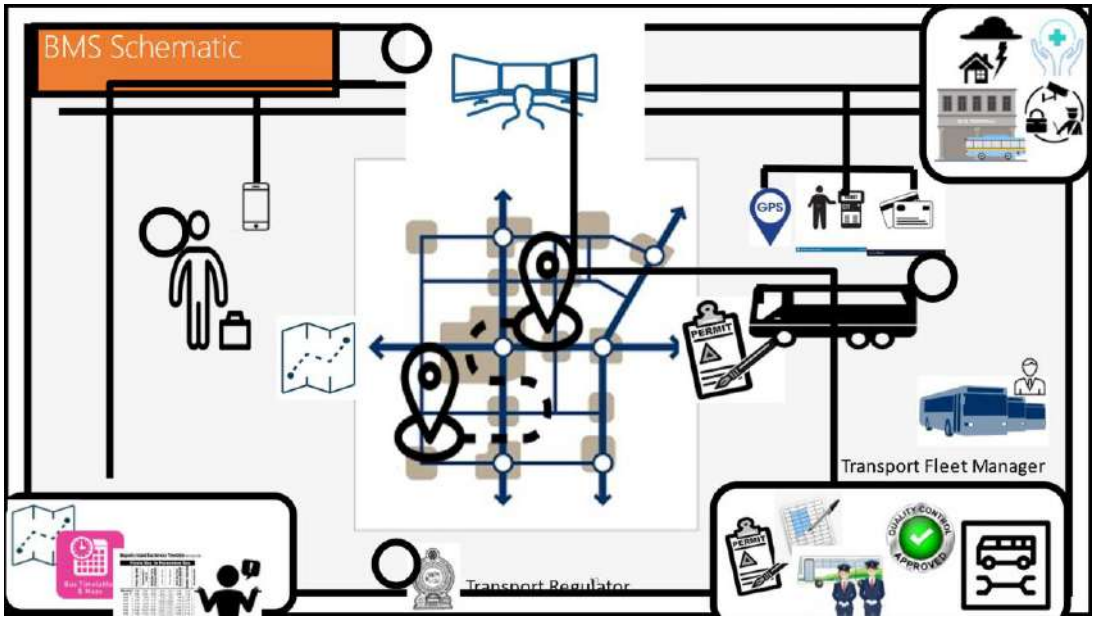
manufacturers authorized representative having proven local experience with full responsibility for proper operation of the BMS system, including debugging and calibration of each component of the entire system.

E.7. INFORMATION AND COMMUNICATION TECHNOLOGY WORK

E.7.1. GENERAL INTRODUCTION

The KMTT is expected to operate using modern technology for all aspects of bus operations, passenger processing and information systems as well as terminal management. The Bus Management System (BMS) already developed for the Transition Arrangement deployed since 2019 is being further developed under the project. The ICT work described in this section is intended to provide the fixed infrastructure required to support the overall functioning of the terminal using smart technology.

The Bus Management System (BMS) in operation at the Bogambara Terminal supporting the bus trnsistion operations since 2019 is being further developed as a site-specific modern state-of-the-art Operating System (OS) that integrates a Bus Operation Control Centre (OCC) with buses, passengers, timekeepers, bus owners, bus crew and route supervisors including ticket checkers as shown earlier:



E.7.1.1. Cable Insulation

a. Either wall embedded PVC insulation or Surface mounted casings for indoor cabling.

b. Outdoor insulations shall be done accordance to IP 66 with galvanized metal casings.

E.7.1.2. Grounding (Earthing)

a. Indoor ICT and Security systems shall connect to the building grounding grid.

b. Outdoor units shall have independent grounding/lightning protection solutions.

c. Earth resistance must be maintained less than 5Ω.

E.7.1.3. Product Selection

a. All the brands/makes shall have minimum of three (03) years‟ service history in Sri Lanka.

b. RoHS compliance.

c. Availability of either a local office or a local registered agent of the manufacturer.

d. Local office or local agent shall have a service history in the related field which is not less than three (03) years.

e. Availability of trained and qualified staff locally to maintain the system.

E.7.2. DATA NETWORK AND TELEPHONE NETWORK SYSTEMS.

E.7.2.1. System Description

a. Structured Cabling System according to the ISO/IEC 11801 standard. Color code standard shall be TIA 568B.

b. Cables which are going to use should be a LSZH cables.

c. An IP PABX System should be installed to cater the telephone requirement with all the necessary accessories.

d. MDF for Telephone system should be fixed in the Control Center for terminal Operation

e. Systems or in the room provided at the implementation stage.

f. A Local Area Network (LAN) System with high availability should be designed with servers, database systems, switches and other required accessories.

g. The terminal operating system for KMTT shall be hosted in an outsourced Tier 3 compliant data center on a cloud – hosting model.

h. When ELV cables and electrical cables are sharing the same trench/trunk path, the contractor should be responsible to maintain zero level („0‟) EMI according to ANSI/TIA-569.C standard.

E.7.2.2. Performance and Requirements

a. The system provided shall use hierarchical star topology utilizing Category 6 copper cable in the horizontal subsystem and fiber optic cables in the backbone. Fiber optics shall be Single Mode and Multimode (as necessary) while maintaining the initial uplink bandwidth of 10 Gbps. There should be redundant uplinks for each switch in the network.

b. All data switches shall have 10/100/1000 Mbps ports and 10G fiber uplink ports populated with SFP fiber Modules.

c. Cables shall be drawn from network rack units in each floor to the nearest consolidation box or to the nearest walls via cable trays, conduits or under appropriate trunking system which is accepted by the engineer.

d. When ELV cables and electrical cables are sharing the same trench/trunk path, the contractor should be responsible to maintain zero level („0‟) EMI according to ANSI/TIA-569.C standard.

E.7.2.3. Construction Requirements

a. The passive components including Fiber pigtails, Optical Fiber patch panels, copper patch panels, patch leads, Fiber Optic Cables, multi core voice cables shall be in same brand and which will be approved by the client to achieve 25 years system warranty.

b. The contractor shall be capable of providing end to end Physical Infrastructure Solution for all requirements and shall not be restricted only to cabling / connectivity products or Enclosures etc.

c. All equipment and materials shall be compatible with all applicable Safety and Protection Constraints.

d. All equipment and fittings shall be suitable for their intended purpose and environment, e.g. aggressive environment, water tight, ambient temperature and humidity, vandal resistant, etc.

Note: Active equipment will be purchase under provisional sum indicated in price schedule in a later stage and the specification should be match with the required context at that stage.

E.7.3. CCTV / IP SURVEILLANCE SYSTEM

E.7.3.1. System Description

a. CCTV/IPSS shall be completely an IP based system.

b. Cameras must use PoE power. Additional power should be provided if required (eg. PTZ cameras).

c. This system shall be used for monitoring all public areas, parking lots, entrances (Number Plate recognition cameras also should be include for the entrances and bus parking lots), etc..

d. System shall provide 24x7 live monitoring with full HD resolution and 25fps.

e. The system shall have at least 30 days recording for all cameras with full HD resolution and 25 fps with RAID 5.

f. System shall provide 24x7 live monitoring.

g. A complete Video Wall with Operator Workstation shall be installed inside the Security Room, work stations should be provided as monitoring stations to required areas with all required accessories and equipment for Live Views, Playback Views and to control all CCTV Cameras in the system.

h. advanced video analytics features, should be available to use as required. (Eg. Facial Recognition, etc..)

E.7.3.2. Performance and Requirements General

a. Video transmission shall be mainly through a combination of CAT6/RJ45 and optical fiber cables.

b. Cameras shall sense the objects using IR in low light conditions (0 lux). The camera shall have IR filter which will switch from colour to monochrome automatically by either sensing the illumination level or via the alarm input.

c. The system shall be provided weatherproof outdoor IP cameras with housings and mountings.

d. All outdoor cameras shall be followed IP-66 standard and shall be with vandal proof housing.

e. The System shall have proper Lightning protection.

E.7.3.2.1. Video Management Software (VMS)

a. VMS software shall be compatible with cameras and other equipment. VMS shall be a highly scalable, enterprise level software solution. It must offer a complete Video Surveillance solution that shall be scalable.

b. VMS shall have the capacity of handling present design and future expansions.

c. Video management software shall offer both video stream management and video storage management. Recording frame rate and resolution in respect of individual channel shall be programmable.

d. The system shall have friendly graphical user interface and own media player to view the recorded video.

e. VMS shall have a navigation panel to allow the user to select the required camera.

f. VMS shall provide continuous recording, manual recording, auto recording, event recording and motion recording.

g. The Software shall resume recording automatically after reboot or network re-connection.

h. For each camera set up bit rate, frame rate and resolution shall be independent from other cameras in the system. Altering the setting of a single camera shall not affect the settings of other cameras.

i. The Software shall provide electronic map, in which user shall be able to view video by double click mouse on the camera icon on the map and also support Alarm video creation and snapshot creation.

j. Video Management Software shall be compatible with H.264, M-JPEG or MPEG-4 encoding.

k. VMS shall allow live, playback viewing modes of cameras. And VMS Shall have facilities for play, forward, rewind, pause along with fast forward and rewind for reviewing the recorded videos.

l. Shall have Client-Server architecture with different authentication levels and groups. m. VMS shall allow the control of PTZ cameras with joystick.

m. The software shall support searching as per camera, event and date/time. Shall have Auto complete drop-down list facility for easy search.

E.7.3.2.2. Network Video Recorder (NVR) / Storage server

a. The NVR server shall have adequate storage capacity to make continuous recording of all cameras with Full HD resolution and 25 frames per second (fps) for at least 30 days.

b. Necessary number of hard disk drives having at least RAID-Level 5 storages shall be provided and it shall be full hardware implementation with a separate RAID controller.

c. NVR server shall have adequate performances (RAM capacity, processor speed and etc.) to handle above situations and provide proper functionality.

E.7.3.2.3. Workstations

a. The workstation shall include client software or web interface and shall provide full access to operations through a user-friendly and highly intuitive graphical user interface.

b. Interface shall use drag-and-drop operations, context menus, and tool tips to enable interactions. The PC workstation shall have sound, graphics, color, and on-screen messages to provide ongoing feedback about user activity and system status, and it shall have on- screen PTZ control and device property control.

c. Allow administrators to configure devices, set up users, adjust network settings, and create recording schedules. Permission to access functions and all other system services shall be configured according to access level of user.

d. The workstation shall have advanced search capabilities, event logging, and alarm interface displays.

E.7.3.3. Construction Requirements

a. All equipment and fittings shall comply with BS, IEC and RoHS regulations.

b. All equipment and fittings shall be compatible with all applicable Safety and Protection Constraints.

c. All CCTV/IPSS equipment installed indoors and outdoors shall be properly grounded and surge protected.

d. All the cameras and Video Management Software shall be compatible with H.264 and MJPEG encoding.

e. All outdoor cameras shall be in IP-66 and vandal proof. All outdoor items for cameras like Junction Boxes, Power Supply, and Media Convertors etc. shall be in water poof

E.7.3.4. Control System

a. The IP surveillance System shall allow event based, motion based, alarms schedule based, continuous, time based and camera wise recording with different speeds (fps) and different resolutions for each camera.

b. It shall also be possible to search and replay the recorded images on date, time and camera- wise. It shall provide onscreen controls for remote operation of PTZ cameras.

c. CCTV/IPSS shall be on a hierarchical administrator level. There shall be minimum 3 hierarchical levels of security for providing user level log in.

d. Video management software shall offer both video stream management and video storage management. Recording frame rate and resolution in respect of individual channel shall be programmable.

e. VMS shall allow live, playback viewing modes of cameras. And VMS Shall have facilities for play, forward, rewind, pause along with fast forward and rewind for reviewing the recorded videos.

f. VMS shall allow the control of PTZ cameras with joystick.

g. The software shall support searching as per camera, event and date/time.

h. Other features,

    i. VMS should be user friendly and customer configurable

    ii. Recording format should be an open standard protocol which allows export and playback on open source video playback software.

E.7.3.5. Electrical Works

a. Electrical installations shall comply with General Electrical Work Specification at site.

b. The power supply to any CCTV camera/PTZ, Switches, Servers, Display panels and other components of system shall be through a UPS.

c. If any equipment operates on any voltage other than the standard supply voltage and supply frequency, necessary conversion/correction device of approved make shall be supplied along with the equipment.

Note: Active equipment will be purchase under provisional sum indicated in price schedule in a later stage and the specification should be match with the required context at that stage.

E.7.4. PUBLIC ADDRESS AND PIPE MUSIC SYSTEM (PAPMS)

E.7.4.1. System Description

a. Mainly PAPMS is used for three functions.

i. Emergency broadcasting

ii. Public Address System

iii. Pipe music System

E.7.4.1.1. Emergency Broadcasting

When an emergency situation has occurred, the system shall be used for broadcasting necessary announcements to evacuate the area immediately.

