KOLKATA METRO RAIL CORPORATION LIMITED
EAST WEST METRO PROJECT

CONTRACT– UG-L & E (PHASE-II)

DETAILED DESIGN, DETAIL ENGINEERING, PROTOTYPE, MANUFACTURE, SUPPLY, DELIVERY AND STORAGE AT SITE, INSTALLATION, TESTING AND COMMISSIONING (INCLUDING INTEGRATED TESTING & COMMISSIONING), TRAINING OF PERSONNEL, DEMONSTRATION OF PERFORMANCE OF SYSTEM/ EQUIPMENT AND ANNUAL MAINTENANCE CONTRACT OF LIFTS & ESCALATORS (L & E) OF FOUR UNDERGROUND STATIONS OF KOLKATA METRO EAST-WEST LINE PROJECT (PHASE-II)

TENDER DOCUMENTS

VOLUME – 3 (PART-I)

EMPLOYERS REQUIREMENTS
SPECIFICATIONS
LIFT & ESCALATOR SYSTEM

KOLKATA METRO RAIL CORPORATION LIMITED
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India

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KOLKATA METRO RAIL CORPORATION LIMITED

EAST WEST METRO PROJECT

DETAILED DESIGN, DETAIL ENGINEERING, PROTOTYPE, MANUFACTURE, SUPPLY, DELIVERY AND STORAGE AT SITE, INSTALLATION, TESTING AND COMMISSIONING (INCLUDING INTEGRATED TESTING & COMMISSIONING), TRAINING OF PERSONNEL, DEMONSTRATION OF PERFORMANCE OF SYSTEM/ EQUIPMENT AND ANNUAL MAINTENANCE CONTRACT OF LIFTS & ESCALATORS (L & E) OF FOUR UNDERGROUND STATIONS OF KOLKATA METRO EAST-WEST LINE PROJECT (PHASE-II)

CONTRACT– UG-L & E (PHASE-II)

SUMMARY OF TENDER DOCUMENTS

Volume 1

- Notice of Invitation to Tender
- Instructions to Tenderers (including Annexures)
- Form of Tender (including Appendices)

Volume 2

- General Conditions of Contract
- Special Conditions of Contract (including Schedules)

Volume 3

- **Employer's Requirements Specifications (Part-I)**
- General Specification (Part – II)

Volume 4

- KMRCL Conditions of Contract on Safety, Health and Environment (CD)
- Safety, Health and Environment Manual (CD)

Volume 5

- Tender Drawings (in CD ROM)

Volume 6

- Pricing Documents
- Schedule of Payment

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1.0 INTRODUCTION

1.1 Scope and Purpose

1.1.1 This specification defines the objectives, guidelines and requirements for the contractor's Detailed Design, Detailed Engineering. Prototype, Manufacture, Supply, Delivery and Storage at Site, Installation, Testing and Commissioning (including Integrated Testing & Commissioning), Training of Personnel, Demonstration of Performance of System/Equipment & Annual Maintenance Contract of Lift and Escalator System (L&E) of Four Underground Stations of Kolkata Metro East-West Line Project (Phase-II).

1.1.2 The works to be executed under the Contract include the Detailed Design, Detailed Engineering. Prototype, Manufacture, Supply, Delivery and Storage at Site, Installation, Testing and Commissioning (including Integrated Testing & Commissioning), Training of Personnel, Demonstration of Performance of System/Equipment & Annual Maintenance Contract, Operation and Maintenance Documentation, Statutory Government Approvals, and co-ordination/interface with Designated Contractors for a complete System necessary to deliver the requirements of the Contract.

1.2 Relevant Documents

This Specification shall be read in conjunction with the following documents

a) Notice of invitation to tender for submission of Techno Commercial Bid.

b) Instructions to Tenderers (including Annexures)

c) General and Special Conditions of Contract (including Schedules)

d) Employer's requirements- Specification (Part -I)

e) Employer's Requirements – General Specification (Part-II)

f) Tender Drawings

g) Pricing Document

h) Safety, Health and Environment Conditions

k) Schedule of Dimensions

In the event of a conflict between this Specification and any other standards or specification quoted herein, the requirements of this Specification shall prevail. The order of precedence, with item a) having the highest priority, is:

a) Employer's Requirement - Specification (Part -I)

b) Employer's Requirement - General Specification (Part-II)

c) Indian Standards

d) International Standards referenced herein.

e) Other International Standards

f) Other National Standards.

Notwithstanding the precedence specified, the Contractor shall always immediately seek advice from the Employer in the event of a conflict between the above items.

1.3 Responsibilities of the Contractor

1.3.1 This Employer's Requirement - Specification (Part I) has been prepared based on the conceptual design prepared by the Consultants. The Contractor shall thoroughly satisfy himself that the proposed sizes, ratings, specifications and quantities of equipment meet the functional, operational and performance requirements of the Lifts and Escalators specified in General and Employer's Requirement - Specification (Part I)

1.3.2 The proposed capacities, sizes, ratings of sub-systems /equipment in Lifts and Escalators System, as a result of the design development shall be demonstrated by a proper design and simulation study and subject to approval by the Engineer.

1.3.3 The Contractor shall be responsible for Detailed Design, Detailed Engineering. Prototype, Manufacture, Supply, Delivery and Storage at Site, Installation, Testing and Commissioning (including Integrated Testing & Commissioning), Training of Personnel, Demonstration of Performance of System/Equipment & Annual Maintenance Contract, supply of Contract Spares, O & M manuals, Statutory government approvals, training, As-Built Documentation, co-ordination with Designated Contractors and other obligations for ensuring delivery of Lifts and escalators, complete in all respect for four underground stations of Kolkata Metro East- West Line (Phase-II) in accordance with the Contract.

1.4 Definition of Terms

1.4.1 Terms used in this document, which are not defined specifically, shall have the meaning given to it in the Conditions of Contract or General Specification.

1.5 CODES AND STANDARDS

- Ø Latest Editions shall be considered.
- Ø Unless otherwise stated herein, the design, installation, testing and commissioning of all works associated with Lifts and Escalators for U/G Stations shall generally comply with the latest edition of all applicable standards issued by the Bureau of Indian Standards and other relevant local regulations applicable.
- Ø In addition to local requirements, Lifts and Escalator system designs shall also comply with the following codes of practice, standards, specifications and manuals.
- Ø Local codes, regulations and standards shall take precedence where these standards or requirements are more onerous than other international standards.
- Ø Indian Electricity Rules
- Ø NFPA 130 (Latest Edition) - Fixed Guide way Transit Systems: any non-compliance shall be approved in writing by the KMRC.
- Ø Lifts shall comply with the requirements as per latest edition of EN 81 (Latest Edition) and BS 5655 (Latest Edition) of the British Standards: Safety rules for the construction and installation of electric lifts. The provisions related to the application for handicapped persons stated in these codes shall also be complied with. The Contractor shall also comply with the “Guidelines and space standard for Barrier free Built Environment for Disables and Elderly Persons” published by C.P.W.D. (Central Public Works Department). India.
- Ø The contractor shall comply with the guidelines for safety of elevator circulated vide A. V. series circular no. 822, issued by Ministry of Urban Development and Poverty Alleviation, Govt. of India vide their letter no. C-31011/1/2001-AVII dated 7.12.2001.
- Ø Escalators (public service application) shall comply with the requirements of the heavy-duty type for Mass Transit application in accordance with latest edition of British Standard BS EN 115 (Latest Edition), and European Standard EN115 (Latest Edition): Safety rules for the construction and installation of Escalators.
- Ø British Standards or other internationally recognised standards as approved by the Engineer.

1.5.1. Unless otherwise stated herein, the design, installation, testing and commissioning shall comply with the latest edition of all applicable standards issued by the Bureau of Indian Standards and other relevant local regulations applicable.

- Ø IS – 14665: All parts (Latest Version):
- Ø IS –15330: Installation and Maintenance of lifts for Handicapped Persons – Code of Practice
- Ø IS 15785: Installation and Maintenance of Lifts without conventional machine rooms
- Ø IS – 7759: Specification for lift doors locking device and controls.
- Ø IS-1860 Code of practice for Installation, Operation and Maintenance of Electric passenger and goods lifts
- Ø IS – 4591: Code of Practice for Installation and Maintenance of Escalators.
- Ø IS 1554 and IS 694: LSHF Cables.
- Ø IS - 2147: Degree of Protection
- Ø National Building Code of India
- Ø Additional requirements imposed by statutory or government authorities not listed above shall be complied with.
- Ø IS: 1893 – Part 1 & 2 -2002 – Seismic Zone – Code Requirements for seismic risk zone V.
- Ø CVC Guidelines.
- Ø BS 476 Part 22:1987 – Code requirements for Fire door rating.
- Ø Additional requirements imposed by statutory or Government authorities not listed above shall be complied with.
- Ø **All the codes and standards mentioned above should be as per the latest edition/amendment.**

1.5.2. The standards to be followed during construction and installation of the Lift and Escalators System shall be generally as listed, except where specific requirements are given in the Specification, which shall take precedence. The Contractor may propose alternative or additional standards for review by the Engineer at least 60 days before application.

1.5.3. All codes and standards shall be submitted in English language. The design of any one system shall be to a single code or specification. The parallel use of different codes for particular items or components shall not be allowed.

1.5.4. International Standards

- Ø EN 81-20 & EN81-50
- Ø EN 81-3: Part 3: Safety Rules for the construction and Installation of Electric and Hydraulic Service Lifts
- Ø EN 81-28: Remote Alarm on Passenger and Goods Lifts
- Ø EN 81-70: Accessibility to Lifts for persons with disabilities.

- EN 81-72: fire Fighter's Lifts.
- EN 81-73: Behavior of the Lifts in the event of fire.
- EN 81-58- Code requirements for Fire door rating.
- EN 115-1, Safety of escalators and moving walks — Part 1: Construction and installation
- ASME 17. A: American Standards for Fire Operation of Lifts
- NFPA 101: Life Safety Code.
- EN 12015 & EN 12016 – Electromagnetic Compatibility standard for Lifts
- BS 7255: Safe Working of Lifts
- EN 13015 – Maintenance Instructions for Lifts and Escalators
- EN 60204-1: Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)
- IEC 61000-2-4 and IEE 519 – Electromagnetic Compatibility
- BS 6007, BS 6387, BS 7211 and BS 7629: LSHF Cables
- Climatic tests - EN60068-2-1; EN50125-3
- Vibration tests - EN50125-3; EN60068-2-27; EN61373
- Compatibility - EN50128
- System integration test - Depending on customer requirements
- Quality approval to ISO 9001:2000, and environmental standard ISO 14001
- Protection class IP code (EN60529)
- BS7671 (IEE wiring regulations).
- BS7211 or BS6724 - Power cables will be Low Smoke Zero Halogen (LSZH)
- BS 729 – Galvanizing
- BS 1452 – Cast Iron
- BS 3900 & BS 6150 – Painting
- BS 5950 – Specification for use of structural steel –Tolerances
- BS 6399: Part 1: Design Loading for Buildings (Part 1 dead and imposed load)
- BS 6206 Impact Performance Requirements for Flat Safety Glass and Safety Plastics for Use in Buildings
- BS 952 Glass for Glazing: Part 1: Classification
- BS 5512 – Bearing
- BS 5135, BS 4870 and BS 639 – Welding
- BS 4395 – High strength friction grip bolts and nuts
- BS 4190 and BS 3692 - Bolts, Screws and Nuts
- BS 1432 and BS 1977 – Copper
- BS 7854 – Mechanical vibration – Evaluation of Machine Vibration by measurements on non-rotating parts
- IEC 60754 -2 – Cable no corrosive smoke emission
- IEC 479 – 1 – Technical Report – Effects of Current on Human Beings and Livestock

- Ø NFF 63826 –Halogen free cables
- Ø NFF 16101 and DIN 5510-2– Fire Behavior – material choosing
- Ø IRS S35/93, IRS S63/89 And 5 and IRS TC30/05 - Cables
- Ø NFEN10025 - Steel
- Ø ISO R 1996 and NFS 30010 - Noise Disturbance
- Ø EN ISO 12100-1: Safety of machinery — Basic concepts, general principles for design — Part 1: Basic Terminology, methodology (ISO 12100-1:2003)
- Ø EN ISO 13850, Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)
- Ø EN ISO 13857: Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)
- Ø BS 6206 – Glazing - Impact performance requirements for flat safety glass and safety plastics for use in buildings.
- Ø EN 1461 – Welded Steel Construction Hot Dipped Galvanized (70 microns minimum) corrosion protection for Structural Steel Works.
- Ø The glazing shall conform to Class A as stated in Clause 4 of BS 6206 when subjected to the tests described in the standard.
- Ø The Contractor shall conduct the impact tests in accordance with the relevant clauses of BS 6206, but the size of the test sample for all thicknesses shall be taken as the largest pane of glass in the system.
- Ø Additional requirements imposed by statutory or government authorities not listed above shall be complied with.
- Ø **All the codes and standards mentioned above should be as per the latest edition/amendment**.

1.5.5 The Contractor shall also comply with the “Guidelines and space standard for Barrier free Built Environment for Disables and Elderly Persons” published by C.P.W.D. (Central Public Works Department). India.

1.5.6 The contractor shall make available at site all relevant Indian standard Codes of practice, CPWD and MOST Specifications and IRS & IRC Codes as applicable and other relevant British/German/American Standard. Wherever Indian Standards do not cover some particular aspects of design/construction, relevant British/German/American Standards will be referred to.

1.5.7 In case of discrepancy among Standard Codes of Practice viz. IS, IRS, CPWD, IRC, IEC, BS, UL, DIN, MOST, the decision of Engineer will be final and binding.

1.5.8 The levels, measurements and other information concerning the existing site that shall be shown on the Tender drawings are believed to be correct, but the contractor should verify them for himself.

1.6 Climate, Operating Conditions

All equipment and materials shall be fully tropicalized and suitable for use in the local climate and operating conditions. The Contractor is deemed to be familiar with the prevailing local climatic conditions and is aware of high dry bulb temperature and high

relative humidity (up to 100%) during certain times of the year. All equipment/system shall be suitable for operation with dry bulb temperature of at least up to 45 deg C and relative humidity of up to 100%.

1.6.1 **Electricity Supply**

(1) The Contractor shall submit to the General Consultants electrical requirements of all equipment offered and shall be responsible for any modifications/upgrading and expenses incurred as a result of increased electrical requirements of his equipment, whether arising from coordinated services effort or otherwise, from those as shown on the Employer's Drawings.

(2) Unless otherwise specified, the Contractor shall be aware of the following nominal ratings of power supply to equipment:

Voltage	:	415V (for 3-phase electrical supply) ±10%
		230V (for single phase electrical supply) ±10%
Frequency	:	50 Hz ±6%

(3) All equipment shall be suitable for these ratings or the part of the installation concerned.

(4) Step-down transformers shall be provided by the Contractor for power supplies to his own control equipment/system, unless otherwise specified.

(5) Installation Electrical Supply for Lifts and Escalators is to be arranged by Lift and Escalator Contractor at their own cost. For Testing and Commissioning of elevators and escalators, 3 phase power supply will be given by employer only when ASS is fully charged else in need of elevators and escalators testing and commissioning power supply has to be arranged by Lift and Escalator Contractor at their own cost.

1.6.2 **Equipment Installed at Outdoor Location**

(1) For equipment and pipework/ductwork intended to be installed on the open roof or at outdoor locations, the Contractor shall ensure that these equipment and pipework/ductwork are properly protected by weatherproof external casing or cladding. All associated motors, terminals, and electrical components shall be weatherproof type and suitable for outdoor installation. Weather protection shield shall also be provided for all moving parts of the equipment and associated accessories external to the weatherproof equipment casing.

(2) Services installed in close proximity of external openings, louvers, etc. shall also be provided with suitable protective coating to avoid damages caused by external weather conditions.

1.7 PROJECT DETAILS

1.7.1 General

The Kolkata Metro Railway will be carried out in two phases. Phase - I work will be Underground section between Sealdah Station and Subash Sarovar and Elevated section From Subash Sarovar to Salt Lake Sector-V station. Phase – II work will be Underground section between Sealdah and Howrah Maidan station.

This Contract comprises the Detail design, Detailed Engineering, coordination, construction and testing of prototype, validation, manufacture, supply, transportation, delivery and storage at site, installation, testing, performance verification and demonstration of system and equipment, commissioning, maintenance and rectification of defects during the Defects Liability Period of the complete Lift and Escalator systems within each of the new stations of Kolkata Metro East West Line.

PHASE-I – Underground section between Sealdah station and Subash Sarovar and Elevated section between Subash Sarovar and Salt Lake Sector-V station.

Phase - I work will include two nos. Underground Stations (Sealdah and Phool Bagan), Intermediate Ventilation Shafts including Fan rooms and Emergency Egress route and Auxiliary Substation at Scissor cross over between Sealdah- Phool Bagan; Entire length of Tunnels from Sealdah to Subash Sarovar; Six (6) Elevated Stations (Salt Lake Stadium, Bengal Chemical, City Centre, Central Park, Karunamoyee and Salt Lake Sector-V), 33 kV intake RSS substation at Bengal Chemical Building and Auxiliary substation at Central Park depot and the entire length of Via duct between Subash Sarovar and Salt Lake Sector-V.

PHASE-II– Underground section between Sealdah and Howrah Maidan station

Phase - II work will include Four (4) Underground Stations (Esplanade, Mahakaran, Howrah and Howrah Maidan), Intermediate Ventilation Shafts including Fan rooms and Emergency Egress route and Auxiliary Substation and Main Receiving Sub Station Intake Switch Room at Strand Road; Entire length of Tunnels from Howrah Maidan to Sealdah.

1.7.1 Deleted.

2.0 SCOPE OF WORKS FOR ELEVATORS

2.1 Scope

The Contract shall include but not be limited to the following Works: -

a) Provision of Heavy Duty machine-room less Elevators in Underground stations and for the movement of disabled and elderly persons as indicated in Table-No.1

b) All minor civil works like chipping up to 25 mm, plaster up to 25 mm, cutting of unwanted projection inside the lift shaft, making of core cutting holes for cable and earthing entry or any other requirement for installation of Lift, filling of any holes inside shaft, final white wash of complete lift after all modification works, fixing of wire mesh from inside for ventilation cut out, load hook painting, usage of chemical fasteners if required, making good the tiles, granite damaged during installation and hoisting etc. or

any modifications instructed by Employer for installation of the equipment and restoring to final finishes.

c) Transportation of materials and equipment for installation purposes.

d) Spare parts, special tools, testing and diagnostic equipment and measuring instruments.

e) Maintenance during DLP, Training.

f) Documentation.

g) Connection to the Station ISMS. Station ISMS Control Panel (by ISMS Vendor) shall be located in Station Control Room.

h) Comprehensive all-inclusive Annual Maintenance Contract (AMC) for specified period.

i) After sales Services which includes but not limited to supports for operation & maintenance in general as well as management of spares.

j) Contractor to establish at own cost the site office/site container for Phase-II project with mandatory amenities like Computer, Printer, light, Air-conditioning, proper sitting arrangement etc. with subject to approval of Engineer/Employer.

The details of the above works are given in the relevant Chapters of this Specification.

3.0 SCOPE OF WORKS FOR ESCALATORS

3.1 Scope

The Contract shall include but not be limited to the following Works: -

(a) Provision of Heavy Duty Escalators in stations for passenger movements in Underground Stations as indicated in Table-No.2.

(b) All minor civil works like chipping up to 25 mm, plaster up to 25 mm, cutting of unwanted projection inside the Escalator pit, making of core cutting holes for cable and earthing entry or any other requirement for installation of Escalator, filling of any holes inside Escalator pit, any hoisting load hook required for hoisting/installation of Escalator, usage of chemical fasteners if required, making good the tiles, granite damaged during installation and hoisting, gap filling all around escalator top and bottom pit up to 25 mm etc. or any modifications instructed by Employer for installation of the equipment and restoring to final finishes.

(c) Transportation of materials and equipment for installation purposes.

(d) Spare parts, special tools, testing and diagnostic equipment and measuring instruments.

(e) Maintenance during DLP, Training.

(f) Documentation.

(g) Connection to the Station ISMS. Station ISMS Control Panel (by ISMS Vendor) shall be located in Station Control Room.

(h) Comprehensive all-inclusive Annual Maintenance Contract (AMC) for specified period.

(i) After sales Services which includes but not limited to supports for operation & maintenance in general as well as management of spares.

(j) Contractor to establish at own cost the site office/site container for Phase-II project with mandatory amenities like Computer, Printer, light, Air-conditioning, proper sitting arrangement etc. with subject to approval of Engineer/Employer.

The details of the above works are given in the relevant Chapters of this Specification.

Underground Stations - Schedule of Machine Room-Less Type Lifts (Complying to EN-81-20 & EN81-50 Standards) Suitable for Metro Station Operation:

TABLE NO 1														
ELEVATOR DETAILS														
S. N.	STATION NAME	LOCATION	LIFT NO	TRAVEL IN METER	RISE IN METER	Passenger Capacity	Type of Door	NO OF STOPS	SHAFT SIZE (WXD) IN MM	ENTRANCE SIZE STRUCTURAL (WXH) IN MM	DOOR SIZE (WXH) IN MM	PIT DEPTH IN MM	HEADROOM HEIGHT IN MM	DRAWING REF NO
1	HOWRAH	UPPER CONCOURSE TO PLATFORM AT GRID 10	LT-01	18.354	18	13 P	Glass	4	2300 X 2400	1300 X 2300	1100X2100	1900	4930	UG1-SYST-HOW-DWG-NAA-5301, UG1-SYST-HOW-DWG-NAA-5302
2	HOWRAH	UPPER CONCOURSE TO PLATFORM AT GRID 10 & 11	LT-02	18.354	18	26 P	Glass	4	3050 X 2550	1300 X 2300	1200x2100	1900	4930	UG1-SYST-HOW-DWG-NAA-5304
3	HOWRAH	UPPER CONCOURSE TO PLATFORM AT GRID 10	LT-03	18.354	18	13 P	Glass	4	2300 X 2400	1300 X 2300	1100X2100	1900	4930	UG1-SYST-HOW-DWG-NAA-5301, UG1-SYST-HOW-DWG-NAA-5302
4	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 18	LT-04	9.965	10	26 P	SS	2	3050 X 2550	1300 X 2300	1200x2100	1900	4900	UG1-SYST-HOW-DWG-NAA-5306
5	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 7	LT-05	9.965	10	26 P	SS	2	3050 X 2550	1300 X 2300	1200x2100	1900	4900	UG1-SYST-HOW-DWG-NAA-5307
6	HOWRAH	UPPER CONCOURSE TO PLATFORM AT GRID 11	LT-06	18.354	18	13 P	Glass	4	2300 X 2400	1300 X 2300	1100X2100	1900	4930	UG1-SYST-HOW-DWG-NAA-5301, UG1-SYST-HOW-DWG-NAA-5302
7	HOWRAH	UPPER CONCOURSE TO PLATFORM AT GRID 11	LT-07	18.354	18	13 P	Glass	4	2300 X 2400	1300 X 2300	1100X2100	1900	4930	UG1-SYST-HOW-DWG-NAA-5301, UG1-SYST-HOW-DWG-NAA-5302

TABLE NO 1

ELEVATOR DETAILS

S. N.	STATION NAME	LOCATION	LIFT NO	TRAVEL IN METER	RISE IN METER	Passenger Capacity	Type of Door	NO OF STOPS	SHAFT SIZE (WXD) IN MM	ENTRANCE SIZE STRUCTURAL (WXH) IN MM	DOOR SIZE (WXH) IN MM	PIT DEPTH IN MM	HEADROOM HEIGHT IN MM	DRAWING REF NO
8	HOWRAH MAIDAN	UPPER CONCOURSE TO PLATFORM AT GRID 10 & 11	LT-01	5.68	6	13 P	Glass	2	2250x2500	1300 X 2300	1100X2100	1900	4650	UG1-SYST-HOM-DWG-NAA-5260
9	HOWRAH MAIDAN	UPPER CONCOURSE TO ENTRANCE AT GRID 8	LT-02	9.485	9	13 P	SS	2	2250x2500	1300 X 2300	1100X2100	1900	4250	UG1-SYST-HOM-DWG-NAA-5261
10	MAHAKARAN	UPPER CONCOURSE TO PLATFORM AT GRID 11	LT-01	11.70	12	26 P	Glass	3	3050 X 2550	1300X 2300	1200x2100	1900	5000	UG1-SYST-NMK-DWG-NAA-5260
11	MAHAKARAN	UPPER COMNCOURSE TO ENTRANCE AT GRID 22A4 & 3A4	LT-02	10.50	10	26 P	SS	2 (THROUGH LIFT)	2700x3000	1300X 2300	1200x2100	1900	5950	UG1-SYST-NMK-DWG-NAA-5261
12	ESPLANADE	GRID A-(15-16)	LT-01	18.835	19	13 P	Glass	4	2500 X 2210	1400 X 2450	1100X2100	1800	5005	UG2-D-ESP-AR-4447-4448
13	ESPLANADE	GRID D-16	LT-02	18.835	19	21P	Glass	4 (THROUGH LIFT)	2900 X 2600	1400 X 2450	1200x2100	1800	5005	UG2-D-ESP-AR-4449-4450
14	ESPLANADE	GRID G-(15-16)	LT-03	18.835	19	13 P	Glass	4	2500 X 2210	1400 X 2450	1100X2100	1800	5005	UG2-D-ESP-AR-4451-4452
15	ESPLANADE	GRID A-(4-5)	LT-04	18.835	19	13 P	Glass	4	2500 X 2210	1400 X 2450	1100X2100	1800	5005	UG2-D-ESP-AR-4453-4454
16	ESPLANADE	GRID D-6	LT-05	18.835	19	21P	Glass	4 (THROUGH LIFT)	2900 X 2600	1400 X 2450	1200x2100	1800	5005	UG2-D-ESP-AR-4455-4456

TABLE NO 1

ELEVATOR DETAILS

S. N.	STATION NAME	LOCATION	LIFT NO	TRAVEL IN METER	RISE IN METER	Passenger Capacity	Type of Door	NO OF STOPS	SHAFT SIZE (WXD) IN MM	ENTRANCE SIZE STRUCTURAL (WXH) IN MM	DOOR SIZE (WXH) IN MM	PIT DEPTH IN MM	HEADROOM HEIGHT IN MM	DRAWING REF NO
17	ESPLANADE	GRID G-(4-5)	LT-06	18.835	19	13 P	Glass	4	2500 X 2210	1400 X 2450	1100X2100	1800	5005	UG2-D-ESP-AR-4457-4458
18	ESPLANADE	GRID C-20 (GF-MEZI)	LT-07	7.455	7	21P	SS	2 (THROUGH LIFT)	2900 X 2600	1400 X 2500	1200x2100	1650	4400	UG2-D-ESP-AR-4459
19	ESPLANADE	GRID D-6 (GF-MEZI)	LT-08	7.455	7	21P	SS	2 (THROUGH LIFT)	2900 X 2600	1400 X 2500	1200x2100	1650	4400	UG2-D-ESP-AR-4460

Underground Stations - Schedule of Escalators Suitable for Metro Station Operation:

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
1	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 14	ES-01	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5271
2	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 7	ES-02	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5271
3	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 7	ES-03	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5272
4	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 7	ES-04	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5272
5	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 14	ES-05	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5274
6	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 7	ES-06	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5274

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
7	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 14	ES-07	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5276
8	HOWRAH	LOWER CONCOURSE TO PLATFORM AT GRID 14	ES-08	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOW-DWG-NAA-5276
9	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 8	ES-09	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5278, UG1-SYST-HOW-DWG-NAA-5279
10	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 13	ES-10	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5278, UG1-SYST-HOW-DWG-NAA-5279
11	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 8	ES-11	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5282, UG1-SYST-HOW-DWG-NAA-5283
12	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 8	ES-12	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5282, UG1-SYST-HOW-DWG-NAA-5283
13	HOWRAH	UPPER CONCOURSE	ES-13	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5284, UG1-SYST-

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
		TO LOWER CONCOURSE AT GRID 8											HOW-DWG-NAA-5285
14	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 13	ES-14	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5284, UG1-SYST-HOW-DWG-NAA-5285
15	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 13	ES-15	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5288, UG1-SYST-HOW-DWG-NAA-5289
16	HOWRAH	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 13	ES-16	12.67	Glass	3	13	1800	1600	4500	3500	29.944	UG1-SYST-HOW-DWG-NAA-5288, UG1-SYST-HOW-DWG-NAA-5289
17	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-17	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5290, UG1-SYST-HOW-DWG-NAA-5291
18	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-18	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5290, UG1-SYST-HOW-DWG-NAA-5291
19	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT	ES-19	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5290, UG1-SYST-HOW-DWG-NAA-5291

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
		GRID 17											
20	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 8	ES-20	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5294, UG1-SYST-HOW-DWG-NAA-5295
21	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 8	ES-21	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5294, UG1-SYST-HOW-DWG-NAA-5295
22	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-22	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5296, UG1-SYST-HOW-DWG-NAA-5297
23	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-23	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5296, UG1-SYST-HOW-DWG-NAA-5297
24	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-24	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5296, UG1-SYST-HOW-DWG-NAA-5297
25	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-25	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5296, UG1-SYST-HOW-DWG-NAA-5297
26	HOWRAH	UPPER	ES-26	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
		CONCOURSE TO ENTRANCE AT GRID 17											NAA-5298, UG1-SYST-HOW-DWG-NAA-5299
27	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-27	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5298, UG1-SYST-HOW-DWG-NAA-5299
28	HOWRAH	UPPER CONCOURSE TO ENTRANCE AT GRID 17	ES-28	9.965	SS	3	10	1800	1600	4500	3500	25.230	UG1-SYST-HOW-DWG-NAA-5298, UG1-SYST-HOW-DWG-NAA-5299
29	HOWRAH MAIDAN	CONCOURSE TO PLATFORM AT GRID 8	ES-01	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOM-DWG-NAA-5250
30	HOWRAH MAIDAN	CONCOURSE TO PLATFORM AT GRID 8	ES-03	5.68	Glass	3	6	1800	1600	4500	3500	17.838	UG1-SYST-HOM-DWG-NAA-5250
31	HOWRAH MAIDAN	UPPER CONCOURSE TO ENTRANCE AT GRID 9	ES-02	9.485	SS	3	9	1800	1600	4500	3500	24.428	UG1-SYST-HOM-DWG-NAA-5251, UG1-SYST-HOM-DWG-NAA-5252
32	MAHAKARAN	LOWER CONCOURSE TO PLATFORM AT GRID 8	ES-01	5.8	Glass	4	6	1810	1600	4755	3515	18.316	UG1-SYST-NMK-DWG-NAA-5250

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
33	MAHAKARAN	LOWER CONCOURSE TO PLATFORM AT GRID 14	ES-02	5.8	Glass	4	6	1810	1600	4755	3515	18.316	UG1-SYST-NMK-DWG-NAA-5251
34	MAHAKARAN	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 10	ES-03	5.9	Glass	4	6	1810	1600	4755	3515	18.489	UG1-SYST-NMK-DWG-NAA-5252
35	MAHAKARAN	UPPER CONCOURSE TO LOWER CONCOURSE AT GRID 12	ES-04	5.9	Glass	4	6	1810	1600	4755	3515	18.489	UG1-SYST-NMK-DWG-NAA-5253
36	MAHAKARAN	UPPER CONCOURSE TO ENTRANCE AT GRID 2 & 3	ES-05	10.5	SS	4	10	1810	1600	4755	3515	26.456	UG1-SYST-NMK-DWG-NAA-5254 & 55
37	MAHAKARAN	UPPER CONCOURSE TO ENTRANCE AT GRID 2 & 3	ES-06	10.5	SS	4	10	1810	1600	4755	3515	26.456	UG1-SYST-NMK-DWG-NAA-5254 & 55
38	MAHAKARAN	UPPER CONCOURSE TO ENTRANCE AT GRID 15	ES-07	10.5	SS	4	10	1810	1600	4755	3515	26.456	UG1-SYST-NMK-DWG-NAA-5256 & 57
39	MAHAKARAN	UPPER CONCOURSE	ES-08	10.5	SS	4	10	1810	1600	4755	3515	26.456	UG1-SYST-NMK-DWG-NAA-5256 & 57

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
		TO ENTRANCE AT GRID 15											
40	ESPLANADE	B-(3-5), (MEZ TO LC)	ES-09	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4365-4373
41	ESPLANADE	B-(3-5), (MEZ TO LC)	ES-10	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4365-4373
42	ESPLANADE	B-(3-5), (MEZ TO LC)	ES-11	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4365-4373
43	ESPLANADE	F-(4-6), (MEZ TO LC)	ES-12	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4374-4382
44	ESPLANADE	F-(4-6), (MEZ TO LC)	ES-13	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4374-4382
45	ESPLANADE	F-(4-6), (MEZ TO LC)	ES-14	12.685	Glass	4	13	1790	1350	4440	3500	29.910	UG2-D-ESP-AR-4374-4382
46	ESPLANADE	B-(16-18), (MEZ TO LC)	ES-15	12.685	Glass	4	13	1790	1290	4440	3500	29.910	UG2-D-ESP-AR-4383-4390
47	ESPLANADE	B-(16-18), (MEZ TO LC)	ES-16	12.685	Glass	4	13	1790	1290	4440	3500	29.910	UG2-D-ESP-AR-4383-4390
48	ESPLANADE	F-18, (GF TO MEZ)	ES-17	7.455	SS	4	7	1790	1340	4440	3500	20.852	UG2-D-ESP-AR-4391-4394
49	ESPLANADE	F-18, (GF TO MEZ)	ES-18	7.455	SS	4	7	1790	1340	4440	3500	20.852	UG2-D-ESP-AR-4391-4394
50	ESPLANADE	B-11, (LC TO PL)	ES-01	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4401-4402
51	ESPLANADE	D-(14-15), (LC TO PL)	ES-02	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4403-4404
52	ESPLANADE	D-(14-15), (LC TO PL)	ES-03	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4403-4404

TABLE NO 2

ESCALATOR DETAILS

S.N.	STATION NAME	LOCATION	ESC NO	TRAVEL IN METER	TYPE OF BALLUSTRADE	NO OF STEPS	RISE IN METER	PIT WIDTH IN MM	PIT DEPTH IN MM	UPPER CONSTANT IN MM	LOWER CONSTANT IN MM	OVERALL LENGTH IN M	DRAWING REF NO
53	ESPLANADE	G-11, (LC TO PL)	ES-04	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4405-4406
54	ESPLANADE	B-(8-9), (LC TO PL)	ES-05	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4407-4408
55	ESPLANADE	D-(8-9), (LC TO PL)	ES-06	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4409-4410
56	ESPLANADE	D-(8-9), (LC TO PL)	ES-07	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4409-4410
57	ESPLANADE	G-(8-9), (LC TO PL)	ES-08	6.15	Glass	4	6	1790	1350	4440	3500	18.592	UG2-D-ESP-AR-4411-4412
58	ESPLANADE	F-5, (GF TO MEZ)	ES-19	7.455	SS	4	7	1790	1340	4440	3500	20.852	UG2-D-ESP-AR-4395-4398
59	ESPLANADE	F-5, (GF TO MEZ)	ES-20	7.455	SS	4	7	1790	1340	4440	3500	20.852	UG2-D-ESP-AR-4395-4398

4.0 SERVICES

4.1 The Contractor shall use the platform nomenclature in accordance with Table 1 and 2 and design the Lift & Escalator Systems with due regard to the specific details of the straight and curved platforms.

4.2 Detailed Design based on Preliminary Design provided by the Definitive Design Consultants of Underground stations UG-1 and UG-2 Contracts, is made available to the short listed Lift and Escalator (L & E) Contractors as a part of Main Tender document. The Detailed Scope of Work is as follows:

- Ø Detailed Design, Detailed Engineering, Prototype, Manufacture, Supply, Delivery to site, Storage at Site, Installation, Testing & Commissioning (including integrated testing and commissioning), Trial runs, Demonstration of Performance Guarantee of the equipment and System, Submission of O & M Manuals, DLP, Supply of Contract Spares, Training of Staff, Annual Maintenance Contract and co-ordination with Designated Contractors for a complete system necessary to deliver the requirements of the contract.

- Ø Preparation of final detailed Construction drawings/ General Arrangement Drawings and layouts to achieve the desired performance characteristics for submission to the Engineer for obtaining notice of no objection.

- Ø Equipment and Installation shall comply with all relevant latest Codes, Standards and Regulations specified in the Tender document.

- Ø Include all minor civil works as mentioned in clause no 2.1 (b) and 3.1 (b) associated with Lifts & Escalators System works at four underground stations respectively. However all major foundations wherever required are carried out by the Civil Contractors.

- Ø Maintenance/Housekeeping of the premises during Construction and Implementation stage.

- Ø De-mobilization, clearing of all temporary works and facilities after completion of job.

- Ø Interface and coordination with UG-1 and UG-2 Contracts for Civil and Plumbing & Drainage works; Tunnel Ventilation System Contract; Environmental Control System Contract including ISMS and E & M Contract (including Fire Protection System). Interface with all other UG Station Civil and Architectural finishes Contracts and UG E & M Contract (including Fire Protection System).

- Ø Preparation of Operation and Maintenance Manual Training of maintenance / Operation personnel.

- Ø Preparation of working drawings and “As Built” drawings

- Ø Obtaining the clearance certificate from Electrical Lift Inspector/EIG, RDSO and CRS and any other relevant statutory authorities as applicable.

- Ø Obtaining the Fire clearance certificate from Fire authorities and other statutory authorities as applicable.

- Ø Warranty Obligations and maintenance during Defect Liability Period.

- Ø 10 years Comprehensive Maintenance coverage of the entire system executed under the Scope of this tender beyond Defects Liability.

- Ø Detail engineering, equipment sizing and selection based on Sustainable Design, Energy efficiency and obtaining highest level of LEED Accreditation.

- Ø Providing all the required civil works details/inputs including foundations, inserts, openings and other structural works required for the erection of Equipment, system and sub-system to the Civil Contractor (UG-1 & UG2) and UG Station Architectural Finishes Contractor in time for casting.

- Ø Works to be performed shall also include all general works preparatory to the above mentioned works of any kind necessary for the due and satisfactory execution, completion and maintenance of the works to the intent and meaning of the drawings adopted and technical specifications, to best Engineering standards and orders that may be issued by the Engineer from time to time, compliance by the agency with all Conditions of Contract, supply of all materials, apparatus, plants, equipment, tools, fuel, water, transport, offices, stores, workshop, staff, Labour and the provision of proper and sufficient protective works, diversion, temporary fencing, lighting and watching required for the safety of the public and protection of works on adjoining land; first-aid equipment, sanitary accommodation for the staff and workmen, effecting and maintenance of all insurances, the payment of all wages, salaries, provident fund, fees, royalties, duties or the other charges arising out of the erection of works and the regular clearance of rubbish, clearing up, leaving the site perfect and tidy on completion.