E.7.4.1.2. Public Address System

PAPMS shall allow public announcements through via installed microphones. Prerecorded messages shall be broadcast automatically and manually.

E.7.4.1.3. Pipe Music System.

In ordinary situation, speakers play background music. Administrator shall be Able to select BGM source which may CD/DVD Player, FM/AM tuner.

b. An Emergency Override Announcement Facility shall be provided to the entire BGM System.

E.7.4.2. Performance and Requirements

E.7.4.2.1. General

a. PAPMS System shall be constituted of the following basic functions.

i. Sound amplification and directing.

ii. Automatic broadcasting of emergency messages

iii. Digital Signal Processor (including Equalizer and Filter) for each output.

b. The Design and installation of the fully Digital PAS shall ensure that the System is capable of future expansion.

c. The Public Address System shall be used for broadcasting fire evacuation messages.Therefore, all the cables and speakers related to the Public Address System

should be fire rated and the head end equipment shall be complied with EVAC.

E.7.4.2.2. Announcement priority

a. Emergency announcements shall have priority over any announcement.

b. PA System shall be capable of delivering automatic pre-recorded evacuation messages in case of Fire or dangerous operational conditions.

E.7.4.2.3. Background music interface

System shall provide background music interface to system for an analog audio signal from the background music source.

BGM Source shall be shall support MP3 music files in removable disks, SD Cards, DAB digital broadcasting's and FM tuners.

E.7.4.2.4. In case of fire

When a fire is triggered, PA system shall send automatic emergency messages which are stored in the system, to appropriate zone/s. System shall use three wire system from the amplifier to volume control. If the volume control is switched off, system must by pass the emergency messages to the speakers.

E.7.4.3.Construction Requirements

a. The entire system with all component, equipment and materials including microphones, speakers, controls, housings and equipment shall be supplied by the contractor with the approval of the Engineer.

b. All equipment and materials shall be compatible with all applicable safety and protection constraints.

c. All equipment and fittings shall be suitable for their intended purpose and environment e.g. water tightness, ambient temperature and humidity, vandal resistant, etc.

d. All equipment of this System installed outdoors shall be protected by Voltage surge protection.

E.7.4.4. Interface works

a. The PA system shall be connected with fire detections system.

b. An optional programmable interface shall be available providing an OPC interface to

link the system with an integrated building management system. The interface shall provide system status information and allow a broadcast control so far as acceptable by the applied voice alarm standards.

Note: Active equipment will be purchased in a later stage and the specification should be matched with the required context at that stage. List of proposed items should be mentioned in detail under provisional sum. Sufficient pricing should be included with provision for those items under the provisional sum mentioned for each system.

E.7.5. PARKING MANAGEMENT SYSTEM

E.7.5.1 Scope

a. Entry Ticket Dispenser with Automatic Boom Barrier for both car parking and bus parking areas

b. Exit Ticket Reader with automatic Boom Barrier for both car and bus parking areas

c. PMS Main server should be in the server room.

d. PMS shall share same network equipment with Local Area Network (Cabling, Switches, Racks, UPS etc.)

e. PMS system shall have separate VLANs.

f. PMS shall available for all entrances and exists to the internal car parks in the building.

E.7.5.2 Parking Management System Server Features

a. Car park Guidance System

b. Shows real time parking spaces availability digitally.

c. Automated Alerts

d. Summarized reports on daily/weekly/monthly basis

   i. Current parking Utilization by Zone

   ii. Parking Utilization Summary by Zone by Date

   iii. Parking utilization Details by Zone by day, week, month, year

iv. Current Overstay Violations by Zone

v. Overstay Violation by Zone by date

vi. Average time bays are occupied by day, week, month, year

vii. Bay stay reporting

viii. Sensor Failures

e. Various Statistics reports

Note: Active equipment will be purchased under provisional sum indicated in price schedule in a later stage and the specification should be matched with the required context at that stage. It should have connectivity to the data network backbone.

E.7.6. DOOR ACCESS CONTROL SYSTEM (DACS)

E.7.6.1. System Description

a. This system shall be used for monitoring, all Entrance doors to office areas.

b. DACS shall be completely an IP based system and this system shall physically independent with Data and Voice LAN, but same network with CCTV IP Surveillance System.

c. The DACS shall be integrated with other systems such as CCTV/IP Surveillance System, Fire Detection System through Building Management System (BMS) with related protocols and particular devices.

d. DACS shall be capable of controlling access control equipment such as smart card readers etc.

e. All readers shall be intelligent readers which can be used as standalone if necessary.

f. DACS shall have capable of providing attendance of all registered employees for administration purposes.

g. There shall be monitoring workstations.

h. The system capable to send an alert automatically to DACS administration workstation when someone breaks the Emergency Exit Device.

i. There shall be a DACS primary server with failover server including dual network interfaces.

j. Entrances and Exits of Each floor shall be controlled by DAC System.

k. DACS software shall be capable of changing Fail safe or Fail secure according to the security situation. (Fail-safe locks and strikes require power to lock. When power is interrupted by an access control or power outage the door will unlock. Fail-secure locks and strikes require power to unlock. When energized by use of an access control the door unlocks)

l. The Door Access Control System shall comply with UL 294 and BS All readers shall be intelligent readers which can be used as standalone if necessary.

E.7.6.2. Performance and Requirements

E.7.6.2.1. Door Access Control System Software Requirements

a. There shall be no limitations on the number of PC workstations/thin clients, readers and alarm inputs.

b. Users who have attempted more than 3 times to check in/out shall be alert to the DACS Administration workstation.

c. The software shall have the ability to take scheduled automatic database backups and maintenance. A searching function to trace user details and to check logs of particular user or a reader.

d. The searching function shall include querying according to users, doors, day, time and section (zone).

e. The system shall record and store at least one-month transactions.

f. System shall be supplied from emergency power to eliminate system crash from power failure.

g. The software shall have the ability to produce the following report types: alarms and alert reports, user reports, hardware and software configuration, setting changes, access level reports, employee time & attendance reports.

h. DACS capable of giving attendance of all registered employees. i) The reports shall be available in PDF and MS Excel formats.

i. Report filters must be convenient and user friendly: allow operator preview user photos, content of access levels, hardware settings and time zone configuration.

j. The software shall have the ability to divide the building in to any number of zones.

k. The software shall support to add required number of building floor plans (not less than

25).

l. The software shall support “full-screen” mode that would take up 100% of the

m. monitor area.

n. All card activation and user accessibility changes shall be sent to administrator immediately after the changes were made.

o. DACS software shall have Auto complete drop-down list facility for easy

p. search.

q. The software shall use an industry standard latest database engine. q) The software shall be available in English language.

r. The software shall have a user-friendly graphical user interface (GUI).

s. In order to reduce the amount of work done by an operator, the software shall incorporate an option to copy objects: users, doors, floor plans, time schedules, access levels.

E.7.6.2.2. Particular Requirements

a. Fingerprint Reader shall have the fingerprint sensor, PIN code key pad and card detector sensor.

b. Keypads shall be mechanically designed for heavy duty and keypad shall not be erased on heavy use.

c. Fingerprint Reader must have the following three authentication modes.

   i. Smart Card only

   ii. Fingerprint and PIN

   iii. Fingerprint, PIN and Smart Card based Access

   iv. If IP readers compatible with Near Field Communication (NFC) it should follow ISO/IEC 18092 and ISO/IEC 21481 standards.

Entry/ Exit Reader (Contactless card)

a. One-to-many verification shall less than two (2) second (with the database of 10,000 users).

b. If readers compatible with Near Field Communication (NFC) it should follow ISO/IEC

18092 and ISO/IEC 21481 standards.

Door Access Controller

Controller is not a mandatory component for the Door Access Control system and it shall be used if readers are not intelligent or the contractor suggests a system with controllers.

a. There shall be a controller for each door.

b. If IP Controllers compatible with near field Communication (NFC) it should follow ISO/IEC 18092 and ISO/IEC 21481 standards.

Administration Workstation

a. Administrators and building entrance receptions have different levels of access privileges for DACS.

b. Workstations shall have finger scanner and digital camera with camera stand and a flasher.

c. Administration workstations shall include all related software with licenses.

Access Control Cards

a. Card Technology: Contactless smart card (Standard ISO/IEC14443 - 13.56 MHz).

b. Encryption Technology: Triple-DES/ 128bit AES encryption or higher.

c. Supported Card: iCLASS, MIFARE DESFire EV1/ NFC compliant smart card.

d. Card Type/ Physical Characteristics: Composite PVC cards (Standard ISO/IEC 7810 (85.60 × 53.98 mm))

e. Minimum erasable programmable read only memory (EPROM) shall be 4 kB.

Door Access Control Server Features

a. Time attendance management system

b. Visitor management

c. Programmable zoning feature

d. Card validity configuration

e. Access mode changes (day/night/ holiday/immanency)

f. Critical Area Control

g. Back up & data protect system

h. Support when reader scaling Up

Integration with fire Detection System

According to the fire signal (address or zone), access control system shall release low security level doors which are in activated fire area.

Electrical Supply

a. Electrical supply shall comply with General Electrical Work Specification.

b. All DACS switches shall be connected to the Uninterrupted power Supply (UPS). c) If PoE or PoE+ not sufficient for any device or equipment, additional UPS systems

c. and UPS wiring shall be supplied and installed by the contractor. UPS Wiring shall comply with electrical wiring standards and minimum backup duration shall be 1 hour.

Note: Active equipment will be purchase under provisional sum indicated in price schedule in a later stage and the specification should be match with the required context at that stage.

E.7.7. VEHICLE (BUS) TRACKING SYSTEM

E.7.7.1. System Description

The software for Vehicle (Bus) Tracking has been developed locally under the project as an integral component of the Bus Management System and continues to be updated. The active equipment to be fitted on buses has been purchased and is currently operational and will be updated/replaced at a later stage to fit the requirements of the updated specifications to be issued at that stage.

The schematic of the system architecture of the BMS is shown below. The Vehicle Tracking System is in-built under into the BMS and provides a direct input to the Terminal Management System (TMS). For this purpose, the GPS devices to be procured under this item, should be mounted on the buses and their location coordinates digitally fed directly to the TMS server through an API link.

As shown above the BMS integrates multiple devices (GPS (VTS), ETM, IOT sensors and mobile phones). It has been developed to work with large-scale transport agencies having state of the art features summarized below:

- Integrated System of Bus Management, GPS, Document Control systems & ERP etc.
- Open-Source Technology and availability of source code
- The availability of database together with its design, and ability to access the da-tabase

directly or through API

- Incorporation of Mobile technology and mobile Apps
- Modelled on Global Bus Operating Features
- Customized to fit single bus ownership and SLTB (a unique feature)
- Customized to work on single platform for different operators/regulators
- Expandable to provide passenger and operator added features
- Functions and outputs to be easily customized for each operator
- Real time operations features
- Big data analytics feature for improved planning
- Customized reporting formats

The Operational Control Centre **(**OCC) which uses the BMS performs the following functions connecting around 2,000 buses at present.

- Maintaining data base of bus routes, owners, buses and other operating details
- Making approved changes to bus ownership, routes and other approved operating changes
- Providing security features for log entries
- Providing on the job training to all personnel using software
- Regular (monthly) updating of software version developments
- Monitoring compliance of Timetables using GPS and reporting compliance levels for buses and routes on a weekly basis
- Monitoring travel speeds and timetable compliance using GPS feed
- Providing daily summary of Key Performance Indicators (KPIs) of operating statistics by route such as actual performance % with scheduled
- Providing dashboard for below par operations
- Carry out comparative analysis between buses, routes etc. to study variations

- Prepare weekly and monthly reports on underperforming performing buses
- Aiding the selection of best performing bus crews
- Storing of all data on cloud based secure environments
- Enabling terminal operations and performance reporting

E.7.7.2. Performance and Requirements

The required cabling should be provided within the KMTT for networking all the operational and passenger locations within the terminal area, ticketing areas, loading gates, and platforms, bus operator offices and include the bus parking area and entrances as per clients/system developers requirements. It should enable interconnectivity to the data network backbone.

The following hardware equipment would be required for purchase to connect the Bus Tracking System in operation and being further developed. All devices should be supplied, fixed (where necessary) and maintained under full warranty with parts for a period of three years. The response time for equipment attention should not exceed two hours during all hours of bus operations, with replacements provided when repairs are deemed to take more than two hours.

The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even without a contract. The devices should be connected to the available on-board power or fixed power source as is the case and the required fixtures provided both off-board and on board each bus as the case maybe.

1. 2,000 Nos of a combined device that can function both as a GPS device as well as an Electronic Ticket Machine that has feature for both carry on or being fixed on-board buses using the KMTT. These devices should have capacity to print a ticket and transmit the data after each bus stop to the main BMS server to be read through an API. The location data should be transferable every 15 seconds and adjustable as required.

A. GPS Specification of Combined Device (to be upgraded to industry standard at time of calling for bids to ensure technology upgrades are observed)

(1) Feature	(2) Required Specification	(3) Remarks
	A. Hardware Specification	
Make		

	Teltonika or any other	
Year of Manufacturing	Within last two years	
Dimensions	Maximum to be 100mm length, 100mm width and 40mm height	
Weight	To be less than 300g	
Network	Mobile data communication facility shall be compatible system of Sri Lanka	
Band	850/900/1800/1900/2100Mhz	
Support GNSS systems	Please Specify	
GPS Sensitivity	-159dBm or better	
GPS Accuracy	Less than 10m	
GPS Start time	Start time maximum 60s	
Voltage **Backup battery** **Storage Temp.**	12V-24V (preferred) or 12V-36V Chargeable 3.7V at least 500mAh, Polymer Lithium battery 0°C to +70°C	The back-up battery should keep the unit working for 2 hours minimum
Working environment	Inside buses, behind the dashboard of buses of Sri Lanka, buses with non-air conditioning and air conditioninig	

B. ETM Specification of combined device (to be upgraded to industry standard at time of calling for bids to ensure technology upgrades are observed)

Purchaser's Requirement			
Seri	**Parameter**	**Specifications**	**Bidders offer**
		A. Hardware Specifications	
1.	**Product**	Please Specify	
2.	**Make/Brand**	Telpo, Axionent or any other compatible brand	
3.	**Model Number**	Please Specify	
4.	**Country of Origin**	Please Specify	
5.	**Year of Manufacturing**	Within last two years	
6.	**Dimensions**	Please Specify	
7.	**Weight**	To be less than 200g (Without Paper Roll)	
8.	**Processor**	1GHz Quad core CPU or Better	Minimum to support multi-threading feature

9.	**RAM**	1 GB (minimum) or Better	Minimum to support multi-threading feature
10.	**Flash Memory**	8 GB (minimum) or Better	Minimum to support multi-threading feature
11.	**Extendable Memory - SD/ Micro SD card interface**	Minimum 16GB	I think 2 GB minimum is enough
12.	**Display**	4.5" WVGA 850x480 IPS or Better	increase in screen size will increase battery consumption and also ETM unit will be more expensive
13.	**Touch Screen Display**	Industrial grade, Capacitive Multi-point touch panel	Should be optional
14.	**Camera**	5MP or Better	Should be optional
15.	**Operating System**	Android / Linux / Windows	
16.	**Satellite Positioning**	GPS/GLONASS/BDS	
17.	**Keypad**	Minimum 10 alphanumeric keys, 7 function keys	
18.	**Built-in printer**	High speed thermal printer 57 mm (32 characters per line). Minimum print speed 18 lines/sec, easy paper roll loading. Should support minimum 15-meter length 55 GSM thermal paper roll (30 mm diameter)	
19.	**SAM slots**	Minimum 3 SAM slots, fully compliant with ISO 7816, supports PPS protocol	
20.	**External (mobile)**	GSM - 850 / 900 / 1800 / 1900	
21.	**Battery**	Rechargeable and Replaceable battery 3.7v, 4500mAh or better	Over-charge / over-voltage / over-current protection. Easily removable / replaceable.
22.	**Security**	Should support encryption standards including 3DES and AES	
23.	**Contactless Smart Card Reader**	Fully compliant with ISO14443, Type A Type B. in compliance with qPBOC L1& L2 certification standard	
24.	**Audio (optional)**	Audio Beeper (optional)	
25.	**PC Interface**	USB or Serial	
26.	**Host PC**	Windows/ Linux	
27.	**Accessories**	Shoulder carry bag and hand strap	
28.	**Operating Environment**	Temp 0°C~50°C; humidity 10%~90% (non-condensing)	
29.	**Extra Features**	Real time clock, may be powered from a separate battery, ability to configure two-level authorization facility, online synchronization ability	
30.	**Offline printable reports**	Fare table, No. of passengers for the journey, total collection, duplicate ticket with an indication to mark it as "duplicate" (optional), revenue separation between luggage and passenger	

31.	**Contents to be printed on the ticket**	Route, Start and End Stations, Ticket Details of the ticket (Full, Half, Group, Concession, Free Passes, Luggage) Fare, Card No., Balance amount (in case of offline stored value card) time of issue, bus identifier, conductor identifier, discounts or concessions, bus turn, a short message to the passenger (optional), Customer Service Number Etc..	
32.	**Trip Summary Report**	Trip summary report should be made available to each owner of POS machine (bus owner) via password. The trip summary report should include "section by section" information of issued tickets and revenue in each section.	
33.	**List of tickets issued**	• Full tickets • Half tickets • Group tickets • Concession tickets • Free Passes • Luggage tickets	
34.	**Data**	Transaction level POS data should be made available to the Operations Control Center and Data formats must be compatible with SAMs provided by Acquirers and the Bus Management System(BMS)	
35.	**Multi Threading**	Required	
36.	**Operational Details**	A unique user ID and PIN will be issued to each conductor to login into ETM application. Only after successful login, conductor will be able to start duty/trip as per the duty allocated	
37.		It shall be able to manage Route Data, Fare Matrix and Fare Rules, and downloading the same from the backend	
38.		During ticketing, the number of total passengers, battery level and other relevant information will be available on ETM ticketing screen for conductor convenience	
39.		System will support over-the-air (OTA) master data updates	
40.		Capable of reading/writing contactless smart cards (RFID/NFC based)	
41.		Quick printing and issuing of paper tickets with minimum clicks	
42.		Generation of daily collection report, smart card / cash ticket issue report, inspection report, collection summary at any point of time	
43.		Friendly, interactive and fast application to minimize the operation time for issue of tickets	

44.		The ticketing data from ETM application will be transferred from ETM device to backend on real time basis. In case of non-availability of GPRS network, the ticketing data will be stored in ETM's memory and transferred later to backend whenever connectivity is established.	
45.		Provision to manually extract transaction data from ETMs using cable interface, in case the data is not communicated to central server due to problem in communication or ETM device	
46.		The comprehensive dashboard of ETM application software interface will be available at Operations Control Centre for live monitoring of overall performance of the ETM system such as total number of deployed ETMs, details up to last ticket issued, total revenue collected up to the time, etc.	
47.		Provide for issuance of tickets through Electronic Ticketing Machines, as per the fare rules of the operator	
48.		For fare payment on ETMs, payment facility using either cash or post-paid transport NFC based smart cards should be supported	
49.		Facility to update fare revisions quickly (push and pull capability)	
50.		Minimum number of keystrokes by conductor to switch from Card ticket to Cash ticket and vice versa	
51.		Specify minimum time taken to issue a ticket (from tapping of the card to complete printing of a ticket	
52.		Provision of additional battery and mobile charging facility in the bus	
53.		Adequate number of service locations within the region	
54.		Availability of consumable items of the ticket machine (paper roll, head, etc.)	
55.		3 year on site comprehensive warranty. Annual Maintenance for 4th, 5th and 6th year.	
56.		Quick administrative mechanism in case of a lost or stolen ticket machine	
57.		Length of Paper roll/ number of tickets per paper roll	

2. 5 nos. outdoor CCTV cameras to be mounted at key gateways to the KMTT to identify arriving and/or departing buses with streaming video and wi-fi connections including night vision and high resolution for enable number recognition software to be used.

05 nos	Video surveillance through CCTV - at junctions	**Outdoor camera specification** **Camera Shape:** cylindrical / bullet or box

		Construction Material: Should be composed of metal with a weather proof rating of IP66 or higher **Resolution Format: 2 MP or better** **Lens:** 2.8 ~ 6 mm **Angle of view:** 80 to 90 degrees **Voltage:** 12 V DC **Weight:** less than 1000 g **Operating Temperature:** 0 ~ 60 ºC **Operating Humidity:** < 95**%** **Video Output connection:** BNC connector **NVR specification** **Network connection:** wired or wireless (preferred) **Operating System:** Window / Linux **Video Inputs:** 16 or higher **Input bandwidth:** up to 320 Mbps **Output bandwidth:** up to 320 Mbps **Other Connections:** USB 2.0, USB 3.0 **Operating Temperature:** 0 ~ 60 ºC **Weight:** Less than 3kg **Warranty:** 2 or more years **Dimensions:** Around 450mm * 300mm * 60mm **Powering and networking method** **Power supply for cameras:** 12V DC and 10A **Networking**: Ethernet cables to connect cameras to NVR or Wi-Fi routers can be used to connect cameras to NVR, HDMI or VGA cables to connect NVR to Displays/Monitors **Recommended brand for the products** Hikvision, Axis or equivalent

3. 6,000 nos personal digital identity cards to be issued to bus crew to enable login to on-board GPS/ETM device or entry to KMTT facilities and other facilities or activity where bus crew credentials are deemed necessary. Such identity cards should be readable by the KMTT door access control system and parking control system described above.

6000 nos	Digital IDs for Drivers and Conductors	**Digital ID size:** CR79 or CR80 (Preferred) **Type:** Organizational Digital ID protected with passwords, PINs or security tokens. **Recommended brand for the products:** Any authorized company that provides secured service.

4. 2 nos blade type computer servers with high processing power to provide server room facility together with the required air-conditioning facilities server, rack and power systems including UPS

systems for 60 minutes. Minimum specification is Rack mountable, 1 x Intel Xeon- E5- 24xx v2 Series or better processor, Processor speed of 2.4GHz, 6 or higher Processor cores, 15 MB or higher/Processor L3 Cache, 1333MHz RAM Speed, 64GB RDIMMs with ECC RAM installed, Up to 128 GB RAM Expandability, 16X DVD ROM Optical Drive, 6 x SFF Hot-Plug SAS HDDs 6G 10K, 1000GB or higher, Minimum 8 SFF HDD's (All cages should be installed with cage blank covers) Hard Drive Cage, Support RAID Level 0/0+1/1/5 With 256MB of Flash Backed Write Cache Array Controller, Minimum 4 x 10/100/1000Base T Network Interfaces, Minimum 4 (2 front, 2 back) USB Ports, Dedicated remote administration port (NIC) with server console access Remote Management, Dual Redundant power supplies (2) 240 V, 50/60 Hz Power supply, Full Redundant System Fans, 2 PCIe Expansion slot, Rack mounting kit, Cable management arm, Power and Network Cables, 3 years comprehensive on-site manufacturer authorized warranty (including labor, parts and configuration support). Replacement backup server with same or better configurations need to be provided during the repairs.

5. 4,000 nos. CCTV cameras to be fitted on-board 2,000 buses as required, with on-board data recording devices adequate for 36 hours operation, with facility for upload in KMTT terminal when wi-fi connections are available, including required SIM cards for en-route transmission both as still images as well as streaming video if so required.

4000 nos	Video surveillance through CCTV - Inside buses	**Specification of the camera** **Camera Shape:** cylindrical / bullet or box or dome **Construction Material:** metal or plastic with a weatherproof rating of IP66 or higher **Resolution Format: 2 MP or better** **Lens:** 2.8 ~ 6 mm **Angle of view:** 80 to 90 degrees **Voltage:** 12 V DC **Weight:** less than 800 g **Operating Temperature ºC:** 0 ~ +60 C **Operating Humidity %:** < 95 **Video Output connection:** BNC connector **Networking method:** Ethernet cables to connect cameras to NVR or Wi-Fi routers can be used to connect cameras to NVR **Storage required:** 4GB or higher **Video back up and server details:** The recorded footage should be transferred to the data servers at terminals or stations through automatic Wi-Fi connections **Recommended brand for the products** Hikvision or equivalent

E.7.8. PASSENGER INFORMATION SYSTEM

E.7.8.1. System Description

The software for Passenger Information Displays is being developed locally under the project as an integral component of the Passenger Information Display System currently operational within the terminal area which will continue to be updated as required to provide commuters with on-route information in real-time.

E.7.8.2. Performance and Requirements

The active equipment should fit the requirements of the updated specifications to be issued at that stage. Cabling should be provided for networking the indoor Passenger Information Displays to be located within the KMTT areas and outdoor Passenger Information Displays to be located for each of the bus platforms within the KMTT and for selected bus halts located within the Kandy city, as per clients/system developers' requirements. It should enable interconnectivity to the data network backbone. The requirements are as follows:

1. 9 nos of outdoor LED Passenger Information Displays for selected bus halts located within the Kandy city having a display size of between 55-65 inches diagonal measurement depending on the site location.
2. 2 nos of indoor LED Passenger Information Displays for two locations within the KMTT areas as may be decided once the design is finalised having a display size of 150 inches diagonal measurement.
3. 6 nos of indoor LED Passenger Information Displays for within the KMTT areas as may be decided once the design is finalised having a display size of 100 inches diagonal measurement.
4. 42 nos outdoor LED Passenger Information Displays for each of the bus platforms within the KMTT as may be decided once the design is finalised having a display size of 42 inches diagonal measurement.