- Ø Any other item of work as may be required to be carried out for completing the work under this Contract in all respects in accordance with the provisions of the Contract and/or to ensure the safety of installation during and after execution.

- Ø The proposed capacities, sizes, of sub-systems/equipment in Lifts & Escalators system, as a result of the design development shall be demonstrated by a proper design and testing / simulation study and subject to review by the “Engineer” and Notice of No Objection by the Employer.

- Ø The Contractor shall be fully responsible for obtaining relevant safety certificate or any other approvals required from statutory authorities for installation, commissioning and operating the Lifts & Escalators System before Revenue Service and submit the certificate to the employer immediately.

- Ø The Contractor shall provide adequate signage and graphics on the Lifts & Escalators System to comply with statutory requirements, for the safe and proper use of equipment, and for user’s convenience and subject to review by the “Engineer” and approval by the “Employer”.

- Ø Incoming cable connections / arrangement for Power supply at 415 V, 3 phase, 50 Hz to Lifts & Escalators shall be provided by the E & M Contractor up to an L&E Isolator at a specified location on lift wall/escalator pit/escalator room mentioned by L&E Contractor at U/G Stations. The Lifts & Escalators Contractor is required to provide suitable connection from these Lift and Escalator Isolators provided by L&E contactor to their respective Control panels which include cables, cable containment and termination at both ends.

- Ø To ensure there is no touch voltage hazard between the Lifts & Escalators System and the station structure. The same will be bonded directly to the station earth / return rail.

- Ø The Ohmic value from any point on the Lifts & Escalators System structure to the station earth terminal will not exceed 0.1Ω providing the station earth terminal is 25m of the Lifts & Escalators System.

- Ø It is possible that a potential difference may exist between the Lifts & Escalators System and the vehicle. If a potential difference does exist it is the responsibility of the contractor to ensure that this is maintained at a safe level and does not cause a touch voltage hazard between the Lifts & Escalators System and the vehicle.

- Ø All necessary UPS / Power pack Back up for control supply of Lifts & Escalators shall be made available by Lift & Escalator Contractor. Only Generator back up power supply will be made available.

- Ø Spare parts.

- Ø Presentations, reviews and audit support as specified in the Specification.

- Ø Interface management as specified in the Specification.

- Ø System operations and maintenance support services.

- Ø Training for the Employer's Engineers and Training Instructors, operations staff, maintenance staff and Engineering staff.

- Ø Integrated System testing.

- Ø The Contractor will have to interface with the following designated Contractors / Consultants as a minimum during the course of execution as part of Design and Construction interfaces.

    i. Contractor (UG-1 and UG-2) for Civil, Structure and Architectural works, UG Station Architectural finishes contractors.

    ii. Contractor for U/G-E&M, U/G-ECS including ISMS, and UG- PSD (R) & UG/TVS (R) works.

    iii. Other Rail System wide contractors viz signaling & telecom, rolling Stock, Power Supply, AFC and Track work.

4.3 Other statutory requirements

4.3.1. The Contractor shall be fully responsible for obtaining relevant safety certificate or any other approval required from statutory authorities, Commissioner of rail Safety, Government Lift Inspector/ EIG etc. for installation (Erection Permission), commissioning and operating the Lift and Escalator System before Revenue Service. The renewal of the license / safety certificate during DLP will also be the responsibility of the contractor. Fee, if any for obtaining such license/ certificate shall be borne by the contractor.

4.3.2. The Contractor shall submit the original copies of the license/relevant safety certificates to the Employer. Coloured photocopy of license should be displayed in the glass frame inside the elevator car and for escalators designated place after the employer's approval.

4.3.3. The Contractor shall provide adequate signage and graphics on the Lifts and Escalators System to comply with statutory requirements, for the safe and proper use of equipment, and for user's convenience after getting the approvals from employer.

4.4 System Components and Interfaces

4.4.1. It is a maintenance requirement that plant and equipment can be delivered via the platforms onto Works Trains and vice versa during non-traffic hour. To meet this objective, the Lifts and Escalators installation shall be designed such that removal and restoration of equipment shall be accomplished during non-traffic hour without disruption to the operation of the railway operation in the following day. Contractor to make all such arrangement for transportation including supply and operation of special trolleys. All such trolleys to be used for transportation of material to station must be cleared by Engineer before use.

4.4.2. Lifts and Escalators Support Structures and Architectural Components

The Lifts and Escalators Systems provided by the Contractor shall be complete entities including all appurtenances, finishes and components. This shall include all necessary structural, semi-structural and architectural elements required to form, adequately support, restrain and reinforce the entire Lifts and Escalators installation.

These elements shall have the appropriate properties, and be of adequate design, to safely accommodate all the design loads identified herein in addition to Lifts and Escalators dead weight, operational and dynamic loads.

5.0 DESIGN and PERFORMANCE REQUIREMENTS

5.1 General

5.1.1 Detailed Design, Detailed Engineering, Prototype, Manufacture, Supply, Delivery to site, Storage at Site, Installation, Testing & Commissioning (including integrated testing and commissioning), Trial runs, Demonstration of Performance Guarantee of the equipment and System, Submission of O & M Manuals, DLP, Supply of Contract Spares, Training of Staff, Annual Maintenance Contract & Statutory government approvals, of the Heavy Duty Machine-room less Elevators and Heavy Duty Escalators shall meet the design and performance requirements within the design environments specified in this PS.

5.2 Design Environment

5.2.1 Climate Conditions/Operating Environment stipulated in Volume 2 (Part II) of General Specification shall apply.

5.2.2 Isoceraunic level: Average 30 thunderstorm days per year as per IS 2309:1989.

5.2.3 The stations are exposed to extreme weather conditions such as heat, dust humidity and occasional seepage. The system design shall, take into consideration these conditions and ensure that performance of the system remains unaffected due to such conditions.

5.3 Basic Design Philosophy and Requirements

5.3.1 Proven Design

(a) The Contractor shall develop the design based on this specification and on proven and reliable Engineering Practices. The design details shall be submitted with technical data and calculations to the "Engineer" for review.

(b) The System, including all Sub-systems and Equipment shall be of proven design.

(c) The Elevator and Escalator Sub-systems and Equipment proposed by the Contractor shall have been in use at minimum two Metro Projects to and have established their performance reliability over a period of at least two years during past ten years. The performance certificate from the client/ User of the system is to be submitted.

(d) Where similar equipment or Sub-systems of a different rating are already proven in service, then the design shall be based on such equipment. In case these stipulations are not fulfilled, the Contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered Sub-system.

The design philosophy should meet the following criteria:

(i) Application of state-of-the-art Technology
(ii) Service proven design
(iii) Design life 30 years
(iv) Minimum life cycle cost
(v) Low maintenance cost
(vi) Use of interchangeable, modular components
(vii) Extensive and prominent labelling of parts, cables and wires
(viii) Use of unique serial numbers for traceability of components
(ix) High reliability and ensure Zero passenger trapping
(x) Low energy consumption
(xi) System safety
(xii) Adequate redundancy and factor of safety.
(xiii) Fire and smoke protection
(xiv) Use of fire retardant materials
(xv) Environment friendly
(xvi) Adherence to operational performance requirements

(xvii) Maximum utilisation of indigenous materials and skills, subject to quality conformity.

(xviii) Security system (a CCTV camera and cabling to be installed, in the lift shaft, shall be procured and handed over by the Communication Contractor to the Lift Contractor to be installed in the lift car at site).

(xix) Lighting in conjunction with station lighting and architecture.

(xx) A PA speaker and cabling, to be installed in the lift shaft, shall be procured and handed over by the Communication Contractor to the Lift Contactor at site

(xxi) Lift contractor to ensure in design that when PA speaker is activated, Lift announcement system of the elevator has to be stopped automatically.

5.3.2 Adequate margin shall be built into the design particularly to take care of the higher ambient temperatures, dusty conditions, and high seasonal humidity, etc. prevailing in Kolkata Region.

5.4 Design Management and Control

5.4.1 In order to ensure that the requirements of this Employer's Requirements Specification Part I and Part II are met, the Contractor shall establish and maintain documented procedures using ISO 9001 to control and verify the design of the System and all its equipment. These procedures shall be subject to review by the "Engineer".

5.4.2 The Contractor shall establish and maintain a systematic, documented, comprehensive, and verifiable system integration process throughout the execution of the Contract.

5.4.3 This process shall ensure that interfaces and interaction between System, infrastructure, sub-systems, software, and operating and maintenance requirements have been identified and engineered to function together as a system.

5.5 System Integration Process

5.5.1 The Contractor shall systematically identify and formally document all design, manufacturing and operational interfaces between equipment within the System, and between the System and external systems, facilities, operations and the environment likely to affect or be affected by the System.

5.5.2 A mechanism and assigned project responsibility for interface management and control shall be provided, such that every identified interface has a defined resolution process that can be monitored.

5.5.3 The Contractor shall define methods to confirm compatibility between System equipment and carrying out integration tests at different stages of the design and

interface management process to demonstrate that all equipment functions perform properly, both individually and as part of the complete System.

5.5.4 The Contractor shall ensure that performance, availability and safety requirements are addressed in the design process and that the reliability and maintainability of all equipment will enable the service performance to be met.

5.5.5 The system integration process shall be capable of audit by the "Engineer".

5.6 Interface Management Plan

5.6.1 The Contractor shall submit to the "Engineer" for review an Interface Management Plan (IMP) and Detail Interface Documents, in accordance with the Specification, which defines how the Contractor will systematically identify and document technical interfaces. This will not absolve the contractor of the ultimate responsibility for ensuring timely & appropriate interface.

5.7 Design Submission Requirements

5.7.1 The Contractor shall perform his designs for the Contract in accordance with the requirements of this Employer's requirement Specification Part I and Part II. The Contractor shall submit to the "Engineer" for his review, relevant design information as identified under each stage. Such submissions shall incorporate the relevant Standards applicable.

5.7.2 The design submission requirements are detailed in the Employer's requirement Specification Part I and Part II.

5.8 Performance Features Required

5.8.1 The Contractor shall provide built-in diagnostics and remote monitoring functions for each microprocessor-based equipment and module of the systems such that the performance requirements can be demonstrated.

5.8.2 The reliability and maintainability processes and procedures shall be planned, integrated and developed in conjunction with the operating environment, and the design, development and production functions to permit the most effective and economic achievements of the systems and equipment design objective.

5.8.3 The systems shall meet or exceed the requirements for safety and reliability as specified in National or International Standards for such mass rapid transit system. The reliability of the systems designed, supplied and installed is the principal element for availability. It is essential that the System reliability is as high as reasonably practicable.

5.8.4 A high design standard incorporating redundancy if practicable, flexible system arrangement, together with good quality products, and adherence to strict construction standards, are required to ensure high reliability of systems installed for smooth operation of train services.

5.9 Reliability Requirements

5.9.1 The achieved level of reliability for each lift shall be 565 hours MTBF prior to COD and 1,125 hours at the end of the DLP, resulting in a Service Failure as defined in section 7.

5.9.2 The Contractor shall comply with the guidelines of EN 50126, IEC 60300-1, IEC 60300-2 and IEC 60571 for electronic equipment, and IEC 60605-1 in meeting the reliability, availability and maintainability requirements of equipment

5.9.3 The reliability of equipment should ensure that it does not result in passenger trappings in the Elevator due to equipment failure. Any claim/ Damage /Compensation claimed by the affected passenger/ Elevator / Escalator user on account of equipment failure shall be recovered from the firm.–Employer's Representative may impose a penalty @ Rs: 15000/- (Rs. Fifteen Thousand Only) per case. The penalty is applicable during DLP and AMC

5.10 Availability

Service Availability Targets

- Quantitative targets have been set for the System availability to ensure that the reliability of the Systems does not jeopardise the reliability of services of the Kolkata East West Metro System.
- The Systems shall be designed to ensure that failure of any major equipment, caused by an external accident or negligence of internal staff, will not lead to unavailability of the whole System, other than temporary outage of the failed equipment.
- All elements of the systems shall be able to be maintained during out-of-traffic hours to avoid interrupting passenger train services.
- The safety related features of the lift shall achieve a minimum availability of 99.99% at the end of the DLP

5.11 Maintainability

5.11.1 The Contractor shall undertake maintainability analysis to assess the preliminary maintainability targets of the systems.

5.11.2 The Contractor shall state the maintainability requirements and demonstrate that System maintainability is sufficient to support the claimed System reliability and availability performance. The Contractor shall demonstrate that maintenance errors

have been considered, and, as far as is practicable, the risk of maintenance-induced faults has been mitigated by the appropriate design.

5.11.3 The equipment to be supplied by the Contractor must be designed for minimum or no maintenance. Maintenance activity required must be capable of being performed with minimum or no impact on the train service.

5.11.4 Maintenance activities may be classified into two areas, routine preventative and corrective, both of which affect service availability. Other maintenance strategies such as condition monitoring may be incorporated.

5.11.5 Routine/preventive maintenance periods shall be limited to non-operational maintenance hours during the night or if essential during off peak periods.

5.11.6 To optimise speedy corrective maintenance, techniques employing automatic diagnostics test points, and rapid repair facilities shall be provided.

5.11.7 The MTTR time measurement shall include on site diagnostics and rectification of the failure up to the point that the system is restored to full functionality. In the event that the failure cannot be rectified, the measurement shall include the time necessary to remove the failure piece of equipment from the system and replaced it with a functioning module.

The maintainability shall measure by fault rectification time which should not exceed One (1) hour since its reporting to contractor call centre or his representative by OCC/Employer's Representative.

Failure: Lifts not available for more than one hour for passenger service shall be registered as a failure provided. Date and time of the fault with error code provision is required.

5.11.8 Call out ratio

Failure: Elevator not available for more than one hour for passenger service shall be registered as a failure provided:

(1) Failure is attributable to –

(i) Design defect
(ii) Equipment failure / replacement
(iii) Manufacturing defect.
(iv) Wrong Erection
(v) Maintenance lapse (during DLP & AMC by the contractor)

OR

(2) "Mantrap" resulted because of any of the above defect. The call out ratio i.e. Engineer visit to the site for non-schedule maintenance for the failures as defined above should not exceed 2 on any one of the elevators in a year. The average call out ratio should not exceed 1.5 for No of elevators provided by the bidder under this

contract on the concerned line. The period one year will commence from date of Revenue Operation Taking over whichever is later. If the visit of engineer for non-schedule maintenance exceeds 2 per lift per year or 1.5 average call out ratio exceed, a penalty of Rs. 15,000/- (Rs Fifteen Thousand Only) shall be imposed for each such visit. The penalty shall applicable during DLP and AMC

5.12 Safety

5.12.1 Safety Requirements

§ The installation design shall incorporate measures to avoid presenting safety hazards to people.
§ The Systems design shall incorporate measures to provide for its safe management and operation.
§ The Systems shall not give rise, or be subject to, dangerous interactions within the railway or with other systems.
§ The installation shall meet the fire safety requirements generally as per NFPA-130 and NFPA 101
§ The design of the earthing system shall conform to IS 3043: 1987

5.12.2 Safety Targets

· The Contractor shall show that the Systems can be maintained safely. The Contractor shall prepare a Quantified Risk Assessment (QRA) to model the risk to (a) travelling public and (b) maintenance and operations staff. The QRA may be based on a comparison of System features and operating practices with other system metro systems for which risk levels are known.
· The contractor shall demonstrate that the systems have been designed to minimise the risk due to operator and maintainer error, considering both ergonomic aspects of the system designed to reduce the likelihood of the error, and protective measures to mitigate the consequence of such error.
· The Contractor shall demonstrate that risk to passengers, members of public, including trespassers is as low as reasonably practicable.

5.13 Conformity with Governing Specifications and other Statutory Requirements

5.13.1 The work shall be carried out in accordance with the following governing specifications and other statutory rules:

· Indian Electricity Rules 1956 with latest amendments.
· Indian Electricity Act 1910 with latest amendments.
· Rules and Regulations prescribed by local authorities as applicable.

- Relevant, Indian Standards, IEC Standards, British Standards, and other National/International standards as applicable.

5.13.2 The Contractor shall furnish information asked for by a statutory body (e.g., Inspector of lifts, Inspector of Escalators, Commissioner of Railway Safety, etc.) in particular format as directed by "Engineer".

5.14 Functional Requirements – Machine - Room less Elevators

Heavy Duty Machine-room less Elevators shall be provided in the stations to facilitate the movement of commuters, handicapped person, staff and cash trolleys between the different levels of the stations from Subway to Ground level (GL) to the Concourse (C) or from Concourse (C) to Platforms (P).

The Contractor shall verify the number of Elevators vertical rises, travels, stops, delivery routes and all other relevant information by co-ordination with the respective Civil Contractors. It shall be responsibility of the Contractor to provide the elevator suitable for the constructed shaft. No variation on this account will be payable.

5.15 Functional Requirements - Escalators

Heavy Duty Escalators shall be provided in the stations to facilitate the movement of commuters between the different levels of the stations from Ground Level (GL) to the Concourse (C) or from Concourse (C) to Platforms (P). The Contractor shall verify the number of Escalators, vertical rises, lengths, travels, stops, delivery routes and all other relevant information by co-ordination with the respective Civil Contractors.

6.0 DESIGN CRITERIA AND PERFORMANCE SPECIFICATION - machine-room less Elevators

6.1 Introduction

Kolkata East-West Metro System shall be equipped with Heavy Duty machine-room less Elevators for handicapped & elderly persons and staff in locations as listed in the Particular Specification. The lift design should comply with EN81-20 & EN81-50 and any latest edition which is applicable.

6.2 General Requirements

6.2.1 Each Elevator shall have its own driving machine. The method of drive shall be Electric Traction motor having VVVF Control.

6.2.2 All Elevators shall be capable of operating satisfactorily and smoothly at a rate of 180 motors starts per hour or above for a period of not less than 20 hours per day, seven day a week, within the environmental conditions as stated in the General Specification and at the location where the Elevators are to be installed. These elevators should be designed for minimum 10, 00,000 (Ten

lakh) operations per year and with minimum failures as defined in Employer's requirement Specification Part I and Part II .

6.2.3 The design of the Elevators shall be such that no major repair shall be necessary for a period of 20 years from the date of issue of Certificate of Taking Over. This is based on the requirements that detailed inspections and maintenance are carried out annually, whilst routine cleaning and maintenance are carried out as necessary.

6.2.4 Major repair shall mean replacement of car frame, car enclosure, car and landing doors, elevator shaft wiring (except travelling cables), guide rails, drive machine, gear box and driving sheave, but parts attached to these components which are subjected to normal wear and tear are excluded.

6.2.5 The design of the Elevators shall take into consideration fire prevention, elimination of dust and dirt traps, and easy accessibility for cleaning and routine maintenance.

6.2.6 The gear less drive machine shall be mounted on guide rails accommodated within the elevator shaft. The power switch gear and main control equipment shall be suitably located inside or near the Elevator shaft, the location of which is to be decided in coordination with the Designated Civil Contractors. No separate machine-room is proposed to be provided for machine room less Elevators

The function of each Elevator involves primarily for the movement of disabled and elderly persons and also of other commuters and staff. The reliability of the Elevator is therefore of paramount importance.

The nominal speed for the Elevators shall be 1.0 m/s in either direction.

The Contractor shall take all necessary measures to accommodate the Elevators in the dimensions of shaft. The Contractor shall co-ordinate with the Designated Civil Contractors for all matters related to shaft size. Any minor reduction in the shaft size (depth and width) to the tune of **+ 250 mm and – 100 mm** shall have to be accommodated in the design by the contractor by way of provision of suitable guide brackets/stainless steel channels without any additional charges. The contractor shall be responsible for any delay on this account.

6.2.7 The false ceiling height of the Elevator car shall not be less than 2300mm. The Elevator and door shall be configured so that it is possible to handle a person on a wheel chair.

6.2.8 Both the car and landing entrance clear opening width shall be as per table no 1 and the door shall be of center opening type.

6.2.9 The approximate travels and the location of Elevators are given in Table-1. The Contractor shall verify the above and all other relevant information through co-ordination with the Designated Civil Contractors.

6.2.10 The Contractor shall submit in their technical packages the requirement in respect of reaction load on the walls and in the pit and other relevant shaft requirements. The Contractor is required to interface with Designated Civil Contractor in respect of the Elevator shaft requirement. The Contractor shall co-ordinate with the Designated Civil Contractors to finalize all the details.

6.2.11 The Contractor shall provide Seismic operation Control system with primary wave sensor for the Lifts measurable in Richter scale. These shall be integrated with Seismic operation control device through RMS/ ISMS System. Upon detecting such wave, the equipment shall direct all the Lift cars in the Station to the nearest floor and immediately open doors for safe exit. The lift shall only be reset manually after the signal is clear and the lift has been inspected by the maintenance personnel. Minimum One number of primary wave seismic sensors shall be provided in each station.

6.2.12 Upon Detection of a Seismic wave, a signal to be sent to the Central Monitoring System. Display on CPI/HPI & voice announcement shall be commenced during this operation.

6.2.13 Seismic risks should be considered, and special supports shall be provided, wherever required.

6.2.14 Earth Quake Design: Apart from earth quake rescue system, the elevator vendor should provide rope and counter weight retaining brackets, Counterweight displacement detector with low voltage wire, anti-snag guards to prevent swinging ropes and traveling cables from hanging up. Once earth quake shock waves have ceased, the elevator hoist way should be inspected for any displaced equipment before placing the elevator in operation

6.2.15 The leveling accuracy shall be within ± 5 mm of the finished floor level. Other Design criteria requirements are as follows:

A. Car Speed: ± 2% of contract speed under any loading condition.
B. Car Capacity: Safely lower, stop and hold 125% of rated load.
C. Car Stopping Zone: ±4mm under any loading condition.
   Door Opening Time:
D. Door opening speed should be adjustable at site.
E. Door Closing Time:
   Door closing speed should be adjustable at site.
F. Mean time between failures (MTBF) shall be in excess of 8500 hours, i.e. one failure per year measured under corrective maintenance. . MTBF does not include failures due to Acts of God but only failure of the equipment due to normal wear and tear or plant failure.
G. Mean Time to repair (MTTR) under corrective maintenance shall be less than 4 hours per year. This time includes diagnosis time, to time to repair / replace/ adjust the equipment, time to restore to service and time to carry out any functional or safety checks. This time excludes the routine maintenance time. MTTR does not include failures due to Acts of God

but only failure of the equipment due to normal wear and tear.

H. Car Ride Quality:

1. Horizontal acceleration within car during all riding and door operating conditions. Not more than 15 mgal (geared) peak to peak (adjacent peaks) in the 1 - 10 Hz range.
2. Acceleration and Deceleration: Smooth constant and not more than 0.9144 meter/second^2 with an initial ramp between 0.5 and 0.75 second.
3. Sustained Jerk: The jerk rate shall not be more than 1.5 times of acceleration/deceleration and in no case shall exceed 8 feet/second^3.

6.2.16 The running clearance of each Elevator between the Elevator car threshold and landing door sill shall not be less than 15mm but not more than 30mm.

6.3 Electric Traction Drive System

6.3.1 Traction Machine

The construction of all Elevator machines shall conform to IS-14665 and BS 5655: Part1

6.3.2 Motor

(a) Driving motor shall be of the Permanent Magnet AC synchronous/asynchronous axial type designed for special duty cycles required for Elevator operation with no slip rings. It should have a high starting torque, high power factor, high efficiency and low energy consumption. The motor efficiency should be not less than 90% and the power factor should be not less than 0.9 at any load & speed/RPM. The bearing used should be of spherical roller type to ensure longer life. The drive sheave, and deflector sheave (if required) shall be mounted in proper alignment on a common, isolated bedplate.

(b) The motor shall be capable of not less than 180 starts per hour without excessive temperature rise.

(c) The maximum temperature rise of the winding shall not exceed 50 ^{0}C above ambient temperature when operated under normal condition. During prototype ambient temperature has to be created as per Kolkata ambient conditions for motor test to validate the requirement.

(d) The motor to be tested at full load capacity and maximum temperature rise of the winding shall not exceed 50 ^{0}C above ambient temperature when operated under normal condition.

(d1) Third party test report has to be submitted by lift contractor. Third party test will be witnessed by employer/consultant and thereafter the design will be accepted. The third-

party type test report should be as per Kolkata ambient temperature condition for motor test to validate the requirement.

(e) Provision shall be made to enable the speed to be checked at main Control cubicle.

(f) The motor shall carry a nameplate giving full details of its ratings and characteristics

(g) The motor used shall have Class F insulation, IP 54 and shall be designed for 110% of rated load.

6.3.3 Brake

(a) The Electro-magnetic brake shall be of the spring applied and electrically released type.

(b) The brake shall be capable of stopping and holding the Elevator car in its downward travel to rest with 125% of its rated load from the maximum governor tripping speed. In this condition the retardation of the Car shall not exceed that resulting from the operation of the Safety gear or stopping on the buffer.

(c) Springs used to apply the brake shoes (two nos.) shall be in compression and adequately supported.

(d) Brake linings shall be of renewable incombustible materials and shall be secured to the brake shoes that normal wear shall not weaken their fixings. Band brakes shall not be used.

(e) No earth fault, short circuit or residual magnetism shall prevent the brake from being applied in the event of loss of power supply to the Elevator motor and control circuit.

(f) A means of adjusting the brake plunger stroke and releasing the brake in emergency shall be provided.

(g) The Elevator machine shall be fitted with a manual electrical emergency device with battery backup capable of having the brake released by hand and requiring a constant effort to keep the brake open. In normal operation, the electromagnetic brake shall only be applied when the lifts have come to complete stands still. The brake shall only be meant for holding the lift in the position at every landing, providing best stopping control without any jerking effect. In case of MRL lifts, the motor brake shall be able to be remotely released outside the lift well.

Additionally, the battery charging status is to be linked with RMS/ISMS to monitor the status.

(h) In case manual electrical emergency device with battery backup operational fails, additionally manual system has to be provided for rescue of the passengers.

Design for additional manual system will be reviewed and functionality will be witnessed by employer/consultant during prototype and thereafter the design will be accepted and the clearance for the manufacturing will be granted.

6.3.4 Encoder

Encoder shall be of Direct drive, solid-state, digital type. These shall be able to update car position at each floor and automatically restore after power loss

6.3.5 Driving Sheaves

(a) The sheaves shall be manufactured in steel or SG iron and fitted with sealed for life lubricated bearings. Bearing make to be approved by employer and test certificate has to be produced for the bearing.

(b) The sheaves shall have machined rope grooves that can be reworked for future wear.

(c) Adequate provision shall be made to prevent any suspension ropes leaving groove due to rope slack or introduction of foreign objects.

6.3.6 Alignment

(a) The brake plunger, collar, sleeve, motor, sheaves and all bearings shall be mounted and assembled so that proper alignment of these parts is maintained.

(b) The assembly shall be reviewed and rectified when excessive noise is emitted during operation.

6.3.7 Anti-Vibration Supports

The whole traction machine shall be mounted on appropriate anti-vibration supports to minimize noise and vibration.

6.4 Hoisting Rope

6.4.1 At least three (3) steel wire ropes specially manufactured for Elevator use shall be employed for the suspension of Elevator car and counterweight. The diameter of rope for the car and counterweight shall conform to latest version/ amendments of IS: 14665 (Part 4/Sec. 8).

A plate giving the number, size and ultimate tensile strength of the rope used shall be permanently fixed to the crosshead.

6.4.2 Before installation, manufacturer's certificates shall be supplied for each set of hoisting ropes with the following data: -

(a) The type of wire rope

(b) The diameter in mm

(c) The manufacturer's rated breaking strength

(d) The month and year the ropes were manufactured

(e) The manufacturer's name

6.4.3 The factor of safety based on maximum static load for car and counterweight ropes shall be least 12.

6.4.4 The ropes shall be attached to dead-end hitch assemblies, fitting to supporting beams, car frames, counterweights by means of suitable rope termination. A locking device or anti-twist rope device shall be fitted to the roping system. Alternately approved arrangement for wedge type rope or Flat reinforced belts complying to latest edition of EN81-1 may be used. The number and size of ropes shall comply with the factor of safety requirements to the latest edition of EN81-1. Necessary Test certificates for ropes or belts for compliance with appropriate Code shall be provided prior to shipment. If Flat belts are used, vendor shall ensure that the flat belts are of adequate strength so that there is no bouncing of the lift car at any level. Further a safety device or sensor shall be installed so that if any strand of the flat belt breaks, the functioning of the lift is stopped until the belt is changed.

6.4.5 Compensation ropes or chains or any other arrangement shall be provided if necessary to achieve the leveling required and smooth starting. If chains are provided, they shall be galvanized and enclosed in canvas hose or other accepted means to reduce noise.

6.5 Counterweight

6.5.1 Guide shoes, having non-metallic renewable linings requiring minimum lubrication shall be provided at the top and bottom of the counterweight. The counterweights shall be made of cast iron, wrought iron, steel or lead and shall be appropriately secured. They shall be of uniform density and physical dimensions.

Structural Steel frame with cast-iron sub weights secured with tie rods or steel sub weights secured with clamps to prevent movement. Weight shall be equal to total car weight plus 40-50% (±3%) of contract load. Counterweight shall be screened by means of a rigid, galvanized steel sheet to a height of 2.5m from the bottom of the pit and at the point

where the Counter Weight and car crosses. Provide counterweight safety device as per code. Arrange the counterweight frames so that fillers can be added or removed without disturbing the ropes. If there are pulleys on the counterweight they shall incorporate devices to avoid the suspension ropes (if slack) leaving the grooves and the introduction for any foreign objects between ropes and groves.

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6.5.2 Not used

6.6 Clearances and Run-by for Car and Counterweight

6.6.1 The top clearance of the car and counterweight shall be as stated in IS Standards.

6.6.2 The bottom run by of car and counterweight shall be as per relevant IS Standards.

6.6.3 When the car rests on its fully compressed buffer, there shall be a vertical clearance of at least 600 mm between the pit floor and the lowest structural or mechanical part, equipment or device installed beneath the car platform except guide shoes or rollers, safety-jaw assemblies and platform aprons, guards or other equipment. However, when the car rests on its fully compressed buffer, no part of the car or any equipment attached thereto shall come into contact with any part of the pit or any part of the equipment located therein.

6.6.4 The clearance between the car/counterweight and the hoist way enclosure shall be at least 20 mm except on the side for loading and unloading.

6.6.5 The clearance between the car and the counterweight shall be at least 25 mm. The clearance between the counterweight and the counterweight screen shall be at least 20 mm.

6.7 Guides and Fixings

6.7.1 Planed steel tees shall be provided as guides for the Elevator car and counterweight, as appropriate, erected plumb and fixed securely to the Elevator shaft by steel brackets. The bracket shall be solidly fixed with the RCC beam/bonds. The guide rails shall be connected by steel fish plates

6.7.2 The rail contact surfaces of the connecting rail plates and back of the guide rail ends shall be accurately machined and fitted at site to form smooth joints.

6.7.3 The stem sections of all guides shall be tongued and grooved to provide matched joints. The guides and their fixings shall be able to withstand the forces imposed by a fully loaded car traveling at or higher than the tripping speed of the governor, due to the application of the safety gear, without permanent deformation or bending due to the uneven loading of the car. The guide rail brackets shall be hot-dipped galvanized.

6.7.4 Guide rail brackets shall be of steel and bolted securely to the building or structure steelworks. The brackets shall be designed and located such that the rail will not deflect more than 5 mm under normal operation. There shall be a minimum of two brackets per piece of guide rail and the distance between brackets shall not be more than half the length of each piece of guide rail. The bracket should be fixed to PCC blocks or RCC beams. This particular requirement is to be ensured during interface with designated civil contractor. It is the sole responsibility of the elevator Contractor to interface with Civil Contractor, to satisfy himself about the Shaft strength before taking up Lift Installation and get the strength of the shaft wall certified from the civil Contractor.

6.7.5 The fixing of guide rails to their brackets and to the building structure shall permit compensation, either automatically or by simple adjustment, due to normal settling of the building or shrinkage of concrete. The strength of guides, their attachments and joints shall comply with EN 81-20 & EN 81-50 and be sufficient to withstand the forces imposed due to sudden application of safety gear under maximum load and deflection due to uneven loading of the car. It is the Contractor's responsibility to provide exact / suitable support system, fixing accessories and distances. When rail length exceeds 30 m, means shall be provided to absorb rail expansion and structural settlement.

6.8 Elevator Car

6.8.1 Guide Shoes

Roller guides shall comply with the following requirements:

i. Each roller guide shall consist of three wheels tyred with polyurethane or a durable resilient material, each rotating on ball bearing having sealed-in lubrication, assembled on a substantial metal base. They shall be so mounted as to provide continuous contact of all wheels with the corresponding rail surfaces under all condition of loading and operation. The wheels shall run on three finished rail surfaces. The Contractor shall provide a means of adjustment of spring pressure and of play between shoes and guide rails.

ii. The roller guides shall run on dry guide rails. Sheet metal guards shall be provided to protect the wheels on top of the car and counterweight. The roller wheels for the car shall not exceed 500 rpm and the roller wheels for the counterweight shall not exceed 1000 rpm at rated speed.

iii. The car and the counterweights are to be statically balanced following fitting of all its equipment and finishes prior to fitting the guide shoes.

iv. Catalogue for the manufacturer with all the specification to be submitted along with the design.

6.8.2 Car Frame

A suitable car frame fabricated from galvanized rolled steel, bolted, or welded together to form a rigid structure shall be provided. The deflection of the members carrying the platform shall not exceed 1/1000th of their span under static conditions with the rated load uniformly distributed over the platform. It shall be able to withstand the operation of the safety gear or any condition loading without permanent deformation and shall not transfer the load to the enclosure. The safety factor of the frame shall not be less than five (5).

6.8.3 Car Enclosure

(a) The car enclosure shall be fabricated from SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness or any other material where specified and securely fastened to the car platform and so supported that it cannot be loosened or become displaced in ordinary service or on the application of safety gear or on buffer engagement. The design of the final finishes of the walls, ceiling and floor is subject to the acceptance of the “Engineer”.

(b) Elevator car should be provided with trap door above false ceiling for evacuation with proper locking arrangement as approved during prototype. No wood or other combustible materials shall be used for any part of the Elevator car including car door and emergency trap door.

(c) The enclosure shall be designed and supported such that when subjected to a pressure of 335N applied horizontally at any point over an area of 5 cm^2 on the walls from the inside of the cars toward the outside, there shall be no permanent deformation and deflection shall not be more than 10mm.

(d) The enclosure shall be insulated to prevent the transmission of noise and vibration from the car frame.

(e) The SS 304 honeycomb pattern should be either horizontal or vertical throughout for car enclosure, car operating panel, displays, landing and car doors, SS landing door architraves etc. and to be approved by employer.

6.8.4 Car Platform

(a) The car platform shall be constructed from spray galvanized rolled steel with steel flooring. The platform shall be designed on the basis of the rated load being evenly distributed with a minimum safety factor of five (5). The design of the final floor finish is subject to acceptance by the "Engineer".

(b) The car platform shall be insulated to prevent the transmission of noise and vibration from the car frame to the platform.

6.8.5 The car roof shall be suitably constructed with stainless steel and reinforced to permit the maintenance and inspection of the Elevator shaft equipment to be carried out by maintenance personnel standing on the car roof. Perforated with mesh construction of the roof or wooden platform(s) on the car roof shall not be acceptable. The car roof shall be fitted with guard rails set as at a height and of suitable dimensions and strength to protect maintenance personnel.

6.8.6 A toe guard shall be provided for the car doors conforming to Paragraph 8.4 of EN81 Part 1. The toe guard for Elevators shall be made of galvanized sheet steel of not less than 1.5mm thick and painted and shall be adequately braced at the back. The depth of the toe guard shall be sufficient to prevent any object from being trapped between the underside of the car platform and the landing during re-levelling operation (with a minimum of 700 mm).

6.8.7 Ventilation

(a) Each Elevator car shall be adequately ventilated using a Fan/Blower to achieve a minimum standard of 20 air changes per hour. The 4 fans/Blowers shall be located above the suspended ceiling or recessed in the car ceiling as appropriate.

(b) A low speed fan of low noise, axial blower type shall be used. The noise from the fan measured at a distance of 1 meter away within the Elevator car shall not exceed 50dBA.

(c) The effective area of ventilation apertures shall be at least 1% of the car platform area

(d) Fan and lights shall switch on automatically when car is called or when landing doors are opened, remain switched on whilst car is in operation, and switch off by time relay 180 - 240 seconds after car has stopped. However, a fan control switch should be provided in the Car Operating panel so that passengers can control the cooling as per convenience. LED lighting shall be provided inside car. Lighting

fixtures shall be provided with heat tempered safety glass. Samples shall be submitted for approval of Employers.

(e) Natural ventilation shall be provided for each car irrespective of provision of forced ventilation or air conditioning.

6.8.8 The car door shall be provided with an electric contact arranged to prevent the normal operation of the Elevator unless the gate is in the closed position. The car gate shall be arranged to give the minimum clear opening width as specified.

6.8.9 The car junction box with IP Class 65 protection, for the traveling cables and car enclosure wiring shall be installed at the car top. Car junction box with IP class 65 shall be used for all UG stations.

6.8.10 Car Interior and Elevator Finishes

Unless specified elsewhere in this Specification, the following finishes for the Elevator shall be complied with: -

(a) **Landing Finishes**

i. Landing Transom Panels - Scratch Resistant Stainless steel, SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness

ii. Architrave (Fascia/ Jamb) - Scratch Resistant Stainless-steel SS 304 honeycomb, stainless steel of not less than 1.5 mm in thickness

The fascia of minimum 300 mm width on every landing or as per site condition for fixing the Landing Plate, Indicators, MCP etc. shall be of Scratch Resistant Stainless-steel SS 304 honeycomb and shall be in scope of elevator Contractor. The architrave design with drawings and details have to submitted and approval to be taken before manufacturing.

Stiffener to be provided for the rigidity of the architrave panels. MAP/MCP and Isolator to be aesthetically designed without any gaps in the panels.

There should not be any gap between wall and architrave.

No screws should be visible on the architraves.

Stone cladding matching SS architrave should be coordinated, and proper interface is to be done by Lift Contractor.

iii. Landing Doors - Scratch Resistant Stainless-steel SS 304 honeycomb, stainless steel of not less than 1.5 mm in thickness

- For the glass Door, Thickness of glass door shall not be less than 10mm and with the Scratch Resistant stainless-steel frame. The fire rating of the glass shall be minimum 1 hour.

(b) Car Finishes

i. Car Transom Panels - Scratch Resistant Stainless steel, SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness

ii. Car Door Frame - Scratch Resistant Stainless steel, SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness

iii. Car Wall

1. Front Panels - Scratch Resistant Stainless steel, SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness

2. Side Panels - Scratch Resistant Stainless steel, SS 304 honeycomb stainless steel of not less than 1.5 mm in thickness including the COP (Car Operating Panel)

3. Back Panels - Scratch Resistant Stainless steel, SS 304 honeycomb Joints in all surfaces shall be coordinated. All fixings to be of the hidden secret type (Cover strips at joints are not acceptable)

iv. Car Doors - Scratch Resistant Stainless steel, SS 304 honeycomb with 1-hour fire rated stainless steel of not less than 1.5 mm in thickness

- For the glass door, Thick ness of glass shall not be less than 10mm and with the stainless-steel SS 304 honeycomb. The fire rating of the glass shall be minimum 1 hour.

v. Car Floor - 15mm thick Granite having anti-slippery design, with the approval of Employer.

vi. Car Ceiling - Scratch Resistant Stainless-steel panels SS 304 honeycomb with sufficient down LED lights or other ceiling design to be coordinated with the overall station design to the “Engineer” acceptance. Suitable arrangement to be provided for trap door operation.

vii. Car Kick-Plates and skirting - Scratch Resistant Stainless-steel SS 304 honeycomb finish,

viii. Hand/grip rail - Polished Stainless steel, steels SS 304

All stainless-steel materials specified for car and landing finishes shall be of grade of 304 and shall be subject to the acceptance of the "Engineer". The samples have to be given for approval from employer.

All car interiors/architrave, doors and interfaces with civil structure and finishes shall be subject to the acceptance of the "Engineer".

6.8.11 Illumination of Cars and Lighting Fixtures

The minimum illumination level at the floor of the Elevator car shall be 150 lux using energy saving LED fittings with. The use of indirect lighting shall be subject to the acceptance of the "Engineer".

6.8.12 Emergency Lighting

In addition to the normal car lighting provided, a maintenance free emergency light fitting shall be provided in each elevator car, which may be the same type of fitting as the normal car light and shall illuminate immediately and automatically in the event of failure of the normal car lighting electrical supply. The fitting shall incorporate a permanently illuminated signal to indicate mains healthy and shall be connected to the emergency battery. The luminous intensity of the emergency lighting shall be not less than 100 lux measured at floor level and on the car operating panel(s).

6.9 Elevator Doors

6.9.1 Car and Landing Doors

Each elevator shall be provided with horizontal sliding doors complete with door frames and architraves, arranged in centre opening with two panels.

Unless otherwise specified, the car and landing door panels shall be imperforate and fabricated from stainless steel hairline (grade304) finish of at least 1.5mm thick. The back of the door panels shall be treated with an anti-drumming compound which is non-combustible and shall not emit toxic fume when affected by fire. The compound shall be reviewed without objection by the "Engineer".

The requirement of Glass Door is specified in sub – clause 6.29 below. There should not be any visible projection of any component on landing glass door.

The door shall be able to withstand horizontal or lateral load according to latest version/ amendments of IS: 14665 (Part 4/sec 6): 2001.

The doors shall be provided with keyways for interlocks.

Doorsills shall be of Stainless-Steel Grade 304 with a non-slip wearing surface. Grooves for the guides shall be extruded with minimum clearance for the guides.

6.9.2 Door Hangers and Rollers

Both car and landing doors shall be fitted with sheaves type door hangers. The sheaves wheels shall be tyred with as sound attenuating material and shall rotate on grease packed precision ball bearing. The up thrust of the door shall be taken by a roller mounted underside to the hanger track.

The roller shall be mounted on an eccentric stud to provide for adjustment. Alternately, any other approved device for door adjustment may be used. The hanger tracks shall be of either formed cold rolled steel or cold drawn steel of heavy section with surfaces shaped to conform to the tread of the hanger sheaves and rollers. Suitable means shall be used to transmit motion from one door panel to the other.

6.9.3 Door Operators

The door operator for each Elevator shall consist of a motor, operating mechanism, linkages and switches to give adjustable or variable speed door operation and shall be adjusted to ensure smooth, fast opening and closing. The average door speed shall be between 150 – 250 mm/sec. The car and landing doors shall operate simultaneously and quietly while the Elevator car is levelling.

For the car and landing door made of glass panels with stainless steel SS 304 frame, steel cover of not less than 1.5mm thick or other suitable arrangement for headers shall be provided with “Engineer” approval to prevent the door locking devices, door tracks and mechanism from accumulation of dust. For stainless steel Elevators steel door covers shall be made of galvanised steel.

On “Without Attendant” mode, if no command is registered or due to some abnormality in Lift Safety circuit, after the expiry of a preset time interval of 10-30 seconds (Adjustable) the door shall re-open once for 30 seconds (Adjustable) so as the commuter can come out and then close.

For Elevators on “With Attendant” operation, the car and landing doors shall open automatically but the closing of doors will be subject to the pressure on “Door Close’ button. During the closing motion it shall be possible to reverse quickly and open the doors by pressing of the “Door Open” button.

The door lock shall prevent the car doors from being opened by the door operator or by force when the car is moving or is not stopped within the unlocking zone of a landing. Electric interlocks shall be provided to ensure that elevator will not operate, if the car door is not closed and locked. If the car door is forced open, the Elevator shall stop, and the alarm activated (even when the Elevator is out of order) until the door is fully closed. The audio-visual alarm signal shall be sent to the relevant landing as well as to SCR and CC rooms.

6.9.4 Door Safety Devices

6.9.4.1 Electrically Operated Proximity Detection Device

Electrically operated proximity detector devices(s) shall be installed on the leading edge of the car doors. The device(s) shall create a three-dimensional zone of protection for the entire height of the door opening. This zone of detection shall extend a short distance in front of the landing doors. The zone of detection shall move forward as the doors close and the presence of a person, if within this zone, shall activate the detector to stop the closing movement of the doors and re-open them before hitting the person. After a preset time, interval (which is programmable) the doors shall start to close again in the absence of further interruption. A passenger entering or leaving the car shall not cause the doors to stop and re-open unless the doors' edge reaches a certain predetermined proximity to the passenger. The contractor shall consider the ambient condition inclusive of sunlight before deciding the sensitivity of the device, so as to avoid mal operation.

If the doors are prevented from closing by the pressing of hall and/or car buttons or a person in their path for an adjustable pre-set time, the safety devices, except the mechanical door safety edge, shall be rendered inoperative to cause door reversals. The doors shall proceed to close at a reduced speed and a buzzer located on the car shall sound before and during the closing.

6.9.4.2 Photo Cells

Two Photo cells shall be provided for each car door for preventing door closing when a passenger is entering or leaving the car. This should act as a backup protection to 3D-infrared curtain.

6.10 Not Used

6.11 Car Operating Panel (COP)

6.11.1 Car operating panels and car call buttons shall be ergonomically designed and of robust construction to the Engineer acceptance. The car operating panel shall be integrated and flush mounted, on one of the side panels. All buttons on the panel shall be of robust design and construction and flush with the panel. The samples of all the buttons with manufacturer test certificate shall be submitted to employer for approval.

6.11.2 The faceplate shall be made of scratch resistant stainless-steel grade SS 304 honeycomb finishes. Each car operating panel shall contain, but not limited to the following:

6.11.3 Flush Mounted in the COP on the side Panel.

(a) An alarm button in yellow colour with bell shaped symbol self-illumination type, when pressed, shall activate the alarm hooters and register the alarm condition through the Remote Monitoring System at the SCR/ CC room or as per requirement of employer. The Audio-Visual console/display of suitable size shall be installed at the top most and lowest landings as well as in SCR /Customer Care Room.

(b) A red “Car Overload” indicating lamp with buzzer and announcement in Hindi, English & Bengali Language.

(c) Two vertical rows (where appropriate) of car call buttons for floor designations bearing numerals/ alphabets and Braille code next to each button for visually handicapped.

(d) A “Door-Open” button which, when pressed, shall cause the closing door to reopen or when continuously pressed shall keep the door open.

(e) A “Door-Close” button which, when pressed, shall cause the door to close to shorten the door open time.

(f) An intercom button (self-illuminating feedback type), when pressed, shall allow direct communication with the personnel in the SCR/CC room, and main control cubicle. The Contractor shall submit their features and proven Vendor of intercom to Employer for review and approval.

(g) A capacity plate engraved onto the car operating panel shall indicate the rated load in kilograms and the maximum number of passengers to be carried. The size and design of the lettering shall be subject to the acceptance of the "Engineer".

(h) Not used.

(i) An "ON/OFF" switch whereby the ventilation fan shall be automatically controlled through car calls.

(j) Provide Emergency stop button in the car operating panel. When operated shall bring the lift to nearest landing with alarm and the communication through ISMS to SCR/OCC etc

Each button shall be of micro-push suitable for heavy duty and vandal proof type. The response light shall be either orange or red when illuminated.

6.11.4 A key operated switch shall be provided on the car operating panel at a suitable location to facilitate elevator operation as under;

(a) One or more switches whereby the following modes of operation can be affected as desired:

i. Fully Automatic without Attendant operation.

ii. Automatic with Attendant operation.

iii. Operation by Firemen in accordance with local standard and statutory requirements.

(b) Not used.

(c) Not used.

(d) "UP/DOWN" buttons which shall cause a car to travel in the desired direction. These buttons shall be operative only during the "Attendant" operation.

(e) An "ON/OFF" switch whereby the ventilation fan can be switched on and off.

(f) Not used.

(g) Not used

6.12 Car Position Indicator

6.12.1 The faceplate of the car position indicator shall be made of SS 304 honeycomb. The Stainless-steel plate should be 2-2.5 mm thick and its mounting arrangement should have minimum two sunken screws. This plate should be pilfering proof. Floor numbers shall be digitally displayed using 5 “x 7” LCD. There shall also be an arrow in motion vividly and dynamically indicating car movement and direction. It shall also be capable of displaying simple message such as, floor names like Over Load, Ground level, “Concourse, Platform”, “Out of service”, under maintenance”, ‘’Fireman Operation’’, ‘’Seismic”, ‘’Automatic Rescue Device’’ etc. The surface of the display unit shall be non-glare type.

A voice announcer, in English, Hindi & Bengali shall be provided to indicate operation of the doors and the floors where the elevator stops and the direction of the elevator. It shall also announce Over load, "Seismic", "Fire” ARD function when applicable. The announcement shall be 100% synchronized with the actual operation of the elevator. During PA Speaker is announcement, Lift announcement should stop automatically.

6.13 Elevator Inter-Communication System

6.13.1 The Contractor shall provide an Elevator inter-communication between the Elevator Car, main control cubicle and Station Control Room (SCR) / OCC/BCC room consisting master and slave stations.

6.13.2 All stations shall be equipped with handsets except those slave stations installed inside the Elevator cars, which shall be of the hands-free type.

6.13.3 A master station shall be supplied and installed in the Station Control Room (SCR) room.

6.13.4 A slave station shall be supplied and installed in the main control cubicle and also in each Elevator car. The loudspeaker and microphone unit of the slave station shall be concealed in the car operating panel. The necessary cabling, conduits including from SCR room to main control cubicle etc shall be provided by the Contractor with proper interfacing with designated Contractor. Routing shall be finalized with the designated contractors before fixing of the false ceiling in the stations. It should be possible to decipher the identity of calling Elevator at the SCR room. The Lifts (inside and outside) should also be numbered at each station for the purpose of easy identification.

6.14 No-Smoking Notice

6.14.1 A "SMOKING IS STRICTLY PROHIBITED" sign shall be supplied, and surface mounted on the front return panel in each Elevator. The graphics, lettering and material shall be subject to the acceptance of the "Engineer".

6.15 Certificate Holder

6.15.1 A framed, and glazed panel made of stainless steel, suitable to display the Elevator certificate shall be provided above the car operating panel. This shall be subject to the acceptance of the "Engineer".

6.16 Hallway Equipment

6.16.1 Landing Doors

(a) Fire Rating

Stainless steel landing doors shall have a minimum of 2 hours fire rating. Landing doors with glass panels shall have a minimum of 1 hour fire rating. These doors shall be suitably tested and provided with approved stickers.

(b) Door Frames

Door frames shall be of at least 1.5 mm thick stainless steel in SS 304 honeycomb finishes and shall comprise head and jamb sections of the same material. The door frames shall be suitably braced and reinforced.

The frames shall be provided with adjustable wall anchors or comparable devices to permit bonding of these anchors or devices into the walls after the frames are in place. All frames shall be securely fastened to sills and hanger supports and shall be returned to the hoist way side to present a neat appearance.

The gaps between the structure and the door frame / door jambs shall be neatly finished by fire rated materials/ fire sealant by the lift contractor.

(c) Door Sills

All door sills shall be of at least 3.0 mm thick SS 304 with a non-slip wearing surfaces. Grooves for the guides shall have sufficient clearance for movement of the guides. The sills shall be supported on steel anchor plates securely fastened to the landing door sill supports. The costs for providing all the

necessary steel support for the door sills shall be deemed to have been included in the Contract.

Toe guards similar to those provided to the car door sill shall be provided beneath each landing door sill.

(d) Supports and Covers

Structural steel angles shall be furnished and of sufficient size to accommodate the door closing equipment. The angles shall be continuous and securely bolted to the sills and the building structure.

Hanger cover plates shall be made of galvanized steel, for Elevators with landing as well as car door made of stainless-steel SS 304 honeycomb finish. For other Elevators having car door as well as landing door made of glass with scratch – resistant SS 304 stainless steel frame, hanger cover plates shall be made of stainless-steel SS 304 honeycomb finish. These covers shall be removable, and so arranged to ensure hanger accessibility from within the Elevator car for maintenance purposes. Cover bolts and threaded screws shall be adequately strong, with long life and capable of frequent opening and closing.

(e) Self Closing

Gravity or spring actuated self-closing device shall be fitted to the landing doors so as to automatically re-close the doors when manually opened by means of the emergency unlocking device. The gravity weight shall move freely and quietly within its enclosure fixed at each end of the door sill and be protected from falling into the elevator shaft due to whatever reason. This device shall not be accessible to public. The ends of door weights shall be covered with Teflon caps to eliminate the noise during closing and opening of the door.

(f) Locking Device

i. Each landing door shall be provided with an accepted locking and interlocking device to prevent the operation of the elevator unless all landing doors are closed and locked.

ii. It shall not be possible to open the landing door from the landing side without a landing door key.

iii. The locking device shall have at least IP 54 protection.

iv. The electric contacts of the door locking device shall open positively independent of gravity. The circuit of the electrical contact shall be routed through ARD battery back-up.

v. Each landing door panel shall be provided with its own locking device.

vi. Provision shall be made for opening of all landing door locks by means of a landing door key by an authorized person irrespective of the position of the Elevator car.

(g) Fascia

Where the gap between the car door sill and surface of the Elevator shaft wall exceed 125 mm, galvanized sheet steel fascia plates of not less than 1.5 mm thick shall be provided. These shall be fixed between the undersides of landing entrance sills and the top of the door hanger case to form a flush surface in the path of travel at the car entrance. The plates shall cover the whole width of the landing door and extend by 150 mm on each side of the door. It shall be rigid and properly reinforced. The fascia plate shall be painted in a accepted colour.

6.16.2 Hall Call Buttons

One (1) set of halls call buttons shall be provided for each Elevator at every floor served. The set of buttons shall be installed on the wall adjacent to each Elevator landing.

The faceplate shall be made of stainless-steel grade SS 304 honeycomb finishes. The Stainless-steel plate should be 2-2.5 mm thick and its mounting arrangement should have two minimum Sunken Screws. This plate should be pilfer proof. The hall call buttons shall be micro-push type, suitable for heavy duty and vandal proof. The response light of the call buttons shall be orange or red, when illuminated. When an Elevator arrives at the hall, the illumination shall cease.

Pushbuttons: Provide single riser(s) with flush mounted faceplates. Include pushbuttons for each direction of travel which illuminate to indicate call registration. Include approved engraved message and pictorial representation prohibiting use of Lift during fire or other emergency situation as part of faceplate. Provide vandal resistant pushbutton with Braille markings, LED illumination and tactile symbols. The buttons should be permanently illuminated of dull illumination and on activation shall be bright illumination. Hall fixture face plates shall be stainless steel SS 316 or 304. Sizes should be submitted by the Contractor to Client for review and finalization during detailed design phase

6.16.3 Hall Position Indicator

One (1) set of hall lanterns shall be provided for each Elevator at every floor served. The set of lanterns shall be installed on the wall adjacent to or on top of each Elevator landing. The display shall be the same as the car position indicator.

1. Hall position indicator of LCD type shall be provided at all landings for Lifts. It should indicate the position of the car in the hoist way with single or dual numeral and /or letter designations along with a scrolling arrow indicating direction of car travel including all functions as mentioned in revised Cl No 6.12 Car Position indicator also should display.

2. Hall Lantern: To provide for each Car(s). Provide at each entrance of each elevator to indicate travel direction of arriving car. Chime (for passenger Lifts) shall be provided to indicate car arrival. Illuminate up or down LCD display and sound tone once for up and twice for down direction prior to car arrival at floor. Sound level shall be adjustable from 20 - 100 dbA measured at 1.5 meter in front of hall control station and 1 meter off floor. Illuminate light until the car doors start to close.

3. An electrical alarm bell shall be provided in or adjacent to the elevator Hoistway. This bell shall be connected to the alarm button in the car operating panel. An alarm button in yellow color with bell shaped symbol, when pressed, shall activate the alarm hooters and register the alarm condition through the Remote Monitoring System at the SCR/ CC room or as per requirement of employer. The Audio-Visual console/display of suitable size shall be installed at the top most and lowest landings as well as in SCR and Customer Care Room.

4. The Contractor shall hand over emergency keys to all landing doors to the Client's Representative.

5. Fireman switch shall be installed at landing lobby in a locked cabinet with glass break feature for each elevator or a group of Lifts

6. Prior to the car's arrival, the hall lantern shall begin flashing and the chime shall sound twice.

7. The response light of the "UP" and "DOWN" indication lanterns shall be green and red respectively when illuminated.

6.16.4 Elevator Designation Number Sign

At each landing, Car Designation Number Signs shall be supplied and installed next to each Elevator by the Contractor. The Job number of elevator (as recorded on the elevator license) shall also be indicated on the plate.

The Number Signs shall be made of stainless-steel grade 304 mirror finishes. They shall fit into the designated space to be coordinated with the Civil contractor and shall be subject to the acceptance of the "Engineer" acceptance.

6.16.5 The Elevators equipment (i.e. Indicators, landing call plate, MCB etc.), if any at Ground level should be pilfer proof.

The Stainless-steel plate for mounting the indicators and landing call buttons should be minimum 2-2.5 mm thick and its mounting arrangement should have minimum two Sunken Screws.

6.17 Elevator Functions

The Elevator shall incorporate the following functions.

6.17.1 Not used

6.17.2 Door Nudging Feature

If the Elevator doors are kept open longer than the pre-determined time, an override alarm shall sound to alert the passenger that the doors must close so that system performance is not adversely affected.

6.17.3 Not used

6.17.4 Not used

6.17.5 Next Landing

The car shall automatically proceed to the nearest floor with a functioning landing door if the car doors fail to open at the designated floor.

6.17.6 Door Load Detector

When an object is caught in or interferes with the opening or closing of the doors, the doors shall reverse direction when an excess load is detected.

6.17.7 Safety Door Edge

When a passenger comes in contact with the door safety edge when the doors are closing, the doors shall re-open.

6.17.8 Overload Holding Stop

When the car load exceeds the pre-determined weight, in addition to the overload buzzer with the announcement of overloading, the Elevator shall not operate, and the doors shall remain open. The load cell /strain gauge mounted on the car frame shall be used as load weighing device. The complete technical features of devices that can be used for sensing the over load in the car should be most reliable and defined. The approval for the same to be obtained from the Employer.

6.17.9 Electronic Door Safety

When passengers are boarding or exiting the car as the doors are closing, the doors shall re-open before touching the passengers.

6.17.10 Homing Service

This function shall automatically home the respective Elevators to the pre-assigned floors. After transporting passengers to the assigned floor, the Elevator shall automatically home to its pre-assigned floor.

6.17.11 Not used

6.17.12 Up/Down Selective Collective Automatic Operation

The Elevator shall respond to all registered hall calls and car calls automatically. It shall respond to all registered hall calls and car calls in the direction of service. When no call is registered then after a pre-set adjustable period elevator car shall come to

designated floor and open the door for 30 seconds (adjustable time) and then park the car there with doors closed.

6.18 Operating and Safety Devices

6.18.1 Each Elevator shall be provided with an overload device of accepted design, which shall operate when the load in the car exceeds the rated load. When activated, this device shall prevent any movement of the Elevator car and shall cause a warning buzzer on the car to be set off and illuminate an “Overload” signal. This device shall be incorporated in the car-operating panel.

6.18.2 The water sensors in the elevator pits shall be provided wherever pits are on the ground level or below the ground level. The requirement of water sump in the elevator pits for such Elevators shall be coordinated with the civil contractor.

6.18.3 An inspection control panel shall be fitted on the top of the Elevator car for maintenance purpose. The design of the inspection control panel shall comply with the following requirements and prevent the Elevator car from being operated accidentally: -

a. It shall not be possible to control the Elevator car from any other position after the NORMAL/TEST change-over switch has been set to the TEST position. When in the TEST position, the UP and DOWN continuous pressure push buttons within this panel shall become operative.

b. An ON/OFF switch shall be provided. It shall render the Elevator inoperative in any mode, when the switch is in the OFF position.

c. The Elevator car shall only move when all safety devices are in the safe position.

d. The Elevator car shall move in either direction only on continuous pressure of the appropriate direction button at a car speed not exceeding 0.25m/s.

e. Not used

f. The control panel shall incorporate an adequately protected permanently located light fixture with a separate switch and a 15A switch socket outlet.

g. A door operator ON/OFF switch shall be provided. The door operator shall only be operative when the switch is at the “ON” position.

h. Associated with this control, a terminal stop limit switch shall be provided to stop the car from traveling in an upward direction not less than 1.8m from the soffit of the Elevator shaft. When this switch is activated, it shall not stop the car from operating in the down direction.

i. All switches and buttons on the inspection control station shall be clearly engraved with their functions. All buttons and switches shall be shrouded against accidental operation, with the exception of the emergency stop button.

6.18.4 The Elevator shall be provided with a floor-leveling device, which shall automatically bring the Elevator car to stop within ±5 mm of the level of the floor for which a stop has been initiated regardless of the load or direction of travel. In case of EBD mode, the car should stop within ± 10mm of the level of floor, this is subject to the Engineer's Acceptance at the design stage.

An automatic re-leveling device shall be provided which returns the Elevator to the floor automatically should the Elevator creep down or move up from floor level for any distance from 6 mm to 50 mm. This device shall be operative at all floors served whether the landing and car doors are opened or closed.

6.18.5 Each Elevator car shall be provided with safety gear mounted on the lower member of the car frame structure. This safety gear shall be capable of operating only in the downward direction and capable of stopping the car with full load at the tripping speed of the over speed governor, by gripping the guides and holding the car stationary. The motor circuit shall be opened by a switch on the safety gear before, or at the same time the safety gear is applied. It shall be possible to release the safety gear by raising the Elevator car without the use of any special tools.

A mechanical device and electrical device shall be provided to prevent the car movement resulting from maintenance / inspection that can be dangerous to persons carrying out maintenance / inspection works from inside the car or car roof.

6.18.6 An over speed governor shall be provided, which is capable of activating the safety gear in the event of the Elevator exceeding the rated speed by 40%. The tripping of the over-speed governor for the safety gear shall occur when the car speed exceeds 140 % of the rated speed downwards. A mechanically operated safety switch shall be provided to disconnect the power supply to the motor when the governor is activated. The governor shall be adjusted to operate the safety gear in accordance with the recommended limits set out in IS 14665. The governor rope shall be of steel and shall comply IS: 14665.

An over speed governor shall be provided to the Counter weight in case of Hanging pit. The Contractor is required to interface to designate Contractor for the requirement of hanging pits.

6.18.7 A phase protection device and 3 phase as well as single phase earth leakage protection device shall be provided in the main control cubicle of each Elevator to prevent the Elevator car from moving in the event that there is a phase failure, or the phase of the power supply being reversed due to any reason whatsoever. These devices, when activated, shall cause a visual indicator to illuminate on the main control cubicle, until the fault has been rectified.

As in the case of Power failure (including single phasing / unbalanced phase) elevator should operate in the EBD mode with EBD battery backup. This software for providing this feature is subject to the Employer's acceptance. The batteries status of charge/discharge shall be communicated to RMS/ISMS.

6.18.8 Two switches shall be provided in the Elevator shaft, one at bottom landing and other in the pit which, when in the "STOP" position, shall prevent any movement of the Elevator car, including inspection/test operation, until both the switches are set to the

"RUN" position. The switching positions shall be prominently labeled. The knob of these switches shall have luminous paint.

6.19 Electrical Requirements

6.19.1 Each Elevator shall be provided with a main control cubicle to accommodate all electrical switchgear. A caution notice with the wording "Danger- 415V/240V A.C. Do Not Remove Cover Unless Incoming Supply is Switched Off" shall be affixed to the cover/door.

6.19.2 The Elevators shall be designed to operate on a 415V±10% A.C. 3 phase, 4 wire, 240V±10% A.C. 50Hz single phase, power supply. Power supplies up to elevator's main control cubicle, will be provided and terminated by the Designated Contractors. The Contractor shall coordinate with the respective Contractors to incorporate their requirements. Main switch/MCB Box with ELCB etc. in unpaid area should be in lockable enclosure and in scope of elevator contractor. MCB box shall be IP-54. All ELCB's, MCBs & Switches should be as per Employer approved vendors. The shaft lighting (Lux requirement as per the IS), Ventilation arrangement and pit socket outlets shall be provided by the Elevator Contractor. The Fixtures and cables will need to get approval from the Employer.

6.19.3 All switchgear and other auxiliary apparatus shall be of accepted design and labeled for identification.

6.19.4 The control wiring shall be laid out neatly and clearly in cable sleeves and all terminals and cables shall be labeled or marked for identification. Embossing in the cables/Wires should contain Month & Year of Manufacturing.

Also, all the equipment's /fittings/ accessories which are supplied should not be more than four months old manufacturing.

6.19.5 All casing, covers, trunking and armouring shall be thoroughly and efficiently earthed and adequate protection shall be provided to prevent fuses and circuit breakers from arcing to earth or between phases.

6.19.6 Maintenance Access Panel (MAP) should preferably be located at top landing of lift. Maintenance Access Panel (MAP), its enclosure shall be IP 54, Pilfer proof. MAP shall have data down loading facilities for fault diagnostic through RS – 485 port. Fault data logging in MAP should have date & Time stamping facilities. MAP locking arrangement should be of SS 304. The wirings inside the MAP panel should be neatly dressed.

6.19.7 Shaft Lighting shall be in scope of lift contractor by maintaining the lux level as per statutory requirement and Indian standards. Shaft lighting fixtures should be LED Type.

6.19.8 The design of the contactors and relay contacts shall be such that the break and make contacts shall not be closed at the same time at any position of the armature. The operating conditions shall be as follows: -

a. If, one of the break contacts (i.e. normally closed) is closed, all the make contacts are open.

b. If, one of the make contacts (i.e. normally open) is closed, all the break contacts are open.

Not Used

6.19.10 In the control and safety circuits, the operating voltage of the mean value in the case of direct current or the r.m.s. value in the case of alternating current, between conductors or between conductor and earth shall not exceed 250V.

Control circuits shall be protected by fuses or equivalent means independent of the protection for the main circuits. All electronic components and relays shall be protected against starting and voltage surges by appropriate surge suppressers / surge arresters.

6.19.11 In the event of failure of the normal electrical supply, the supply to the alarm system, intercom system, emergency car lighting, and the ventilation fan shall be automatically switched to an uninterrupted power supply (UPS) provided by the Lift Contractor. The battery shall be of sealed maintenance free type with total capacity sufficient to maintain the operation of above equipment for at least two hours. All Hoistway and car top safety switches shall be rated to IP Class 55 (minimum). The rating of UPS is subjected to prior approval by Engineer.

6.19.12 All wiring and apparatus shall be subject to acceptance and suitable for the specified electrical supply. The insulation of all wiring including those within the controller shall be of flame retardant, low smoke halogen free type for underground stations only complying with the special cable requirement of this Specification.

6.19.13 All field wiring shall be multi-strand copper conductor type. No joints shall be permitted in any cables or wires in any location.

6.19.14 All wires shall be run in galvanized conduit or steel trunking. All conduit outlets shall be bushed with insulating bushes of accepted pattern. All wiring connections to switches and conduits shall be water tight.

6.19.15 The arrangements of terminals at either end of flexible trailing cables shall be identical and the terminal blocks marked to identify the cables connected to them. The cable boxes and wiring for the car light and the alarm bell shall be entirely independent of the elevator control wiring. Flexible trailing cables shall be securely clamped at each end so that the weight is not supported by any fixing of the various cores. The outer sheath of these cables shall be of waterproof and flame-retardant material. A total of 10 or 10% of the total number of wires used whichever is more and 2 spare shield cables shall be provided per Elevator. The outer sheath of these cables shall be waterproof and flame resistance material which shall not emit toxic fume when affected by fire (i.e. Low Smoke Halogen Free) for underground stations only.

6.19.16 The compatibility of MCB and ELCB used for Elevators shall be verified with the requirement of the Elevators. The MCB & ELCB are in the scope of elevator

Contractor, However, termination of main incoming cable on the MCB/ ELCB provided by the elevator Contractor shall be responsibility of Station E&M Contractor.

6.20 Provision for Remote Monitoring System (RMS)

6.20.1 The RMS will be provided by the designated contractor. However, the Contractor shall provide/receive the following status monitoring points and control points to the RMS in the form of interface voltage free contacts. Fault data logging should have Date & Time stamping facility.

a. Provision of elevator fault/trip signal

b. Provision of elevator car alarm signal

c. Provision of power available and failure status

d. Provision of elevator under maintenance signal

e. Receiving remote control signal for parking on/off operation

6.20.2 The elevator fault/trip signal shall be activated whenever there is a fault in the elevator system, which causes a breakdown. The signal shall be latched on for at least 10 seconds. It shall only be reset after the fault is cleared. The Audio Visual shall be available in Customer Care Cell and SCR, with the approval of Employer.

6.20.3 The alarm signal shall be activated with an audio repeated beep till it is reset whenever the alarm inside the elevator car is pressed.

6.20.4 A by-pass switch with illuminated indication, which shall de-activate the fault/trip signal to RMS when switched “ON” and give a “under maintenance” signal to RMS in SCR shall be provided in the controller for maintenance purpose. The switch shall be labeled in both Hindi and English and shall be subjected to the acceptance by the “Engineer”.

6.20.5 Upon actuation by remote switch from the RMS for parking on, the elevator shall complete the last landing or car call, if any, and return to the designated landing and stop there with both the car and landing doors open for 15-20 seconds and then close. The “Not in service” indicator shall be illuminated on the landing indicator automatically for a pre-determined time and then extinguished. The car light and ventilation fan shall be switched off automatically at the same time. The essential buttons e.g. door open, intercom and alarm bell etc. on the car operating panels shall be remained functional and illuminated when the Elevators have been parked and locked out.

6.20.6 Upon actuation by remote switch from the RMS for non-parking, the elevator shall be switched back to normal operation and both the car light and ventilation fan shall be switched on automatically.

6.20.7 The Elevator Contractor shall provide RMS cabling from Elevator to Interface Terminal Block (in Station Control Room). ITB is in scope of elevator contractor. The Contractor shall connect the contacts with screen wires and terminate the data cable for RMS at the terminals in the ITB to be located in SCR whereas the conduits from

the Elevator shaft to the SCR will be provided by the designated Electrical Contractor. The Contractor shall coordinate and interface with designated Electrical Contractor and/or his sub-contractor in association with conduits routing and sizing requirement. The connection from ITB to the RMS computer will be provided by the Designated Contractor. The Contractor shall coordinate and interface with the Designated Integrated Station Management System (ISMS) contractor with regards to this matter. The average length of data Cable for RMS from Elevator Panel to ITB is likely to be 30 meters in Rail Corridors and 85 meters in Metro (Underground) Corridor, but the actual length may vary as per site conditions, for which no adjustment (increase / decrease) in payments shall be applicable.

6.21 Special Emergency Operations for Elevators

6.21.1 The Elevator operation system shall be designed to provide the following emergency operation. The Contractor shall provide the ITBs with terminals for the Designated Contractor to terminate the fire and power failure signals. The Contractor shall provide the cabling up to the ITB.

6.21.2 Emergency Operation of Elevators in the Event of Power Failure

In the event of power failure or power interruption or single phasing or unbalanced phases (or any problem in the power supply which affect the normal operation of the lifts), the supply to all Elevators shall be automatically switched over to the emergency power supply (EBD Mode) and the Elevators shall be brought to the designated floor and shall park there with the doors remaining open. In case Power supply to the lift is restored through DG set/ Alternate source before the lift reaches designated floor even then EBD will complete its function and lift doors open at designation floor to evacuate the passenger. Thereafter, Elevator designated by the authorized person may resume operation depending on the capacity of emergency power.

6.21.3 Emergency Operation of Elevators in the Event of Fire

In the event of fire when any fire detection devices is activated, all Elevators shall automatically be brought to the designated floor (Ground Floor in case of Ground to concourse lift and Concourse in the lift of Concourse to Platform Lift or as per requirement of Employer) and shall park there with the doors open for 15-20 seconds and then close. All Elevators shall automatically be rendered inoperative after it has been brought to the designated floor. The essential buttons such as “Door Open”, intercom and alarm bell etc. on the car operating panels shall remain functional and illuminated. Normal operation of the Elevators shall be manually reset by the operation of a reset key switch.

6.21.4 Emergency Operation of Elevators in the Event of Power Failure and Fire

In the event of power failure and fire, the operation of the Elevators shall be in accordance with the “Emergency Operation of Elevators in the Event of fire” and the power supply shall be from the emergency supply panel at the stations.

6.21.5 A battery back-up device to home the Elevators to the landing in the event of power failure shall be provided. This shall be battery operated and shall be able to move the

Elevators with any load from no load to full load at reduced speed to the landing and open the doors. The Elevators door shall remain close until resumption of power supply and the Elevators shall automatically reset to normal. The direction of travel shall depend upon the load in the Elevator. During this operation all safety features of the Elevator shall remain operational. The rescue time of the device from the time of power failure to the time the doors fully open shall not exceed two minutes. However, the EBD start time can be adjusted from 0 to 30 sec depending upon resumption of emergency supply from alternative source / DG sets. The requirement of EBD will be finalized during the design stage depending upon availability of power from DG set. The landing accuracy shall be less than +/- 10.0 mm. The capacity of the battery when fully charged, shall be capable of operating the Elevator at rated load from one landing to another for a minimum of 3 trips without further charging. To ensure the same new battery shall be capable to perform the test for 6 trips without intermediate charging at the time commissioning. The battery shall be housed in a cabinet/ rack with a corrosion proof finish. The device shall immediately stop the Elevator and prevent further movement immediately, if there is a short circuit or open circuit in the inverter output. The rating of the battery shall be approved by the Employers during the design stage.

This device shall not modify the Elevator design and all its original safety features. The device shall be an additional accessory to the Elevator and shall not in any way affect the performance of the Elevator.

The performance of the charger and charging rate shall be equivalent to that of the UPS unit. Maintenance free batteries conforming to the relevant Indian or international standard shall be provided. There shall be no tripping of UPS in case rescue working. The specification of UPS shall be with approval of employer.

6.22 Elevator Monitoring and Fault diagnostic system

6.22.1 An Elevator monitoring and fault diagnostic system shall be provided for each Elevator by the Elevator Contractor. This system shall provide an auxiliary output port on the controller for plugging the laptop and down loading historical data, which will be reviewed at design stage.

6.22.2 Not used.

6.23 Not Used

6.24 Pit Facilities

6.24.1 Oil buffers shall be provided in the Elevator pit.

6.24.2 A safety switch to prevent the car from moving when the governor rope tension weight is out of position shall be provided.

6.24.3 Fixed cat ladders shall be provided between the bottom landing and the pit floor by the Contractor.

6.24.4 Two stop switches, one at bottom landing level in the shaft and the other in the pit shall be provided, which, when in the “STOP” position, shall prevent any movement of the elevator car including movement during inspection operation, until both the

switches are set in the "RUN" position. The switch shall have a mushroom head (red). It shall be locked off when pushed and reset manually.

6.24.5 First stop switch shall be accessible from the lower landing on opening of the landing door and the second switch from the pit floor. A stainless-steel faceplate of not less than 2mm in thickness, indelibly marked "Pit Stop Switch" in both English and Hindi characters and with legends to show the "STOP" and "RUN" positions shall be provided and fixed immediately adjacent to the switch. The knob of these switches or plate shall have luminous Paint.

6.24.6 Designated Civil Contractor shall provide proper drainage. But, to ensure proper drainage of Lift Shaft shall be the Elevator Contractor responsibility before starting the Installation.

6.25 Corrosion Protection

The Contractor shall take into consideration, the corrosive effect of the atmosphere in the Elevator design.

6.25.1 All steel components shall be hot dipped galvanized in accordance with BS 729, with minimum thickness of 85 µm.

1) Car Frame;

2) CW Frame;

3) Machine Frame;

4) Guide Rail Brackets;

5) Buffer Supports;

Other components shall be Cold Galvanized (Epoxy Zinc Coating)

6.25.2 All mechanical and cast-iron assemblies shall be cleaned and painted. The running surfaces of car guides shall be treated with an accepted rust preventive compound.

6.25.3 All parts constructed in sheet steel shall be either galvanized by the hot dipped process or fabricated from hot dipped galvanized sheet steel.

6.25.4 All hardware, fastenings, screws and shims shall be hot-dipped galvanized. However, all visible screws and fastenings shall be of stainless steel.

6.25.5 Wherever galvanization on ferrous components has been damaged in handling the same shall be given two coats of zinc chromate primer and two coats of aluminum paints conforming to IS 2339.

6.25.6 Galvanization shall comply with the standard mentioned below: -

ISO 1459	-	Metallic Coatings - Protection against corrosion by hot dip galvanizing – Guiding Principles;
ISO 1460	-	Metallic Coatings - Hot dip galvanized coatings of ferrous materials –Gravimetric determination

of the mass per unit area;

ISO 1461	-	Hot dip Galvanized coating on fabricated ferrous products – Specification;
ISO 2064	-	Metallic and other non-organic coatings – definitions and conventions concerning the measurement of thickness;
ISO 2177	-	Metallic Coatings measurements of coating thickness – coulometric method by anodic dissolution;
ISO 2178	-	Non-magnetic on magnetic substrates – measurements of coating thickness – magnetic method;
ISO 2859	-	Sampling procedures and tables for inspection by attributes.

6.26 Provision for the Disabled and Handicapped

All Elevators shall be provided with following features:

(a) Elevator control buttons at locations and height specified in IS 15330.

(b) Hall call buttons at locations and height specified in IS 15330.

(c) Hand rails shall be provided on the side walls of the Elevator at height & locations specified in IS:15330. An international symbol of access of the disabled shall be permanently and conspicuously displayed at each and every Elevator landing next to the Elevator entrance (to be provided by signage contractor). Braille notations indicating the floor levels shall be incorporated next to each button at the handicap COP and handicap hall call buttons.