All devices including connecting fixtures should be supplied, fixed (where necessary) and maintained under full warranty with parts for a period of three years. The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even

without a contract.

The following features would be required to connect the Passenger Information Displays being assembled.

1. Display Sizes

Display Type	Quantity	Display Size (Diagonal Measurement)
Outdoor Monochromatic LED SMD amber Passenger Information Displays	09	55”-65”
	42	42”
Indoor Color LED Passenger Information Displays	02	150”
	06	100”

2. Specifications of Displays

Specification / Display Type	Indoor Color LED Passenger Information Displays	Outdoor Monochromatic LED SMD amber Passenger Information Displays
Resolution of single LED module (pix*)	Minimum 32x32	Minimum 16x32
Pixel pitch (mm)	4	6
Luminance (nits)	4500 or Higher	4000 or higher
Number of rows	Customized	Customized
IP protection	IP54/ IP65	IP22/ IP54/ IP65
Temperature (^{0}C)	$-25^0/+50^0$	$-25^0/+50^0$
MTBF (h)	100000	100000
Vac supply	220-240 V 50Hz	220-240 V 50Hz
Anti-vandalism	✓	✓
Brightness sensor	✓	✓
Glass break sensor	✓	✓
Case opening sensor	✓	✓
Shock sensor	✓	✓
Anti-reflective glass	✓	✓
Control system	DVI, HDMI, LAN, Serial	DVI, HDMI, LAN, Serial

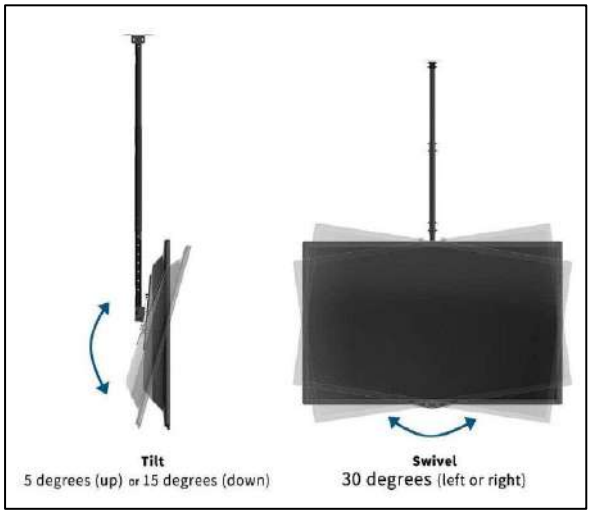
Total size (mm)	As defined in table above	As defined in table above

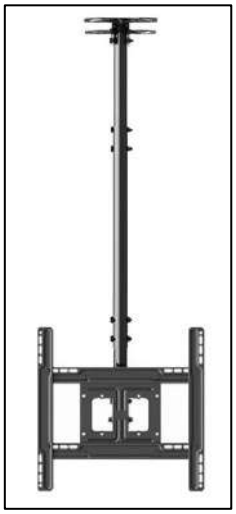
3. Structural Requirement of Connections

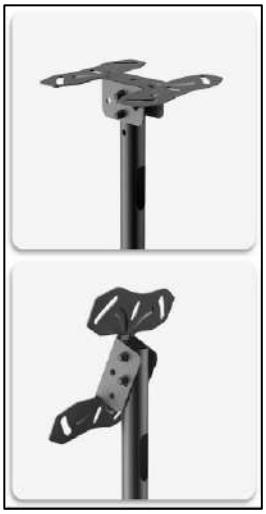
Depending on the mounting location and display size, supplier has to provide the mounting arrangement (as illustrated below) such that display can be pulled out easily for maintenance.

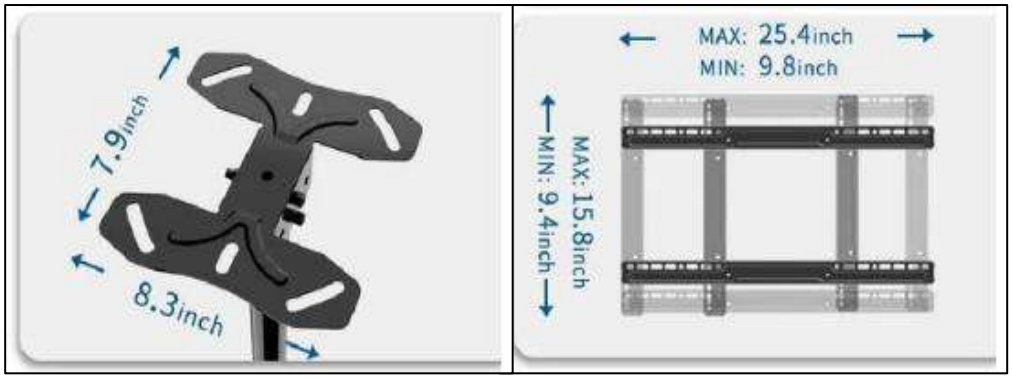
Typical Wall Bracket (with swivel and articulating tilt arm) – Fits displays up to 55”

Typical Ceiling Mount Bracket – Fits Displays of 32”- 65”









Recommended Brands -Displays shall be of reputed make such as SAMSUNG, TOSHIBA, SONY, PANASONIC, LG.

E.7.9. ELECTRONIC TICKETING SYSTEM

E.7.9.1. System Description

The software for Electronic Ticketing System has been developed locally under the project as an integral component of the Bus Management System, and is currently operational and continues to be updated. The active equipment to be fitted on/issued to buses has been purchased and is operational. The same system should be extended to the ticketing counters and passenger boarding gates to fit the updated specifications to be issued at that stage.

E.7.9.2. Performance and Requirements

Cabling should be provided within the KMTT for networking all the ticketing locations within the terminal area, including the ticketing counters, loading gates, and platforms. It should enable interconnectivity to the data network backbone.

The following hardware equipment would be required for purchase to connect the Electronic Ticketing System being developed. All devices should be supplied, fixed (where necessary) and maintained under full warranty with parts for a period of three years. The response time for equipment attention should not exceed two hours during all hours of bus operations, with replacements provided when repairs are deemed to take more than two hours.

The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even without a contract. The devices should be connected to the available on-board power or fixed power source as is the case and the required fixtures provided both off-board and on board each bus as the case maybe.

1. 10 nos electronic ticketing POS machines to be made available at two each to the ticketing booths in the main terminal lobby areas

10 nos	Equipping Ticketing Counters	**Computer specification** **Operating System:** Windows/ Linux/Android **Processor:** 1GHz Quad core CPU or higher **RAM:** 1 GB (minimum to support multi-threading feature) or higher **Flash Memory:** 4 GB (minimum to support multi-threading feature) or higher **Extendable Memory:** Minimum 2GB Operating Environment: Temp 0°C~50°C; humidity 10%~95% **PC Interface:** USB or Serial **Ticket printer specification** **Built-in printer:** High speed thermal printer 57 mm (32 characters per line). Minimum print speed 18 lines/sec, easy paper roll loading. Should support minimum 15-meter length 55 GSM thermal paper roll (30 mm diameter) **Offline printable reports:** Fare table, No. of passengers for the journey, total collection, duplicate ticket with an indication to mark it as “duplicate” (optional), revenue separation between luggage and passenger **Contents to be printed on the ticket:** Route, Start and End Stations, Ticket Details of the ticket (Full, Half, Group, Concession, Free Passes, Luggage) Fare, Card No., Balance amount (in case of offline stored value card) time of issue, bus identifier, conductor identifier, discounts or concessions, bus turn, a short message to the passenger (optional), Customer Service Number etc. **Trip Summary Report:** Trip summary report should be made available to each owner of POS machine (bus owner) via password. The trip summary report should include "section by section" information of issued tickets and revenue in each section.

		List of tickets issued: Full tickets, Half tickets, Group tickets, Concession tickets, Free Passes, Luggage tickets **Requirement from the other service** **Battery:** Rechargeable and Replaceable battery, 4500mAh or higher **Display:** 4.5" WVGA 850x480 IPS or Better **Satellite Positioning:** GPS/GLONASS/BDS **SAM slots:** Minimum 3 SAM slots, fully compliant with ISO 7816, supports PPS protocol **External (mobile) communication:** GSM - 850 / 900 / 1800 / 1900 HSDPA - 850 /900 / 1900 / 2100 LTE - 1(2100), 3(1800), 8(900) **Security:** Should support encryption standards including 3DES and AES **Contactless Smart Card Reader:** Fully compliant with ISO14443, Type A Type B. in compliance with qPBOC L1& L2 certification standard **Recommended brand for the products** Telpo, Axionent or any other compatible brand

2. 27 nos electronic ticketing POS machines to be made available at each of the passenger loading bays for the regular platforms (other than the touch and go platforms)

02	Ticket machines for Gates	**POS Machine Dimensions:** Height 300mm, Width 300mm at accessible height from the ground level for any passenger **Display information details** **Dimensions:** 10-inch **Type:** LCD touch display **Keypad:** Minimum 10 alphanumeric keys, 7 function keys **Specifications** **Processor:** 1GHz Quad core CPU or higher **RAM:** 1 GB or higher **Flash Memory:** 4 GB or higher **Extendable Memory:** Minimum 2GB **Built-in printer:** High speed thermal printer 57 mm (32 characters per line). Minimum print speed 18 lines/sec, easy paper roll loading. Should support minimum 15-meter length 55 GSM thermal paper roll (30 mm diameter) **Operating Environment:** Temp 0°C~50°C; humidity 10%~95% **Requirement from the other service**

		Power Adaptor: with surge protection and operating range 100 to 240V input. **Battery:** Rechargeable and Replaceable battery, 4500mAh or higher **Security:** Should support encryption standards including 3DES and AES **Contactless Smart Card Reader:** Fully compliant with ISO14443, Type A Type B. in compliance with qPBOC L1& L2 certification standard **Recommended brand for the products** Telpo, Axionent or any other compatible brand

E.7.10. COMPUTERS FOR TERMINAL MANAGEMENT SYSTEM

E.7.10.1. System Description

The software for Terminal Management System is being developed locally under the project as an integral component of the Bus Management System. The equipment is required to be fixed to the Operational Control Centre of the KMTT with the updated specifications to be issued at that stage.

E.7.10.2. Performance and Requirements

Cabling should be provided within the KMTT for networking all the operational and passenger locations within the terminal area, ticketing areas, loading gates, and platforms, bus operator offices and include the bus parking area, bus entry and exit locations and passenger entrances as per clients/system developers' requirements. It should enable interconnectivity to the data network backbone.

The following hardware equipment would be required for purchase to connect the Terminal Management System being developed. All devices should be supplied, fixed (where necessary) and maintained under full warranty with parts for a period of three years. The response time for equipment attention should not exceed two hours during all hours of bus operations, with replacements provided when repairs are deemed to take more than two hours.

The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even without a contract.

1. 55 nos laptops from i7 11th Gen or better version available at that time, with 240GB SSD drive, 8GB Memory, latest Windows operating system, Microsoft office software.

E.7.11. LED WALL DISPLAYS FOR TERMINAL MANAGEMENT SYSTEM

E.7.11.1. System Description

The software for Terminal Management System is being developed locally under the project as an integral component of the Bus Management System. The equipment is required to be fixed to the Operational Control Centre of the KMTT with the updated specifications to be issued at that stage.

E.7.11.2. Performance and Requirements

Cabling should be provided within the KMTT for networking all the operational and passenger locations within the terminal area, ticketing areas, loading gates, and platforms, bus operator offices and include the bus parking area, bus entry and exit locations and passenger entrances as per clients/system developers' requirements. It should enable interconnectivity to the data network backbone.

The following hardware equipment would be required to purchase for the Terminal Management System being developed. All devices should be supplied, fixed (where necessary) and maintained under full warranty with parts for a period of three years. The response time for equipment attention should not exceed two hours during all hours of bus operations, with replacements provided when repairs are deemed to take more than two hours.

The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even without a contract.

1. 2 nos LED based video walls for Operational Control Centre in KMTT with a display of 75 inches diagonal measurement.

2. 2 nos CCTV wall fixed operations monitors with a display of 55 inches diagonal measurement.

a. Display Sizes

Display Type	**Quantity**	**Display Size (Diagonal Measurement)**
LED based video wall for OCC	02	75"
LED Display for CCTV monitoring in OCC	02	55-65"

b. Specifications of Displays

Specification / Display Type	**Indoor Color LED Passenger Information Displays**
Resolution of single LED module (pix*)	Minimum 64x84
Pixel pitch (mm)	4
Luminance (nits)	4500 or Higher
Number of rows	Customized
IP protection	IP54/ IP65
Temperature (^{0}C)	$-25^0/+50^0$
MTBF (h)	100000
Vac supply	220-240 V 50Hz
Anti-vandalism Brightness sensor Glass break sensor Case opening sensor Shock sensor Anti-reflective glass	✓ ✓ ✓ ✓ ✓ ✓
Control system	DVI, HDMI, LAN, Serial
Total size (mm)	As defined in table above

E.7.12. PRINTERS FOR TERMINAL MANAGEMENT SYSTEM

E.7.12.1. System Description

The printer is needed under the project as an integral component of the Terminal Management System. The equipment is required to be fixed to the Operational Control Centre of the KMTT with the updated specifications to be issued at that stage.