(d) A digital voice system for announcing the car position, opening/closing of doors, direction of travel and messages shall be provided as per IS: 15330.

(e) A laminated framed safety mirror of at least half of the size shall be installed on rear panel at appropriate position. To facilitate easy reversal / exit of person on wheel chair from the elevator without the need of rotating the wheel chair in the elevator.

6.27 Miscellaneous

6.27.1 Circuit wiring diagrams shall be provided for all electrical circuits. They shall be in A1size paper suitably treated to prevent deterioration from dirt or age.

6.27.2 A data plate shall be attached to the cross-head members of the car frame giving the following information: -

(a) Contract load of the Elevator,

(b) Speed of the Elevator,

(c) Year of manufacture.

A Do's and Don'ts instruction SS 304 plate shall be provided on all landings of the elevators and inside the car cab only after approval of Employer. There should two different plates one outside and one inside the car. These plates should be very friendly and simple.

The instruction plate inside the car shall be provided for guiding the passenger how to act at the time of lift stopping.

6.27.3 Special tools required for the operation, servicing, maintenance and repair of the Elevator shall be provided and the list of such tools shall be submitted in Technical package.

6.27.4 Fault diagnosis procedures and circuit diagrams of the printed circuit board, detail information, software and technical data shall be provided to assist in trouble shooting for breakdown during normal operation and maintenance

6.27.5 A maintenance barrier shall be provided for elevator landing entrance which shall prevent people from entering the elevator car. The barrier shall be painted yellow, made from aluminum and be of minimum height 900mm.The sample of the same has to be submitted for approval from employer.

6.27.6 Accessories

Elevator shall be provided with the following accessories:

a. Two sets each of all necessary keys for the landing door, -MAP, ELCB panel per elevator at station

b. One set of Data Cables/instrument if applicable for downloading the fault error codes per station.

c. Not used.

d. Four sets of maintenance barrier per station for elevators.

6.28 Earthing

All the Elevators shall be provided with earthing arrangements as per IS- 1860.

6.29 Special Requirement for Elevators with car and landing doors made of glass panels with stainless steel hairline frame

6.29.1 Detail design of the Lifts of Glass door with stainless steel SS 304 honeycomb finish frame shall be carried out by the Contractor and reviewed without objection by the "Employer/ Employer's Representative" before fabrication.

6.29.2 Prototype landing and car doors made of glass panels with stainless steel SS 304 honeycomb finish frame shall be pre-assembled in factory for inspection before delivery. The glass doors shall be of a design that includes a frosted glass panel/ sticker at lower section of the glass doors to provide privacy for women wearing dresses of length midway between knee and waist level.

6.29.3 Car roof shall be stainless steel SS 304 honeycomb finish cover panels exposed to public view with a collapsible maintenance platform or any other suitable arrangement with "Employer/ Employer's Representative" approval above. It shall be able to sustain two persons and be able to resist a vertical force of 2000N at any position without permanent deformation. Permanent, hinged and foldable safety balustrades or any other suitable arrangement_with "Employer/ Employer's Representative" approval forming an integral part of car top maintenance platform shall be provided. The design shall be to the review of the "Employer/ Employer's Representative".

Glass shall comply with the following requirements:

(a) General

i. All glass shall be clear float glass.

ii. Glass thickness shall not be less than 10 mm. The selection of glass thickness and type shall be in accordance with the information contained in the latest editions of BS 6262, BS 952: Part 1, BS6206 and European Standard EN81, Annex J or equivalent international standard.

iii. Particular regard shall be given to adequacy of glass thickness to withstand the calculated design loads and types of location to satisfy safety recommendations. Any reduction in strength characteristics due to acid etching, etc. shall be taken into account.

iv. Where the edge of laminated glass is to be exposed, the interlayer material must be shown to be resistant to the effects, including clouding and delaminating, of moisture absorption and contact with normal industrial strength cleaning solutions.

v. The Contractor shall conduct a thermal stress analysis of the glazing system, undertake thermal calculations and make due allowance for toughened glass.

vi. All glass shall be manufactured and processed in a factory where the quality control procedures comply with the latest editions of ISO 9000 (BS 5750, or equivalent international standard) and are independently maintained.

vii. No glass shall be used which contains scratches, chips, bubbles or other blemishes which are likely to lead to failure at loadings less than which the unit is designed to withstand.

viii. The glass shall be free of all discernible body and surface faults, and no glass which exhibits discernible optical or reflective distortions shall be used.

ix. Unless reviewed without objection by the "Employer/ Employer's Representative", all glazing shall be marked with permanent identification in accordance with the latest editions of BS 6206, and in a position visible but not prominent at the bottom left hand corner of the glazing unit.

x. Glazing shall be provided with edges that are ground, have a frosted appearance and arises chamfered and polished.

xi. Toughened glass shall be tempered on a roller hearth furnace and shall conform to Class A Classification in accordance with the latest editions of BS 6206 or equivalent international standard. Vertical toughening shall not be permitted. The glass panel of car door shall have minimum half an hour fire rating and glass panel of landing door shall have minimum one hour fire rating.

xii. All toughened glass shall be heat soak tested to prevent the risk of spontaneous glass breakage due to nickel sulphide inclusions and other impurities. The method of heat soak testing shall be determined by the glazing manufacturer, such that after testing the probability of failure in service shall be less than one in 130 tonnes of glazing. The Contractor and glazing manufacturer shall, after testing, demonstrate by statistical analysis of test data that the probability of failure is not greater than the specified value.

xiii. All edgework, holes and notches in the toughened glass shall be completed before the toughening process.

xiv. Permissible roll distortion inherent in toughened glass shall be restricted to the horizontal plane when glazed/installed, and local defects such as tong marks shall not be permitted.

xv. Dimensional tolerance on panel size shall be +/- 1mm of the theoretical dimension required.

(b) Glass door Lift cars are to meet the following performance criteria:

i. Laminated glass with one pane of toughened glass and one pane of heat strengthened glass.

ii. Glass panels to be capable of resisting applied loads when supported at each corner by a bolt fitted within a hole drilled in the glass. The details shall be reviewed by the "Employer/ Employer's Representative":

Applied loads:

Dead:	Self-weight of glass. Dead loads imposed by adjacent glass panels (if any).
Live:	Normal to panel 0.75 KN/m^2. Live loads 0.75 KN/m^2@ mid pane.
Impact:	Equivalent to 50 Kg baggage trolley @1.8m/sec.

iii. Laminated toughened glass shall be capable of resisting point impacts, to the toughened face, equivalent to a 85mm hardened steel ball freely dropped from a height of 3m, carried out in accordance with the latest editions of BS 5544.

iv. The glass shall remain in place if either one or both panes break.

v. The glass shall be free of bow sufficient to cause visual distortion when viewed normal to glass.

vi. Maximum deflection under applied loads 15mm.

vii. Statistical/failure rate of glass under normal operating load <0.4%.

viii. A prototype glass wall assembly, indicative of the Passenger/Glass Lift car enclosure, shall be fabricated during the prototype/testing stage, and shall be subject to the strength and deformation tests.

(c) All glass shall be marked to identify that it has been tested and inspected to manufacturer's standard which is reviewed without objection by the Employer's Representatives.

(d) The tolerance of glass shall be within:

i. Panel size + 3mm.
ii. Step in laminated edge + 3mm.
iii. Bolt hole position + 2mm.

(e) A typical 5mm gap shall be allowed between adjacent glass panels and between edges of glass panel and stainless-steel corner. The gaps shall be sealed with a suitable sealant material. Extent of seal shall be from the base of the floor to the top of the glass walls. All areas of glass edges subject to contact with the sealant shall be treated with a separator chemical to mitigate the chemical reaction between the PVB interlayer and sealant. The Contractor shall conduct standard test from the glass manufacturer to demonstrate compatibility between sealant and PVB interlayer, the width of edge de-lamination is not to exceed 1mm under simulated exterior exposure for a period of 2½ years.

6.30 Special Cable Requirements

6.30.1 All cables used except those within the enclosed controller shall comply with the following requirement: -

6.30.2 All Control cable shall be rated for minimum 750 v and maximum to 1.1 KV grade and power cables used shall be rated for minimum 1.1 kV grade.

6.30.3 The conductor shall be of stranded conductor composed of plain annealed copper wire complying with IEC 228, Class 2.

6.30.4 The insulation shall consist of an extruded layer of cross-linked polyethylene complying with IEC 502.

6.30.5 All cables shall be manufactured from fire retardant, low smoke, halogen free materials for underground lifts.

6.30.6 Fire retardant, low smoke, halogen free materials shall meet the following requirements: -

(a) London Transport Executive Three Meter Cube Smoke Emission Test, using optical measuring instruments. The maximum value of absorbance AO (ON), AO (OFF) shall be 0.8 & 1.2 respectively.

(b) The US National Bureau of Standard Smoke Chamber Test used to evaluate plaque samples of materials of constant thickness. (NFPA-258 Smoke Generation of Solid Materials 1982). The maximum specific optical density shall be 170 under the non-polluted condition.

(c) The flame propagating criteria of US IEEE Standard 383, with a minimum test short circuit time of five minutes, in the IEEE Standard 383 test.

(d) IEC 332 Parts 1 and 3, Category B, tests on single and bunched cables under fire conditions.

(e) Limiting Oxygen Index of at least 30, to ASTM D-2863.

(f) A temperature index (TI) of 260°C to ASTM D-2863.

(g) All insulation is to be moisture and heat resistant, with temperature ratings appropriate to the application conditions, and in no case lower than 120^{o}C.

(h) When a sample of the cable is subjected to a combustion test for the determination of the amount of halogen acid gases (other than hydrofluoric acid) as set out in IEC 754 - Part 1 the halogen acid evolved shall not exceed a maximum of 0.5%.

Fire retardant materials shall meet the requirements of item (c), (d), (e), (f) and (g) only.

6.30.7 The above requirements shall be met without compromising the anti-termite, pest-resistant, mechanical and electrical properties of the cables both during and after installation to meet the other requirements of this Specification.

6.31 Noise Generation

6.31.1 The whole of the elevator assembly, including the opening and closing of the car and landing doors shall be quiet in operation and shall be free of rattling or squeaking noises. Elevator door operation shall be smooth to avoid the transmission of impact noise to the surrounding structure.

6.31.2 Noise levels resulting from the operation of the elevator, including direct sound transmission, breakout noise and re-radiation of structure borne noise shall not exceed 55dB(A) (fast response) at 1.5m from the elevator shaft and 1.5m above the floor.

6.31.3 Machinery noise level under normal operating conditions shall not exceed 70 dB(A) at 1m from the equipment in free field.

6.31.4 The total noise level in a moving elevator car shall not exceed 55dB(A) with ventilation fan operating.

7.0 DESIGN **CRITERIA AND PERFORMANCE SPECIFICATION - ESCALATORS**

7.1 Definitions

The following words and phrases used in this Specification shall bear the meanings given below.

(a) Angle of Inclination - The angle at which a passenger travels with respect to the horizontal.

(b) Anti-Slide Device - A device to be installed on the decking between the handrails of the adjacent Escalators, or on the decking between the handrail and the adjacent wall, to prevent people or objects from sliding down on the decking.

(c) Balustrade - The enclosure at both sides of the moving steps, consisting of decking, inner and outer panels, and skirts.

(d) Ceiling Intersection Guard - A guard provided at the intersection of Escalator decking and ceiling or soffit.

(e) Comb - The pronged portion of the comb plate at the landing which meshes with the step tread grooves.

(f) Comb plate - The plate supporting the combs at the landings.

(g) Control Equipment - The components by means of which motion, direction of travel, speed and stopping are controlled.

(h) Deck, decking and decking extension - The portion of the balustrade outside the moving handrails that are transversely horizontal. This shall include anti-slide devices where applicable.

(i) Driving Machinery - The motorized power unit for driving the Escalator.

(j) Electro-mechanical Brake - A brake consisting of friction shoe(s) applied to a brake drum or disc by means of springs that are electrically released.

(k) Handrail - A power driven moving rail for passengers to grip whilst using the Escalator.

(l) Handrail Guard - A guard for the moving handrail at the point where the handrail enters or leaves the balustrade.

(m) Landing - The stationary areas at the entrance to or exit from an Escalator.

(n) Landing Plate/Floor plate - The portion of floor plate next to the comb plate at the landing.

(o) Newel - The portion of the balustrade on the landing at the end where the moving handrail changes direction.

(p) Number of Flat Steps - Flat steps shall be measured from the point at which the first step emerges from under the comb plate in a horizontal direction to the first exposure of the riser of an adjacent step, both at the upper and lower landings.

q) Panel - The portion of the balustrade occupying the vertical space between the top of the decking and the moving stairway excluding space occupied by the skirts.

r) Skirt - The portion of the balustrade immediately adjacent to the moving stairway, occupying the vertical space between the steps and the deck or inner panel.

s) Step - The unit which forms the moving stairway.

t) Step Chain - The main chain to which the steps are attached.

u) Step Roller Track - The track on which the step roller runs.

v) Step Tread - The horizontal portion of the step grooved in the direction of travel and on which the passengers are carried.

w) Step Roller - The rollers attached to the step and supporting the step.

x) Truss - The supporting structure on which the various components are mounted.

y) Working Point – The intersection of the Escalator step nose line and the projection of the Escalator floor plate level.

z) Constant length – The horizontal distance between the Escalators working point and the end of Escalator support.

7.2 General Requirements

7.2.1 Escalators shall be heavy duty, reversible type and capable of operating safely, smoothly and continuously in both directions for a period of not less than 20 hours a day, seven (7) days a week with a alternating passenger load reaching 100% of Contract Load (120kg per step) for three hour and 50% of Contract Load for the following hour within the environmental conditions as stated in the General Specification and at the location where the Escalators are to be installed.

7.2.2 Escalators shall be designed for installation and operation at an angle of inclination of 30°.for concourse to platform and 30°.for ground to concourse escalators

7.2.3 Operating speeds of the Escalators shall be as follows: -

(a) Service (rated) speed - Nominal 0.65m/s and 0.5 m/s (optional)

(b) Maintenance / Idling / Crawling Speed - Less than 0.2m/s.

Escalator shall attain the standby speed of 0.2 m/sec on non-detection of passenger movement for 1 minute. And if further, there is no detection of passengers for 1 minute (at least the anticipated passenger transfer time plus 10 seconds) the escalator will completely stop until the passenger movement is detected.

Auto start by sensors: Automatically detects approaching passengers and controls the escalator to run only when needed, thus allowing for maximum energy efficiency and equipment life. The escalator shall be switched ON and

OFF automatically with the use of these sensors. These sensors shall be appropriately located as per manufacturer's details, but they should detect passenger movement at least 1300 mm or more before the comb intersection line. It shall be ensured that when the person reaches the comb intersection line the escalator shall have achieved the speed of minimum of 0.2 times the nominal speed and then accelerates less than 0.5 m/s^2

7.2.4 Step width shall be at least 1000 mm.

Three and Four flat steps shall be provided at both upper and lower landings as per Table No 2.

A. Handrail Speed: Consistent with step speed (slip rate to be less than 1%).

B. Track Radius: Upper landing 2600mm minimum

Lower landing 2000mm minimum

C. Brake load per step and at nominal width: 120 kg/step as per EN115.

7.2.5 Safety factors used in the design shall, as a minimum, conform to the following: -

(a) Trusses – As per EN 115 (as applicable for Public Service Escalators)

(b) Step roller tracks and steps - 8.

(c) Driving Machinery - 8 for steel and bronze components; 10 for cast iron parts.

(d) Chains – 8.

(e) Any other item (if not specified elsewhere) – As per EN 115 (as applicable for Public Service Escalators).

(f) Stopping distances: The stopping distances for unloaded and downward moving loaded escalators shall be between the following values: -

Nominal Speed V	Stopping distance between
0.50 m/s	0.20 m and 1.0 m
0.65 m/s	0.30 m and 1.30 m
0.75 m/s	0.40m and 1.5 m

The stopping distance for an unloaded escalator shall be close to the minimum value, while for a downward moving loaded escalator it shall be close to the maximum value. The stopping distances shall be measured from the time the electric stopping device is actuated and shall comply with the requirements as per the latest edition of EN 115

7.2.6 Ceiling intersection guards and anti-slide devices shall be provided where necessary. The anti-slide devices shall be constructed from minimum 1.2 mm stainless steel of grade 304. They shall be located not more than 1.8m apart along the decking, where

(a) The outer edge is more than 300 mm from the centerline of the handrail.

(b) The distance between centerline of handrails of two adjacent Escalators is more than 400 mm.

(c) Child Barrier, Fill Panels, Wedge guards, Deflectors to be provided.

7.2.7 Escalators shall be self-contained units consisting of truss, tracks, step drive units, steps, step chains, comb plates, handrails, landing plates, driving machines, controllers, safety devices, balustrades and all other components required to provide a complete installation. Materials used

shall be non-combustible and selected to achieve a fire-resistant installation. The design of the Escalators exposed to outdoor conditions shall take into account the adverse effects due to the inclement weather conditions in Kolkata Region.

7.2.8 Escalator design shall be such that no major repairs shall be necessary for a period of at least fifteen (15) years from the date of issue of 'Certificate of Taking Over', assuming that regular inspection and maintenance are carried out in accordance with the manufacturer's recommendations. Major repairs shall consist of repairs to the steps, track system, step chains, main drive system, traction machines, landing plates and tension carriage due to causes other than those attributable to normal wear and tear.

7.2.9 Escalator design shall give consideration to fire prevention, elimination of dust and oil trapping configurations, ease of handling, access into the station and easy accessibility for routine maintenance.

7.2.10 In the case of adjacent Escalators, it shall be possible to remove or replace all components of one unit, without stopping or interfering with the operation of the adjacent unit.

7.2.11 Escalator components shall be protected against corrosion as follows: -

(a)	Truss, floor plate and comb plate supporting structure and backing.	:	Hot-dipped galvanized, minimum thickness 85µm.
	Tension carriage, main drive	:	3 Layer Epoxy coating of minimum thickness 150 µm
(b)	Tracks and handrail guide.	:	Zinc plated steel profiles.
(c)	Step chain	:	Special protection during installation to be provided.
(d)	Steps	:	Corrosion proof materials.
(e)	Floor plate infill	:	Corrosion proof materials.
(f)	All bolts, nuts, shims and other hardware	:	Zinc plated.
(g)	Balustrade supports and all other parts	:	All parts constructed from steel or sheet steel shall be either galvanized by hot-dipped process complying with BS 729 or fabricated from hot galvanized sheet steel or with epoxy powder coated finishes.

			Cast iron assemblies shall be cleaned and painted with corrosion resistant paint.
(h)	Balustrade profiles, decking panels, skirt panel, outer cladding panels.	:	2.0mm thick for skirt panels & 1.5mm thick for remaining panels, grade stainless steel in accordance with ASTM A 182-61T or F-304H or ASTM A 167-61T T-304 or DIN 1.4301 or equivalent.
(i)	Interior balustrade panels	:	Refer to clause 7.3.8

7.2.12 All electrical equipment supplied and installed shall at least have the following class of protection.

Machine : Protection IP Class 55.

Controller : Protection IP Class 55 or 54.

Isolating Switches : Protection Class 67 if outside and IP 55 if inside controller.

All safety switches and interface boards : Protection IP Class 67.

Safety switches and control equipment coming on the lower pit or likely to be submerged in water shall be IP 67.

7.2.13 The elongation of the main drive chain and handrail drive chain shall not exceed 2% of the length of chain within the first year of operation.

7.2.14 All key switches used shall have the same type of switch cylinder and the key shall be common to all Escalators. The cylinder used shall be unique to this Contract.

7.2.15 The lower pit of all Escalators shall be provided with detection device, such as float switch, to stop the Escalators if the pit is flooded.

7.2.16 PVC shall not be used in any component.

7.2.17 If any obstacle such as intersecting floor slab, is less than 600mm from the centre line of the nearer handrail, a intersection guard fabricated by light weight material reviewed without objection by the “Engineer”, shall be provided in accordance with EN115.

7.2.18 It shall be possible to reverse any Escalator manually irrespective of the direction of travel. After being reverse, the Escalator shall run smoothly in the desired direction without adjustment and under any passenger load conditions.

7.2.19 All similar parts, elements, sub-assemblies and assemblies shall be totally interchangeable between Escalators of same type and duty.

7.2.20 All ball or roller bearings whether or not sealed for life time greasing shall have a

working life of at least 110,000 operating hours under operating conditions as laid down in Clause 5.2.1.

7.3 Mechanical Requirements

7.3.1. Structural truss shall be of sufficient strength to carry the dead weight of the Escalator which shall include any exterior claddings and decking extensions plus passenger load. Passenger loading shall be assumed as 5000 N/m^2 , however, exact loading in N/m^2 shall be considered as per latest edition of EN 115 (load carrying areas = nominal width of Escalator x distance between supports). The truss shall be designed to retain the steps and the running gear should the track system fails. The truss shall also be designed to support an additional load of the outer cladding panels and truss claddings up to a maximum load of $300N/m^2$.

7.3.2. Truss shall be supported at both ends (and at intermediate support for vertical rises above 6m) with resilient supports and bearing plates. The provision of bearing plates and resilient supports shall be included in this Contract but shall be co-coordinated with the respective Civil Contractors. Resilient supports shall be designed for the purpose of preventing the transmission of noise and vibration to the station structure. The truss shall be designed to support the dead weight of the Escalator plus the passenger load. Considering the passenger load, the maximum calculated deflection shall not exceed 1/1000th of the distance between supports.

Truss Extensions or Reduction: Provide truss and access cover extensions at entry and/or exit landings as required and/or to suit building structural support locations. However, there may be a tolerance as per site conditions.

Truss Isolation: Provide isolation pads at support locations to isolate truss and prevent transmission of noise and vibration to building structure

7.3.3. Please refer Table No 2 for all the dimensions of the escalator. The Contractor shall coordinate with the Civil Contractor for all interfacing requirement. In the event that there are some civil restraints such that the “Engineer” may or may not require to revise the well way dimensions either as a whole or in part, the Contractor shall provide the Escalator(s) with the truss so designed to suit the civil structure as directed by the “Engineer” at no cost to the Employer.

7.3.4. Expansion Joints: The contractor shall include provision of special sliding and fixed Escalator supports to accommodate movement of the building expansion joints. Seismic risks should be considered, and special supports shall be provided, wherever required. Upon seismic activities escalators must shutdown and remain shut down until controller is manually reset and the units are started with a key. The contractor shall provide one fixed and one floating support. The seismic signal shall be sent from the ISMS in Operation Command centre to all the equipment in all the stations through Fiber Optic Backbone system. In this case the lift vendor shall ensure that his controller shall receive the signals transmitted by ISMS to stop the Escalator. All necessary interfaces required shall be provided by the Escalator Contractor

7.3.5. Track system shall be designed and fabricated to support and retain the steps, running gears and prevent step up-lifting continually, under all load conditions at design speeds.

The design shall allow installation and removal of mechanical components without dismantling the structure. The track system shall be constructed of steel. The track surface shall be straight and smooth. All joints, where possible shall be diagonal across the width of the running surface. The maximum deflection of the track system shall not exceed 1.00 mm between any two adjacent track supports under 6000N/m^2.

Radii of the upper and lower transitional tracks shall be equal to or greater than the following: -

(a) Upper - 2.6m

(b) Lower - 2.0m

7.3.6. Stainless steel (SS 304) surface comb plates and corrosion resistant die casted aluminium alloy comb section (teeth) with yellow colour painting shall be provided at both landings of each escalator. The alternatives like coloured fiber, for the Comb plate is subject to the Employers acceptance at the design stage. Corrosion resisting aluminium alloy comb teeth shall be provided at both landings of each Escalator. The comb plate structure shall withstand a load of 6000N/m^2 with a deflection not exceeding 2.0 mm. The teeth of the combs shall properly mesh with the cleats on the step treads and shall be designed to permit simple replacement in sections. The yellow colour light in the pits shall be provided to demarcate the moving and the non-moving parts of the Escalators. The Escalator Contractor shall provide UPS of suitable capacity to feed power to Comb light, pit light, etc.

7.3.7. The comb sections shall be so designed such that when a foreign object is caught between the comb teeth and the step tread surface, the comb teeth shall either deflect, whilst remain matching with the grooves of the tread surface, or break. The load which may cause a comb tooth to break at its tip shall be not less than 700N nor more than 1900N. In the event that a foreign object caught between the comb teeth and the step tread surface cannot be removed as mentioned above, and is likely to cause damage to the steps, comb plate or its supporting structure, the comb plate safety switch as specified in Clause 7.8.10 shall be actuated and shall cause the Escalator to halt.

7.3.8. Escalator landings shall be provided with easily open able, hinged landing plates suitable for access to the drive mechanism. Landing plates shall have a non-slip, stainless steel surface (complying with SS 304) that will facilitate sectional replacement. Lifting handles shall be provided to facilitate opening of the landing plate. Means, such as hydraulic cylinders, shall be provided so that the force required to lift the floor plate is not more than 200N. The floor plate shall withstand a uniformly distribution load of 6000 N/m^2 over its entire area, the deflection shall not exceed 4mm during load application and there shall be no permanent deformation after the load is removed.

7.3.9. Escalators shall be provided with balustrade as specified in the Escalator Schedule in the form of tender. Balustrades shall consist of handrail decks, inner panels, outer cladding panels, skirts and lighting installation as given below:

(a) Handrail decks profile : Minimum 1.5mm thick stainless steel, and hairline finish (Grade 304)

(b)	Inner panels	:	For stainless steel panels, minimum 1.5 mm thick stainless steel, hairline finish (Grade 304), with reinforcement and sprayed-on fire resistant vibration/ sound attenuating backing subject to the acceptance of the "Engineer".
(c)	Outer cladding panels	:	Minimum 1.5mm thick stainless steel with hairline finish (Grade 304) as per approval of "Engineer". Panels shall be with reinforcement and sprayed – on fire resistant vibration / sound attenuating backing material subject to the acceptance of the "Engineer". The cladding shall be provided on all three sides including bottom side.
(d)	Skirt panels	:	Minimum 2.0 mm thick stainless steel, Hairline finish, with a material of low coefficient of friction such as Teflon or equivalent as reviewed without objection by the "Engineer" applied on the surface.
(e)	Lighting	:	LED comb lighting. Power supply shall be supplied from the UPS, to be supplied by the Escalator Contractor.

Measures other than frictional or gravitation methods shall be provided to prevent the inner panels from dislodging during normal operation. The fixing method shall be subject to the acceptance of the "Engineer".

7.3.10. The distance between the inner decking immediately below the handrail shall not be less than 1200 mm. The step width is 1000 mm. The skirt panel will have width of approx. 1006 to 1010 mm. The starting point of inner decking shall have width of same 1010 mm. But the distance between points on the inner decking below the handrail shall be 1200 mm. This implies that the inner decking has a slope component of approx. 95 mm on each side (under the handrail) and then becomes flat to meet the balustrade.

7.3.11. Where necessary, all outer sides of the balustrades and truss shall be provided with reinforced claddings. The gap between Escalators and the sides of Escalator and the adjoining walls/ parapet walls shall be provided with decking extensions. The Contractor shall allow a gap of approximately 15mm between the decking and the adjacent walls/ parapet walls. The gap shall be filled up by the Escalator Contractor with flexible sealant subject to review without objection by the "Engineer". The claddings and decking extensions shall be fabricated from 1.5 mm thick stainless steel (complying with SS 304) hairline finish. The inner surface shall be reinforced to prevent warping. It shall be sprayed with fire resistant vibration/sound attenuating backing material to the acceptance of the "Engineer". The claddings and decking extensions shall have tight butt joint and be fastened to the truss with concealed stainless steel bolts, nuts and washers. The joint

line shall be perpendicular to the Escalator step nose line without any longitudinal joints. All joint lines of interior decking, exterior decking/decking extension shall be aligned and staggered in arrangement in line with the joint line of interior panel. For SS Balustrade joints of, skirt panel, inner panel, top decking, outer cladding etc. should be in one line & for glass balustrade joints of, skirt panel, inner decking, glass joint, outer decking and outer cladding should be in one line. The design and the fixing details are subject to the acceptance by the "Engineer".

7.3.12. The balustrade shall withstand the loading without permanent deformation after removal of loading as specified in EN115.

7.3.13. Glass Balustrade shall meet the following requirement: -

a. The glass balustrade shall be fabricated of tempered safety glass with minimum thickness 10mm and sufficient mechanical strength and rigidity in accordance with EN115 as a minimum.

b. Glass and glazing shall gently comply with BS 952 Part 1, BS 5713, BS 6206 and BS6206 and BS 6262.

c. All glass shall be capable of easy replacement.

d. The balustrade shall be glazed at the entire section from upper to lower newel ends.

e. The glass balustrade shall be self-supporting without mullions and the edges of the glass panels shall be bevelled and polished with joints perpendicular to the Escalator step nose line rather than the horizontal.

f. Handrail drive system of Escalators with glass balustrades shall be designed such that the drive system is below the passenger side and cannot be seen in the glazed portion.

g. All glass shall be manufactured and processed in a factory where the Quality Control Procedures comply with ISO 9000 and are independently maintained.

h. The thickness and safety design of the glass shall be the responsibility of the Contractor, having due regard to the performance requirements of this Particular Specification and the location where they are installed. Written confirmation from the glass manufacturer in respect of these matters shall be submitted for review without objection by the "Engineer".

7.3.14. The Escalators shall be provisioned with roller chain arrangement for easy Maintenance.

7.4 Handrail and Handrail Drive System

7.4.1 Balustrades shall be provided with smooth and continuous handrails moving in the same direction and at the same speed as the steps with tolerance of 0% to 2% of the speed of the steps. The handrail shall have a life span of at least seven (7) years under operating

conditions as stated in clause 7.2.1. The color of the handrails shall be black, but the Employer reserves the right to select other colors or designs at no extra cost.

7.4.2 All handrails shall have inserts and sliding surfaces of endless construction designs, synthetic materials, traction type, with a single, smooth, vulcanized joint. Both the inserts and sliding surfaces shall be made from synthetic material. The minimum braking strength of the joint shall be greater than 85% of the minimum breaking strength of the handrail. The hardness of the outer stock shall not be less than Shore $70^{o} \pm 5A^{o}$. The handrails shall run on specially formed guides except when in contact with a tension device. Appropriate action shall be taken to prevent the buildup of static electricity in the handrail. Hand and finger guards shall be provided at the point where the handrail enters the balustrade. The clearance between the guard and handrail shall not exceed 3.0 mm to prevent trapping.

7.4.3 The handrail drive system shall be provided with guides immediately before and after the drive wheel. The returning portion of the handrail shall be supported by guide rollers at not more than 2m interval. Adequate provisions shall be provided to maintain proper tensioning throughout the service life of the handrail and prevent tightening/loosening and excessive heating up of the handrail during operation. The temperature rise of the handrail during operation shall not exceed 6°C above station ambient temperature.

7.4.4 The handrail shall overlap sufficiently with the handrail decking (top deck), to prevent pinching and trapping fingers or hands due to running clearance. The lips at the handrail shall be of sufficient rigidity to prevent the handrail being easily removed from the handrail guides by a force of 300N.

7.4.5 Lifetime greases packed roller bearings of manufacture reviewed without objection by the “Engineer” are preferable for all newel wheels. However, if non-lifetime bearings are used, greasing nipples for the wheel bearings shall be accessible without necessitating removal of balustrade panels from the passenger side.

7.4.6 The newel stands shall be of sufficient rigidity and suitably braced to the main structure of the truss to prevent undue distortion. Provision shall be made to permit checking of alignment of the newel wheels on site.

7.5 Steps and Step Chains

7.5.1. Each step shall be supported on four wheels, two of which shall be the step chain wheels and shall be capable of carrying the basic load with the safety factor as per clause 7.2.5. Individual step loading shall be assumed as $6000N/m^2$. . The design of the mounting of

all wheels on the step shall ensure that the centre line of the wheel shall remain perpendicular to the running track under all load conditions. Step dimensions shall have a tread width of at least 400 mm deep and not more than 210 mm high. Steps and step chains arrangement provided should be easy to maintain.

7.5.2. The step shall be one piece, pressure die-cast, high wear and corrosion resistant aluminium alloy. The step casting shall bear a marking, which clearly indicates the month and the year of manufacture. The ingot materials for die-casting of steps shall be new and not previously used. Certificates of origin and chemical composition for the material shall be provided when required by the "Engineer".

7.5.3. Both sides and the rear edge of each step shall be painted with yellow demarcation lines of at least 20mm wide and the paint shall be applied on the entire surface of the step riser and the grooves of the step tread except the walking surface shall remain unpainted in natural aluminium finish.

7.5.4. Step riser shall be of a cleat-and-groove type. The grooves shall be painted black and dull finish except those areas specified in Clause 7.5.3 above. Step shall be covered with sound deadening material.

7.5.5. Step chains shall be of the endless roller type located on both sides of the moving step. The chains shall be provided in matched lengths and be of high quality steel construction incorporating links, pins, bushes, axles and rollers with three pitches between adjacent rollers. The step rollers and the chain rollers shall be located outside the chain links and shall be easily replaceable without dismantling the links. All chain pins shall be circlipped. Each step chain shall be provided with an automatic tension device to ensure proper tension under varying load conditions.

7.5.6. The design of the fixing of the step to the step axle including detail of bushing, pin or any other means, shall be of proven design and have been in used for an extended period in existing mass transit system(s) at a speed of **Speed of 0.5 m/s and 0.65m/s**. The fixture shall permit quick and easy removal of step to enable quick maintenance without dismantling any part of the step chain and the balustrade.

7.5.7. Step Chain Pin Pressure

The step chain pin pressure of all Escalators shall not exceed 20N/mm^2 with a design life of at least 110,000 operating hours.

7.5.8. The step shall be type tested according to BS EN115.

7.5.9. The chain rollers/wheels shall have durable elastomer materials bonded to a metal die case hub. The shore hardness of the tyre materials shall be $92^{o} \pm 3^{o}$A when cured. The bond shall have sufficient strength to avoid de-tyring under all load conditions.

7.5.10. The minimum diameters of the chain roller and the trailer rollers shall be 75mm. Preference will be given to designs that provide larger roller diameter for Escalator above 8.0 metres vertical rise. The roller shall have a minimum width of 20mm.

7.5.11. The step chain tension device shall be designed and constructed to maintain the step chains at correct tension automatically and continuously under varying load conditions by means of compression springs. The tension device shall be located at the lower landing, mounted within the truss and supported on truss members, with adjusting bolts of the compression springs readily accessible and easily adjustable.

7.6 Drive Mechanism

7.6.1 Each Escalator shall be independently driven by a traction machine. Driving Machine: Worm geared, planetary or helical spur gear reduction unit coupled directly to AC induction or P.M.S.M. drive motor. It is preferred that the handrail drive shall be directly coupled to drive machine.

7.6.2 All drive components shall be easy accessible. All drive components shall be designed for a continuous running of 20 hours per day / 7 day a week under an appropriate load profile. When a chain drive system is used, an automatic lubrication system shall be provided for the main drive chain and the handrail drive chain and include drive chain monitoring contacts.

7.6.3 Each Escalator shall be equipped with an auxiliary braking system. The contractor shall design the Escalator gears in such a way that an oil change will not be required for at least 30000 hours. An oil level switch shall be provided to monitor the gearbox oil level.

Traction machines shall be easily removable from the truss i.e. without dismantling the machines. Suitable lifting points shall be provided.

7.6.4 Each Escalator shall be equipped with an auxiliary braking system. The contractor shall design the Escalator gears in such a way that an oil change will not be required for at least 30000 hours. An oil level switch shall be provided to monitor the gearbox oil level. The traction machines shall be provided with mechanically applied and electrically released brakes. The brake shall automatically bring the Escalator to a halt whenever the power is interrupted, or any of the operating and safety switches is operated. If more than one brake is provided, all brakes shall operate simultaneously.

7.6.5 The contractor shall provide detailed design that includes sound reducing rubber pads, shock absorbing buffers, acoustic linings or other approved means to control vibration and noise transmission. Under conditions of normal operation and at rated speed and load, the noise level at 1m above the tread way at each comb plate shall not exceed 65dB (A) up to 0.65 m/s with the floor and landing plates in place. Under similar conditions, the noise level at 1m from motor enclosures ventilation openings shall not exceed 65dB (A).

7.6.6 Drive components including motor shall be suitable for continuous operation including a VVVF inverter drive for speed regulation.

7.6.7 At rated frequency and at rated voltage, the speed, measured under no load condition in the direction of movement of the steps, shall not deviate from the rated speed by a maximum of ± 3%.

7.6.8 Drive station shall be easily accessible for servicing and repair. Hatches or doors shall be provided, finished flush to other panel sections when closed. Suitable ventilation system shall also be included.

7.6.9 Drive Motor: Three (3) phase, operating at not greater than 1500 rpm. Motors shall be designed to operate in confined non vented spaces. Motor insulation class “F” or greater and temperature rise shall be restricted to class “B”. Power factor at any load shall be ≥ 95%. Slip at 100% load shall be less than 4%.

7.6.10 Service Brake: Electromechanical brake to safely decelerate, stop and hold rated load per Code requirements. The brake shall, in the event of tripping of any safety device, engage immediately and bring the Escalator operating in any direction to a smooth stop at a relatively constant rate not greater than three feet/second^2 in accordance with the latest edition of EN115 and relevant local codes. The brake shall be held off electrically and spring applied to ensure fail safe operation. The brake linings shall be asbestos free. The contractor shall include electrical monitoring for wear of brake lining and brake lifting for both service brake and auxiliary brake in his design.

7.6.11 Safety Brake: The contractor shall equip Escalators with safety brake, in addition to service brake, which shall engage after an adjustable time lag setting. Safety brake shall be actuated by brake release solenoid and manually resettable In case of power failure, the safety brake shall be engaged by stop push button or operation of any safety device.

7.6.12 Each escalator shall be independently driven by a traction machine.

7.6.13 Each traction machine shall be mounted within the truss or the machine pit/room and connected by chain or directly coupled to the main drive shaft of the escalator.

7.6.14 A device shall be provided to prevent the starting of the Escalator if the brake does not operate properly. An indicator to indicate the wearing of the brake lining shall also be provided.

7.6.15 A data plate indicating the brake torque, in Newton-metres shall be provided. Provision for testing the brake torque shall be provided.

7.6.16 Where chains are used to connect the traction machine to the main drive shaft, an additional brake (auxiliary brake) shall be provided which will operate automatically on the main drive shaft should the chains fail.

7.6.17 Provisions for hand winding and the necessary tools to effect the hand winding shall be provided for each Escalator.

7.6.18 Where possible, self-lubricating maintenance free sealed bearings shall be used in the traction machine. Where regular greasing of the bearings is required, this must be accomplished without removing any part of the traction machine and yet provide adequate lubrication. If face-to-face roller bearings are used, matched pairs with provision for greasing of each bearing shall be provided.

7.6.19 The design of the traction machine shall ensure that there shall be no oil leakage from any part of the machine under normal operating conditions. Synthetic oil shall be used in the gearbox. Use of circulation pump for gear oil will not be accepted.

7.6.20 The worms and gears of the machine shall comply with BS721.

7.6.21 The starting current shall not exceed 3.5 times full load current. The starting current characteristic and the speed/torque characteristic for different duty ranges shall be submitted for the acceptance by “Engineer”.

7.6.22 The overall efficiency of the combined motor and gearbox shall not be less than 82% at full load.

7.6.23 An oil gauge shall be provided in the gear housing to clearly indicate the oil level. An inspection plate shall be provided to check the condition of the gear.

7.6.24 Vibration isolation for drive units and switching must be sufficient to ensure no measurable increase in noise levels in local occupied areas during operation of the Escalators.

7.7 Lubrication System

7.7.1 Automatic means shall be provided to lubricate the main drive chains, step chains and handrail drive chains efficiently and economically. Lubricants shall be selected on the basis of maintaining the highest possible flash point consistent with effective lubrication. The duration between two successive lubrications shall be adjustable from 15 to 150 hours of operation of the Escalator. The duration for lubrication for each individual chain shall also be adjustable according to operational requirements. A low oil detection device based on the principle of 'oil level detection' or 'oil pressure detection' shall be provided to prevent the re-starting of the Escalator after a predetermine time as recommended by the manufacture's but is no case more than one week when low oil is detected. Grease shall not be used for chain lubrication. Detailed proposal shall be submitted for review and approval of the "Engineer".

7.7.2 **Soffit Corrosion resistant,** Oil tight, smooth galvanized steel plate for machine soffit minimum 3 mm thick welded to side members of main truss with sufficient strength to withstand weight of workmen, installed beneath step band over whole area of the escalator. Sides shall be provided with sheet galvanized steel plates of minimum 3 mm thick. Dirt collection trays shall be provided at both ends.

Drip Pan: Corrosion resistant, Oil-tight drip pans of galvanized steel sheet of not less than 1.5 mm thick shall be installed beneath the full length of the track, step band or other oil lubricated components over whole area of the Escalator, thereby to collect the dripping oil from these lubricated components. Drip pans shall be designed to collect and drain off both oil from the machines, tracks etc. and water that may enter through the landings, floor plates, exposed portions of escalators or from fire suppression systems. All gaps shall be properly sealed to prevent leakage. Means shall be provided to drain and collect any excess lubricating oil from the chains to removable container(s) at the lower landing machine pit for easy removal and cleaning.

7.7.3 Guards shall be provided at the truss adjacent to the main drive chain, handrail drive chain and step chain to reflect oil splatters from the chains back to the oil drip pan. No oil splatter shall be allowed to get onto the truss, the back of the outer cladding panels, the outside of the truss and brakes. There shall be no oil spillage through the outer panels, claddings or the truss to the surrounding areas. Proper mean reviewed without objection by the "Engineer" shall be provided to prevent the problem of oil spillage onto machinery spaces, step risers and step surfaces.

7.8 Operating and Safety Devices

Operating and safety devices conforming to the following requirements shall be provided:

7.8.1 Starting Switch

Spring-return key operated starting switch with running directions marked on the face plate shall be provided at both ends of the Escalator. These switches shall be positioned to enable the operator, when using the key to start the Escalator, to see the entire Escalator. The key shall be removable only in the neutral position.

7.8.2 Service Stop Switch

Service switches shall be provided within the machinery spaces at both ends of the Escalator. The switches shall be conspicuously and permanently marked and located such that switching can be accomplished without passing or reaching over any part of the machinery. The operation of these switches shall disconnect electrical power to the controller and the drive mechanism and shall activate the brakes. The switch shall be rated to interrupt the starting current of the motor and the fuses shall be rated for the available fault current at the switch. Inspection run shall also be prohibited.

7.8.3 Emergency Stop Switch

Recessed type, momentary pressure, emergency push button stops switches with extended sleeve to protect against accidental operation shall be provided on each Escalator. A minimum of one switch shall be located in conspicuous and accessible positions at the incline section as well as at the newel at both ends of the Escalator. The switch provided at the incline portion shall have protection from the dust ingress which may join its operation. The distance between the switches shall not exceed 15m for the Escalators, otherwise, additional switches shall be provided. The operation of these switches shall disconnect electrical power to the drive mechanism and activate the brake(s). It shall not be possible to start the drive mechanism by the use of these switches. Proper signage shall be displayed so that the location of the switch can be easily identified.

7.8.4 **Speed Governor**

Speed governor shall be provided which disconnects electrical power to the drive mechanism and activates the brake, should the speed of the steps exceed the rated speed by more than 20%.

The speed governor is not required in cases where alternating current induction driving motors are used, provided the slip does not exceed 10% and the motor is directly connected to the drive mechanism.

7.8.5 **Broken step Chain Safety Device**

Devices shall be incorporated as part of each tension carriage which shall disconnect electrical power to the drive mechanism and activate the brake if the step chain breaks,

or if the tension on either chain drops below (or exceeds) a predetermined value, or if the motion of a chain is interrupted.

7.8.6 **Broken Drive Device**

Where the drive mechanism is connected to the main drive shaft by chains, a device shall be provided which will disconnect electrical power to the drive mechanism and shall activate both the operational brake, and the additional brake in the event if the driving chains fail or excess sagging.

7.8.7 **Non-Reversing Device**

A device shall be incorporated to detect reversal from the pre-set direction of motion and activate the operational and auxiliary brakes to stop the Escalators.

7.8.8 **Handrail Finger Guard Safety Device**

Detection devices shall be provided at points where the handrails enter the Escalator newels. These devices shall disconnect electrical power to the drive mechanism and activate the brake in the event of an object entering the gap between the handrail and newel.

7.8.9 **Step and Skirt Safety Devices**

Detection devices shall be provided in Escalator skirting panels in close proximity to the upper and lower comb plate tips, on the track system at the upper and lower curves and at 7.5m intervals along the incline of each Escalator. Electrical power to the drive mechanism shall be disconnected and the brake(s) applied should any one of these devices be activated due to the skirt panels being forced away from the steps.

7.8.10 Comb plate Safety Device

Safety devices shall be incorporated at both sides on the comb plates at each landing, which shall disconnect electrical power to the drive mechanism and activate the brake should any object become wedged between the comb and the step. The device shall be able to operate in the vertical and horizontal direction.

7.8.11 Step Lowering Device

Devices shall be provided which will disconnect electrical power to the drive mechanism and activate the brake, should a step be lowered due to excessive load or breakage. The detection shall be effective at the left, centre and right side of the step. The device shall be located near the top and bottom curves for the Escalators. These shall be located such that the lowered steps stop in front of the comb in order to prevent further damage.

7.8.12 Normal Stop Switch

Normal stop switch in the form of a key switch shall be provided at each landing to stop the Escalator without activating the fault (trip) signal. Proper signage shall be displayed so that the location of the switch can be easily identified.

7.8.13 **Inspection Control**

Inspection control complying with BS EN115 shall be provided at both landings.

7.8.14 Missing step detection device

Detection device(s) shall be provided to stop the Escalator before the missing step opening appears on the passenger side of the Escalator.

7.8.15 Handrail Speed Detection Device

Each handrail shall be fitted with a device, which shall stop the Escalator when the handrail speed exceeds ± 15% of the rated speed as per the latest editions of EN115.

7.8.16 Broken Handrail Device

Each handrail shall be equipped with a mechanically operated electrical safety device of Approved design to detect undue tension, excessive elongation and handrail failure.

7.8.17 Floor Plate Safety Device

Safety switch of Approved design shall be provided underneath each hinged floor plate at both the upper and lower landings. The Escalator shall stop when the floor plate is opened unless under maintenance / inspection mode.

7.8.18 Step Up-thrust Device

Safety device of Approved design shall be provided at the upper and lower landings to stop the Escalator should a step be lifted or displaced against the “up – thrust” track at the transition curve from incline to horizontal in the passenger carrying side of the track system.

7.8.19 Dress Guard

Brush type deflector device shall be provided along the step nose line on the skirt panel to keep feet and loose clothing clear of the possible trapping point. The brush bristles shall be made of fire resistant nylon filaments with split ends to give a soft face.

7.8.20 Brake Lining Safety Switch

Safety device of design review without objection by the "Engineer" shall be provided at each brake shoe of the machine brake to monitor the lining thickness and to detect any abnormal or uneven wear of brake lining.

7.8.21 Phase Protection Device

A phase protection device shall be provided in the control cubicle to prevent setting in motion or to stop the Escalator in the event of phase failure or phase sequence reversal of the power supply. An illuminated visual indicator shall be provided on the control cubicle to signify actuation of this device due to phase failure or phase sequence fault. The indicator shall remain illuminated until the fault is rectified.

7.8.22 Motor Overload Device

a. The driving motor shall be protected against excessive current due to either overloading or short-circuiting by means of a suitable device to be submitted for review without objection by the "Engineer". Such protective devices shall be provided for each phase of the motor winding. After the intervention of this safety device, the power supply to the motor shall be disconnected and it shall only be possible for a competent person to reset it back to its normal working condition.

b. If the detection of excessive current depends upon a temperature increase in the motor winding, such a device may be automatically reset after the fault is removed and the winding cooled down sufficiently but shall not restart the Escalator automatically.

c. Built-in type thermal protection, if offered, shall conform to BS 4999 Part 72.

7.8.23 Earth Leakage Protective Device

An earth leakage protective device, or Residual Current Device, to be submitted for review by the "Engineer" shall be provided such that any dangerous earth leakage to the Escalator metalwork shall cause the immediate stopping of the driving machine and disconnection of the power supply. The return to service to shall not be possible except reset manually by a competent person.

7.8.24 Other Safety Devices shall be provided, in accordance with EN115:2008 requirements and local codes, but not limited to the following:

- Excessive / Under speed shall cause the Escalator to stop.
- Step demarcation lights.
- Comb – Step safety switch.
- Access Panel switch (a bypass is required during maintenance mode)
- Auxiliary braking system
- Brake lining safety switch
- Handrail chain safety switch.
- Overload detection device.

- Step link Safety device
- Main drive chain safety switch.
- Step up thrust Switch.
- Step sag switch.
- Handrail speed monitoring device

7.9 Monitoring and Fault Diagnostic System

7.9.1 A micro-processor based monitoring and fault diagnostic system to provide information on the operation, identification and display of all faults that have caused the Escalator to stop including emergency stops shall be provided. The system shall be able to record at least 100 events in their order of occurrence and display them sequentially in a last-in first-out sequence.

7.9.2 An Alpha – numeric display unit indicating the fault code and fault message shall be installed at an easily accessible and protected location on the handrail decking at both the landings.

The display of the last fault can only be re-set, after the fault causing the stop is cleared but the historical record shall remain in the micro-processor.

Faults that do not require the attendance of the maintenance staff shall be easily identified to enable the operator to re-set and re-start the Escalators.

7.9.3 The system shall capture, display and retain the following information,

a. Record number
b. Fault/status code/alphanumeric display
c. Date
d. Time at which fault started
e. Time at which fault cleared
f. Direction of operation with starting time
g. Total operation hours with break down for “Up” and “Down” operations.

7.9.4 An LCD display panel and means for programming the system shall be provided at the controller.

In addition, serial interface output ports shall be provided at the controller to allow the system to be connected to a Notebook computer for down loading the historical data for trend analysis. Suitable compatible driver software has to be provided to download data for analysis and presentation by Microsoft Office.

The power supply for the system shall be provided by Designated Contractor, but the Contractor shall provide back-up power supply so that the data can be retained for a period of at least 8 hours. The Contractor shall co-ordinate with the Designated

Contractor on the load requirements. This shall be taken from the same incoming isolator/switch as the comb light.

7.10 Provisions for the Remote Monitoring System (RMS)

7.10.1 The Contractor shall provide a PC based Remote Monitoring and Control System (RMS) to be run on the computer of Integrated Station Management System (ISMS) system in the Station Control Room being provided by Designated ISMS Contractor. The RMS shall provide continuous monitoring and controlling of the Escalators.

7.10.2 The following monitoring function shall be provided for RMS.

a. Power On / Off status indicator

b. Trip (fault) indicator

c. Current operation status: Automatic / Maintenance / Fault (breakdown) status.

d. Status of the Emergency Stop Operation: Whether the Emergency Stop Pushbuttons have been pressed, in a crisis/panic situation

e. Trip (fault) indicator

f. Safety switch tripped

g. Location of tripped safety switch

h. Up (Escalators) direction indicator

i. Down (Escalators) direction indicator

j. Start override indicator

k. Speed of the Escalator (0.0, 02, 0.05 or 0.65 m/s)

l. Running Time

7.10.3 The trip signal shall be activated whenever the Escalator is stopped by any fault or emergency stop button during operation and the activation of the control functions in (a) and (b) in Clause 7.10.2 above. The signal shall be latched on until it is manually re-set by key switches located at the two landings or remotely via the RMS. The Escalator shall only be re-started after the “trip” is cleared and the ‘trip” signal has been re-set. Re-starting of Escalators shall also be allowed for those fault signals activated by safety devices without the necessities of maintenance personnel to carry out inspection and the safety device is automatically re-set. Detail proposal shall be submitted by the Contractor for review without objection by the “Engineer” prior to manufacture.

7.10.4 The following control function shall be provided for RMS: -

(a) Remote stop control

(b) Override control switches to prevent unauthorized starting of the Escalator for both normal run and inspection run locally. This shall only function when the

Escalator has been stopped. A by-pass (Local/Remote) switch with illuminated indication which shall by-pass this function shall be provided in the controller.

(c) Remote re-setting of trip (fault) signal.

(d) Remote starting comprising of option to select Up / Down direction of movement for Escalators.

(e) Upon receiving a fire alarm signal all escalators going against the direction of egress at that time will stop. All escalators going in the direction of egress will continue to operate.

7.10.5 The RMS system shall also be used jointly to operate the functions of the Remote Monitoring and Control Systems of lifts. The Contractor shall integrate display requirements of different functions of both lifts and Escalators into single software. The choice of size, system of display and background shall be furnished for the consent of the Employer or his representatives. The Contractor shall interface with Designated ISMS Contractor for integration of RMS system with ISMS.

7.10.6 The Contractor shall be responsible for the provision of all conduits, trunking, cabling and interface terminal board (ITB) in connection with the installation of the RMS except that the conduits and trunking from the Escalator Controller Room to the Station Control Room will be provided by the respective Electrical Contractor. The Contractor shall coordinate and interface with Electrical Contractor and/or his sub-contractor in association with conduits / trunking routing and sizing requirement.

7.10.7 It is preferable that the Contractor proposes the use of a serial data link for RMS e.g. RS485. The physical characteristics and data transmission protocol proposed shall conform to an internationally recognized publicly available standard. The Contractor shall also provide serial data link of each Escalator, terminated in the interface terminal board (ITB) located in the Station Control Room for connection to ISMS System. The information to be carried by serial data link is detailed in Clause 7.10.2 above. The Contractor shall interface with “ISMS Contractor” in this regard. Please note that provision of ITB is in the scope of escalator contractor

7.10.8 Screened cables shall be used for the connection between the communication as described in contacts in clauses 7.10.2 & 7.10.3 above.

7.11 Energy Saving Device

An energy saving device to conserve energy when the Escalator is operated at no load and light load shall be provided such as by means of provision of speed reducing, load sensor and timer. When operating in the energy saving mode the device must not cause

abrupt change in speed or jerk in normal operation. The devices shall not cause harmonic feedback to the power supply system or emit electromagnetic interference to other systems. Provision shall be made to allow the Escalator to be operated without this device. The Contractor shall submit the detail calculation of saving of energy for following options considering the Kolkata East west Metro System load

i. On no load after certain time (depend upon the travel time on Escalator) Escalator should come to crawling speed and then stop.

ii. On no load after certain time (depend upon the travel time on Escalator) Escalator should come to crawling speed and remain at crawling speed of 0.2m/s.

When the Escalator is operating at no load, the quantum of energy saved with this device should not be less than 30% as compared to operation without this device.

Data and calculation shall be provided to substantiate energy savings claimed by the Contractor for various loading on the Escalator.

7.12 Landing/ Machine Rooms/Pits and Closets

7.12.1 The space required for machinery and other accessories shall be provided by the Civil Contractors in accordance with the coordinated requirements of the Contractor. Controllers and other accessories such as incoming isolators, ITBs, switches, shall be housed inside the truss in Enclosure of controller below the Escalator inclined section or in wall recess/closet besides the upper landing. Further wiring work including conduits/ trunking from the incoming isolators to Escalator equipment shall be provided by the Contractor.

The Contractor shall co-ordinate with civil contractor for the layout of the equipment in the wall recess/closet.

7.12.2 Each machine pit and controller enclosure shall be provided with suitably protected permanent light fixtures, electrical outlets, mechanical or natural ventilation and suitable access as part of this Contract. The lighting, electrical outlets and mechanical ventilation (if required) shall be independent from the power supply to the Escalator machine and may be fed either by a separate cable or a branch cable which is connected before the main switch of the Escalator.

7.12.3 The Contractor shall provide a 15A single phase switched socket outlet and a protected permanent lighting in the lower landing machine pit/returning station pit and upper landing machinery space.

7.13 Electrical Requirements and Controller

7.13.1. Escalators shall be designed to operate on power supplies of 415 V AC + 10%- 15%, 3 phase, 50Hz, 4 wire, or 240 V AC + 10% -15%, single phase, 50Hz. All electrical components shall be rated to these voltages. Escalator power supply shall be provided by

designated contractor. The Contractor shall co-ordinate with them for the appropriate electrical requirements to be terminated with suitable fused isolators/switches installed within each controller enclosure / closet next to the controller. Provision of heavy duty selector switch to bypass VVF drive to switch over to star, delta mode in case of VVF failure.

7.13.2. Cables, trunkings, conduits and conduit fittings necessary for the power, control and lighting circuits shall be installed in accordance with the latest edition relevant BIS standards.

7.13.3. Trusses, machines, motors and all other non-current carrying metal parts and components shall be effectively earthed by the L&E Contractor to the incoming earth provided by E&M Contractor.

7.13.4. Electrical safety switches and controllers shall be suitably enclosed to provide protection against accidental contact.

7.13.5. Motors shall be of ample capacity and rated to continuously operate the Escalators efficiently, quietly and smoothly under all conditions of load as specified. The motor insulation and temperature shall comply with class F standard in BS2757.

7.13.6. Controllers shall be provided to control starting, rotational direction and stopping of Escalator motors. The controller shall bring Escalators to a stop in the event of activation of any safety device, power failure, or normal shut down.

7.13.7. Controllers shall incorporate power supply switches (3 phase, 3 pole and one phase one pole), main switch, selectable manual/auto resetting thermal overload, inherent low voltage release, unbalanced and reverse phasing protection and earth leakage protection. Following Electrical requirements are to be provided:

A. Main control circuit breaker: The Escalator Contractor shall provide MCCB with adequate protection and with shunt trip coil for safety trips. Activating this breaker shall break the supply to the motor, to the brake releasing device and to the control circuit. The control mechanism of the protective breaker shall be easily and rapidly accessible after opening the trap doors.

B. Terminal Identification: All terminals are to be marked. All cables shall have color coding and numbered ferrules. Numbering and ferruling shall be in accordance with the requirements of standard specification.

C. Wiring shall be arranged neatly and clearly in conduits and terminated on shrouded terminal blocks.

D. All electrical cables shall be low smoke emission and halogen free type (LSHF). Colour coding, numbering and ferruling to be in accordance with the requirements of standard

specification.

E. Control circuit breaker shall be provided in driving and return stations in order to switch off the Escalator from any of these two stations.

F. Maintenance sockets for plugging in maintenance push button control device for testing operation of Escalator are to be provided at upper and lower stations, with maintenance control extension device and sufficient cable length. All maintenance socket outlets shall be fitted with dummy plugs to maintain the continuity of the escalator safety line

G. The Escalator contractor shall coordinate with the Electrical Subcontractor for fixing of any specialist lighting on the underside of the Escalator Metal Cladding.

H. The Escalators shall be provided with illuminated dynamic sign showing the direction of movement and no entry, according to the use/direction and located, in principle, in inner decking

Following Electrical requirements are to be provided

A. Controller: variable frequency AC only

i. Compartment: Each Escalator shall have individual instrument and control gear, self-ventilated and removable from machine space for ease of access to controls and wiring; steel cabinet shall be with protection IP 55 or 54 minimum), shed mounted and located within drive station, and comprising main circuit breaker, motor control gear, protective devices, relays, cut off and tripping displays etc.

ii. Microprocessor: Related Hardware

iii. Provide built-in noise suppression devices which provide a high level of noise immunity on all solid-state hardware and devices.

iv. Provide power supplies with noise suppression devices.

v. Isolate inputs from external devices (such as safety switches) with opto-isolation modules.

vi. Design control circuits with one leg of power supply grounded.

vii. Safety circuits shall not be affected by accidental grounding of any part of the System.

viii. System fault log memory shall be retained in the event of power failure or activation of any safety device. Controller shall be able to memorize complete details of a minimum of the last 10 events.

ix. Equipment shall be provided with Electro Magnetic Interference (EMI) shielding and shall not affect adjacent services and systems operation. EMI requirement shall comply with latest editions of EN12015 and EN12016

B. The controller shall include a diagnostic system with an alphanumeric display (LCD) or equivalent system shall be provided. This display shall monitor and indicate the general operational status of the Escalator, statistical information and status of all

safety devices. A duplicate fault display shall be also provided at the return station. The system shall be designed in such a way that all this information can be transmitted to the Building Management System. An additional fault indicator display shall be provided in decking at newel end (at both ends) in order to facilitate fault recognition without opening the floor coverings. All the fault messages shall be in English language

7.13.8. Control circuits shall be protected by fuses or equivalent means independent of the protection for the main circuits. All electronic components and relays shall be protected against starting and voltage surges by appropriate surge suppressers / surge arresters.

7.13.9. Control system shall not depend upon the completion or maintenance of an electrical circuit for the interruption of the power supply to the drive mechanism or brake.

7.13.10. All switches, relays, timers, and all auxiliary apparatus shall be of accepted design and labelled for identification.

7.13.11. The power and control wiring shall be laid out neatly and terminated with suitable cable termination sleeves. All terminals and cables shall be labelled and marked for identification. All live terminals from other sources shall be properly protected and identified with yellow warning signs.

7.13.12. The Escalator controller shall be housed in an IP65 spray painted, 1.5mm thick galvanized sheet (with minimum 85µm thick Galvanizing) metal cabinet with hinged door, lockable with a dedicated key. For UG stations the protection rating controllers shall be IP65 The operating buttons / switches etc shall be provided in lockable enclosure to restrict access to authorized person only. The size of the controller cabinet shall be suitable for mounting into a wall closet of maximum dimensions 2000 mm (width) x 2000mm (height) x 500 mm (depth) with doors and shall be suitable to house the incoming power supply isolators and ITBs.

The contractor will have to suitably design the layout after due interfacing with other designated contractors and with the approval of “Engineer”.

7.13.13. Escalators controller shall be fixed properly.

7.13.14. The Controller equipment shall be designed as per design environment specified under clause 4.2.

7.14 Special Cable Requirements

All cables used except those within the enclosed controller shall comply with the following requirement: -

7.14.1 All cables used shall be rated for 1.1 kV Voltage grade.

7.14.2 The conductor shall be of stranded conductor composed of plain annealed copper wire complying with IEC 228, Class 2.

7.14.3 The insulation shall consist of an extruded layer of cross-linked polyethylene complying with IEC 502.

7.14.4 All cables shall be manufactured from fire retardant, low smoke, halogen free materials.

7.14.5 Fire retardant, low smoke, halogen free materials shall meet the following requirements: -

(a) London Transport Executive Three Meter Cube Smoke Emission Test, using optical measuring instruments. The maximum value of absorbance AO (ON), AO (OFF) shall be 0.8 & 1.2 respectively.

(b) The US National Bureau of Standard Smoke Chamber Test used to evaluate plaque samples of materials of constant thickness. (NFPA-258 Smoke Generation of Solid Materials 1982). The maximum specific optical density shall be 170 under the non-piloted condition.

(c) The flame propagating criteria of US IEEE Standard 383, with a minimum test short circuit time of five minutes, in the IEEE Standard 383 test.

(d) IEC 332 Parts 1 and 3, Category B, tests on single and bunched cables under fire conditions.

(e) Limiting Oxygen Index of at least 30, to ASTM D-2863.

(f) A temperature index (TI) of 260°C to ASTM D-2863.

(g) All insulation is to be moisture and heat resistant, with temperature ratings appropriate to the application conditions, and in no case lower than 90°C.

(h) When a sample of the cable is subjected to a combustion test for the determination of the amount of halogen acid gases (other than hydrofluoric acid) as set out in IEC 754 - Part 1 the halogen acid evolved shall not exceed a maximum of 0.5%.

Fire retardant materials shall meet the requirements of item (c), (d), (e), (f) and (g) only.

7.14.6 The above requirements shall be met without compromising the anti-termite, pest-resistant, mechanical and electrical properties of the cables both during and after installation to meet the other requirements of this Specification.

7.15 Interface with Fire Protection Systems

All the Escalators shall be equipped with a sprinkler system in the landing pits and machine rooms. The Contractor shall provide sprinkler pipes and heads inside truss for the Escalators and shall co-ordinate with designated Contractors and make adequate provision

to incorporate all the required fire protection equipment and to get the sprinklers provided in the landing pits and machine rooms connected to the main Fire Sprinkler / Suppression system.

7.16 Lighting

7.16.1 Lighting for areas surrounding Escalators will be provided by others and will emphasise illumination on the landings. The minimum lighting level is 50 lux at the centre of the floor plate between the balustrades. The Contractor shall co-ordinate with designated Contractor to provide adequate lighting.

7.16.2 The comb lights shall be provided with a UPS by the Contractor. The lighting level of the comb light shall not be less than 50 lux at the centre of the comb.

7.17 Noise Generation

7.17.1 Equipment shall be designed to operate quietly and smoothly. The sound level at one meter from the balustrade of each Escalator shall not exceed 65 dBA average values as measured by a slow response sound level meter. The required acoustic treatment shall be supplied and fitted as necessary to meet this requirement.

7.18 Fault Diagnosis Procedures and Circuit Diagrams

Fault diagnosis procedures and circuit diagrams down to component level of the printed circuit boards, detail information software and technical data shall be provided to assist in trouble-shooting for breakdown during normal operation and maintenance.

7.19 Escalator Signage's and Interface with Station Signage Contractor

7.19.1 The contractor shall provide signage's and user instructions on each Escalator as per EN115. This design shall be subject to review by "Engineer".

7.20 Data Plate

A data plate of durable material containing all relevant technical information essential for maintenance and replacement of parts such as rise, length, part number, etc, shall be provided in the machine pit of the Escalator.

7.21 Accessories

Each Escalator or stated otherwise shall be provided with the following accessories:

(a) Two sets of maintenance barriers.
(b) Two sets of starting keys.
(c) One set per Escalator.
(d) One set of hand lamp.
(e) One set of inspection boxes with cable per Escalator.
(f) One set of floor plate opening tools.
(g) Two sets of inner panel opening/removal tools per station.

(h) Two sets of keys for controllers.

(i) Two sets of keys for each type of by-pass switch.

(j) One set of Controller Lifting Devices

7.22 Maintenance Barrier

A barrier shall be provided for both Escalator landings, which shall prevent people for entering the pits and Escalator. The barrier shall be painted yellow, made from aluminum and be of minimum height 900mm.

7.23 Variable Speed Control/Drive

Variable speed control/drive shall be provided. The control shall be integrated with the Escalator control. It shall be able to operate the Escalator at Rated speed of 0.65 m/s. An easily accessible manual change-over switch, with clear label to the "Engineer" acceptance, for selecting the normal and reduced speed, shall be provided in the controller.

If there is no movement of passenger for adjustable predetermined time (say 3 minutes) (Adjustable between 1-5 minutes) the Escalator shall operate at crawling speed 0.2 m/s and further if there is no passenger movement for 10 minutes (adjustable 5-30 minutes) the Escalator will stop.

When commuter approaches the Escalator, it will start and attain nominal speed.

When Escalators detect no load or light load under a predetermined period, the service speed shall decrease to the idling speed (0.2 m/s) or stop after pre-determined time (Adjustable time).

To meet the above requirements, the drive shall be capable of Operating as follows: -

(a) Service (rated) speed **of 0.5 m/s and 0.65m/s**

(b) Maintenance / idling speed - < 0.2m/s.

(c) Stop, if No Load for predetermined time (Adjustable from 5 to 30 minutes)

Dwell frequency function to hold the output frequency temporarily when driving a heavy load

(a) S-curve (soft start) acceleration / deceleration

(b) Motor slip & torque compensations

(c) Jump frequency to avoid VFD operation at resonant oscillation frequency caused by mechanical system.

(d) Multiple acc / dec. Time minimum 4 with at-least i no. Possible to change without an external input.

(e) High slip breaking should be available

VFD manufacturer shall have a variety of communication interface cards for communication of drive with the DCS / PLC system. Most likely protocols shall be MODBUS, PROFIBUS-DP, and DEVICE NET etc.

a. VFD shall employ sine wave PWM control with 12 pulse drive and shall be

able to directly control the current (or torque) of an induction motor based on present control theory utilizing a magnetic flux observer.

b. VFD system shall be designed to run at 50 deg ambient temperature and a maximum relative humidity of 90%. Necessary duration to be taken into account for this.
c. Offered VFD model shall be able to handle voltage 415v (no load transformer voltage) with fluctuations of +10% & -10% on above.
d. The control card CPU shall be 32 bit processor and shall be common for the entire range to limit the inventory on spares.
e. Voltage drop across the VFD system shall be less than 1% and VFD shall be able to delivery, output voltage equivalent to the input supply voltage at rated current. VFD system with higher voltage drop is likely to be rejected during inspection.
f. The converter section shall consist of full wave diode bridge rectifier of necessary rating.
g. The offered VFD shall necessarily employ either ac or dc reactors at the input side for limiting the harmonics.
h. Inverter section shall be insulated gate bipolar transistors (IGBT's) based only.
i. Drive should have data storage for 2 motor set.
j. . Due to standing wave phenomenon, high voltage spikes get generated at motor terminals operated with VFD. This results into premature burn out / failure of motor winding. To safe guard motor against these voltage spikes, VFD system shall consist of appropriate protection device at output of the inverter e.g. Output reactor, sinusoidal (du/dt) filter
k. Following protections shall be built in within the inverter
    - Motor overload / over torque
    - instantaneous over current
    - Ground fault
    - Over voltage
    - Under voltage
    - O/p short circuit
    - Output phase loss
    - Input phase loss
    - Over speed
    - Heat sink over temperature
    - Stall prevention (during acceleration, decal

7.24 Earthing System

All the Escalator equipment, structures and other metallic parts shall be suitably earthed with the station earthing system as per the standard practices. The station earthing system shall be provided by the Designated Civil Contractor and the Contractor shall make necessary arrangements to extend the Escalator system earthing connections up to the station earths in co-ordination with the Designated Contractor.

7.25 Additional feature for Outdoor/ Semi Outdoor Escalators

Contractor shall note that the entrance Escalators are to be installed in a semi outdoor as well as outdoor environment. The contractor shall take necessary measures while designing, manufacturing and installing such Escalators so that ingress of water or dust shall not deteriorate the performance and reliability of Escalators and the finish/properties/strength of the Escalators' exposed parts. The contractor shall also incorporate necessary additional safety devices for these Escalators. The water sensors shall be provided wherever Escalators are operating from ground level to stop the Escalator operations in the event of flooding.

8.0 QUALITY ASSURANCE AND SYSTEM ASSURANCE

8.1 General

A Quality Assurance programme shall be developed and implemented as a means of determining compliance with the Employer's Requirements. This programme shall comply with the requirements as set out in ISO 9000. The programme shall include but not be limited to the procedures necessary to ensure that all equipment, materials, systems and sub-systems are properly specified, designed, purchased, recorded, inspected, installed and tested at all appropriate stages. The procedure shall also ensure that handling, storage and delivery arrangements are satisfactory.

8.2 Quality Assurance Programme

The Contractor's quality assurance programme shall include as a minimum, the following functions: -

8.2.1 **Inspection System**: A system for in process inspection of work operations and manufacturing as well as installation processes, including observations, measurements and tests, to ensure conformance with the requirements of the Contract.

8.2.2 **Calibration System**: A system for periodic calibration and control of the accuracy of precision instrumentation and gauges.

8.2.3 **Record System**: Data and records essential to the operation of the quality programme shall be maintained by the Contractor and made available to the "Engineer" upon

request. These records shall include work performance, inspection and testing observations and the number and type of deficiencies found. In addition, records shall be maintained for monitoring work performance, inspection and testing which indicate the acceptability of work or products and the remedial action taken in connection with deficiencies.

8.2.4 **Supplier Control System**: A system for ensuring that all supplies and services procured from suppliers (subcontractors and vendors) conform with the requirements of the Contract.

8.2.5 **Manufacturing Control System**: A system for providing necessary control over manufacturing operations to ensure that the final product conforms with all requirements of the Contract. This system shall include controls for the following areas:

(a) **Materials**

Suppliers' materials and products shall be subject to inspection to demonstrate conformance with the technical requirements.

(b) **Production Process and Fabrication**

The Contractor's quality assurance programme shall ensure that all machinery, wiring, batching, shaping and basic production operations (of any type) together with all processing and fabricating are accomplished through documented work instructions. These instructions shall be the criteria for acceptable workmanship.

(c) **Completed Item Inspection and Testing**

The quality programme shall ensure that there is a system for final inspection and testing of completed products. Such testing shall provide a measure of the overall quality of the completed product and be performed so that it simulates, to a sufficient degree, product end use and functioning.

(d) **Statistical Quality Control and Analysis**

Statistical methods may be utilised for planning, analysis, tests and quality control whenever such procedures are suitable for maintaining the required control of quality. Sampling plans shall be subject to the acceptance of the “Engineer” prior to use.

(e) **Indication of Inspection Status**

The Contractor shall maintain a positive system for identifying the inspection status of products. Identification may be accomplished by means of stamps, tags, routing cards, move tickets or other control devices acceptable to the “Engineer”.

8.2.6 Installation Control System: A system providing necessary control, monitoring, inspection of the progress, quality of work and protection of equipment, to ensure that the equipment is installed according to the requirements of the contract

The system shall include but not be limited to the following, which shall be subject to the acceptance of the “Engineer” prior to use:

(a) **Shop Drawings**

All layout and shop drawings giving detailed layout of equipment, structural cut-outs, supports, openings, all dimensions, tolerances setting, etc.

(b) **Assembly Procedures and Drawings**

This shall show details of all installation and assembly procedures, including tolerances, tightening torque, alignment, precautions, etc.

(c) **Inspection Checklist**

Checklists giving all items to be checked and inspected with tolerances setting, etc.

8.2.7 The Contractor shall submit checklists to demonstrate compliance with all applicable standards.

8.3 Systems Assurance General

8.3.1. Reliability, Availability & Maintainability (RAM) requirements and goals shall be developed in terms of Mean Time between Failure (MTBF), percentage Availability and Mean Time to Repair (MTTR). The Contractor shall perform RAM analysis up to the point of interface with Designated Contractor's systems.

8.3.2. The Contractor shall comply with the guidelines of EN 50126, IEC 60300-1, IEC 60300-2 and IEC 60571 for electronic equipment, and IEC 60605-1 in meeting the reliability, availability, maintainability & safety requirements of the system.

8.3.3. The Contractor shall submit a RAM Plan & Safety Plan as specified in the Employer's Requirements: General Specification, System RAM Plan and Project Safety Plan. Human Factors Engineering is an integral part of System Assurance and shall be considered and reflected within the RAM Plan & Safety Plan. The Contractor shall verify, after system designs have been completed, that the system assurance requirements will be met.

8.3.4. Safety engineering shall provide analyses for the minimisation of the magnitude and seriousness of those events or malfunctions which could result in injury to passengers or staff and damage to equipment or property; and must eliminate category I and II hazards as defined in Project Safety Plan.

8.3.5. Reliability, maintainability and availability engineering analysis shall ensure a high degree of failure free operation and minimise down time during routine maintenance and failure repair

8.3.6. The Contractor shall co-ordinate results of systems assurance analysis with design disciplines, particularly as the results affect design and hardware development. The Contractor shall make recommendations for redesign or modifications necessary to assure compliance with specified requirements including installation of test points, built-in test capabilities and self-diagnostics; utilisation of in-service status displays to enhance fault isolation and test; the utilisation of high reliability components with easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

8.3.7. The Contractor shall document instances where evaluations or analyses indicate an

unresolved problem area and formulate appropriate recommendations as well as maintain records which show that follow-up action has been taken to resolve the problem.

8.3.8. The Contractor shall ensure participation of his systems assurance organisation in all design reviews.

8.3.9. The Contractor shall maintain documentation of systems assurance throughout the design and make it available to the "Employer/ Employer's Representative" for examination.

8.3.10. During consideration of precedence in the control of system hazards, the Contractor shall take account of human limitations as a design constraint. The Contractor shall take actions to satisfy requirements in the following order of precedence:

i) Incorporation of failsafe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure.

ii) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

8.3.11. The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensures that the safety device does not introduce an additional hazard or system malfunction.

8.3.12. The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder.

8.3.13. The Contractor shall recommend special equipment operating procedures to reduce the probability of a hazardous event

The Tenderer shall demonstrate a clear understanding of all the requirements of this Clause in his tender submission.

8.3.14. Failure Definition

8.3.14.1. Relevant Failures:

A relevant failure of an item is an independent failure which results in a loss of function of that item caused by any of the following:

a) A fault in an equipment or sub-system while operating within its design and environmental specification limits;

b) Improper operation, maintenance, or testing of the item as a result of the Contractor supplied documentation

8.3.14.2. Non-relevant Failure:

Any failure of an item not included in the definition of relevant failure, such as the following:

a) A failure caused by malfunction of other equipment or subsystem that is not supplied by the Contractor;

b) A failure caused by human error, except as noted in Relevant Failure above;

c) A failure caused by accidents not associated with the normal operation of the item;

d) A failure caused by operating the equipment or sub-system outside of design or environmental specification limits

8.3.14.3. Service Failure:

Any relevant failure or combination of relevant failures of the Escalator during revenue service operations, simulated revenue operations, or during non-revenue equipment status check outs, which results in the inability of the Escalator to perform the intended function, the occurrence of unexpected action or the degradation of performance below the specifications shall be considered as a service failure. The decision of the Employer shall be final in this regard.