E.7.12.2. Performance and Requirements

The active equipment should fit the requirements of the updated specifications to be issued at that stage. It should enable interconnectivity to the data network backbone.

All devices including connecting fixtures should be supplied, fixed (where necessary) and

maintained under full warranty with parts for a period of three years. The supplier shall facilitate the direct transfer of all digital data as maybe specified by the client directly to the client server without any fee or restriction both during the maintenance/ warranty period and thereafter even without a contract. The following features would be required for purchasing the printers.

1. Printer Specifications

Specification / Printer Type	Black and White Printers	Colour Printers
Quantity	05	03
Printing technology	Laser	Laser
Paper trays	02	02
Paper size supported	A4, Legal, Letter	A4, Legal, Letter
Printing speed	up to 25/30 ppm	up to 25/30 ppm
Print quality (dpi)	Up to 600 x 600	Up to 600 x 600
Duplex printing	Yes	Yes
Both Wired & Wireless Connectivity	Yes	Yes
Paper handling	50 sheets or more multipurpose, 250 sheets or more input tray, 150 sheets or more output tray	50 sheets or more multipurpose, 250 sheets or more input tray, 150 sheets or more output tray
Power requirement	220 – 240V (±10%) 50 / 60Hz (±2Hz)	220 – 240V (±10%) 50 / 60Hz (±2Hz)
Functions	Print	Print, Copy, Scan, Email

2. Recommended Brands

Printers shall be of reputed make such as CANON, HP, TOSHIBA.

E.8. INTERNAL ROADS AND PARKING AREA

E.8.1. GENERAL REQUIREMENTS

This chapter shall be demarcated on the general requirements and specifications to be followed by design proposer, in design, construction, testing and maintenance during defect liability for internal roads and parking area developments.

Scope of the works defined as per Section B and Functional Requirements of KMTT as given in

Section 04 and Design Goals & Objectives, Key Design Concepts to be considered in design construction of internal road and parking areas. KMTT facility requirements are given under the Section 05, accordingly parking Bays and overall scope of work to be considered in developments by Proposer.

E.8.1.1. Conceptual Design

Based on studies, traffic modeling's, investigations and surveys undertaken previously, the Employer has arrived at certain design concepts for the various components constituting the project, as per the attached Architectural conceptual drawings submit herewith.

In the designs and constructions, the Employer requirements shall be done by the Project Proposer to conform to certain technical standards and specifications. These standards and specifications are referred to in this volume under technical requirements.

E.8.1.2. Observed Design Constraints

As given in Sub-section 7.2.11 of Section B, amendments to be done on the KMTT Design Development architectural design. Comments are noted under the subtitle for Roads. Accordingly, the proposer to be taken necessary design measures to avoid such noted design issues.

E.8.1.3. Proposer's Preliminarily Design

The Project Proposer in his proposal shall provide a preliminarily design that would closely match the conceptual design and the Design Development of the Employer at the evaluation stage. This shall be true for all the component of the project with avoiding of identified design issues and constrains.

E.8.1.4. Design Standards

In particular in regard to road construction, the design shall conform to the specifications for:

- Geometric Design Standards of Roads 1998 issued by Road Development Authority (GSDR 1998)
- Traffic Signs and Markings – Local Markings and Signs (Gazette Publication Document No. 1940/21 dated 12th Nov 2015)
- Technical Specifications – "Standard Specifications for construction and maintenance of roads and bridges, ICTAD publication No. SCA/5, Second Edition June 2009.

The design elements which are not addressed in the local codes are derived from other international standards which are listed below:

- AASHTO (American Association of State Highway & Transportation Officials) Paveme Design guide 1993
- Design Manual for Roads and Bridges (DMRB) (British Standards)
- American Association of State Highway and Transport Officials - AASHTO (Policy on Geometric Design of Highways and Streets)
- Overseas Road Note 31
- Austroads - Design Guidlines

E.8.1.5. Design Criteria

Vehicular movements of the proposed Terminal building, Parking building and ground roads to be designed to proposed design vehicle in line with all the design features such as horizontal geometry, vertical alignments, Cross sectional elements, pavement features. The elements to be satisfied the design standards and tabulated Table E. 22: Design Criteria respectively.

In consideration of ground roads, terminal area and parking areas, all road movements of in and out from these Access roads to be facilitated to avoid the conflicts of right turn movements and the geometry to be met to design standards to have smooth circulation of the traffic hence special attention to be given in designing of the horizontal geometry.

Since the bus parking areas is at the First-floor level of the Parking building, smooth reaching, turning and exit from bus parking area to be considered as prime requirement, hence relevant design features such as gradient, cross-sectional width, turning paths, clear heights to be evaluated.

There are four different bus bays as Touch and Go, Boarding and Alighting, Layover Parking, Operation & Maintenance proposed as Bus route operational changes through infrastructure modification within the terminal. The Proposer to be considered all the vehicular turning paths in parking, turning, reversing movements with respect to design standards and smooth traffic flow to be considered via the functioning in minimum disturbance to other vehicular lanes.

The following design criteria to be adopted in design of various design element by the project proposer. The detailed design report on pavement design and geometric design to be submitted during detailed designs.

Table E.34: Design Criteria

No	Item	Units	Design Value
01	Design speed	Km/h	20
02	Minimum Vertical clearance	m	5.2
03	Stopping Site Distance (SSD)	m	20
04	**Cross sectional elements**		
	a. Carriage width	m	3.5
	b. Normal Cross slope of the Carriageway	%	2.5
	c. Cross slope of the outer shoulder	%	2.5
	d. Maximum Cross slope (Maximum Super Elevation)	%	2.5
05	**Horizontal Elements**		
	Minimum Circular Curve Radius	m	19
06	a. Maximum Gradient	%	+/- 5%
	b. Minimum Gradient (Drainage Gradient)	%	+/- 0.3%
	c. Minimum K value for Crest Curves		1
	d. Minimum K value for Sag Curves		3

Gradient of the walkway should not be steeper than 1:12. Provision of barrier free facilities, such as dropped kerb at grade crossing point, tactile pavement etc for people with disabilities shall be designed.

E.8.1.6. Pavement Design and Finishing of Road pavements

A flexible pavement shall be adopted for driveways, First Floor bus parking area and existing road widenings, Refer the finishing schedule of Architectural drawings in identifying the type of paving finish requirement.

Pedestrian Pathways /Pavement and Ground floor Bus parking bays, Car parking areas and Three-wheel parking area shall be Cement Concrete Block Pavers in line with the drawings and the specifications. Designer to be given appropriate proposal for separation areas with the different background finishes for easy eye-catching in identifications. Appropriate kerb types to be used as standard, drop kerbs, dropper kerbs ,etc.

For the existing roads widening, Pavement design has to be carried out considering the following factors:

- CBR testing results
- Total traffic loads; - proceed traffic from the development traffic

- Design Life (20 years)

E.8.1.7. Road storm water Drainage within KMTT and Road Corridors

The Project Proposer shall design with appropriate cross slopes in designing of road storm water drainage system within the KMTT – Road premises. In Bus Parking areas and other Road corridors, Ramps to be manage the surface runoff and perennial discharge in conformity with the storm water discharge arrangements.

Where road areas in open to sky areas, such to be not ponded and proper road storm water drainage design to be submitted.

E.8.1.8. Pedestrian movements

Pedestrian movements to be discourage through the driveways by the design itself, hence necessary design features to be introduce to encourage the pedestrians to use the vertical cores to reach their destinated parking location through the terminal passages.

E.8.1.9. Road Lighting

Adequate road lighting shall be provided for all roads and walkways to ensure safe driving and walking, which shall be covered under Electrical design scope.

E.8.1.10. Technical Standards and Specifications

The design shall conform to the stated technical standards and specifications However, if the Contractor is proposing to adopt other standards and specifications, he shall prove them to be superior or equivalent to the stated standards and specifications.

Further, the Contractor shall at all times abide with the existing rules and regulations applicable to Sri Lanka.

E.8.1.11. Data Information and Drawings

To facilitate the Project Proposer's preliminary design, information from studies, investigations and surveys undertaken previously by the Employer will be provided as indicated in the Employer's requirement. The Project Proposer shall be responsible for interpreting these information and data for himself, if necessary, further inquiries/studies with can be carried out to satisfy himself and to prepare his proposal comprehensively.

E.8.1.12. Establishment of Reference Benchmarks and Grid Reference Point

Contractor shall proceed the Work with the established bench marks and grid reference points. Details of Control points is available in the topographical survey details.

E.8.1.13. Traffic Management System

Proposer shall arrange interim arrangements during the KMTT construction period to facilitate the users to access for the services located at the site such as SLTB fuel station, Telecom and Electricity to use and service the installations, as per the contract. The proposer shall have to obtain the prior approval for the method statements of traffic management before commencement the work.

Proposer shall give provisional sum for Traffic Management, Safety Control and Temporary Diversion of Traffic, including provision of general traffic management plan, diversions and provision of traffic control personals in required nos. necessary for transporting debris out of the Site and machinery transport as directed by the Engineer. This shall Include maintaining of Access Roads and internal roads without any muddy condition throughout the contract period.

Also note the Table A.01: The Employer‟s Environmental Management Plan of Annex A under the followings themes which are reference to the Traffic management

1.24 Traffic Safety Among the Community

1.25 Planning of Temporary Traffic Arrangements

2.15 Disruption to Users

2.15.1 Traffic Jams and Congestion

E.8.1.14. Transport Management

Re-routing and Re-location of the busses have already been carried out. The initial Management for commissioning of the new terminal is to be handled by the Proposer with Employer. Cost of the activity including the removal of temporary location used for bus operation has to be demolished and removed as per direction of Engineer. It is proposed a provisional sun Item for these works.

E.8.1.15. Road Markers and Road Signage

The Proposer shall provide appropriate road markers and sign boards to all road furniture items and other structures at appropriate locations along new permanent roads, Passenger Terminal Building, Parking Building for bus turning and Parking, Ramps,etc. He shall also erect warning boards at appropriate locations as per given design standards.

Road marking and road signage with reflective road marking paint approved colour and quality as per the Gazette note (2015) dated 12.11.2015.

E.8.2. TECHNICAL REQUIREMENTS

E.8.2.1. Road Construction

E.8.2.1.1 Site clearing

The work shall include the clearing and grubbing necessary for the work, disposal of the all cleared material, back filling of holes and depressions caused by removal of stumps, removal of Fences, removal of existing structures, Demolition & removal of Existing Asphalt etc. & waste remove from the site as instructed by the Engineer. Work to be confirm to confirming to standard specifications of SCA/05.

E.8.2.1.2 Utility Relocation

The work shall include the assist the utility agencies and relocation of the utility service as per the requirements of the utility service agency and the road agency.

E.8.2.1.3 Earth works

The work shall include the Roadway Excavation and preparation of subgrade in cut area as per SCA 05 - Clause 300. Work to be include classification of soil as the soil suitable for filling, Hard rock, soft rock, boulders, unsuitable soil, road pavement excavation, Subgrade replacement. Also work shall be include the preparation of subgrade in cut areas to the accepted tests and standards. Disposal of excavated material off site and dump to an approved land, all as directed by the Engineer. Rate shall include for loading, unloading, levelling the soil and all machine hire chargers and operating cost etc.

E.8.2.1.4. Embankment Construction on Soft Ground Areas

It shall be the responsibility of the Project Proposer to identify soft ground stretches their respective extend from visual inspection and soil investigation reports, where later construction of embankment of roads was required.

The Project Proposer is required to study all available and obtainable data characterize the sub surface stratification from the longitudinal and cross section mappings of the soil investigation reports and propose design for typical embankment construction on soft ground areas confirming to standard specifications of SCA/05

The Proposer shall give the method statement preliminary drawings and detail engineering design for such identified areas.

E.8.2.2. Reconstruction of Existing Road Bases

The proposer shall provide the design options for improve base failure sections with identified sections on existing base sections.

E.8.2.3. Pavement layers

All road pavement material and thickness of pavement layers to be as per the approved pavement designs and construction requirements to be confirm to the standard specifications of SCA/05.

E.8.2.4. Sub-Surface Design

It shall be the responsibility of the Project Proposer to identify stretches and their respective extend for sub surface drainage required from visual inspection and soil investigation reports. The proposer shall give the method statement and preliminary drawings and detail engineering design for such identified areas.