8.4 Systems Assurance Plan

a) The Systems Assurance Plan shall be developed specifically for this Contract and shall address in particular the following items:

i) Safety engineering which shall provide analyses for the minimisation of the magnitude and seriousness of those events or malfunctions which could result in injury to passengers or staff and damage to equipment or property; and must eliminate category I and II hazards which are defined latter in this Clause.

ii) Reliability, maintainability and availability engineering analysis which shall ensure a high degree of failure free operation and minimise down time during routine maintenance and failure repair.

b) The Contractor shall formulate and document criteria to satisfy the requirements for systems assurance through the Works.

c) The Contractor shall produce a Systems Assurance Plan that integrates the systems assurance elements in all phases of the Works and incorporates a disciplined approach to evaluate the escalator system design. The Contractor shall prepare hazard identification, assessment and resolution; prediction of unreliability; and determination of degree of maintainability. At a minimum, this shall include:

i) Organising the Systems Assurance Plan to include specific sections for the disciplines of safety, reliability and maintainability engineering.

ii) Describing the procedures to perform the specific tasks necessary to meet safety, reliability and maintainability requirements.

iii) Clearly defining the responsibilities of personnel directly associated with systems assurance policies and implementation of the programme.

iv) Describing the systems assurance organisation.

v) Identifying the authority dedicated to the systems assurance organisation and the relationship between the assurance organisation and other organisational components.

d) The Contractor shall co-ordinate results of systems assurance analysis with design disciplines, particularly as the results affect design and hardware development. The Contractor shall make recommendations for redesign or modifications necessary to assure compliance with specified requirements including installation of test points, built-in test capabilities and self-diagnostics; utilisation of in-service status displays to enhance fault isolation and test; the utilisation of high reliability components with easy accessibility and quick disconnect connectors; and, the use of mechanical keying to reduce errors during installation and repair.

e) The Contractor shall document instances where evaluations or analyses indicate an unresolved problem area and formulate appropriate recommendations as well as maintain records which show that follow-up action has been taken to resolve the problem.

f) The Contractor shall ensure participation of his systems assurance organisation in all design reviews.

g) The Contractor shall maintain documentation of systems assurance throughout the design and make it available to the “Engineer” for examination.

h) During consideration of precedence in the control of system hazards, the Contractor shall take account of human limitations as a design constraint. The Contractor shall take actions to satisfy requirements in the following order of precedence:

i) Incorporation of failsafe or vital features which would allow the system to transfer from a high loss or risk mode to a lower loss or risk mode upon the occurrence of a critical failure.

ii) Reduction of the probability of occurrence of a failure by increased component reliability or by provision of supervised redundant components.

i) The Contractor shall use safety devices to reduce the magnitude of the loss or risk once a hazardous mode has been entered; and ensures that the safety device does not introduce an additional hazard or system malfunction.

j) The Contractor shall use warning devices and systems which are audio/visual portion of a vital system in which the human is the responder.

k) The Contractor shall recommend special equipment operating procedures to reduce the probability of a hazardous event.

8.5 Safety Engineering

a) The Contractor shall as part of the safety engineering activity prepare analyses of identified potential hazards to ensure resolution of hazards. The following analyses shall be prepared and submitted by the Contractor:

i) Subsystem Hazard Analysis (SSHA)
ii) Interface Hazard Analysis (IHA)
iii) Operating and Support Hazard Analysis (O&SHA)
iv) Quantitative Fault Tree Analysis (FTA)
v) Failure Modes, Effects and Criticality Analysis (FMECA)

b) The Contractor shall prepare a Fire Safety Design Report for review and acceptance by the “Engineer”. At a minimum, this report shall contain documentation of the specific fire hardening and life safety features and attributes the Contractor has incorporated in the elevator design; especially those relating to:
-

i) Structural fire resistivity
ii) Choice of electrical wiring and insulation for vital safety critical circuitry.
iii) Flammability, smoke emission, and toxicity characteristics of selected materials.

c) The Contractor shall compile a list of critical/ catastrophic hazard items identified as a result of hazard analyses, or by other means. This Safety Critical Items List (SCIL) shall be updated as required and carried forward throughout implementation until final resolution of identified hazards is achieved.

d) The qualitative measures of hazard severity are defined as follows:
Hazard Category I -Catastrophic: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause death or system loss.

Hazard Category II - Critical: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause severe injury to personnel, severe occupational illness or major system damage.

Hazard Category III - Marginal: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies may cause minor injury to personnel, minor occupational illness or minor system damage.

Hazard Category IV - Negligible: Operating conditions such that personnel error, environment, design deficiencies, subsystem or component failure or procedural deficiencies will not result in injury to personnel, occupational illness or damage to the system.

e) Further, the information presented by the Contractor shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the materials' characteristics and behaviour.

8.6 Reliability and Maintainability Engineering

a) Reliability and maintainability requirements and goals shall be developed in terms of Mean Time between Failures (MTBF) and Mean Time to Repair (MTTR).
b) Final reliability and maintainability predictions shall be verified by testing after system design has been completed.
c) The subsystems and equipment shall be designed to maximise system availability during traffic hours, to minimise the amount of maintenance required and to

ensure that any maintenance can be easily and quickly carried out at minimum cost.

d) The Contractor shall perform reliability and maintainability analyses up to the point of interface with other systems.

e) Reliability block diagrams shall be developed which show each equipment element that is essential to the performance of the system, including element interrelationships. Block diagrams shall be revised to keep current with design iterations.

f) The Contractor shall develop a reliability model consisting of reliability block diagrams and probability of success equations. The model shall show the relationships required for system success. The Contractor shall revise the model to keep current with design iterations.

g) The Contractor shall provide reliability prediction and apportionment in accordance with established techniques or standard or properly documented and verifiable field failure data for identical or similar equipment. The standards used or the source of field data shall be identified.

h) Quantitative maintainability assessments to all significant functional levels of the system, subsystems or equipment shall be allocated. Maintainability analyses during design, development and testing shall be used to evaluate the degree of achievement of the maintainability requirements. The Contractor shall identify the standards by which these allocations are made.

i) The Contractor shall develop predictions to judge the adequacy of the proposed design to meet quantitative maintainability requirements and shall identify design features requiring corrective action during early stages of design and development.

j) The Contractor may submit existing analyses which are properly documented and verifiable for equipment and applications which are identical or manifestly similar. The documents used for calculating the Reliability, Availability and Maintainability shall be certified by the Customer whose data's are used. Existing data need not conform to the agreed format but shall contain the same data presented in a neat, concise and logical manner.

8.7 Reliability and Maintainability Demonstration Tests

a) The Reliability Demonstration Testing (RDT) shall be carried out after commissioning the escalators. All equipment shall be included in the RDT and shall be fully operational. The Contractor shall perform failure/incident data

analyses, component analyses and provide corrective action designs and tests. The Contractor shall submit weekly status reports, which shall include as a minimum a statement of failures, status of failure dispositions and achieved MTBF for each subsystem.

b) The Maintainability Demonstration Testing (MDT) shall be conducted on assemblies, components and subsystems jointly selected by the "Engineer" and the Contractor. The "Engineer" reserves the right to settle any disputes in the selection of subsystems to be tested.

8.8 Submissions

a) The Systems Assurance Plan shall be submitted 30 days after Contract Award for acceptance by the "Engineer".

b) The Preliminary Systems Assurance Report shall be submitted for acceptance as part of the Preliminary Design submission.

c) The Final Systems Assurance Report shall be submitted for acceptance as part of the Pre-Final design submission.

d) The Reliability, Maintainability and Safety Demonstration Test Plans shall be submitted for acceptance as part of the Final Design submission.

e) Reliability, Maintainability and Safety demonstration test results shall be submitted for acceptance 30 days after completion of the demonstrations.

9.0 DESIGN SERVICES - ELEVATORS

9.1 Design Requirements

The Contractor shall perform all design functions necessary for the development, manufacture, installation and site testing of Elevators as described in this Specification. The contractor shall submit Preliminary & Detailed Design in soft copy in CD 3 sets & 3 sets of hard copy for review to Engineer & Employer though official submittal, also 5 sets of hard copy along with 5 CD as a soft copy for the final approved Preliminary & Final Detailed Design Document to Engineer & Employer.

9.1.1 The design of each component shall achieve the minimum service life given below. The failure rate of the components shall not exceed 5%. Failure rate is defined as the number of failures (during the service life) divided by the total quantity of the components in one section.

Elevators		Service life(years)
(i)	Safety gear rope	10
(ii)	Governor	20
(iii)	Anti Creep device	20
(iv)	Hoisting chain/hoisting rope	10
(v)	Contractors/relays	10
(vi)	Traction machine/motor	20

The Service life of each equipment shall be specified by the firm in the design submission.

9.1.2 The Contractor shall prepare and submit drawings, which clearly illustrate details of equipment down to sub-assembly and component level, equipment locations and configurations. Drawings shall indicate plan views, elevations, sections, charts, tables, schematics and diagrams with legends, dimensions, part numbers, tolerances, setting clearances, materials, etc., as required to cover the facilities being provided under the Contract. Drawings shall also be prepared showing circuit wiring for each of the systems included in the Contract.

9.1.3 The Contractor shall prepare and submit specifications to provide a clear description of the functional requirements such as, loading, materials, clearances, tolerances, of all equipment and its components planned for use in the Contract. The specifications shall indicate acceptable levels of performance, the expected normal life span, and the mean time between failures (MTBF) for the equipment, materials and workmanship, with due consideration given to the service and environment to which such equipment will be

subjected. The Contractor shall identify, by manufacturer and model or part number, each component, which he plans to install under the Contract.

9.1.4 The Contractor shall prepare and submit a Quality Assurance programme in accordance with requirements contained in the Specification.

9.1.5 The Contractor shall submit all applicable data, criteria, standards, directives and information used as a basis for the design of the Elevators.

9.1.6 The Contractor shall comply with the drawings and graphic standards identified in the Employer's Requirements.

9.1.7 The Contractor shall submit the design calculations for the following, to demonstrate how the operational requirements are achieved.

(a) Structural loading to pit and shaft wall.

(b) Heat dissipation value for the elevator

(c) Power requirements and efficiency of motor/machine.

(d) Any other information necessary or asked by the Employer

9.1.8 The Contractor shall submit catalogues and/or samples for all parts and components used in this Contract as per Employer’s Requirement.

9.1.9 The Contractor shall prepare equipment layout plans and other documents necessary to facilitate the design interface co-ordination with other System-wide and Designated Contractors. These plans shall, (if necessary) be incorporated in design drawings but they must be prepared at appropriate times and in sufficient detail to permit successful co-ordination of space provisions for the Elevators.

9.2 Endorsement Requirement

All drawings, calculations, test certificates, technical information, data and analysis submitted in this Contract shall be endorsed by the Contractor's registered Professional Engineer.

9.3 Co-ordination with Designated Contractors

The Contractor shall co-ordinate with the Designated Contractors, shall finalise and agree with the Designated Contractors all relevant matters relating to the equipment including but not limited to the following:

a) space requirements, including tolerances for construction of the civil works.

b) fixing requirements

c) loading

d) interface with architectural finishes

e) cabling routes, termination details including providing information to the Designated Contractors.

f) information on embedded parts, box-outs, etc. to enable the Designated Contractors to provide the necessary works.

g) equipment access route and temporary/permanent lifting requirements.

h) lighting requirements

i) power requirements

j) ventilation requirements

k) fire detection/protection/Water supply for sprinklers

9.4 Interface with Integrated Station Management System (SCADA)

9.4.1 The Contractor shall terminate the status transmitting points for transferring the status warning or alarm in the Operation Control Centre (OCC) on a separate interface board located in the Station Control Room. The Integrated Station Management System Contractor shall wire his communication channels to the other side of this terminal board. The interface board shall be supplied, installed and wired by designated contractor. The proposed operation /control /monitoring requirements for various functions shall be as defined in Para 6.20 but will be reviewed based on the final design of the whole system. The Contractor shall submit his proposals for the consent of the Employer or his representative.

9.4.2 The information transmitted between the equipment and the OCC shall be carried by Integrated Station Management System equipment supplied by a designated Integrated Station Management System Contractor. The Contractor shall draw a table indicating the various number, type and physical layout of the terminals used for transmitting the status or the measurements to the OCC and provide this information in clear logical form to the designated Integrated Station Management System Contractor in accordance with the project programme.

9.4.3 The equipment on the side of the interface receiving the information shall provide the power supply and all infrastructure support for operation/control/monitoring requirements and the sending side shall provide Ethernet or the serial data link. The physical characteristics and data transmission protocol proposed shall conform to an internationally recognized publicly available standard e.g. RS485. It will be the responsibility of the contractor to interface and co-ordinate to mutually finalize the type of interface, data transmission speed etc. with the Integrated Station Management System and Designated contractor.

The interface shall have the following features:

i) The Contractor shall provide isolated 'voltage – free' dry contacts, each rated at nominal 24V 1A dc, for the SCADA transfer points. Each point shall be

terminated at the interface board through an individually shielded twisted-pair screen wire. The 24V dc power supply for relay contact integration and conversion to serial data link shall be provided by the ISMS **/** Contractor.

ii) Common return wires shall not be used.

10.0 DESIGN SERVICES - ESCALATORS

10.1 Design Requirements

The Contractor shall perform all design functions necessary for the development, manufacture, installation and site testing of escalators as described in this Specification. The contractor shall submit Preliminary & Detailed Design in soft copy in CD 3 sets & 3 sets of hard copy for review to Engineer & Employer though official submittal, also 5 sets of hard copy along with 5 CD as a soft copy for the final approved Preliminary & Final Detailed Design Document to Engineer & Employer.

10.1.1 The design of each component shall achieve the minimum service life given below. The failure rate of the components shall not exceed 5%. Failure rate is defined as the number of failures (during the service life) divided by the total quantity of the components in of that section

Escalators		Service life(years)
(i)	Steps	15
(ii)	Relays, timers and control gear	10
(iii)	Handrail drive system	15
(iv)	Step chains and step axles	15
(v)	Tension carriage assembly	15
(vi)	Main drive assembly	15
(vii)	Emergency brake assembly	15
(viii)	Step and chain rollers	8
(ix)	Handrail	7

The Service life of other equipment's / Parts shall be defined in the design submission.

10.1.2 The Contractor shall prepare and submit drawings, which clearly illustrate details of equipment down to sub-assembly and component level, equipment locations and configurations. Drawings shall indicate plan views, elevations, sections, charts, tables, schematics and diagrams with legends, dimensions, part numbers, tolerances, setting clearances, materials, etc., as required to cover the facilities being provided under the Contract. Drawings shall also be prepared showing circuit wiring for each of the systems included in the Contract.

10.1.3 The Contractor shall prepare and submit specifications to provide a clear description of the functional requirements such as, loading, materials, clearances, tolerances, of all equipment and its components planned for use in the Contract. The specifications shall indicate acceptable levels of performance, the expected normal life span, and the mean time between failures (MTBF) for the equipment, materials and workmanship, with due consideration given to the service and environment to which such equipment will be subjected. The Contractor shall identify, by manufacturer and model or part number, each component, which he plans to install under the Contract.

10.1.4 The Contractor shall prepare and submit a Quality Assurance programme in accordance with requirements contained in the Specification.

10.1.5 The Contractor shall submit all applicable data, criteria, standards, directives and information used as a basis for the design of the escalators.

10.1.6 The Contractor shall comply with the drawings and graphic standards identified in the Employer's Requirements.

10.1.7 The Contractor shall submit the design calculations for the following, to demonstrate how the operational requirements are achieved.

(a) Structural loading and deflection of the escalator truss (with and without intermediate support).

(b) The loading of the following escalator components: -

(i) bearings
(ii) drive chains
(iii) step chains
(iv) steps
(v) motor/machines
(vi) brakes
(vii) handrails
(viii) comb plate
(ix) track system

(c) Power requirements and efficiency of motor/machine.

(d) Escalator brake torque and stopping distances under no load and full load condition.

(e) Any other information necessary or asked by the Employer

10.1.8 The Contractor shall submit catalogues and samples for all parts and components used in this Contract. During the design stage some of the samples of the equipment can be asked by the Employer for review and acceptance without any extra cost. The samples will be released to the Contractor after commissioning of the equipment's.

10.1.9 The Contractor shall prepare equipment layout plans and other documents necessary to facilitate the design interface co-ordination with other System-wide and Designated Contractors. These plans shall, (if necessary) be incorporated in design drawings but they must be prepared at appropriate times and in sufficient detail to permit successful co-ordination of space provisions for the escalators.

10.2 Endorsement Requirement

10.2.1 All drawings, calculations, test certificates, technical information, data and analysis submitted in this Contract shall be endorsed by the Contractor's registered Professional Engineer.

10.2.2 The information transmitted between the equipment and the OCC shall be carried by ISMS equipment supplied by a designated ISMS Contractor. The Contractor shall draw a table indicating the various number, type and physical layout of the terminals used for transmitting the status or the measurements to the OCC and provide this information in clear logical form to the designated ISMS Contractor in accordance with the project programme.

10.2.3 The equipment on the side of the interface receiving the information shall provide the power supply and all infrastructure support for operation/control/monitoring requirements and the sending side shall provide the serial data link. The physical characteristics and data transmission protocol proposed shall conform to an internationally recognized publicly available standard e.g. RS485. It will be the responsibility of the contractor to interface and co-ordinate to mutually finalize the type of interface, data transmission speed etc. with the ISMS contractor.

11.0 INSTALLATION

11.1 The Contractor shall be responsible for the timely and proper setting out of the Works which shall include verifying the positions, levels, dimensions and alignment of elevator pits, supports, shaft, walls and floor openings, etc. Any error in the civil construction in so far as they relate to the Works shall be immediately brought to the attention of the "Engineer" and the Designated Contractor to allow prompt rectification by the Designated Contractor so as to avoid delays to the Works. The Contractor shall not be entitled to claim for any additional costs incurred by him arising out of such errors in the civil construction, if such additional costs could reasonably have been avoided had the Contractor carried out timely and proper setting out of the Works. The method adopted for installation shall be in accordance with relevant standards with latest versions/

amendments stated at Clause 11.17 of this specification. Contractor shall submit the "request for inspection" in a stage wise inspection format to Engineer/Employer and accordingly it shall be witnessed and approved by Engineer/Employer. The stage wise sequential format for Lift and Escalator shall be reviewed and approved by Engineer/Employer.

11.2 The Contractor shall be responsible for all aspects of the Work required to install the equipment, including the provision of all lifting facilities such as frames where the provision of hooks is not possible. The Contractor shall co-ordinate with the Designated Contractors on the necessary precautions to be taken by both the parties to prevent damage to any part of the civil works during installation. The Contractor shall take all necessary pre-cautions including transportation of various part of Elevators on rubber typed wheel and handling these with proper equipment so that floor finishes are not damaged by the Contractor during erection of Elevators at the stations. In case any floor finish is damaged by the Contractor the same shall be made good by the Contractor in full panel / area at his cost, so as to maintain uniformity.

11.3 The Contractor shall ensure that levelling of all landing equipment shall be within $\pm$ 1.0 mm. The vertical alignment of all door jambs, doors etc. shall be truly plumb to within $\pm$ 1.0 mm.

11.4 Guide rail shall not be skewed. The distance between guide rail shall be within $\pm$ 0.5 mm. Guide rail joints shall be smooth to within 0.1 mm. It shall be erected plumb within $\pm$ 1.0 mm.

11.5 The Contractor shall provide protection, such as plywood box-up etc., to protect the door, the jamb, decking, from being damaged until the work is handed over at no additional cost. Any damages to the equipment will be the sole responsibility of Contractor and the firm shall replace the damaged part without any extra cost. The complete equipment will be inspected and tested at the time of taking over of the equipment.

11.6 All Elevator landing door gaps shall be less than 4 mm.

11.7 The Contractor shall be responsible for the installation of all guide rail brackets, separator, sill supports, hanger brackets including drilling and all related materials. The contractor shall verify and satisfy themselves in respect to the loading capability of the shaft wall holding the bracket etc. If the Contractor feels that load test is necessary/ required, then he can arrange the same in co-ordination with civil contractor.

11.8 All equipment shall be fully protected against the ingress of grit, dust and moisture during delivery, storage and installation.

11.9 The equipment shall be delivered to Site in accordance with an accepted installation programme with a minimum temporary storage period to avoid damage.
Access into the station will be either by train or by road depending on site environment and constraints.

11.10 The Contractor shall design the equipment to comply with the Site access restrictions

and shall ensure that the largest piece of equipment can be brought into the station through the access opening/entrances and passage ways. Method Statement of Installation shall be submitted for Employers review and approval at least 30 days prior to the starting the installation. As part of the preliminary design submission the Contractor shall submit to the "Engineer" for acceptance a General Method of statement for Installation However, Contractor will submit schedule of tests giving full details of all tests to be carried out

11.11 Where the structure does not permit the provision of lifting points, the Contractor shall make his own arrangements to provide the required lifting facilities such as "A" frames or similar arrangements to carry out installation work at no extra cost.

11.12 Once the elevator shaft is handed over to the contractor to commence installation, he shall be responsible for providing fencing and barricades to protect his working areas during the installation period for the safety of his workers and other personnel working in the station until the taking over of the lift by Kolkata East-West Metro.

11.13 Under normal circumstances where the civil structure does not prohibit the provision of lifting facilities, such facilities in the form of lifting point will be provided by the Civil Contractors at the upper and lower landings and along the incline section of the escalator well ways for ease of installation. The contractor shall verify and satisfy themselves in respect to the loading capability of the lifting point/ hooks. The load test, if Contractor feels necessary/ required, can arrange in co-ordination with Civil contractor.

11.14 The Contractor shall be responsible for providing fencing and barricades to protect his working areas during the installation period for the safety of his workers and other personnel working in the station until the equipment is handed over to the Kolkata East West Metro (KMRC).

11.15 The Contractor shall provide protection, such as plywood board etc., to protect the landing plate, handrail and balustrade etc from being damaged until the equipment is handed over at no additional cost. Any damages to the equipment are the sole responsibility of Contractor and shall replace the damage part without any extra cost. The equipment in full will be inspected and tested at the time of taking over of the equipment.

11.16 The contractor shall provide the installation plan with organization chart for the project to obtain the approval from employer.

12.0 TESTING AND INSPECTION

12.1 General

12.1.1 As part of the preliminary design submission the Contractor shall submit to the "Engineer" for acceptance a schedule of tests giving full details of all tests to be carried out. Contractor shall submit the "request for inspection" in a stage wise testing & commissioning inspection format to Engineer/Employer and accordingly it shall be

witnessed and approved by Engineer/Employer. The stage wise sequential format for Lift and Escalator shall be reviewed and approved by Engineer/Employer.

12.1.2 Tests at places of manufacture to be witnessed by the "Engineer" shall be grouped together so far as can be arranged so that as many tests as possible can be witnessed on each visit.

12.1.3 The Contractor shall prepare and forward to the "Engineer" an original and four copies of all Test Reports as soon as practicable after completion of each test whether witnessed by the "Engineer" or not. All test data shall be certified by the Contractor's Professional Engineer.

12.2 General Requirements for Type Tests and Acceptance Tests

12.2.1 The Contractor shall provide details of any type and acceptance tests, which have been carried out on equipment offered, or any additional tests he recommends.

12.2.2 In general, certificates of previous type tests may be accepted if it is not older than three years at the discretion of the "Engineer", provided that they are for identical equipment and conditions. Where appropriate, new and/or modified components to meet the requirements of this Specification shall be made available for type testing.

12.2.3 Type tests on equipment shall be carried out strictly as specified in the Specification.

12.2.4 The "Engineer" shall have right to witness tests and inspections on individual materials, components, or sub-assemblies, and details of these shall be agreed between the Contractor and the "Engineer".

12.2.5 At the conclusion of all type tests, the Contractor shall compile all the test data together with any observations made during the tests, file them into a type test binder and submit it to the "Engineer" for acceptance and record.

12.3 General Requirements for Tests during Manufacture

12.3.1 The Contractor shall carry out tests during manufacture as specified and propose any additional tests to be carried out. These tests shall be subject to the acceptance of the "Engineer". Routine tests shall be integrated with the manufacturing programme. The "Engineer" will, at his discretion, witness the routine tests during the period of manufacture, or accept the records of the Contractor's in-house quality control scheme, where appropriate, as sufficient evidence for the execution of the routine tests.

12.3.2 Routine tests shall be carried out strictly as specified in the test specification as outlined in Clause 12.4.

12.3.3 On completion of the manufacture of items or sub-assemblies and following completion of the manufacturer's own tests and inspection, the "Engineer" shall be invited to witness such tests as he deems appropriate. The Contractor shall schedule the routine tests to meet the manufacturing programme, whether or not the "Engineer" will be present at the

tests, provided advance notice has been served to the "Engineer" in accordance with Clause 11.8 of GS.

12.3.4 The "Engineer" will determine and advise the Contractor of those tests where certification by the manufacturer may be acceptable in lieu of witnessed tests.

12.3.5 Before equipment is dispatched, the "Engineer" will signify his acceptance by signing certificates releasing such equipment from the place of manufacture or test.

12.3.6 Methods of packing and shipping shall be as specified in the Employer's Requirements, the "Engineer" reserves the right to visit the manufacturers' or packers' premises to ensure that accepted methods are employed.

12.4 Test Specification

12.4.1 The Contractor shall submit for acceptance by the "Engineer", test specifications for type tests, routine tests, tests on site, final acceptance tests and commissioning. The specifications shall detail the methods of conducting the tests, the tools and instruments used. Reference to the accepted documents and drawings shall be included in these specifications. The records/results shall be tabulated in a prescribed format applicable to this Contract.

12.4.2 Nothing in this Specification shall prevent the "Engineer" from calling for extra tests.

12.4.3 These test specifications shall include the design values of all quantities to be verified, with allowable tolerance or limits. Summary drawings or diagrams shall be included with the test specifications to show the dimensions and tolerances of all structural assemblies and sub-assemblies. In the case of welded fabrications, key diagrams giving all weld data shall be provided to enable systematic inspection to take place.

12.4.4 Verification of accuracy shall be required for all tools, apparatus, testing jigs, measuring instruments and 'go' or 'no go' gauges used for the purpose of routine tests.

12.4.5 All test instrument shall be calibrated not more than one year prior to their use. The Contractor shall submit calibration certificate or other documents for proof of Compliance.

12.5 Testing of Materials and Details

12.5.1 Where materials or components used in this Contract are not covered by separate test specifications, samples of such materials, or up to two per cent of such components shall, if desired by the "Engineer" be tested at the Contractor's expense at an approved laboratory.

12.5.2 The Contractor shall supply the material required for testing free of charge and shall supply and prepare the necessary test pieces, labour and appliances for making all tests, and for carrying out all gauging and weighing on his premises in accordance with the terms of this Specification. If the Contractor is unable to provide approved facilities

at his own factory for making the prescribed tests, the Contractor shall bear the cost of carrying out the tests elsewhere, at a place subject to the "Engineer" acceptance.

Such radiographic examination of welds or castings as the "Engineer" deems necessary shall be carried out.

12.6 Escalator Prototype Tests

12.6.1 One complete average rise escalator which is generally representative of all types shall be available for the commencement of witness testing after Contract Award. All spares to be supplied shall also be tested and supplied subject to their acceptance.

12.6.2 A complete escalator system including truss, track, chain, rollers, steps, controller, handrails, balustrade, monitoring and fault diagnostic system, electrical wiring, safety devices, supporting systems etc. shall be built at the Contractor's works to undergo a comprehensive running and functional testing in accordance with the approved test specification to verify compliance with the Specification.

12.6.3 The tests shall include the following as a minimum:

a) Truss deflection shall be recorded under full load conditions;

b) Carry out a full escalator assembly inspection as specified in Clause 12.12.13.

c) Verify the functionality of the monitoring and fault diagnostic System, all safety devices and all other electrical switches.

d) Inspection to verify that the balustrade complies with the Specification and is aesthetically pleasing.

e) Insulation resistance and pressure testing of all power and control circuits.

f) Carry out a 24 hours continuous running test, 12 hours in each direction, without stopping except to change direction.

g) Record the noise levels to verify compliance with the Specification.

h) Braking Tests.

12.7 Elevator Prototype Tests

12.7.1 One complete Elevator shall be available for the commencement of witness testing after Contract Award. The selected Elevators shall be representative of their various types.

12.7.2 A complete Elevator system including traction drive system, in addition to the controller, Elevator car enclosure, landing and car doors, protection devices and call fixtures shall be assembled on a test rig or inside a test tower to undergo a comprehensive running and functional testing in accordance with the accepted test specification to verify compliance with the Specification.

12.7.3 The tests shall include the following minimum requirements.

a) Verification of the suitability of the traction drive system;

b) Verification of the car operation and response to call fixtures, door operation including the safety edges, all indications and signaling features, and car top control features;
c) Weight tests on safety gear and measurement of electrical readings and verification of the operating speed under various loading conditions;
d) Verification of riding comfort and leveling accuracy under various load conditions.
e) Verification of the fault indication and fault diagnosis features.
f) Verification of the construction of the various control panels to the specification shall be done. Insulation resistance and high voltage tests shall be conducted in accordance with the test specification.
g) Any additional testing as required by BS 5655 Part 10.
h) A 12-hour duty cycle test, during which the Elevator shall run continuously with the contract load for 12 hours and shall travel up and down with intermediate stops such that the number of starts per hour as specified.
i) Complete functional tests on the isolating transformer and ripple filter.
j) Operation of the battery back-up device and the battery-operated power supply.
k) Simulation of the emergency homing sequence during fire and power failure.

12.8 Escalator Type Tests

12.8.1 Driving Mechanism

One unit selected by the "Engineer" for each range of duty of the driving machines provided for this Contract.

Scope of Tests

a) Dimensional Checking

Dimensionally check gear assembly backlash and shaft end float as follows:

i) Backlash with four consecutive 90^{o} turns, in the same direction, of the input shaft.
ii) Backlash with four consecutive 90^{o} turns, in the same direction, of the output shaft.
iii) Input shaft end float where applicable.
iv) Eccentricity of shafts on ground section adjacent to glands or oil seals.
v) Output shaft end float.

b) Dynamic Tests

The gears shall be "blued", with non-oil soluble ink, in addition to the assembly in order that the transfer mark for the contact area can be determined. The input shaft shall be turned a sufficient number of revolutions to establish the position of the contact area prior to the dynamic tests.

The test machine shall be run at simulated full load conditions at contract speed continuously for 8 hours, 4 hours in each direction.

The following temperatures are to be recorded prior to the run, during the run, at 30-minute intervals and on completion of the run: -

i) Oil
ii) Input shaft bearing (drive end)
iii) Input shaft bearing (non-drive end)
iv) Output shaft bearing (output side)
v) Output shaft bearing (non-output side)
vi) Gear casing
vii) Motor casing
viii) Ambient

The temperature of the rim on the gear of the output shaft shall be recorded prior to the run and immediately on completion in each direction.

The contact area of the gears shall be checked on completion of the run in each direction. This shall demonstrate that the wear pattern is forming in a correct manner.

The machine shall also be run under no load and at test load conditions at full speed in each direction for a sufficient period to record the maximum vibration amplitudes at: -

i) Mounting points
ii) Bearings

c) Verification of Efficiency

The overall efficiency of the machine shall be verified by calculation from the results of the tests.

12.8.2 Motor

Frequency of Tests

One unit selected by the "Engineer" for each range of motors supplied for this Contract.

If the quantity of the same range of motor exceeds forty, an additional motor shall be selected from the second batch by the "Engineer" to repeat the same tests described below.

If a separate motor is used for achieving maintenance speed, the same requirements shall also apply to the maintenance motors.

In general, all tests shall be conducted in accordance with the relevant parts of BS 4999.

Scope of Tests

a) Insulation Test

i) Insulation resistance of windings using 1000V megger shall not to be less than 200 M ohm.

ii) Insulation resistance of thermistors subject to 1000V for 5 seconds shall not be less than 200 M ohm. Windings shall be earthed.

iii) Main and slow speed winding shall each be pressure tested to 2000V r.m.s. for 60 seconds. During this test, thermistor wires shall be grounded to earth.

iv) Cold resistance of both high and low speed windings shall be recorded.

b) Dynamic Tests

i) No load current and speed shall be recorded at rated voltage and frequency for both high and low speed windings.

ii) Full load, 75%, 50% and 25% load tests shall be carried out on both high and low speeds at rated voltage and frequency. Current and speed shall be recorded for each. Input power, efficiency, slip and power factor shall be established and recorded for each. For Load Test (as per EN 115) the Escalator shall be started at No Load and subsequently the Load will be increased incrementally to test the Motor for different loads

iii) Temperature rise test on full load shall be carried out on high speed windings only. Voltage shall be 415V. Frequency shall be as rated.

iv) Ambient, air outlet, casing, output power and temperatures shall be recorded at 15-minute intervals for the first two hours and 30-minute intervals subsequently until temperature levels off.

v) Voltage, current, frequency, output power and temperatures shall be recorded at 15-minute intervals for the first two hours and 30-minute intervals subsequently until temperature levels off.

vi) When the temperature has leveled off, the motor shall be switched off and the winding temperature rise shall be established using the resistance method as specified in BS 4999 Part 101.

vii) A momentary overload of 200% full load shall be applied for 15 seconds. The motor shall not stall or abruptly change speed.

viii) A locked rotor test shall be carried out at rated voltage and frequency for both high and low speed windings. Current and torque shall be recorded in both cases.

ix) The speed/torque characteristic and the starting current characteristic shall be produced from the results obtained.

12.8.3 Main Drive Shaft

Frequency of Tests

Depending on the number of different types of main drive shaft to be provided for this Contract at least one for each of the high- and low-rise range of main drive shaft shall be

selected to undergo the type tests. The "Engineer" will determine if the intermediate range is required for the tests.

Scope of Tests

a) Dimensional Checking

Ten main drive shafts selected by the "Engineer" shall undergo a comprehensive checking and testing which includes but is not limited to the following: -

i) Dimensional checking of the shaft to verify conformance of the manufacturing tolerances.

ii) Check alignment of sprocket position and parallelism of sprockets.

b) Radiographic checks or other approved non-destructive testing on the welds shall be carried out on the shaft after the checking in a) i) above have been completed. A certificate of the welder's qualifications shall accompany the report to be submitted.

12.8.4 Steps

Frequency of Test

One step shall be required to undergo the type tests as described below: -

Scope of Tests

a) Static Test

The testing procedures shall conform to the requirements as described in EN115 Clause 8.2.2.1 as a minimum.

b) Dynamic Test

The testing procedures shall conform to the requirements as described in EN115 Clause 8.2.2.2 as a minimum.

12.8.5 Step Chain

Frequency of Test

One sample of each range of step chain provided in this Contract shall be required to undergo the type test.

Scope of Tests

a) A destructive test to verify the tensile breaking strength of the chains.

b) Dimensional checks on the test sample to check the link plates, step axles and chain pin, and to verify compliance with the manufacturing tolerance of the components.

c) Evidence of the heat treatment of the link plate, if applicable, shall either be provided or verified by test.

d) The method of protecting the chain for shipment shall be inspected for conformity with the correct approved procedures.

12.8.6 Wheels

Frequency of Test

Three samples each of the chain wheel and trailer wheel from the first batch of production shall be taken for the test.

Scope of Tests

a) Dimensional Checking

The dimensions of the test sample shall be checked to determine compliance with the manufacturing tolerance.

b) Hardness of the Bonding Material

The same samples as used in (a) above shall be used to determine the hardness of the bonding material.

c) Bonding Strength

The purpose of this test is to determine the bonding strength between the tyre and aluminum hub under a Tensometer.

i) A full depth section of tyre of sufficient length shall be removed to insert a cutting tool and detach the bond.

ii) The wheel shall be held by a pin at the stationary end of the Tensometer and the wheel shall be free to rotate.

iii) The detached end of the tyre shall be clamped firmly between the jaws of the operating end of the Tensometer.

iv) The load shall be applied gradually until a load of 1 kN is achieved. The rotation of the wheel shall not be more than 40^{o}.

d) Dynamic Test

The test sample shall be mounted on test jigs and subject to simulated load conditions to test their working life. Accelerated speed and increased loading to shorten the testing period may be acceptable, but full details of supporting calculations shall be provided.

12.8.7 Controller

Frequency of Test

One of each type of controller shall be type tested.

Scope of Tests

a) Physical Construction Checking

The construction of the control cubicle shall be checked against the approved drawings. Facilities to padlock incoming fused isolator shall be checked. Verification of the protection classification to IP55 shall be conducted and/or provided.

b) Pressure Test

i) Earth leakage circuit breakers shall be tested on both poles. The current and time required to trip shall be recorded. Similarly, the dc earth leakage unit shall be tested and values to be recorded.

ii) Pressure testing at 2000V ac r.m.s. for 60 seconds between:
phase to phase and phase to earth.

iii) Control wiring shall be pressure tested at 1,500V ac r.m.s. for 60 seconds between control/auxiliary wiring and frame. Insulation tests shall be carried out before and after the above tests by a 1000V insulation tester. The insulation resistance thus measured shall not be less than 200M ohm.

iv) All protection on electronic circuits shall be tested.
Wiring to all electronic components shall be megger. Megger setting shall be at the discretion of the "Engineer".

v) Verification of the protection circuit shall be carried out in accordance with the approved procedures.

c) Functional Tests

Functional testing of the completed control cubicle shall be carried out by simulation of the escalator operation to verify compliance with the Specification.

Temperature rise during the tests shall be recorded and verified.

12.8.8 Tension Carriage

Frequency of Test

One sample from each range of tension carriage (if different types are provided), shall be selected to undergo the type tests.

Scope of Tests

a) Dimensional Check

The test sample assembly shall be checked thoroughly to ensure that all the dimensions comply with the manufacturing tolerances.

Check alignment of sprocket position and parallelism of sprockets.

b) Radiographic Check

The welds on the same sample shall be checked by radiographic examination or any other approved non-destructive method. A certificate of the welder's qualifications, who performed the welding of the tension carriage, shall accompany the report to be submitted.

12.8.9 Driving Chains

Frequency of Test

One of each type of driving chains shall be required for the type tests.

Scope of Tests

Each chain selected shall undergo destructive tests to prove its breaking strength.

12.8.10 Handrail

Frequency of Test

One sample selected from the first batch of production shall be made available for the tests. If the mould for vulcanization is changed due to any reason during the subsequent manufacturing period, the same test shall be repeated, if so desired by the "Engineer".

Scope of Tests

a) Physical Checking

The inner element of the test sample shall be checked against the approved drawings before vulcanization. The vulcanized sample shall be checked to confirm the dimensions and manufacturing tolerances.

The inner layer shall be tested to confirm its water-repellent property. The rigidity of the lips shall be tested to verify compliance. Two samples of the outer stock shall be taken from the test sample and checked to verify their Shore Hardness.

b) Breaking Strength

The same sample shall be tested to confirm the minimum breaking strength. A factory prepared joint shall also be tested to verify that its breaking strength is not less than 85% of that of the test sample.

c) Ozone Aging Test

The rubber sample shall be tested to prove its ozone aging resistance in accordance with the test specification.

12.8.11 Braking System

Frequency of Test

One of each type of brake provided shall be required to undergo type testing.

Scope of Test

A full dimensional check shall be carried out to verify compliance with the manufacturing drawings and a full functional test shall be carried out. A demonstration of brake adjustment and setting shall be carried out.

12.9 Elevator Type Tests

12.9.1 Driving Mechanism

One unit selected by the "Engineer" for each range of duty of the driving machines provided for this Contract.

Scope of Tests

a) Dimensional Checking

Dimensionally check gear assembly backlash and shaft end float as follows:

i) Backlash with four consecutive 90^{o} turns, in the same direction, of the input shaft.

ii) Backlash with four consecutive 90^{o} turns, in the same direction, of the output shaft.

iii) Input shaft end float where applicable.

iv) Eccentricity of shafts on ground section adjacent to glands or oil seals.

v) Output shaft end float.

b) Dynamic Tests

The input shaft shall be turned a sufficient number of revolutions to establish the position of the contact area prior to the dynamic tests.

The test machine shall be run at simulated full load conditions at contract speed continuously for 8 hours, 4 hours in each direction.

The following temperatures are to be recorded prior to the run, during the run, at 30-minute intervals and on completion of the run: -

i) Oil

ii) Input shaft bearing (drive end)

iii) Input shaft bearing (non-drive end)

iv) Output shaft bearing (output side)

v) Output shaft bearing (non-output side)

vi) Gear casing

vii) Motor casing

viii) Ambient

The temperature of the rim on the gear of the output shaft shall be recorded prior to the run and immediately on completion in each direction.

The contact area of the gears shall be checked on completion of the run in each direction. This shall demonstrate that the wear pattern is forming in a correct manner.

The machine shall also be run under no load and at test load conditions at full speed in each direction for a sufficient period to record the maximum vibration amplitudes at: -

i) Mounting points

ii) Bearings

c) Verification of Efficiency

The overall efficiency of the machine shall be verified by calculation from the results of the tests.

12.9.2 Motor

Frequency of Tests

One unit selected by the “Engineer” for each range of motors supplied for this Contract.

If the quantity of the same range of motor exceeds forty, an additional motor shall be selected from the second batch by the “Engineer” to repeat the same tests described below.

If a separate motor is used for achieving maintenance speed, the same requirements shall also apply to the maintenance motors.

In general, all tests shall be conducted in accordance with the relevant parts of BS 4999.

Scope of Tests

a) Insulation Test

i) Insulation resistance of windings using 1000V megger shall not to be less than 200 M Ohm.

ii) Insulation resistance of thermistors subject to 1000V for 5 seconds shall not be less than 200 M Ohm. Windings shall be earthed.

iii) Main and slow speed winding shall each be pressure tested to 2000V r.m.s. for 60 seconds. During this test, thermistor wires shall be grounded to earth.

iv) Cold resistance of both high and low speed windings shall be recorded.

b) Dynamic Tests

i) No load current and speed shall be recorded at rated voltage and frequency for both high and low speed windings.

ii) Full load, 75%, 50% and 25% load tests shall be carried out on both high and low speeds at rated voltage and frequency. Current and speed shall be recorded for each. Input power, efficiency, slip and power factor shall be established and recorded for each.

iii) Temperature rise test on full load shall be carried out on high speed windings only. Voltage shall be 415V. Frequency shall be as rated.

iv) Ambient, air outlet, casing, output power and temperatures shall be recorded at 15-minute intervals for the first two hours and 30-minute intervals subsequently until temperature levels off.

v) Voltage, current, frequency, output power and temperatures shall be recorded at 15-minute intervals for the first two hours and 30-minute intervals subsequently until temperature levels off.

vi) When the temperature has leveled off, the motor shall be switched off and the winding temperature rise shall be established using the resistance method as specified in BS 4999 Part 101.

vii) A momentary overload of 200% full load shall be applied for 15 seconds. The motor shall not stall or abruptly change speed.

viii) A locked rotor test shall be carried out at rated voltage and frequency for both high and low speed windings. Current and torque shall be recorded in both cases.

ix) The speed/torque characteristic and the starting current characteristic shall be produced from the results obtained.

12.9.3 Controller

Frequency of Test

One of each type of controller shall be type tested.

Scope of Tests

a) Physical Construction Checking

The construction of the control cubicle shall be checked against the approved drawings. Facilities to padlock incoming fused isolator shall be checked. Verification of the protection classification shall be conducted and/or provided.

b) Pressure Test

i) Earth leakage circuit breakers shall be tested on both poles. The current and time required to trip shall be recorded. Similarly, the dc earth leakage unit shall be tested and values to be recorded.

ii) Pressure testing at 2000V ac r.m.s. for 60 seconds between: phase to phase and phase to earth.

iii) Control wiring itself shall be pressure tested at 1,500V ac r.m.s. for 60 seconds between control/auxiliary wiring and frame. Insulation tests shall be carried out before and after the above tests by a 1000V insulation tester. The insulation resistance thus measured shall not be less than 200M ohm.

iv) All protection on electronic circuits shall be tested by a 500 V installation tester.

Wiring to all electronic components shall be meggered. Megger setting shall be at the discretion of the “Engineer”.

v) Verification of the protection circuit shall be carried out in accordance with the approved procedures.

Temperature rise during the tests shall be recorded and verified.

12.9.4 Braking System

Frequency of Test

One of each type of brake provided shall be required to undergo type testing.

Scope of Test

A full dimensional check shall be carried out to verify compliance with the manufacturing drawings and a full functional test shall be carried out. A demonstration of brake adjustment and setting shall be carried out.

12.9.5 Elevators Inter-communication System

Two of each type of Elevator-Inter-Communication Systems shall be type tested. A full functional test shall be carried out to verify compliance with the specification.

12.10 Escalator Routine Tests

The following are the minimum requirements of the routine tests.

12.10.1 Main Drive Shaft

100% Check:

Thorough dimensional checking against the accepted drawings and manufacturing tolerances shall be conducted for every main drive shaft produced. This shall include checking of the alignment of the sprockets on both sides of the shaft.

Random Check:

Ten main drive shafts will be selected to conduct the radiographic examination or other approved non-destructive testing on the welds.

12.10.2 Driving Machines

Random Check:

Each set of worm and gear shall be checked to verify that the backlash and contact area is in conformity with the accepted test specification. Test results shall be recorded for inspection.

Verification of the insulation resistance of the windings using a 1000 Volts megger test. A high voltage test to 2000 Volts r.m.s. for one minute of the stator winding shall be conducted.

A dynamic test for every driving machine shall be conducted for a period of 4 hours continuously without stopping, except for changing of direction, 2 hours in each direction, at contract speed and 25% load conditions. The test is to ensure no undue vibration or abnormal temperature rise occurs in any component.

12.10.3 Step Chain

100% Check:

The assembled chain shall be checked for its overall dimensions and manufacturing tolerance, in accordance with the accepted test specification.

Random Check:

The link plates, chain pins and step axles shall be checked at random by using a “go” or “no go” gauge. Evidence of checking shall be verified on the checklist, if required by the “Engineer”.

12.10.4 Wheels

Random Check:

All wheels and bearings shall be checked at random in accordance with the accepted test specification, to confirm the dimensions and manufacturing tolerances.

Up to two percent of the total wheels for this Contract, if required by the “Engineer”, shall be tested to prove their bonding strength in accordance with the same procedures as for type tests mentioned above.

A failure from the first two percent samples shall necessitate a further two percent sample to be tested. A failure during further test shall render the complete batch to be unacceptable.

12.10.5 Tension Carriage

Random Check:

The carriage shaft shall be checked against the accepted shop drawings to verify the dimensions and manufacturing tolerances. The alignment of the sprockets on both sides of the shaft shall be checked at the same time.

12.10.6 Handrail

100% Check:

All factory prepared joints shall be checked before vulcanization, in accordance with the accepted drawings.

Random Check:

The physical dimensions after vulcanization shall be checked three times a day for, at the beginning, mid-day and before closing of work.The lip strength shall be checked to confirm its rigidity.

12.10.7 Floor Plates

Random Check:

Selected Floor plates shall be checked to confirm their dimensions and manufacturing tolerances, in accordance with the accepted drawings.

12.10.8 Comb Sections

Random Check:

The comb sections shall be checked to confirm their dimensions and manufacturing tolerances, in accordance with the accepted drawings. The accuracy of the holes for the fixing screws shall be checked with a gauge.

If required by the “Engineer”, a destructive test shall be conducted to verify the breaking strength of the comb teeth, in accordance with the accepted test specifications.

12.10.9 Steps

Random Check:

The tread and cleated riser dimensions shall be checked against the accepted drawings.

12.10.10 Handrail Drive

Random Check:

The alignment of the sprockets on both sides of the shaft shall be checked against the accepted drawings.

12.10.11 Control Cubicle

100% Check:

Verification of the insulation resistance of the control wiring and electronic components shall be conducted in accordance with the accepted test specifications.

Each control cubicle shall be checked with a simulator to test for correct wiring and termination, and the correct function of the electrical switches/relays.

12.10.12 Truss

100% Check

All truss work welding shall be subjected to a visual examination to ensure there is no surface porosity, undercuts or any other defects. Non-Destructive Testing shall be carried out on structural welds and on 10% of the remaining welds.

12.10.13 Escalator Assembly

The Contractor shall develop his own inspection checklist for the manufacturing process and for the checking of the assembled escalator. The results shall be properly recorded for the inspection by the "Engineer" or his designated representative during factory visits.

All the components inside the truss, such as the main drive shaft, tension carriage, tracks, wiring, safety switches, steps, and skirt panels shall be installed in position prior to the tests.

100% Check:

All items shall be checked for correct positioning and any measurements taken shall be recorded in the checklist. In particular the following shall be checked to ensure conformity with the Specification.

i) Step to skirting
ii) Riser to skirting
iii) Step to guide at comb
Iv) Comb to tread cleat
v) Step to step
vi) Skirt to step
vii) Carriage tension setting
viii) Carriage scale plate reading
x) Alignment of the truss joints shall be checked in accordance with the accepted test specifications. Through bolts shall be fitted after correct alignment and any shims used shall be marked and identified.
xi) All track joints shall be checked for alignment and smoothness. Sliding tracks shall be fitted correctly, in accordance with accepted shop drawings.
xii) After checking of alignment and correct squareness to the centre line, the housing of the main drive shaft bearings and the tension carriage bearings shall be drilled and fitted with through bolts.
xiii) The partially assembled escalator shall be run under power to check for proper clearance throughout the entire escalator.
xiv) Wiring of the in-truss switches shall be completed and properly terminated.

xv) For low rise escalators, the handrail may be coiled in the upper landing and properly secured.

xvi) When the assembled escalator is ready for dismantling and packing, the step chains and steps shall be anchored to prevent them from movement during transit.

xvii) A list shall be prepared for parts dismantled and will be shipped together with the escalator sections. Those parts to follow shall be clearly shown on a separate list.

xviii) Before shipment can be effective, the "Engineer" shall sign and issue a clearance certificate after he is satisfied with the packing procedures.

12.11 Elevator Routine Tests

The following are the minimum requirements of the routine tests.

12.11.1 Driving Machines

Random Check:

Verification of the insulation resistance of the windings using a 1000 Volts megger test. A high voltage test to 2000 Volts r.m.s. for one minute of the stator winding shall be conducted.

A dynamic test for every driving machine shall be conducted for a period of 4 hours continuously without stopping, except for changing of direction, 2 hours in each direction, at contract speed and 25% load conditions. The test is to ensure no undue vibration or abnormal temperature rise occurs in any component.

12.11.2 Power units

100% check:

The assembled power unit shall be checked in accordance with the accepted test specification.

12.11.3 Main Control Cubicle

100% Check:

The complete control cubicle shall be checked with a simulator to verify correct wiring connection and function of the electrical/ electronic devices.

Verification of the insulation resistance of the control wiring and electronic components shall be conducted in accordance with the accepted test specifications.

12.11.4 Call Button and Fixtures

Random Check:

The call button shall be checked at random to confirm the manufacturing quality.

The assembled fixtures shall be inspected and functionally tested accordance with the accepted test specifications.

12.11.5 Hoist Rope

A manufacturer's certificate or sample test will be acceptable to the "Engineer".

12.11.6 Safety Gear

Manufacturer's certificate or test report on the assembly will be accepted by the "Engineer".

12.11.7 Car Enclosure and Door Assembly

Random Check:

The assemblies shall be checked at random to ensure the correct dimensions and layout. Quality of the finishing shall be inspected to ensure the correct type of materials have been used for fabrication.

Protection of the finished assembly shall be inspected in accordance with the accepted test specifications.

For Glass Elevators, the Contractor shall fabricate and erect a prototype Glass Elevators and carry out strength, deformation and stability testing compliance with European Standard EN 81. In addition, the assembly shall be subject to pendulum impact test according to DIN 52 337 with the following fall heights.

Fall height 0.7m, pendulum impact test with a soft impact body (PW), (sack filled with 45 kg of shot);

Fall height 0.5m, pendulum impact test with solid impact body (PH), (pear-shaped steel ball 10kg).

The Contractor shall provide certification of the test results. Only the complete absence of breakage, permanent deformation, delimitation, dislodging of panels or fixings, and loss of stability will result in a successful test finding.

12.12 Escalator Site Checking and Inspection

A test and inspection specification shall be prepared for each of the following critical phases of work. Forty-eight hours' notice is required prior to completing these phases to enable the "Engineer" to carry out any checks he deems necessary. The following are the minimum requirements:

a) Definition of datum and installation of bearing plate
b) Alignment of truss and end supports
c) Alignment of drive and reverse station
d) Alignment of track brackets
e) Alignment of incline tracks
f) Installation and alignment of upper and lower newel wheels
g) Alignment of skirting brackets and panels
h) Installation of step chain and steps
i) Installation of balustrade steelworks
j) Alignment of handrail tracks

k) Installation of top decking panels, inner panels, skirting returns and kick plates.

l) Installation of upper and lower comb plates and access floor covers.

m) Alignment of "over speed" / "under speed" detection unit drive chain, handrail and countershaft drive chains.

n) Installation of switches and wiring.

o) Installation of lubrication system

p) Installation of wiring and cabling

q) Earthing and bonding checks

r) Installation of controller

s) Installation of escalator cladding and decking extension.

12.13 Elevator Site Checking and Inspection

A test and inspection specification shall be prepared for each of the following critical phases of work. Forty-eight hours' notice is required prior to completing these phases to enable the "Engineer" to carry out any checks he deems necessary. The following are the minimum requirements:

a) Setting out the plumb lines;

b) Erection and alignment of guide rails; rail brackets

c) Erection and alignment of landing doors; jamb, sills, header etc.

d) Erection of Elevator shaft and Elevator pit equipment;

e) Erection of car enclosures;

f) Positioning of machine equipment and control cubicles;

g) Installation of the hoist ropes; and governor rope

h) Erection of landing fixtures and car fixtures;

i) Installation of hoist way and machine room trunking prior to installation of wiring;

j) Installation of wiring and cabling

k) Installation of car fixture and car top equipment

l) Earthing and bonding checks

12.14 Escalator Commissioning and Acceptance Tests

After installation, each escalator shall be tested by the Contractor in the presence of the "Engineer". The tests shall include but not limited to the following: -

12.14.1 Final Electrical

Each escalator shall be subject to a rigorous electrical testing which will prove the functionality of the escalator control, safety and support systems.

a) The over speed protection devices shall be tested by operating the escalator at rated speeds and tripping the over speed device manually. The device shall have been separately tested and set in the factory to operate at escalator speeds called for in this Specification.

b) The handrail tension malfunction devices shall be tested manually.

c) The broken chain protection shall be tested by operating the escalator at rated speed and tripping the broken chain device by hand.

d) The device providing against sudden and unusual strains on the step chains shall be tested by operating the device by hand.

e) All push buttons, starting switches, relays, interlocking, controls and features required in connection with the work shall be inspected and tested to prove that the complete escalator functions properly under any and all conditions of operation within the limits specified.

f) All conductors shall withstand a 1000V megger test with the voltage being applied between each conductor and ground. Each conductor shall show an insulation resistance to earth of not less than 3 Mega ohms.

12.14.2 Weight Test/Load Test

The weight test for each escalator including verification of braking distances shall be conducted when the site testing of the escalator has been substantially completed. Details of the requirements shall be as follow:

a) The escalator shall be run under a series of test load conditions.

b) In line with EN 115, the Escalator will be started at No Load and its Starting Current measurement. Thereafter, the following readings shall be taken under no load, 25%, 50%, 75% and full test load, and no load after adjustment at full test load;

   i) Running current
   ii) Supply voltage
   iii) Motor speed
   iv) Braking deceleration measured as slip through the brake
   v) Escalator and handrail speed

c) A tripping switch shall be provided to enable accurate measurements of braking distances to be made.

d) The stopping distance versus the operation brake spring settings diagram shall be obtained by determining the following points.

   i) Brake spring setting at lower limit of stopping distance at no load.
   ii) Stopping distance at full load at brake spring at d) (i).
   iii) Brake spring setting at upper limit of stopping distance at full load.
   iv) Stopping distance at no load at brake spring setting at d) (iii).

e) It shall be demonstrated that the brakes can be adjusted to meet the requirements of the Specification under all conditions of load and the brake torque checked and recorded.

f) Testing weights shall be supplied, placed in position and removed from site after use, by the Contractor

12.14.3 Final Mechanical

The purpose of this test is to ensure that all site test specifications are complete, all "snagging" faults have been rectified and accepted and there is no damage to any part of the step band following the Weight Test. In addition to the verification that all barriers, signs and notices are provided.

12.14.4 Twenty-Four Hour Run

Each escalator shall be subjected to a 24-hour continuous running test, 12 hours in each direction, without stopping except to change direction. This test is to ensure that there shall be no undue noise, vibration or abnormal temperatures arising from any component during the testing period. If any of these occur, the escalator shall be shut down for checking and/or repair and the same tests shall be repeated.

12.15 Elevator Commissioning and Acceptance Tests

12.15.1 Tests shall be carried out on each Elevator in accordance with the relevant portions of BS 5655, which shall include but not be limited to the following: -

(a) Readings on starting current, running current and supply voltage shall be taken at the rated speed of each Elevator in both directions of operation under no load, 20%, 40%, 60%, 80% and full load conditions.

(b) Both power and control wiring of the controller shall be tested between lines connected together and earth at 1000V 50Hz. This voltage shall be applied and maintained for one minute. The control wiring shall be separately tested between poles and earth. Immediately following each test, a 1000 Vdc. Insulation tester shall show an insulation resistance of not less than 3 M ohms. All field wiring shall withstand a 1000 V megger test on site and each conductor shall show an insulation resistance to earth of not less than 3 M ohms.

(c) The over speed governor shall be tested to ensure that it will activate when the speed exceeds 40% of the nominal speed.

Functional tests on the safety gear with no load at rated speed by manually tripping the governor.

The Elevator car shall be operated up and down several times including tests to demonstrate the levelling operation.

(d) Test on the car and landing doors system

(i) Checking of the condition of the landing and car door for smooth operation,

(ii) Functional tests on the door closing time, door speed, re-opening, safety edge, proximity detection landing and car door contacts of the door lock.

(e) Functional tests on all the landing call buttons, indicators and all function provided in key-switch operated cabinet mounted below the car operating panels.

(f) Functional tests on the emergency call buttons.

(g) Functional tests on the final limit switches, terminal slow down and terminal over travel limit switches.

(h) Functional tests on the following safety switches and devices:-

(i) Overload device.

(ii) Phase protection device.

(iii) Anti-creep system.

(iv) Emergency lowering and raising devices.

(v) Pipe rupture device.

(vi) Over current protection device.

(vii) Counter weight safety (if applicable)

(i) Functional tests on the UPS unit and 2 hour duration test.

(j) Functional test on the car top maintenance panel.

(k) Testing of the Intercom system.

(l) Compress buffer test.

(m) Running clearance tests.

(n) Functioning test of Elevator management, monitoring and fault diagnostic system.

(o) Noise/ sound level test of equipment and installation.

(p) Functional tests of battery backup device.

(q) Complete function tests on track machine, motor brake and control equipment.

(r) Floor leveling accuracy and re-leveling at different loads.

(s) Tests on Emergency Power and Fire operation.

Temperature readings of elevator controller and equipment shall be taken every fifteen minutes for at least 2 hours or the duration of test whichever is longer.

(t) Functional tests of all features and functions not included in the above but required in the Contract.

12.15.2 Twelve Hour Run

Each Elevator shall be subject to a 12-hour duty cycle test, during which the Elevator shall run continuously with the contract load for 12 hours and shall travel up and down with intermediate stops such that the number of starts complied with the specification.

12.16 Interface and Integrated Tests

The Contractor shall co-ordinate and carry out interfacing and integrated testing together with other System-wide Contractors to ensure that the all integrated systems function as desired.

12.17 Certificate of Taking Over

The final acceptance tests of each item of equipment shall be undertaken in the presence of the "Engineer", in accordance with the test specification. Any defects and/or deviations discovered without prior written approval during the tests shall be rectified at the Contractor's own expenses. These shall be entered into a defects list agreed between the Contractor and the "Engineer". The Certificate of Taking Over will not be issued until these tests have been completed and the defect list substantially reduced to such an extent that the "Engineer" considers that the equipment is safe for operation.

12.18 Certification

Upon completion of each elevator the Contractor shall submit to the Employer, a Certificate of Supervision issued by the Contractor's Professional Engineer, in a format acceptable to the "Engineer".

13.0 ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS (EMC)

13.1 General

The requirements stated below must be read in conjunction with the other EMC requirements mentioned in GS.

The contractor shall take adequate measures to reduce conducted, induced, and radiated emissions, especially the levels of harmonics, to acceptable values as specified by the relevant international standards or by the concerned statutory authority.

13.2 Not Used

13.3 Inter-System EMC

13.3.1 The various electrical systems installed on the Railway under Construction will after installation interact with each other by mutual coupling and all plant and systems shall be designed so that there is no malfunction due to interference.

13.3.2 The Contractor shall ensure that all equipment supplied shall have minimum Radio Frequency Interference introduced onto the main network and comply with the Electromagnetic Compatibility (EMC) requirements of the following standards:

EN 50081-1 : EMC Generic Emission Standard

EN 50082-2 : EMC Generic Immunity Standard

BS EN 12015 : Electromagnetic compatibility- Product family standard for lifts, Escalators and passengers conveyors- Emission.

BS EN 12016 : Electromagnetic compatibility- Product family standard for lifts, Escalators and passenger conveyors- Immunity.

13.4 Harmonic distortion

The total harmonic distortion (THD) caused by the elevator equipment to the supply mains at the power supply input terminals of the elevator shall not exceed the following values when the elevator is travelling up at full load and rated speed:

Rated load Current (I_L)	THD (%)
200A $\leq I_L <$ 400 A	< 12.0
20A $\leq I_L <$ 200A	< 15.0
$I_L <$ 20A	< 20.0

13.5 Installation and Mitigation Guidelines

IEC1000-5 series of guidelines must be observed wherever applicable.

13.5.1 Earthing

An earthing system should be designed to assure personnel safety and protection of installations against damage. It should also serve as a common voltage reference and to contribute to the mitigation of disturbances.

To achieve the primary goal of assuring personnel safety and damage control, a low impedance path must be made available to large currents generated due to lightning or power system fault. The potential differences (touch and step voltages) between any two points must be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimise shock hazards to passengers and the maintenance staff.

To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing should be designed to minimise the noise voltage generated by currents from two or more circuits flowing through common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potentials.

Earthing shall also be designed to accomplish the following minimum requirements:

i) Protect personnel and equipment from electrical hazards, including lightning, where practical.

ii) Reduce potential to system neutrals.

iii) Reduce or eliminate the effects of electrostatic interference and electromagnetic interference arising from within the system.

iv) Provide a single-point earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies.

v) Provide a clean zero-volt reference point for signals in computer and related equipment.

13.5.2 Bonding

Bonding all exposed metallic parts of all equipment and connecting them to the earthing network is a way for meeting safety requirements and minimise noise voltages due to potential differences.

Direct bonding should be used wherever practical. Where indirect bonding via bonding strap is used to connect two isolated items, the bond must satisfy the following minimum requirements and prevailing international standards, for example, IEC1000-5-2.

i) Low bonding resistance from DC to at least 2 Ghz.

ii) Low bonding inductance from DC to at least 2 Ghz.

iii) Proper bonding procedure, including appropriate surface treatment before and after the bonding process is adopted.

iv) Proper use of bond material to reduce electrolytic corrosion.

13.6 Reliability and Maintainability

All Elevators shall be subject to the reliability assessment as described in Sub-section 4.9 of this Particular Specification. The Contractor shall ensure that the equipment's supplied shall achieve the availability standard as laid down in Sub-section 4.10 and shall always be under good repair within the environmental conditions prevailing in the General Specification, where the Elevators will be installed.

14.0 MATERIALS AND WORKMANSHIP REQUIREMENTS

14.1 General

14.1.1 General Requirements

This Section covers general standards of workmanship, material requirement and construction methods which are required for the execution of the Work. Any reference to any specific material or plant does not necessarily imply that such is included in the Works.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports, Approval letters and other significant information pertaining to the same, shall be furnished when requested by the "Engineer", who shall have the power to reject any parts which in his opinion are unsatisfactory or not in compliance with the Specification and such parts shall be replaced by the Contractor with neither cost nor programme implications to the Employer.

Samples of equipment submitted for the Approval by "Engineer" shall not be incorporated into the Works without getting the permission in writing from the "Engineer".

The "Engineer" will examine and confirm as Approved or Rejected the quality and workmanship of the first installation for each configuration of the Works. The installation, if approved, will establish the minimum acceptable standards for the Contractor's Works.

14.1.2 Plant Design

The whole of the Works shall be designed to conform to the best Engineering practice. Manufacturer's standard designs shall be used for all items of Plant for which standard designs are available provided that they conform to the Specification.

The Plant shall be designed for simplicity and reliability to give economy, long continuous service and minimum maintenance.

The whole of the Works shall be designed for neat appearance and tidy arrangement. The style and finish shall be consistent throughout the Works. The "Engineer" shall decide the final colors for all paintwork and other finishes to be applied to any part of the Works.

All parts shall be designed to withstand the maximum stresses under the most severe conditions of service after loss of any corrosion allowance and for lifetime of not less than 30 years.

The Plant shall be designed to minimize fire risk and of damage in the event fire.

The Plant shall be designed to prevent the entry of vermin and to minimize the entry of dust and dirt. Adequate safe-guards shall be provided to prevent accidental contact with rotating machinery, hot surfaces, electrically live parts and any other hazardous components or content of the Plant.

14.1.3 Compliance with Standards and Local Ordinances

All materials and components to be used, whether incorporated in the Works, Plant and Equipment at the manufacturer's Works or used for installation on Site, shall comply with the requirements of this Section and applicable Standards. These requirements shall be minimum requirements for general purposes and they shall not relieve the Contractor from ensuring that all his materials and components incorporated in the Works are suitable for their intended purposes and environments.

Where no alternative Standards are stated or agreed in the Contract, all details, materials, equipment and workmanship for which Standards have been issued by the Bureau of Indian Standards shall be in accordance with such Standards, even though no specific Standard may be mentioned in the Contract.

Alternatively, internationally recognized Standards such as IEC, DIN, ASME, ASTM, BS, NEMA, JIS may be Approved by the "Engineer" for manufacture of equipment provided that all parameters specified can be met.

The Works shall conform to all Statutory Ordinances, Orders or Regulations having the force of law.

Where the choice of plant, materials or equipment is affected by Indian Government Regulations or local Ordinances, the plant materials or equipment supplied shall comply with all relevant sections of such regulations even though no particular reference may be mentioned in this Specification. The order of precedence in the event of conflict is stated in this PS.

The Contractor may comply with any equivalent alternative Indian code or standards in lieu of those mentioned in this chapter. However, unless satisfactory documentary evidence and test certificates of compliance with the relevant clauses of this Specification, Standards, Ordinance, Regulation and the like, issued by competent, independent and internationally reputable testing authority (ies) are submitted for "local made" materials, including all components of locally assembled equipment and fixtures, Approval for the use of such materials may not be considered.

14. 1.4 Materials- General

All materials incorporated in the Works shall be suitable for the duty concerned and shall be new and of best commercial quality, free from imperfections, and selected for long life and minimum maintenance under the conditions specified.

All material used shall be of current production and well-proven application for the design and intended usage.

As far as practicable the use of electrically dissimilar metals in contact shall be avoided, but, where unavoidable, these metals shall be so selected that the Electro-chemical potential difference between them does not exceed 250 millivolts. If this is not possible, the contact surfaces of one or both of the metals shall be electroplated or otherwise finished in such a manner that the potential difference is reduced to within the required limits or the two metals shall be insulated from each other by an Approved method.

Where different components of equipment are interconnected to form a complete system, their characteristics of performance and capacities shall be matched in order to ensure efficient, economical, safe and sound operation of the complete system.

The use of asbestos and asbestos-based materials is not permitted.

14.1.5 Workmanship- General

Workmanship and general finishes shall be of best quality and in accordance with best workshop practice.

All similar items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as used for the originals and

shall fit all similar items or plant. Where machining may be needed before fitting renewable parts, the machining fits with their tolerances shall be shown on the drawings accompanying the instruction manuals.

All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and at any load up to the maximum there shall be no significant vibration due to out-of-balance forces.

All parts and equipment, which are subject to, wear or damage by dust or moisture in the environment they are installed shall be totally enclosed in housings of the appropriate degree of protection.

All equipment shall operate without excessive vibration and with a minimum of noise.

The standard of workmanship shall be consistent throughout the Works. Unless otherwise specified, the "Engineer" shall decide the final colors for all paintwork and other finishes to be applied to any parts of the Works.

14.1.6 Topicalization

All items of plant shall be tropicalized to suit the conditions prevailing in Kolkata in general and within the station and location where the escalator is installed in particular. Clause 1.12 in the Chapter 1 of General Specification gives the climatic conditions prevailing in Kolkata above and below ground and the Works shall be suitably designed manufactured and installed to meet these conditions.

In particular, the following points for topicalization of electrical components shall apply:

(i) All components of electrical systems shall be housed in suitable cubicles or enclosures, which provide the degree of protection as specified.

(ii) Operating coils shall be vacuum impregnated with waterproof insulating varnish or epoxy-resin encapsulated.

(iii) Wire-wound resistors shall be on ceramic formers and embedded in fireproof and damp-proof material.

(iv) Current and voltage transformer windings shall be epoxy-resin encapsulated against the ingress of moisture.

(v) Equipment provided with anti-condensation heaters shall be capable of operating without damage should the heaters be left on continuously.

14.1.7 Welding- General

Pull details of proposed procedures for factory and site welding of important components shall be provided by the Contractor. Welding of important structural components shall be subject to non-destructive testing as may be stipulated in this

Particular Specification.

The design and specification of welded joints and connections, and the fabrication of welded steel parts shall conform to the requirements of BS 5135 structural steelwork and BS 7475 for stainless steel and, unless otherwise agreed by the "Engineer", shall also be stress relieved to an Approved code.

Members to be joined by welding shall be accurately cut to size and, where required, shall be rolled or pressed to proper curvature in accordance with Shop/Fabrication Drawings. Edges of members shall be suitably machined for the required type of welding and to permit thorough penetration.

Surfaces prepared for welding shall exhibit sound metal without laminations and other injurious defects. Surfaces of plates to be welded shall be free from rust, grease, mill scale and other foreign matter over a distance of at least 25mm back from weld edges.

All welding operatives assigned to the Works for the manufacture, assembly or erection on Site of pressure-tight or highly stressed components shall be qualified in accordance with an Approved code and shall satisfy the "Engineer" in this respect prior to commencement of work.

If at any time, in the opinion of the "Engineer", the work of any welder appears questionable; such a welder shall be required to undergo, in the presence of the Employer or his representative, tests to determine the welder's ability to undertake satisfactorily the type of work upon which he is engaged. Tests upon the welded specimens shall be undertaken by an Approved examiner.

For such qualification tests and welding techniques shall be identical with those for the work in question and the Contractor shall: -

i. Furnish to the "Engineer" all test plates and welding electrodes

ii. Furnish to the "Engineer" certified copies of reports of results of physic tests

14.1.8 Materials and Ancillaries

a. Structural Steel Sections: -

i. Hot rolled structural steel section shall comply with BS 4: Part 1.

ii. Corrosion protection shall be by hot dip galvanized or heavy protective finished as specified in the Specification.

b. Mild Steel: -

i. Mild steel for general purposes shall conform with the requirement of BS 4360.

ii. Unpainted steel parts shall be zinc sprayed, or zinc coated, zinc plated, passivated cadmium plate galvanized as appropriate to Approved standards and as specified in the Specification.

iii. Unpainted, uncoated or non-corrosion resistant steel parts shall not be used unless otherwise approved by the "Engineer".

c. Steel Castings and Forgings: -

i. All steel castings shall conform with the requirements of BS 3100. Forgings shall be to BS 29.

ii. Before proceeding with foundry and forging work, the Contractor shall submit drawings to the "Engineer" of all steel castings and forgings and all other important components, showing the proposed locations for taking specimens for tensile, impact, fatigue, bend and any other appropriate tests.

iii. Castings shall be true to drawings and any casting in which any dimension is sufficiently reduced to impair its strength by more than 10% or to increase the stresses above specified limits, shall be liable to rejection by the "Engineer". Excessive segregation of impurities or alloys at critical points in a casting shall be sufficient cause for its rejection.

iv. Cracks or other defects disclosed during cleaning or machining operations shall be chipped or grooved out by carbon-are air process to sound clean metal, and then inspected by appropriate non-destructive method(s) to be agreed between the Contractor and the "Engineer". Should removal of metal, to uncover or remove a crack or defect, result in a reduction in stress bearing cross-section of a component or increase the stresses above specified limits by more than 10%, the component may, at the option of the "Engineer", either be rejected or repaired.

v. In such special cases as may be decided by the "Engineer", steel castings and forgings shall be subject to x-ray, gamma-ray or other Approved form of non-destructive testing to appropriate British Standard or such other Standards as may be Approved by the "Engineer". When required by the "Engineer" to do so, the Contractor shall furnish stress calculations and full details of proposed repair procedures before receiving Approval to proceed with remedial works.

vi. No repair shall be undertaken without prior Approval by the "Engineer". Such Approval shall also refer to the procedure for repair. Repairs by welding to steel castings and forgings shall be undertaken only by

properly qualified welders and in full accordance with an Approved procedure. All such repairs shall be subject to stress relief.

d. Corrosion Resistant Steel**:** -

i. Unless otherwise specified or Approved by the "Engineer", stainless steel tubes, sheets and plates used in this Contract shall be in accordance with the following Standards: -

Austenitic stainless-steel tubes shall comply with BS 6323: Part 1 and Stainless and heat-resisting steel plate, sheet and strip shall comply with BS 1449: Part 2, grade 304 unless otherwise specified.

ii. Stainless steel shall have good arc-welding properties and low carbon content. Stainless steels adversely affected by welding shall not be used. There shall be no visible welding mark on the exterior surface. All stainless steels shall be subject to Approval by the "Engineer".

iii. Where cladding with stainless steel is proposed, the method of application shall be submitted to the "Engineer" for Approval.

iv. Stainless steel protective cover shall be applied on the external surface and retained until installation is completed. Covering materials between seams or panel joints shall be removed before assembling. The protective cover shall be removed by the Contractor as instructed by the "Engineer", there shall be no residual covering materials left on the surface or in between seams or panel joints after removal.

e. Cast Iron: -

i. Cast iron shall not be used for systems containing high-pressure air, oil or water or for any components subject to tension or impact stresses.

ii. Where cast iron is used, grades shall not be inferior to BS 1452 Grade 150.

f. **Aluminum and Aluminum Alloys**: -

i. Aluminum used for electrical purposes shall be of the highest purity commercially available, and the Contractor shall substantiate this by submitting certificates of analysis stating the percentages and nature of any impurities. Wrought aluminum and aluminum alloys for electrical purposes shall comply with BS 2898.

ii. Unless otherwise specified, aluminum or aluminum alloy when used for components shall either be painted or be anodized to give a deposit of not less than 50 g/mm and 25-micron thickness. Aluminum and aluminum alloys shall not be in direct contact with dissimilar metals. The treatment of any such paints shall be agreed with the "Engineer".

iii. All die-cast aluminum components in large quantities shall bear a marking clearly indicating the month and the year of manufacture.

iv. Aluminum die-casting shall conform to BS 1490.

g. **Bronze**: -

Bronze castings for bearings, packing boxes, and similar applications shall be of the phosphor bronze type to BS 1400.

h. **Copper**: -

i. Copper tubing shall be of the seamless type to BS 2871.

ii. Copper for electrical purposes shall conform to the requirements of BS1432-4 and BS 1977 as appropriate for the duty.

i. Brass: -

Brass tubing shall be of the heavy gauge seamless type and shall comprise 70% copper, 29% zinc and 1% tin.

j. **Wood**: -

The use of wood shall be avoided as far as possible. When its use is specified or unavoidable, then it shall be fire retardant to BS 476: Part 20 to 22, thoroughly seasoned teak or other Approved hard-wood, tantalised, free from knots and blemishes and naturally resistant to decay. Joints shall be dove-tailed or tongued and pinned where possible. All metal fittings shall be of non-ferrous or stainless steel.

k. **Fabrics, Cork, Paper, and Similar Materials**: -

Fabrics, cork, paper and all similar materials shall not be used unless such use is unavoidable. If used, and where not subsequently protected by impregnation, all such materials shall be adequately treated with an Approved fungicide and shall meet the minimum performance requirements with respect to fire safety. Sleeving and fabrics treated with linseed oil or linseed-oil varnishes shall not be used.

l. **Insulating Materials**: -

Non-impregnated paper, fabric, wood or press- palm shall not be used for insulating purposes. Where synthetic resin bonded insulating boards are used, they shall be fire resistant to the minimum requirements for fire safety and all cut edges shall be sealed with an Approved varnish.

m. **Adhesives:** -

Adhesives shall be specially selected to ensure use of types, which are impervious to moisture, resistant to mould growth and other forms of attack or deterioration. Synthetic resin cement only shall be used for joining wood.

14.1.9 **Finishes**

a. **General Requirements**

Exposed metal surfaces shall, after inspection and witnessed testing in the factory, be thoroughly cleaned of all dust, oil, grease, dirt, scale and rust by grit or shot-blasting in accordance with relevant Part of BS 7079 and then ground smooth where necessary, immediately after which they shall be treated.

Surfaces of castings, steel work, piping and plant which are to be in direct and permanent contact with concrete shall be properly painted and covered, prior to dispatch from the factory, with a substantial coating of cement wash or other Approved proprietary coating plus a lapping of an Approved weatherproof tape.

Except where otherwise specified, all non-embedded pipes and fittings located in inaccessible positions (e.g. in pipe trenches, pits and similar locations) shall be externally coated by dipping in acid-free hot bituminous compound. The coating thickness shall be Approved by the “Engineer”. The pipe or fitting shall then be overlapped with a layer of anti-corrosion tape, which shall be Approved by the “Engineer”.