E.8.2.5. Cross Drainage via. Hume Pipes and Culverts

Where the discharge of drains and any other drainage paths shall cross the road suitable cross drainage structures of Hume pipe culverts or RCC box culverts shall be constructed. All designs and constructions shall conform to British Standards.

E.8.2.6. Road Finish on First Floor for bus turning and Parking Area

The Road parking building for bus turning and Parking area is open to sky, Structural slab to be water proofed as per Structural design details and specifications. The road Asphalt binder shall be laid on waterproofed, sound structural surfacing. The detailed design of the pavement cross section shall to be submitted by the Proposer.

E.8.2.7. Road storm Drainage within KMTT and Road Corridors

The Project Proposer shall design a drainage system within the KMTT – Road for Bus Turning and Parking and other Road corridors, Ramps to manage the surface runoff and perennial discharge in conformity of environmental migratory measures without ponding areas, with respect to Drainage System Design Guidelines, Road Development Authority.

E.8.2.8. Detailed Design

The design of the Work shall be based on the Contractor‟s agreed technical proposals, including any modifications agreed to prior to contract award. No variations to the details in the agreed technical proposal shall be permitted, except with the specific written authority of the Engineer. No such permission should be anticipated by the Contractor. The Contractor shall submit the following information for review:General Design Information - this shall incorporate an augmentation of information provided in the agreed technical proposal as appropriate.

E.8.2.9. Preliminary and Final Reports and Drawings of Road Work

The Contractor shall submit preliminary design reports and drawings incorporating all submissions and including all necessary provisions for services of roads and other structures early in the design stage. The Contractor shall submit a final design report after the Engineer approves the preliminary design. This shall be based on the preliminary design report/drawings and contain any necessary updated or augmented information.

E.8.2.10. General Design Parameters and Criteria

The design criteria stated in this section is given for the information of the Proposer (and, once procured; the Contractor). Designs incorporating criteria outside the stated ranges will not be accepted by the Engineer, unless the Proposer (and, once procured; the Contractor) provides sufficient information to satisfy the Engineer that his design will meet the Employer‟s Requirements in all respects. Regardless of the information provided in this Section and the acceptance by the Engineer of his design the Proposer (and, once procured; the Contractor) shall be solely responsible for designing and constructing the structure and associated facilities that meet the specified requirements and fulfil all the Empolyer's Requirements.

The Contractor shall undertake at his own expense, any additional tests (geotechnical investigation or any other) as may be necessary during the design for him to design the works, providing supporting information to validate his design assumptions. A copy of the results of all such investigations shall be provide to the Engineer.

E.8.3. WORK REQUIREMENTS

E.8.3.1. Standard Specifications

Refer to Standard Specifications for construction and maintenance of roads and bridges, Second Edition June 2009, Published by the Institute of Construction Training and Development (ICTAD)

E.8.3.2. Particular Specifications

The Particular Specifications are an amplification of the Standard Specifications for Construction and Maintenance of Roads and Bridges, Second Edition June 2009, published by the Institute of Construction Training and Development (ICTAD) and contain provisions in respect of items of work not covered by or at variance with the Standard Specifications.Where there is any ambiguity or discrepancy between the Particular Specifications and the Standard Specifications, the requirements of Particular Specifications shall. Prevail. Where BS tests are stipulated in the

Specifications, the equivalent ASTM or AASHTO test method may be substituted with the approval of the Engineer. Only additional clauses and clauses which have been deleted, modified or substituted in the Standard Specifications have been detailed in the Particular Specifications. Any reference to Sections/tables if not detailed in Particular Specifications refers to the relevant section or table in standard specifications.

Clause numbers herein correspond with the numbers of related articles, if any, in the Standard Specifications.

The abbreviations ·AASHTO, ASTM, BS and SLS shall considered to have the following meaning:

AASHTO American Association of State Highway and Transportation Officials

ASTM American Society of Testing and Materials

BS British Standard·

SLS Sri Lanka Standard

400. SUB BASES, BASES AND SHOULDER

401.4 Construction Requirements

(a) Preliminaries (add at the end of this sub section)

Where a sub base is to be laid over an existing pavement, the existing pavement shall be fully scarified to enable the existing bituminous layer and aggregate greater than 100mm in size to be removed. In removing the bituminous layer the Proposer" shall ensure that as much of the adhering existing aggregate as possible is dislodged and left remaining to be mixed with the sub base to be added Where instructed by the Engineer, existing material considered of poor quality shall be removed and disposed of. Extra sub base material shall then be added to the existing pavement material and thoroughly mixed either in place or alongside the area to be strengthened.

412 INTERLOCKING CONCRETE PAVING BLOCKS Add New Clause

412.1 General

Interlocking concrete paving blocks shall comply with the requirements specified herein. Interlocking Concrete paving blocks shall be earth colored precast paving blocks from approved manufacturers.

The project contractor shall provide a 10-year performance guarantee for the paving blocks against de-lamination and color fading in the Sri Lankan environment. The 10-year guarantee shall be back-

to-back from the concrete paving block manufacturer.

412.2 Constituent Materials Specifications

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.3 Shape and dimensions

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.4 Visual aspects

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.5 Physical and mechanical properties

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.5 Sampling

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.7 Criteria for Conformity

Refer SLS 1425 Part 1: 2011 - Specification for concrete paving blocks Part 1: requirements

412.6 Installation of Interlocking Concrete Paving Blocks

Laying of interlocking concrete paving blocks shall be in accordance with the following steps unless otherwise directed by the Engineer:

a) The Contractor shall take samples of the existing subgrade area, Soil Information, of these Standard Specifications. If the existing subgrade meets the requirements it shall remain in place. All low areas shall be raised by filling with compacted borrow material.

b) Levelling of the natural ground surface shall be done, Testing Levels and Evenness of Surface, of these Standard Specifications, and to the proposed grades and slopes. Objectionable material and unsuitable soil shall be removed from the site and disposed of in compliance with Standard specifications, Disposal of Excavated Materials and Surplus Materials, of these Standard Specifications. The Contractor shall furnish borrow material (load bearing) complying these Standard Specifications. All borrow materials shall be placed and compacted in compliance these Standard Specifications.

c) For vehicular pavers, on bus circulation to be concerned as Heavy Duty and the compressive strength to be 50 N/mm2. For medium duty areas, vehicular pavers shall be compressive strength of be 30 N/mm2, place soil sub base complying with these Standard Specifications and drawings,

on the prepared subgrade and to be compacted to the finished grade. The compacted surface shall be at proper cross section, smooth, dense, and free of compaction planes, ridges or loose material. During the compaction operations, shaping will be required to obtain the required surface and cross-section. During shaping operations, it may be necessary to lightly scarify and broom-drag the surface in order to remove ridges or depressions in excess of the permitted tolerance.

The resulting surface shall then be rolled with a smooth steel-wheel roller, weighing not less than ten tons, or pneumatic tire rollers, or both. The final rolling shall be done by a smooth steel- wheel roller. Several applications of water may be required to keep the surface at the proper moisture content, as ordered by the Engineer, during the finishing operation. Water shall be applied by the pressure spray bar method Standard Specifications.

Compaction and finishing shall be done in such a manner as to produce a smooth, dense surface, Free of surface compaction planes, cracks, ridges or loose Material. Immediately after rolling, the surface of the course shall be tested for trueness, transversely and longitudinally.

The finished surface of the course shall comply with Standard Specifications. Surface finishing shall be completed in daylight hours. Any portion of this course which has a density less than that specified shall be corrected or removed and replaced to its full depth to meet the requirements of the Standard Specifications, at the Contractor's expense.

The Contractor shall be required to maintain the aggregate in accordance with these Standard Specifications, and in a manner satisfactory to the Engineer from the time he first starts work until all work has been completed and accepted.

d) Place 5cm of bedding fine aggregate complying with the requirements of Passing limits (BS 882: 1992) specified in Table below:

Sieve Size (mm)	Standard. Min.% Finer	Standard. Max.% Finer
10	100	100
5	89	100
2.36	60	100
1.18	30	100
0.600	15	100
0.300	5	70
0.150	0	15

The bedding sand shall be uniformly mixed over the compacted subgrade for pedestrian areas, or

over the aggregate base for vehicular areas, or on top of RCC slabs and screed uniformly to grade 10 to 15mm higher than required, utilizing temporary templates complying with these Standard Specifications.

e) Place the interlocking pavers in the pattern the Engineer has selected as close together as possible such that the spaces of the joints are between 3mm and 5mm. It is important that the spaces be consistent so that the pattern will remain constant.

f) Any necessary cutting of concrete paving blocks or flagstones shall be done with a mechanical block splitter or a purpose-built proprietary diamond saw. In all such situations, only cut paving units with true, even and undamaged edges shall be laid. Cut paving with ragged edges and producing voids shall not be installed. Cut pieces to be laid shall not be less than 30% of a full paving unit and where necessary the cut shall be shared uniformly with the next complete unit.

g) Dimensional accuracy, uniformity of joint gaps, alignment and squareness shall be checked after laying the first three rows of blocks and thereafter at regular intervals. If joints begin to open the blocks shall be knocked together using a hide mallet.

h) After each 20m² or such area that has been agreed with the Engineer, has been laid the blocks shall be compacted to the required levels using a plate vibrator.

i) Tamp down on rubber pad and level the interlocking concrete paving blocks (now 10 to 15mm higher than required) with a mechanical plate vibrator equipped with a rubber pad on the tamping face (to minimize damage to the finished surface and appearance of the paving blocks), until pavers are uniformly level, true to grade and free of any movement. The mechanical plate vibrator shall have a plate area of 0.20 to 0.35m² and have a compaction force of 12-24 KN and a frequency of approximately 75 to 100 Hz.

j) No paving shall be left un compacted overnight except for the 1m strip at the temporary unrestrained edge.

k) The Contractor shall submit shop drawings indicating various patterns to the Engineer for review and approval. No interlocking concrete paving blocks shall be fabricated and delivered before a specific pat- tern has been approved.

412.7 Acceptance

Upon completion, the finished surface level, shall be within 5mm of the design level and the maximum deviation within the compacted surface, measured by a 3m straight edge shall not exceed 3mm. The level of any two adjacent blocks shall not differ by more than 1mm. Any are- as of

paving which do not comply with these tolerances shall be removed, the sand laying course adjusted and the paving blocks re-laid to the correct levels.

SURFACE APPLICATIONS, SURFACE DRESSINGS AND SURFACINGS

506 Asphaltic Concrete Surfacing

506.3 Mix Requirements

a. Combined Grading of Aggregate and Binder Content Include.

Particular Applications

The grading requirements for the combined aggregate and the binder content shall be as given in Table 506-1. For the Wearing Courses Type 1 is recommended in conformity with the design of pavement. However, the Contractor may select the most suitable mix according to the site conditions and layer thickness required for his constructions. The selection of the optimum mix and trial mixes shall be subject to the approval of the Engineer and carried out in his presence.

The sieve sizes used herein are of ASTM designation. However, equivalent BS sizes as given in Table 107-1 of Section 107 herein may be used with the prior approval of the Engineer.

F. DOCUMENTS AND DETAILS EXPECTED WITH THE PROPOSAL AND AFTER AWARDING OF THE CONTRACT

F.1. ARCHITECTURAL

Design approach of architectural design shall include information that will be considered in designing the building and other structures using the architectural design given in the Design Development Report and addressing issues identified in ER. It shall be submitted by the Proposer at Proposal submission stage. The Proposer shall clearly understand all the important aspects of the Project in setting up his Design Approach. The submission shall cover the requirement specified in this document in minimal.

The evaluation will be done considering the completeness and clarity of the design approach proposed and details submitted, which should sufficiently demonstrate the Proposer‟s understanding and capability of carrying out the Design and Build scope of this project. Proposer will be qualified based on the content of the design approach which shall cover but not limited to all the technical requirements given in the ER.

F.1.1. SUBMISSION OF CONTRACTOR'S PROPOSAL (BEFORE AWARD OF CONTRACT)

F.1.1.1. Design and Technical Proposal- Preliminary Architectural Design

Contractor's Preliminary architectural design proposal shall consist of the following;

1. All architectural drawings shall be checked and signed by the Principal Architect and submitted in duplicate. In addition to the list of hard copies given below, CD contains soft copies of all the preliminary design proposal drawings shall be submitted for design review.
2. Document describing the design intent, design concept, proposed development, planning concerns, zoning of major spaces vertically and horizontally, environmental concerns, energy efficiency, material and finishes, furniture , interior decoration, furnishing, systems, facilities, security features, other features etc., pertaining to the scope of work shall be submitted. Any modification, deviation etc., from the Employers' Requirement shall be clearly noted in this report. Copies of preliminary planning security clearances obtained for the proposed development also shall be enclosed.
3. Site plan showing access roads, boundaries and foot prints of all proposed building structures. (recommended scale 1:500)
4. Floor plans of all floors showing dimensions, areas, general arrangements of activity areas with labeling, doors and windows, levels etc., Demarcation of different areas of KMMIT

office areas and other activity areas with floor areas should be clearly indicated in color. (Recommended scale 1:200)

5. Minimum of four sections taken through building indicating spaces, heights, floors, ceilings. (Recommended scale 1:200)
6. All four elevations of the building. (Recommended scale 1:200)
7. Color exterior 3D views of the building (bird's eye views and views taken at eye level showing the design are preferred)
8. Separate key floor plans in color showing different types of floor, walls and ceiling finishes proposed in the design proposal. Elevations labeling exterior finishes of the building. Photographic expressions /references shall be given for all types of the finishes and materials.
9. Basic Landscape layouts showing general outline of different types of foliage , paved areas, water bodies etc.,
10. General descriptions / details of glazed areas, doors and windows and schedule of doors and windows.
11. General descriptions of handrails, signage and other items coming under interior designs.
12. Photographic references of all finishes, fittings and accessories.
13. summary of total floor area based on KMMIT areas , rentable areas, common areas, technical rooms etc.,
14. Comparison of the floor areas given under the "Space Requirement", " Design Brief" and "As per Design Proposal".

F.1.2.CONTRACTOR'S DOCUMENTS (AFTER AWARD OF CONTRACT)

F.1.2.1. Review the Preliminary Design proposal

The architectural review is done by the employer's architectural consultant. The contactor is required to proceed the schematic architectural drawings according to the given comments by the reviewer. All architectural drawings or requested parts by the reviewer listed out under preliminary design proposal (drawn to the scale of 1:200) have to be submitted by the contractor in this review period.

The Contractor shall get the approval by Employer for the final architectural preliminary design proposal.

F.1.2.2. Detailed Architectural Designs

After finalization and approval of the preliminary design proposal, Contactor is required to proceed with detailed architectural designs and prepare architectural drawings accordingly. All architectural drawings shall be checked and signed by the Principal Architect.

1. All Detail drawings listed out under preliminary design proposal drawn to the scale of 1:100
2. Detail drawings of doors and windows.
3. Detail drawings of stairways , handrails, toilets etc.,
4. Schedule of finishes , details, layout plans showing different types of finishes
5. Floor and wall tiling layouts.
6. Furniture layouts.
7. Reflected ceiling layouts
8. Details of special features.
9. Color 3D views of exterior and interior spaces
10. 3D animation to explain the design.
11. Detail model to a scale of 1:200(with the immediate context)
12. Detailed Building information model (BIM)-Auto Desk Revit, The minimum level of detail (LOD) 350 (include interfaces, supports and connections with other building component showing one system interacts with the other building systems).
13. Sample boards/product details to obtain approval of the Employer for fittings, accessories and finishing materials.
14. Any other drawings, details and information required for Employer /Consultant approvals and construction purposes.
15. Sample boards for finishing material, finishes color schemes etc., to obtain approval from the Employer/Consultant.

The architectural review is done by the employer's architectural consultant. The contactor is required to proceed the schematic architectural drawings according to the given comments by the reviewer All architectural detail drawings or requested parts by the reviewer listed out under detailed architectural design proposal (drawn to the scale of 1:100) have to be submitted by the

contractor in this review period.

The Contractor shall get the approval by Employer for the final architectural detailed design proposal.

After finalization of detailed architectural design drawings, contractor is expected to prepare the architectural drawings and details required for construction purposes. The architectural review is done by the employer's architectural consultant. The contactor is required to proceed the architectural construction drawings according to the given comments by the reviewer. All architectural construction drawings or requested parts by the reviewer (drawn to the scale of 1:100) have to be submitted by the contractor in this review period.

Further the contractor shall prepare shop drawings and coordination drawings required for the construction. The architectural review is done by the employer's architectural consultant. The contactor is required to proceed the architectural shop drawings according to the given comments by the reviewer as well as to obtain approval from the reviewer.

Contractor shall make provision in his financial proposal to produce "Mockups" for the interior spaces and landscaping works.

F.2. STRUCTURAL

F.2.1.DOCUMENTS TO BE INCORPORATED IN THE PROPOSAL AT THE BIDDING STAGE (DESIGN APPROACH)\

Design approach shall include information that will be considered in designing the building and other structures. It shall be submitted by the Proposer at Proposal submission stage. The Proposer shall clearly understand all the important aspects of the Project in setting up his Design Approach. The submission shall cover the requirement specified in this document in minimal.

The evaluation will be done considering the completeness and clarity of the design approach proposed and details submitted, which should sufficiently demonstrate the Proposer‟s understanding and capability of carrying out the Design and Build scope of this project. Proposer will be qualified based on the content of the design approach which shall cover but not limited to all the technical requirements given in the ER.

Design approach shall be include following key information/details.

F.2.2. STRUCTURAL DESIGN CRITERIA

Explanation shall be included with methodologies/ procedures on the buildings & structures design under vertical and horizontal loads, determination of most suitable structural form in resisting the loads, steps and procedures for adopting most suitable foundation systems, technical approaches to be used for super structure designs & retaining structures, fire resistance & to achieve all necessary durability conditions. It shall further explain any other special considerations to be adopted in the structural design stage for satisfying Employers Requirements specified in this document.

Proposer shall explain the design philosophy with reference to the structural loads evaluation, structural analysis, design & detailing procedure expected to be adopted for buildings & other structures. He should clearly mention relevant design parameters, design standards, specifications and references that will be used in the design. Further design criteria shall include basic methodologies / approaches or alternative arrangements that would be proposed to address the highlighted constraints in the design. A precise details on structural analysis software, design software with its version / release shall be specified if Proposer is expected to use such software programs in structural analysis, design and in detailing.

F.3. ELECTRICAL

F.3.1. SUBMISSION OF CONTRACTOR'S PROPOSAL (ALONG WITH THE PROPOSAL)

F.3.1.1.

Following document shall be submitted by the Proposer along with the proposal. All drawings shall be in A1 size

1. Qualification information of the contractor‟s design team with CVs and consent letters (if applicable).
2. Electrical power distribution system design concept (in report format).
3. Statement of compliance for the standards/regulations and guidelines stipulated in the Employer‟s Requirement.
4. Preliminary level electrical load estimation (maximum demand) of the building. Verification of estimated loads is required - building wise loads, floor wise loads (lighting, small power and other) and major loads etc.

5. Proposed location for CEB Substation.
6. Proposed Main Electrical Power Distribution System Schematic Diagram including Medium Voltage (MV) (if the power s st m contains a M V system) , Standby power and Low Voltage (LV) within the premises and design calculations for major equipment selection.
7. Proposed Equipment Arrangements for Transformer Room (if the power system contains a MV system) , and Generator Room.
8. Proposed cable trench arrangement of the entire premises.
9. Proposed Emergency power supply system (calculations, layouts).
10. Main cable/bus trunking system and circuit breaker selection calculations (up to the FDB level).
11. Lighting arrangement (indoor and outdoor) with switching locations with software simulation files and proposal for the lighting control systems associated with green aspects.
12. Socket outlet and industrial socket arrangements.
13. Floor distribution system (layout for the panel room/panel location arrangement, cable management system, areas covered under each DB/CU).
14. General drawings for the proposed Lightning Protection System (Air termination system, down conductor system and earth termination system).
15. Schematic diagrams for the proposed solar PV system, design calculations, technical details of equipment and test certificates of major items (module & inverter).
16. Maintenance strategy for the electrical distribution system of the building after the Contractor‟s defects liability period, draft documents for maintenance agreements.
17. List of spare parts, tools and consumables to be submitted at the handing over.

F.3.2. SUBMISSION OF DOCUMENTS AFTER THE AWARD OF THE CONTRACT

F.3.2.1.

Following document shall be submitted by the selected contractor for the prior approval of the Engineer before the construction. All drawings shall be in A1 size and submitted in 03 set of copies and one set of soft copy in a CD (consists of PDF version)

1. Detailed calculations for feeder cable & protective conductor selection, fault level calculations and selection of protection devices.
2. Detailed schematic diagram of the complete electrical power distribution system (MV (if applicable) & LV).
3. Single line diagrams for all type of Distribution Boards/Consumer Units.
4. Detailed lighting designs with manual calculations/software simulations and lighting layout for the complete building.
5. Detailed small power arrangement drawings for the complete building.
6. Detailed drawings for the proposed Lightning Protection System with detailed calculations including risk analysis.
7. Detailed drawings for the proposed Solar PV System with detailed calculations and the design of the mounting structure.
8. List of offered makes, brands for all main equipment (as specified in the list of recommended manufacturers) with their country of manufacture.
9. Manufacturing experience of the each product manufacturer (as specified under technical requirements).
10. Experience of the local agent in the projects of similar nature for all major equipment (details of projects of last five years shall be submitted).
11. Type test certificates for Medium Voltage (MV) switchgears, MV 11kV power cables, Dry type transformers. (if the power s yste m contains a MV s ystem)
12. Type test certificates for Low Voltage (LV) switchgears, circuit breakers, Solar PV modules, Inverters and all other equipment as specified under technical requirements.
13. ISO certificates for Medium Voltage (MV) switchgears, MV 11kV power cables, Dry type transformers) (if the power system contains a MV system), Low Voltage (LV)

switchgears, circuit breakers, Solar PV modules, Inverters, UPS system and all other equipment as specified under technical requirements.

F.3.2.2.

Following documents shall be submitted by the contractor for the prior approval of the Engineer during the Construction. All drawings shall be in A1 size and submitted in 03 set of copies and one set of soft copy in a CD (consists of PDF version)

1. Detailed construction drawings shall be made available for the approval of Engineer prior to start the works.
2. Conduit layouts (where applicable).
3. Shop drawings for the underground cable laying, MV switchgears, transformer arrangements (if the power system contains a MV system), LV switchgears, standby power system, UPS systems, lighting control systems, cable management systems, solar PV systems and lightning protection system.
4. Ceiling coordination drawings with all services.
5. Prior approval shall be obtained from the Engineer for all materials, fittings and accessories. Submission shall be made with actual samples (where applicable), technical literature, shop drawings, production details such as country of manufacture, Brand names etc.
6. Test certificates before importing/purchasing the items as specified under technical requirements.
7. Required documents to be incorporated to obtain the green rating certification (If required).

F.3.2.3.

Following documents shall be submitted by the contractor at the handing over. All drawings shall be in A1 size and submitted in 03 set of copies and one set of soft copy in a CD (consists of PDF version)

1. As-built drawings - After completion of the project, the contractor shall handover 03 sets of A-1 size hard copies and one set of soft copy in a CD (consists of PDF version) of As-built drawings to cover the entire electrical installation incorporating all the changes and revisions.

2. Operation and maintenance manuals and relevant technical catalogues of equipment installed in the building shall be handed over in triplicate.
3. Warranty certificates.
4. Complete set of test certificates including all system testing & commissioning reports, factory acceptance test (FAT) reports and Chartered Engineer‟s Test Reports etc.

F.4. WATER SUPPLY AND DRAINAGE

F.4.1. SUBMISSION OF DOCUMENTS ALONG WITH THE PROPOSAL

F.4.1.1.

Following document shall be submitted by the bidder along with the bid. All drawings shall be in A4, A3 or A2 size.

1. Information related to Qualification of the contractor's design team with CVs and letters of acceptance (if applicable)
2. History of similar nature of projects undertaken by the bidder, including copy of awarding and completion letters for the proof
3. Water supply, Wastewater disposal `and storm water disposal design concept according to site condition and nature of the project including storage and treatment facilities
4. Estimated tentative water requirement (Preliminary demand) and discharge load for different activities such as building drainage (sewage & wastewater load) and safety purposes etc.
5. Proposed water supply system (portable and harvested rainwater distribution network) – including; design calculations, equipment and material specifications, schematic and preliminary drawings etc.
6. Proposed wastewater disposal system (internal and external up to KCWM connection) – supported with design calculations, equipment and material specifications, schematic and preliminary drawings etc.
7. Proposed storm water disposal system (internal and external) – design calculations, equipment and material specifications, schematic and preliminary drawings etc.

8. Proposal for development of "Meda Ela' – preliminary design calculations, equipment and material specifications, schematic and preliminary drawings etc.
9. Proposed rainwater harvesting system - design calculations, filtration systems, equipment and material specifications, schematic & preliminary drawings etc.
10. Proposed solid waste disposal system- design calculations, space allocation etc.

F.4.2.SUBMISSION OF DOCUMENTS AFTER THE AWARD OF THE CONTRACT

F.4.2.1.

Following document shall be submitted by the selected contractor for the prior approval of the Engineer before execution of construction (during detailed design). All drawings shall be in A1 or A2 size and submitted in 03 set of copies and one set of soft copy in a CD.

1. Detailed calculation for pipe sizing in water supply and distribution networks (pressure flow) to suit delivery at the maximum peak demand during the day
2. Detailed calculation for pipe sizing for sewage and wastewater drainage networks (gravity flow) to cater during the maximum peak flow during the day
3. Schematic diagrams of water supply system, sewage & wastewater disposal system and storm water disposal system.
4. Detailed drawings for water supply, building drainage, rainwater harvesting and disposal system, both internal and external.
5. List of all materials and equipment including specifications of offered makes, brands with country of manufacture, local agent, warranty period, manufacturing experience, after sales service warranty etc.
6. Coordination drawings for underground utilities such as; water supply, wastewater disposal, storm water disposal, other services, structural elements, landscaping etc., to support foundation and ground floor construction
7. Coordination drawings of upper floors where lateral water supply, wastewater and storm water pipes interfere with other services viz., architectural features and structural elements.
8. Documents required for obtaining expected green rating (detailed calculations, drawings, specifications and software simulations etc.) shall be furnished.

9. Detail design drawings and calculations for development of "Meda Ela'
10. Detailed report and drawings for solid waste management system shall be produced
11. Preliminary method statement for all the major activities shall be submitted.

F.4.2.2.

Following documents shall be submitted by the contractor for the prior approval of the Engineer during the Construction. All drawings shall be in A1 or A2 size and submitted in 03 set of copies and one set of soft copy in a CD.

1. Detailed construction drawings shall be made available for the approval of Engineer prior to start the works.
2. Shop drawings for all pipe works, layout drawings for wastewater and storm water drainage in ground floor and upper floors
3. Prior approval shall be obtained from the Engineer for all materials, fittings and accessories. Submission shall be made with actual samples (where applicable), technical literature, shop drawings, production details such as country of manufacture, Brand names etc.
4. Test certificates before importing/purchasing the items as specified under technical requirement.
5. Preliminary operation and maintenance manual before commence testing and commissioning.
6. Detailed method statement for all activities.

F.4.2.3.

Following documents shall be submitted by the contractor at the handing over. All drawings shall be in A1 size and submitted in 03 set of copies and one set of soft copy in a CD (consists of PDF version)

1. As-built drawings - After completion of the project, the contractor shall handover 03 sets of A-1 size hard copies and one set of soft copy in a CD(consists of PDF version) of As-built drawings to cover the entire plumbing installation incorporating all the changes and revisions.
2. Operation and maintenance manuals and relevant technical catalogues of equipment installed in the building shall be handed over in triplicate.

3. Complete set of test certificates including all system testing & commissioning reports etc.
4. Certificates of warranties for all appliances, pumps waterproofing systems etc.
5. Detail of local agent for all the materials, fittings, machineries, accessories etc.

F.5. MECHANICAL

F.5.1. SUBMISSION OF DOCUMENTS ALONG WITH THE PROPOSAL

F.5.1.1. Submission of Documents and Drawings with the Proposal

Preliminary Technical Proposal for all Mechanical systems shall be consisting of followings;

- Design Concept
- Design Criteria, Calculation and Summary.
- Schematic deign drawings in both Soft (AutoCAD) and Hard (A2 Size) formats
- Floor layout drawings indicating all spaces for the Mechanical system such as Chiller plant room locations, Fire pump room, AHU room, Mechanical shafts, Lift machine rooms, etc.)
- Sectional & Elevations drawings as necessary
- Equipment Selection criteria including electrical power requirements, water requirement etc.
- Make/ Brand of Proposed Equipment.
- Proposed Maintenance Agreements for each Mechanical systems.

F.5.1.1.1. Air Conditioning and Ventilation System

The following information shall be submitted with the technical proposal for Air Conditioning and Ventilation system.

- Design Concept report
- Schematic drawings, Zoning strategies, etc.
- Cooling load calculation report generated by reputed licensed HVAC software.
- Major Equipment Selections: Chiller capacities, Pump capacities, AHUs, Cooling towers etc.
- Floor layout drawings indicating single line duct & pipe paths, with dimensions, equipment locations, chiller plant room size, AHU room sizes, Mechanical shaft sizes, etc.

F.5.1.1.2. Fire Protection and Detection System

The following information shall be submitted with the technical proposal for Fire Protection and Detection system.

- Design Concept report together with Schematic drawings, Zoning strategies, etc.
- Design calculations: Sprinkler system and Wet riser system, Detection control panel selection calculation, etc.
- Required Fire water sump capacity
- Major Equipment Selections: Pump capacities, Detection Control Panels, etc.
- Floor layout drawings indicating Fire pump rooms, equipment locations, etc.

F.5.1.1.3. Elevator and Escalator System

The following information shall be submitted with the technical proposal for Elevator and Escalator system.

- Traffic calculation report
- Schematic drawings together with Zoning strategies and indicating pit and overhead heights
- Major Equipment Selections : No of Passenger and Fire Lifts, No of Escalators
- Floor Layout drawings indicating Lift shaft sizes, lifts Machine room sizes and Escalators.

F.5.1.1.4. Building Management System

The following information shall be submitted with the technical proposal for Building Management system.

- Design Concept report
- Schematic Drawings/ BMS architecture diagram
- Point Lists (Schedules)
- Major Equipment Selections

F.5.1.1.5. Fuel Pumping System

The following information shall be submitted with the technical proposal for Fuel Pumping System

- Design Concept report together with Schematic drawings, special safety requirements etc.
- Calculations: Verify the adequacy of fuel sump capacities.
- Major Equipment Selections: Verify required dispenser units, capacity of dispenser pumps etc.
- Floor Layout drawings indicating sump and dispenser units locations, piping arrangement etc.

F.5.1.1.6. Centralized LP Gas Distribution and Detection system

The following information shall be submitted with the Preliminary technical proposal for Centralized LP Gas Distribution and Detection system

- Design Concept report together with Schematic drawings, special safety requirements, etc.
- Design calculations: Gas bank sizing
- Floor layout drawings indicating location of gas bank, gas outlet locations and location of detector points.

Table F.1: Documents and Details Expected With the Proposal-

Mechanical System	Drawing Type	Drawing Title/ Location **		Required Details
Air Conditioning and Ventilation System	Schematic Drawing	Chilled Water Distribution System		General arrangement of the system, Equipment Locations etc
		Smoke Extraction System		
	Floor Layout Drawings	Under Pass Level	Terminal Building, Parking Building, Sky Walk, Fuel Station	Single line duct & pipe paths, with dimensions, equipment locations etc.
		Ground Floor		
		First Floor		
		Second Floor		
		Roof Top Level		
	Plant Room Drawings	Chiller Plant Rooms		Chiller plant room size, AHU room

Mechanical System	Drawing Type	Drawing Title/ Location **		Required Details
		AHU Rooms		sizes, Mechanical shaft sizes, etc. General arrangement of the plant room including required dimensions etc.
		Cooling Tower Area		
Fire Detection and Protection System	Schematic Drawing	Fire Protection System		General arrangement of the system, Equipment Locations etc.
		Fire Detection System		
		Inert Gas System		
		Water Mist System		
		Kitchen Suppression System		
	Floor Layout Drawings	Under Pass Level	Terminal Building, Parking Building, Sky Walk, Fuel Station	Single line pipe paths, with dimensions, equipment locations etc.
		Ground Floor		
		First Floor		
		Second Floor		
		Roof Top Level		
	Plant Room Drawings	Fire Pump Room		Fire Pump Room size, general arrangement of the pump room with required dimensions etc.
Elevator and System Escalator	Schematic Drawing	Elevators and Escalators		Zoning strategies and indicating pit and overhead heights etc.
	Floor Layout	Elevators and Escalators		Lift shaft sizes, floor levels, required openings and arrangement of Escalators etc.
	Plant Room Drawings	Lift Machine Rooms		Lifts Machine room sizes and arrangements etc.
Building Management System	Schematic Drawing	Connectivity between management Level and Automation Level		Location of DDCs, BMS workstation, supervisory panels, connectivity wirings etc.
Fuel Pumping	Schematic Drawing	Fuel Piping System		General arrangement of the system,

Mechanical System	Drawing Type	Drawing Title/ Location **	Required Details
			location of equipment etc.
	Floor Layout Drawings.	Fuel Station	Sump and dispenser units locations, piping arrangement etc
Centralized LP Gas Distribution and Detection system	Schematic Drawing	Gas Distribution System	General arrangement of the system, location of equipment etc.
	Floor Layout Drawings.	Gas Detection System	
	Floor layout drawings	Gas Bank Location	Location of gas bank and general arrangement etc.
		Kitchen Area	Gas outlet locations and location of detector points etc.

** Note: No. of floors and architectural arrangement can be varied. Services shall be provided as per the finalized architectural arrangements.

F.5.2. SUBMISSION OF DOCUMENTS & DRAWINGS AFTER THE AWARD OF THE CONTRACT

The Contractor shall make and furnish three copies of each of the followings for the approval of Engineer but not be limited to those,

- Schematic drawings
- Design drawings
- Material Submittals
- Samples of Materials
- Design Calculations
- Analysis
- Shop Drawings (Working Drawings) and Coordination Drawings
- Detail Drawings
- Schematic & Interconnection Diagrams

- Method statements
- Certificate of Compliance/Test Reports Electrical Control Diagrams
- Testing and commissioning sheets formats.

F.5.2.1. Material Submittals

Material submittals shall include,

- Test reports and quality certificates
- Warranty /Guaranty period
- Selection data
- Capacity and electrical data
- Dimensional and schematics drawings
- Assembling and dismantling data
- Project references
- Other relevant information to determine the adequacy and suitability of the equipment for the proposed systems

F.5.2.2. Selection Data

Selection data shall consist of engineering selection details/Tables provided by the manufacturer for the performances and all other related required details (acoustics data etc.).

- Contractor shall indicate in these details/Tables, the items/Model selected and their designation.
- It shall be made quite clear as to which factors have been taken into account by the manufacturer to correct the listed gross capacity into the net capacity required, due to extreme outside temperature, altitude, enthalpy of entering and leaving air, fan required, fan static pressure, fan RPM, fan motor and temperature differential between supply air entering and return air leaving the room.

F.5.2.3. Shop Drawings

Shop drawings of all systems, sub systems electrical circuit and wiring diagram and any other drawings necessary for fabrication and installation of the system shall be supplied to the Engineer

to determine the adequacy and suitability of the layouts of the proposed air conditioning & ventilation system. In addition contractor shall submit and obtain necessary approvals for coordination drawings, wherever required.

F.5.2.4. Samples

Samples of all materials to be supplied under the proposed Work such as pipes, insulating materials and multiple fittings such as valves, strainers, electric components shall be supplied to the Engineer for approval. Such samples shall be kept with the Engineer until completion of the works and same will be released to the contractor on completion of Work. The items of supplies used for the project shall be equal to the approved sample. Operation and maintenance manuals shall consist of, but not necessarily be limited to the,

- Detailed diagrams of the all plant and equipment supplied, including, electrical supply, ducting, piping, valve arrangements, etc.
- Instructions of the regular maintenance of the equipment
- Frequency of lubrication and specifications of the lubricants recommended shall also be provided.
- All manuals should be printed, and ring bound with hard cover.
- A schedule which may be in the form of a material list giving all particulars together with ordering references of all replaceable parts for all the equipment which will be supplied

As Built Drawings

- On completion of the installation, the Contractor shall prepare a set of As-built Drawings incorporating all changes made to the original design and drawings, which shall represent an accurate description of the installed systems.
- These drawings shall be bound with covers in to an album and handed over to the Engineer

F.5.3. SUBMISSION OF DOCUMENTS & DRAWINGS DURING THE HANDING OVER – HANDING OVER DOCUMENT

The final handing over documents to be submitted by the Contractor on completion of the installation shall comprise the following:

- Maintenance and Operation Manuals (5 Copies)
- Commissioning Sheets (5 Copies)

- Test Reports (5 Copies)
- As Built Drawings (5 Copies and 5 soft copies in CD)
- Guarantee/ Warranty certificates (5 Copies)
- A building owner's manual. (5 Copies)
- A building user's guide (5 Copies)
- A construction stage report (5 Copies)

The all documents shall be bound with covers on to an album and handed over to the engineer.

F.6. ROADS

F.6.1.SUBMISSION OF DOCUMENTS AFTER THE AWARD OF THE CONTRACT

F.6.1.1.

Following documents shall be submitted by the contractor for the prior approval of the engineer during the Construction. All drawings shall be in A1 size and submitted in 03 set of copies and one set of soft copy in a CD (consists of CAD versions and PDF version)

- Road Layout Plan
- Plan Profile details
- Setting out details
- Typical Road Cross Sections
- Bus Route with bus-stop locations
- Road signs and markings
- Standard Details
- Road pavement details
- Road storm water drainage details
- Road finish levels including setting out details of Road edges/ drain Edges /center medians etc. should be provided

F.6.1.2.

Geometric design reports and Pavement detail design report to be submitted.