The internal surfaces of all oil service ferrous pipes and fittings shall be carefully inspected to ensure that all scale and other particles or contaminants have been removed and shall then be protected in an Approved manner to prevent deterioration during transport and subsequent erection.

The external surface of accessible ferrous pipes and fittings shall be treated with two coats of Approved primer paint prior to dispatch from the place of manufacture.

The external surfaces of all plant or items in damp environments shall, unless made of non-ferrous metal, be similarly coated with an Approved bituminous compound. All access ladders and platforms and associate supporting steelwork shall be galvanised.

All other exposed surfaces, except where otherwise specified, shall be thoroughly cleaned of all dust, oil, grease, dirt, scale, rust or other contaminants by power tool operated metal brush, or preferably by shot or grit blasting, and shall then be coated immediately with one coat of an Approved primer paint. Following witnessed factory tests, any rough surfaces shall be filled in and carefully dressed smooth, on completion of which further treatment shall be as detailed hereunder:

i. The interior surfaces of oil-filled chambers and tanks, and the external surfaces of piping or fittings included therein, shall receive one undercoat followed by two final coats of oil-resistant enamel paint of a color and type Approved by the "Engineer".

ii. All internal surfaces of cubicles, kiosks, boxes and the like, containing wiring or other apparatus, and the internal compartments of plant components forwarded to Site in assembled or partially assemble condition, shall be paint-finished with three coats of white enamel the last of which shall be an anti-condensation finish.

iii. The external surfaces of panel suites, cubicles, kiosks, marshalling and junction boxes, etc., shall be factory finished in stove enamel paint (minimum: 40 Micron DFT Primer + 40 Micron DFT Undercoat + 40 Micron DFT Top Finish, where DFT = Dry Film Thickness), and with color in accordance with BS 381C.

iv. All surfaces of plant and machinery shall receive protection to suit the duty involved. In particular all surfaces forming an interior accessible compartment shall receive one primer coat and one undercoat to be followed by two final coats of oil-resistant enamel paint, the application of which shall be undertaken only following completion of site erection.

v. The external surfaces of all other plant components shall have any damage to priming or undercoats made good by the Contractor on completion of installation and shall then be finally painted in Approved colors.

b. **Galvanizing**

Unless otherwise specified, all galvanized coatings shall be applied by hot dip process to BS729 forming a smooth, clean, dull grey zinc coating free from bare spots or other defects, and of uniform thickness complying with BS729. Sheradising, Parkerizing, or other alternative processes shall not be used without the Approval of "Engineer"'.

All drilling, punching, tapping and bending of parts shall be completed and all burrs removed before galvanizing is done.

The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the wire or coated material.

Unless otherwise specified, semi-finished products such as zinc sprayed, zinc coated, zinc plated or hot dip galvanized steel sheet suitable for subsequent fabrication shall have the following coating weights: -

i. Where no paint finish is required the coating weight shall be not less than 300g/m^2 per surface, i.e. 600g/m^2 on both sides.

ii. Where paint finish is required the coating weight shall be not less than 60g/m^2 per surface i.e. 120g/m^2 on both sides.

In the case of steel wire, the coating shall be of such thickness as to comply with the tests of BS 443.

c. **Paint Finishes for E&M Elements of the Works**

i. Unless otherwise specified, the Contractor shall apply paint finish to all exposed metal works including supporting rods and brackets, cable trays, trunking, lighting fittings, pipe works, ductworks, surface conduits and accessories and other equipment, as supplied and installed under this Contract.

ii. **Method of Application**

The paint finish shall be regarded as an additional finish applied over hot dip galvanized steel sheet or extruded aluminum surface, or other coatings already defined elsewhere in the Contract. Details shall be submitted to the "Engineer" for Approval prior to application.

As far as possible, paint finish shall be applied at manufacturer's Works prior to delivery to Site for installation.

iii. **Electrostatic Painting of E&M Equipment at Manufacturer's Works**

The process shall be applicable to escalator steps and other equipment which are fabricated and pre-finished/painted at manufacturer's Works and shall include the following steps: -

(1) Degreasing with alkaline liquid

(2) Washing with water

(3) Drying

(4) Applying primer coats of 1-2 micron thick

(5) Applying undercoats of 10-15 micron thick

(6) Applying finish coats of 10 micron thick

(7) Baking

iv. **Painting of E&M Installations**

The process shall be applicable to supporting rods and brackets, pipe works, duct works and other E&M equipment which tailor-fabricated on and shall include the following steps: -

(1) **Preparation**

Galvanized surface shall be washed with white spirit to remove dirt and grease. Following cleansing the surface shall be washed with a Mordant solution such as British Rail 'T wash'. If metal coating is defective, instructions shall be obtained from the “Engineer” before proceeding.

Mild steel or ductile iron surfaces shall be scraped or wire-brushed to remove rust and loose scale and welding slag or splatter. Crevices shall be cleaned out. Oil, grease and dirt shall be removed using white spirit.

All preparation materials shall be fully cleansed from surface before proceeding.

(2) **General**

Colors as Approved by the “Engineer” shall be agreed prior to painting. For each finish color, the color of undercoat recommended by the paint manufacturer shall be used.

Control Samples: Approval of representative sample areas of each paint type shall be obtained from the “Engineer” before carrying out the remainder.

(3) **Cleanliness**

All brushes, tools and equipment shall be kept in a clean condition.

All surfaces shall be kept clean and free from dust during painting and drying.

A suitable receptacle for liquids, slops, washings etc. shall be provided. Disposal shall be in accordance with the Environmental Protection Department procedure.

(4) **Preparation of materials**

Paints shall be prepared as recommended by the manufacturer.

Any paint showing impurities, lumps, skin or uneven consistency shall be strained through fine gauze prior to application.

Different paints shall not be intermixed.

Paints shall be stirred to attain an even consistency before use.

(5) **Protection**

Freshly applied paints shall be adequately protected from damage.

"Wet Paint" signs shall be exhibited and protective barriers shall be provided on Site where necessary.

Surfaces adjacent to those being painted shall be adequately protected.

(6) **Application**

Paints shall be applied in accordance with the manufacturer's recommendations to clean, dry surfaces in dry atmospheric conditions and after any previous coats have hardened.

(7) **Priming**

Priming coats shall be applied by brush unless other methods are specifically permitted and Approved by the "Engineer".

Priming coats shall be to manufacturer's recommended thickness.

Any primed surfaces that have deteriorated on Site or in transit shall be touched-up or re-primed.

Metal surfaces shall be painted on the same day they have been cleaned.

Undercoats shall be applied by brush in a wet, even film all over surfaces, avoiding uneven thickness at edges and angles.

All priming and undercoats shall be rubbed down to a smooth surface with abrasive paper and all dust shall be removed before applying the next coat of paint.

Unless otherwise specified, finish coats shall be applied by brush in a wet, even film all over surfaces, avoiding brush marks, sags, runs and other defects. Second coats shall be applied within 48 hours of first coats.

Surface shall be cut in neatly and clearly. Adjacent surfaces shall not be splashed or marked.

d. **Materials for Painting of E&M Elements of the Works**

All coating materials for use shall be obtained only from the ISI approved manufacturers, unless otherwise specified. Any of the other listed suppliers' equivalent products can be substituted provided that all compatible coating materials come from the same supplier.

Coating materials shall be delivered in manufacturers sealed containers, clearly labeled with the following information.

(1) Type of material

(2) Brand Name, if any

(3) Intended Use

(4) Manufacturer's batch numbers.

e. **Paints for E&M Finishes**

i. For hot-dip galvanized finish:

(1) Primer shall be zinc chromate primer ICI Dulux F500-388 or equivalent

(2) Undercoat shall be ICI Dulux speed undercoat A543-101 or equivalent

(3) Finish coat shall be ICI Dulux gloss finish A365-line or equivalent

(4) 1 primer, 1 undercoat and 2 finish coats shall be applied

ii. For extruded aluminium surface:

(1) Etch primer shall be IMP Unilite 220 or equivalent

(2) Finish coat shall be polyurethane, IMP Imperite 330 or equivalent

(3) 2 primers and 2 finish coats shall be applied

iii. For other finish/surface:

(1) Undercoat shall be ICI Dulux speed undercoat A543-101 or equivalent

(2) Finish coat shall be ICI Dulux gloss finish A365-line or equivalent

(3) 1 primer, 1 undercoat and 2 finish coats shall be applied

Paint samples and manufacturers shall be approved by the "Engineer" prior to commencement of painting.

Touch-up proposals to make good any areas/surfaces that have been damaged on Site or in transit shall be submitted for the Approval of "Engineer".

f. **Paint for Conduit and Duct Systems**

Bituminous paint for steel conduits and steel cable ducts shall comply with BS 3416, type 1.

Zinc chromate primer for cable duct systems shall comply with BS 4652.

Galvanizing paint for cable duct systems shall be a proprietary type Approved by the "Engineer".

14.1.10 **Nameplates and Labels**

a. **Nameplates**

The Contractor shall provide and attach to each major piece of equipment a metal name and rating plate to be approved by the "Engineer". All nameplates shall be mechanically attached (not adhered) in a manner Approved by the "Engineer".

Each plate shall quote the name and address of the manufacturer, serial number, full rating data and the date of manufacture.

b. **Labels**

Descriptive labels shall be provided for all instruments, gauges, devices, fuses, links, valves, strainers, motors, cables control cubicles and panels and the main apparatus contained therein.

Labels for normal situations shall be of Approved material, suitable for Site conditions and resistant to mechanical shock. Unless otherwise specified, they shall have lettering not less than 6 mm high.

The designation on these labels shall be clear and shall, where practicable, incorporate the appropriate device number along with concise descriptive wording both in English and Hindi. The Hindi wordings will be supplied to the Contractor by the "Engineer".

Labels shall be of engraved type, with durable markings, and, unless otherwise Approved by the "Engineer", samples of ail labels shall be submitted for the "Engineer's" Approval.

Electrical warning signs shall have graphic symbols and wording in red on a white background. All such signs shall be submitted for the "Engineer's" Approval.

All labels shall be mechanically attached to the Approval of the "Engineer".

14.1.11 **Lubrication**

a. The Contractor shall submit a schedule providing details of quantities and recommended alternative manufacturers and grades for all oil and grease necessary for the lubrication of plant equipment and components provided under the Contract. From this schedule the "Engineer" will select a supplier from whom the Contractor shall be required to purchase and provide, sufficient oil and grease, plus an excess of ten per cent, for the flushing and initial charging of all lubrication systems occurring in the Works. Procedures for system flushing and charging shall be subject to Approval by the "Engineer".

b. Unless otherwise specified, each grease lubrication point shall be served by an individual line and nipple. Grease nipples and their location shall be Approved by the "Engineer". For each type of grease an agreed type of nipple shall be used to prevent mixing of non-compatible lubricants.

c. Lubricating points shall be positioned so as to be fully accessible and instructions regarding the type of lubricant to be used shall be affixed immediately adjacent to the lubricant point and shall be plainly visible. Oil level indicators shall be easily visible.

d. All equipment shall be charged with the initial supply of lubricant before running

the equipment, and, where such charging is carried out at a manufacturer's premises or elsewhere, the Contractor shall ensure that this has been done.

14.1.12 **Protection of Works for Electrical and Mechanical Installation**

a. Structures in which electrical and mechanical installations are being carried out shall be maintained in a clean, dry condition, free from dust, during the installation, testing and commissioning phases.

b. The dust level in all escalator "well – way" and EMRs shall be kept to a minimum by using industrial dust extractors of a type permitted by the "Engineer" during and after installation. Temporary screens shall be installed to separate dust-affected areas from the installations or temporary covers shall be installed around the installation as necessary.

14.1.13 **General Samples**

a. Unless instructed otherwise by the "Engineer" the Contractor shall submit in accordance with the Approved Programmes, samples of all materials and components specified and obtain the "Engineer's" Approval prior to confirming orders, and: -

   i. Submit samples in sufficient time to allow inspection, examination and checking by the "Engineer" and not less than 4 weeks prior to the time of required Approval.

   ii. Submit samples in duplicate unless otherwise instructed by the "Engineer".

   iii Label or mark clearly submitted samples with the following information:

      (1) General Description: item and use.

      (2) Relevant References: as appropriate, to Drawings, Specification clauses and Bill of Quantities.

      (3) Date of Submission.

      (4) Date of required Approval.

a. Minimum size of sample board shall be 1500mmx1500mm unless agreed otherwise.

b. The sample submitted shall have markings on it showing the name of the manufacturer or product brand name and where applicable the BS or other recognized international standard the item is manufactured to.

c. Upon completion of the Contract and with an instruction from the "Engineer", the Contractor shall handover the required samples to the designated storage areas for the "Engineer's" future use.

d. The Contractor shall liaise with the "Engineer" to allow suitable space to accommodate samples, mock-ups and prototypes as may be required by the Particular Specification.

14.1.14 **Assessment of Materials and Substances**

Before being brought onto Site any materials proposed by the Contractor shall be assessed by the Contractor for their human and environmental compatibility. Any material that is toxic, explosive or flammable or may otherwise create a hazard shall wherever possible be replaced by a less hazardous product. Where this cannot be done, the Contractor shall conduct a risk analysis and produce a method statement specifying the safe method of use and all associated precautions including personal protective equipment.

14.2 Mechanical Works

14.2.1 Screws, springs and Pivots

The use of iron and steel for screws, springs and pivots in instrument and electrical relays shall be avoided wherever possible. Steel screws when used shall be plated with zinc, chromium or cadmium or, when tolerance limitations preclude plating, shall be of corrosion-resistant steel. All visible fixing screws shall be of stainless steel. All non-ferrous screws to' be electro-tinned, or nickel or chromium plated finish.

Wood screws shall be of dull nickel-plated or other Approved finish. Instrument screws, except where forming part of a magnetic circuit, shall be of brass or bronze.

Springs shall be of non-rusting material (e.g. phosphor bronze or nickel silver) where possible. Pivots or other parts for which non-ferrous material is unsuitable shall be of an Approved corrosion-resistant material.

14.2.2 Bolts, Studs, Nuts and Washers

All bolts, studs and nuts shall be to an Approved Standard and to metric dimensions and shall generally be of bright steel. Those subject to vibration, high temperature or pressure shall be of high tensile material to the Approval of the "Engineer". The use of black grade bolts shall be permitted only Approved locations of minor importance.

Bolts, studs, nuts and washers shall be made of free machining quality stainless steel when: -

i. Subject to frequent adjustment or removal, such as adjusting bolts, removable screws or bolts, and adjustable bearings.

ii. Used for any application subject to corrosion.

Bolts, studs and nuts shall be suitably machined. Rolled threads will be considered

acceptable if conforming to an Approved standard. Washers shall be provided under all nuts and also bolt heads where appropriate. Bolts and stud shall protrude by at least one thread pitch beyond the outside face of nuts.

Jacking and connection screws shall all be of high tensile steel with fine threads of an Approved form.

Nuts, bolts, tap-bolts, set pins and any other item subject to vibration shall be secured with Approved locking devices

14.2.3 Bedplates, Alignment and Leveling

All bedplates of fabricated construction shall, prior to final machining, be fully stress-relieved.

To facilitate the alignment and leveling of larger components, all bedplates shall incorporate jacking screws suitably arranged to provide for movement of driving motors in both axial and transverse directions. Motor seating pads shall be so arranged that single piece machined packers can be inserted in place of shims of required thickness under each foot, or pair of feet, on completion of alignment.

After final alignment checks have been completed, and the unit run at full output for not less than six hours, the alignment shall be rechecked, and the unit securely dowelled to the bedplates.

14.3 Electrical Works

14.3.1 General

a. These requirements of this Section shall be taken to be generally applicable in accordance with good practice, and they shall not relieve the Contractor from ensuring that all plant, equipment and installations incorporated in the Works are suitable for their intended purposes and environments.

b. Where detailed requirements are expressed in Chapter 5 of this specification they shall take precedence over the general requirements hereunder.

c. **Polarity**

The polarity of all apparatus shall be arranged as follows when viewed from the front of the units: -

(1) For two pole apparatus the phase pole at the top (or left-hand side) and the neutral pole at the bottom (or right-hand side);

(2) For three or four pole apparatus-the phases in order, red, yellow, blue and neutral reading from top to bottom or left to right in the case of vertical and horizontal layouts respectively.

All cables shall be so connected between main switches, distribution boards, plant, machinery and accessories such that the correct sequence or phase colors are preserved throughout the system.

d. **Enclosures for Electrical Apparatus**

Cubicles shall be symmetrically arranged as far as possible with projections kept to a minimum and extendable from either end.

. The arrangements of the equipment within each cubicle shall be such that all normal maintenance can be carried out through hinged access doors or removable covers, from the front.

Where two or more cubicles are fitted together they shall form a flush-fronted continuous suite of uniform height when viewed from the front.

Each suite of panels or cubicles shall be fitted with a designation label giving plant identification number, voltage rating and duty. Such labels shall be fitted on the front of the cubicle, and on the sides and/or rear where appropriate.

Where a number of different plant items are in close proximity, the enclosure shall be grouped to form a single suite, or a composite enclosure shall be provided.

e. **Cubicle Construction**

Panels shall be made of sheet steel with a minimum thickness of 2mm and suitably braced to form a rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance. Interior edges shall be smooth.

An Approved method of construction shall be employed, and the use of externally visible assembly bolts and screws will not be accepted.

Enclosures shall provide a degree of protection not less than that defined by characteristic IP 55 in accordance with BS EN 60529.

Individual sections of the enclosures shall be fully segregated to comply with the safety requirements of relevant Indian or British Standard specifications.

The design of cubicles shall be such as to ensure adequate ventilation and air circulation without permitting the entry of vermin. Dust penetration shall be kept to a minimum by the fitting of recessed rubber seals around doors and removable panels.

The cable entries to cubicles shall be closed and made vermin proof by Approved means such as non-magnetic, fireproof barrier plates cut away where required to fit the cables.

All cubicle switchboards shall be in compliance with BS EN 60439-1 FORM 3 in

respect of fault segregation.

The height of the cubicles shall, not exceed 2130mm the size of the Cubicles shall be sufficient for enclosing the Control Panel considering the ventilation & light arrangement and easy access to work in the panel. All cubicles shall be suitable for floor mounting unless otherwise approved by the "Engineer". The design of the Cubicles is subject to the approval of Employer at design stage.

Cubicles shall be provided with flush front access doors fitted with lockable handles and lift-off type hinges so arranged that one shank engages before the other to permit ease of fitting. No instruments or relays shall be mounted on the doors unless otherwise specified. The key of lock shall be similar for all Cubicles.

f. **Switchboards and Motor Control Cubicles**

Switchboards and motor control cubicles shall be fitted with lockable hinged front doors and bolted removable panels at the rear where the removable panels give access to primary conductors, busbars or terminals. Where the voltage exceeds 110V d.c. or a.c., danger plates with suitable labels shall be fitted to give warning of the potentials contained therein. Where applicable, labels shall be fixed adjacent to the warning label advising isolation and earthing of conductors before removal of the panel. The wording of the labels shall be subject to the approval of the "Engineer".

Cubicles for multi-circuit switchboards shall be subdivided into single circuit sections, each provided with individual access door and rear cover. All dividing screens shall be of sheet metal, rigidly secured and arranged to segregate individual circuits and comply with the specified safety requirements.

Control wiring within the cubicles shall be neatly loomed or contained in purpose designed trunking unless every cable is insulated for the highest voltage present in accordance with the requirements of BS 7671.

The front door of all cubicles shall only be opened when the functional unit is locked off.

Live panel wiring terminations shall have a protective cover and warning labels.

g. **Assembly of Panels**

Component layout within panels shall provide a logical arrangement of equipment with the maximum feasible segregation between mains voltage/high current and low voltage/low current components and wiring.

A space allowance across the whole width of panels of a minimum of 100 mm shall be provided between the outgoing (plant) side of the terminal rail and the panel side

of the gland plate for all control and monitoring cables.

For incoming and outgoing power cabling this space shall be increased as necessary to ensure that the bending radius of the conductors is not compromised and segregation between power cabling and control cabling is preserved.

All components within control panels shall be either directly mounted on the back plate by means of screws in tapped holes or onto a "DIN" type mounting rail itself directly mounted on the back plate by means of screws in tapped holes.

h. **Small Wiring and Terminations**

Wiring shall be carried out in a neat and systematic manner and securely fixed by insulated cleats or other Approved methods and arranged so that access to any apparatus or connection point is not impeded.

Where inter-panel wiring passes through panel side sheets the access hole shall be fitted with a suitable rubber grommet.

Identification ferrules shall be fitted on all wires at both ends; numbers and letters used shall correspond with the appropriate wiring diagram and shall read from the terminals outwards. They shall be legible and durably marked and shall not be affected by oil or moisture. All cables connected to any nodal point shall be allocated with a discrete number which must not be used elsewhere in the associated circuits.

The wires shall not be jointed or broken in between terminal points.

Terminations for screw or stud terminals shall be of the crimped-on ring type. Termination of standard conductors to clamp type terminals shall be of the crimped-on solid rod type.

Not more than one core of either internal or external wiring shall terminate on any outgoing terminal. Where duplication of terminal blocks is necessary, suitable solid bonding links shall be incorporated in the design of block selected.

Wiring for all known future equipment shall be provided and all wires shall be terminated.

Wires of different voltages, AC or DC shall be completely separated.

Control and mains cabling shall be enclosed in slotted cable trunking with clip-on covers. No more than 50% of the internal cross-sectional area of the trunking shall be used in any length of trunking. Wiring outside the trunking shall be neatly set for connection to terminals or equipment.

All equipment and terminals associated with voltages in excess of 110 shall be fully shrouded.

i. **Cubicle Electrical Safety Arrangements**

All terminals, connections, relays and other components which may be "live" when access doors are open shall be adequately screened. It shall not be possible to obtain access to any adjacent cubicle when any door is open.

Components within each cubicle shall be fully labeled.

Where several outgoing circuits occupy a common termination chamber all copper work, cable lugs, terminations and terminal boards shall be fully screened or insulated to enable work on any one circuit to be carried out with other circuits live.

Isolators, clearly labeled, shall be provided in such positions and connections so that maintenance can be carried out with maximum safety. This shall particularly apply to control circuits fed from a remote position Where it is necessary to maintain the isolator in the "off" position, such apparatus shall be so screened and labeled as to eliminate the possibility of accidents. Additionally, a system of removable, insulated links isolating-type terminal blocks shall be provided to enable particular components to be isolated for maintenance purposes whilst retaining other essential circuits energized.

j. **Cubicle Control Components**

All individual components of control equipment associated with any item of plant shall be contained in a single control cubicle. Where a similar number of items of plant are specified a composite cubicle shall be provided.

Details of electrical connectors between the control cubicles and the items of plant shall be identified to facilitate cabling.

All instruments, relays, switches, lamps, push buttons and the like shall be arranged on the cubicle in a neat, functional and logic manner.

Similar items shall be of the same type, style, pattern or appearance throughout. Control and changeover selection switches for various functions shall be of the same type of appearance but with a handle of different shape for each specific function. They shall be fitted with facilities for locking to prevent unauthorized operations.

Instruments, controls and relays mounted on different panel sections but having similar functions shall be located in a physically similar position.

k. **Labeling and Marking**

Warning labels shall be fitted in all situations where the removal of covers or access panels may expose live equipment operating at voltages above 50V between circuits or to earth and shall bear the inscription 'Danger - Live Parts' in red letter on a white background. Minimum height of letters is 10 mm.

If the cubicle contains items of equipment which may retain electrical charges after they have been switched off, a warning label shall be provided.

All labels shall be of Formica engraving laminate or similar and Approved, of ample size and engraved in English and Hindi characters. A permanent mechanical means of fixing these labels shall be provided, other than by adhesives.

All equipment and apparatus, both inside and outside the switchboard, including instruments, meters, and relays, which is not clearly identified by integral labeling, shall be adequately labeled by means of an engraved label bearing, in black letters on a white background.

14.3.2 **Electrical Distribution Equipment**

a. **Moulded Case and Miniature Circuit-breakers**

Miniature circuit – breakers (MCB's) and Moulded case circuit – breakers (MCCB's) shall comply with BS EN 60898 and BS EN 60947-2 respectively. They shall be fitted with thermal overload and instantaneous magnetic short-circuit protection.

The instantaneous magnetic short-circuit protection shall be adjustable in MCCB's in frame sizes above 60 amperes.

Earth leakage protection shall be of the current operated type.

Unless otherwise specified, the A.C. rated short-circuit capacity for MCB shall not be less than 6kA, and that for MCCB shall not be less than 25kA

The maximum rating of MCB's shall be 80 amperes.

Triple pole MCB's shall be integral units and interlocked internally so that an overload on any one phase shall trip and all three phase of the breaker simultaneously. An assembly of three single-phase units mechanically strapped together is not acceptable.

b. **Residual Current Circuit Breakers with Integral Overload Protection**

Residual current circuit breakers with integral overload protection shall be current-operated, housed in a totally enclosed moulded/metal case or distribution board, manufactured and tested in compliance with BS EN 61009.

The rated earth-leakage tripping current and time shall comply fully with the requirements of the latest edition of IEE Wiring Regulations.

Provision shall be made for testing the automatic residual current tripping by an integral test device.

Manually operated ON/OFF facilities shall be provided.

The rated tripping currents for various applications shall be 30mA, 100 mA, 300 mA or 500mA and be approved by the "Engineer".

c. **Auxiliary Switches and Contacts**

Auxiliary switches supplied for indication, protection, metering, control interlocking, and supervisory purposes shall be readily accessible and enclosed in a transparent dust-proof cover. Adequate secondary disconnects shall be included to enable the auxiliary switch to be wired to the fixed portion of the equipment.

Spare auxiliary contacts shall be provided (the number being to the nearest manufacturer's standard design with a minimum of two normally open and five normally closed) and shall be wired to suitably identified spare terminals.

Contacts for all applications shall be rated at 6 amperes 240V 50Hz and 110 V de operating current (0.4 power factor inductive load) for one million on-load operations.

d. **Volt-Free Contacts**

Where volt-free contacts are specified or supplied on any equipment e.g. a circuit-breaker or contact starter, they shall comprise of a pair of contacts operated directly by the equipment but electrically separated such that no potential derived from the equipment appears at the contacts. Volt-free contacts will be used to complete external control, alarms or indication circuits, the supplies for these circuits being obtained from an external source. Unless otherwise stated, these supplies shall be low voltage ac or dc sources and auxiliary isolating poles, e.g. on starter isolators need not be provided.

Volt-free contacts shall be readily convertible from N/O. to N/C, and vice versa by simple field adjustment. Contacts shall be rated adequately to make and break and carry continuously not less than 6 amps at 240V ac or 6 amps. at 110V dc, unless specified otherwise.

e. **Operating Coils**

All fine wire operating coils and wire wound resistors shall be vacuum impregnated with an approved insulating varnish.

f. **Terminal Blocks**

Terminal blocks shall be of the type which clamps the wire securely and without damage between two plates by means of a captive screw and permits removal of a terminal without disturbing any adjacent terminals. Pinch screw type terminal blocks where the screw is in direct contact with the conductor shall not be acceptable. The minimum size of terminal shall be suitable for $4mm^2$ conductors. Terminal blocks at different voltages shall be segregated into voltage groups and terminal board layouts

shall correspond with the wiring diagrams. Where Approved barrier pattern screws or stud-type terminal boards are used, covers of transparent, insulating material, which do not sustain combustion shall be provided

Terminals for voltages higher than 110V or which may be alive when the main equipment is isolated from the main supply shall be suitably labeled to reduce the risk of accidental contact. All terminals shall bear permanent identification number or letter.

Terminal blocks shall be located adjacent to the point of cable entry adequate space being allowed for terminating the cable tails on Site.

After terminating all cores (including spares) there shall be not less than 10% spare terminals still available for use.

g. **Insulated Terminal Blocks**

The rated voltage of terminal blocks shall be 415V between terminals, 240V to earth.

Terminal blocks shall comprise brass tubular connectors with screw connections contained within moulded block suitable for working temperature up to 100 deg.C.

Terminals shall be designed to clamp the conductor between metal surfaces with sufficient contact pressure but without causing damage to the conductor. With the largest recommended conductor in position, and tightly clamped, there shall be at least two full threads of the screw engaging in the connector.

h. **Fuses and Links**

Fuses and links shall be provided to enable any circuit to be isolated as necessary for maintenance and test purposes without isolating the whole panel. All fuses shall be of the HRC cartridge type. Fuse carriers and solid link carriers and bases shall be made of plastic moulded insulating material of an approved make. Other type of materials may be used subject to the “Engineer’s” Approval. All accessible live connections shall be efficiently shrouded, and it shall be possible to change fuses with the circuit alive without danger of contact with live metal. The fuses shall be rated to give maximum protection to the apparatus in circuit and the rating shall be inscribed on the fuse label.

Earthing and neutral links in main supply circuits shall be of the solid copper bolted pattern.

Fuses and links functionally associated with the same circuit shall be mounted side by side. At least 10% spare fuses and links shall be provided.

An adequate number of spare fuse cartridges for each rating shall be supplied and fitted in clips inside the panel.

Descriptive circuit/function labels shall be mounted adjacent to all fuses and links, the layout of which shall correspond with the wiring diagrams.

i. **Push Buttons**

Push Buttons shall be colored as follows:

(1) "Start" - Green;

(2) "Stop" Red;

All other push buttons shall be black.

"Start" push buttons shall be effective when the selected switch is in the "local" position. They shall not be effective when the selector switch is in the "off" or "remote" position.

Emergency stop push buttons shall be provided and positioned in the immediate vicinity of the associated motor drive in all cases where: -

(1) There is no direct line of sight between the motor and the controlling starter;

(2) The distance between the motor and the controlling starter exceeds 5 meters; or

(3) The level difference between the motor and the controlling starter exceeds 600mm.

Emergency stop push buttons shall be connected in the control circuits such that they are effective under all conditions and shall have red mushroom headed pushes of the stay put pattern. A deliberate reset action shall be required before the drive can be put back into service but resetting of the push button shall not restart the drive.

In addition to the contacts connected in the control circuits of the circuit-breaker of starter, all emergency stop push buttons shall be provided with an additional contact for remote indication purposes. This additional contact shall close when the emergency stop push button is activated.

j. **Instruments, Gauges and Meters**

All instruments, gauges and meters shall be approved by the “Engineer” and those which perform similar duties shall be of uniform type and manufacture. They shall be flush pattern, dust and moisture proof suitable for the environment in which they are installed. Where hinged covers are necessary they shall be provided with locks. Indicating instruments shall be of the dial type fitted with zero adjuster externally accessible from the front, have no parallax error and have the normal maximum reading at approximately 600/6 full scale. DiaIs shall be white with black scales and black lettering not subject to fading. Scales shall be of such material that no peeling

or discoloration will take place with age under any conditions.

Motor ammeters shall be capable of withstanding and indicating the starting current and shall have a compressed overload scale.

k. **Control Transformers**

All control circuit supplies for contactor starting shall be obtained from a 110V 50Hz internal control transformer contained in the cubicle.

Each control transformer shall be bus bar connected and be provided with isolation facilities and primary and secondary HRC fuses.

Transformers shall be of the double wound pattern and be provided with earth screw button primary and secondary windings. One end of the secondary winding shall be earthed.

l. **Indication Lamps**

Unless otherwise approved by the "Engineer", indicating lamps on panels shall be suitable for operation on voltage below 50V and rated to withstand not less than 20% continuous over-voltage.

Lamps shall be well ventilated, and the design shall readily permit removal of lamp glasses and bulbs from the front of the unit.

m. **Control Switches**

Switches for control selection, motor control and other purposes shall have spade type handles and with key locking facilities. Contacts shall be non-welding.

Control switches shall comply with the requirements of BS EN 60947-5-1.

n. **Current Transformers**

Current transformers shall comply with BS 7626 and shall be of the bar primary pattern where practicable. All current transformers shall have a short-time current rating of not less than that of the switch panel in which it is incorporated. For bar primary current transformers this rating shall be for a period of 3 seconds and for wound primary designs the rating shall preferably be for a period of 3 seconds but may be reduced to not less than 0.5 seconds subject to Approval.

Current transformers shall have identification labels giving type, ratio rating, output and serial numbers.

In balance circuits, the spill current with maximum stability conditions shall not exceed one quarter of the operating current of the relay.

All protective current transformers shall be of Class '10P15' accuracy. Other

metering current transformers shall be of Class "3" accuracy.

Measuring current transformers shall be connected to test terminal blocks. The test blocks shall be provided with easily removable links and designed to facilitate connection of test instruments to load without open-circuiting the current transformers.

o. **Isolating Transformers**

Isolating transformers shall be of the double wound air-cooled pattern to BS3535: Pt. l Class II transformer. Separate windings shall be provided for the primary and secondary. The transformers shall be housed in double insulated enclosures.

p· **Contactors**

Contactors shall generally be of the air-break type fitted with are shields and rolling self-cleaning double-break silver face contacts contained in a dust-tight metal case. The units shall be complete with 240V operating coils, neutral links and HRC control fuses.

Contactors shall be electrically held in when in the closed position and fitted with a latch-in facility for test purposes. Each unit shall be fitted with a direct-coupled mechanically-operated indicator to show the contactor position.

q. **Contactor Type Motor Starters**

All contactor type motor starters shall incorporate air break contactors, triple pole HRC fuses, over current and earth leakage protection relays, necessary auxiliary relays, contactors, timers, auxiliary fuses, necessary wiring, main power cables and terminals which shall be properly interconnected. Control and indication facilities shall be provided on each starter as specified.

All low-voltage contactors shall comply with the requirements of BS EN 60947-4-1 and shall have a Utilization Category AC3 and Mechanical Endurance Class III.

Main drive motor starters shall be suitable for their required frequency duty in line with this Particular Specification. Other motors starters shall also be suitable for their required frequency duty but in no circumstance shall the frequency duty be less than 40 operations per hour. Their performance shall be in accordance with BS EN 60947-4-1.

All medium voltage starters shall incorporate a triple-pole, fully interlocked, load-breaking, isolating switch capable of breaking the installed motors current. Starters may be of the fixed or withdrawable pattern to the manufacturer's standard. If they are withdrawable, facilities shall be provided for testing started control circuits and operation when withdrawn without the necessary for complete removal of the starter

chassis. Where control circuit supplies and interlock circuits are broken via plugs on withdrawal of the starter at least one jumper lead and plug assembly of each size and type shall be provided to facilitate testing in the withdrawn (isolated) position.

All three phase motor starters shall be completed with three HRC fuses suitable for the starting duty of the circuit for short circuit protection and a triple pole hand reset thermal overload device with single phasing protection unless otherwise specified. Auxiliary contacts which close on the occurrence of overload/single phasing and remain closed until reset shall be provided for fault indications.

Where starters incorporate a number of contactors for reversing and/or assisted starting, these shall be both electrically and mechanically interlocked.

r. **Relays**

Protective, control, interlock and alarm relays shall be placed in positions readily accessible during operation of the plant. Unless otherwise Approved, these relays shall satisfy the general requirements of BS 14:

Relays shall be contained in dust-proof cases suitable for flush mounting on panels or cubicles and shall not be fixed to doors without prior Approval.

All metal bases and frames of relays shall be earthed except where they must be insulated for special requirements.

The relays shall be of an Approved type, construction and flush relay equipment shall be of the flush withdrawable pattern and shall have protective means for retention in the service position.

The contacts of all relays shall be adequate for the maximum current that can occur in the circuit they control. They shall also be capable of breaking such currents, unless provision is made for automatically breaking the current on contacts elsewhere in the circuits. The contact shall be of Approved material and shall be capable of repeated operation without deterioration. Contacts for remote alarms and indication shall be volt-free hand reset.

Relays shall not be adversely affected by mechanical shock or vibration, or by external magnetic fields, consistent with the place or method of mounting.

Operation indicators shall be fitted to trip relays and such other relays or relay equipment to enable the type of fault condition to be identified. The indicator shall be capable of being reset without the relay case being opened.

Except when the requirements of auto-control circuits do not permit, all protection relays which initiate tripping (excluding tripping relays) shall have not less than two independent pairs of contacts, of which one shall operate the tripping relay directly

without the interposition of auxiliary contactors, and preferably, without the use of reinforcing contactors.

All de relays shall operate satisfactorily when the supply voltage is between 50% and 120% of the rated voltage.

All relays shall be marked for purposes of identification with the following information:

(1) Function of relay

(2) Device number (BS EN 60617)

(3) Voltage and phase color of the supply (where applicable).

All contacts for control and auxiliary equipment shall be adequately rated for their duty and subject to the Approval of the "Engineer".

s. Earthing Arrangement of All Plant & Equipment

A continuous copper earth terminal shall be provided for all cubicles for connections to the metal cladding or armouring of all incoming and outgoing cables and, where specified, to the station earthing system. The cross-sectional area of the earth bar(s) shall not be less than the recommendations of BS 7430.

Earth bar for main earthing system shall be 300mm^2 tinned copper bar. No earth terminal shall have a cross-sectional area of less than 25mm^2. All metal parts of the Plant and equipment, other than those forming part of any electrical circuit, shall be effectively connected in an approved manner on to the main earthing system.

The entire conduit and trunking installation shall be electrically continuous throughout, forming a completely bonded system. All apparatus or parts thereof not directly connected to the conduit or trunking system, shall be connected thereto by substantial bonding clamps. The earth pin of all switch sockets and the exposed conductive parts of all lighting fitting and all other fittings and equipment shall be effectively earthed.

The Contractor shall test every complete earth loop circuit comprising conduits, cable sheaths, core conductors and transformer windings. The impedance values of the loop circuits for each section of the installation shall not exceed 0.5 ohm.

14.3.3 Cable Trunking, Conducts & Fittings

a. Trunking and fittings shall comply with BS 4678, part 1. Factory fabricated bends and tees shall be used.

b. Trunking shall be manufactured in mild-steel sheet and shall be hot- dip galvanized. Trunking shall have a removable cover throughout its length with Centre- screw latch fixing, or quick-fixing device reviewed without objection by

the "Engineer". The thickness of the sheet metal shall be 1.6mm for trunking size up to 100mm x 100mm and 1.8mm for trunking size of 150mm x 75 mm to 150mm x 150mm. Bonding link shall be fixed on external surfaces unless otherwise specified.

c. Unless otherwise reviewed without objection by the "Engineer", the minimum size shall be 50mm x 50mm.

d. All bend, tee pieces, stop ends, outlets, intersections and adapters will be of the same manufacture as the trunking. All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.

e. All conduits, except flexible conduit, shall be heavy gauge, hot-dipped galvanized welded steel complying with BS 4568: Part 1 Class 4. All conduit fittings and components shall be in accordance with BS 4568: Part 2.

f. Flexible conduit and fittings shall comply with BS 731 Part 1 and in addition shall be of a metallic watertight pattern, over sheathed with a low smoke halogen free material and with a separate earth wire enclosed within the conduit.

g. The minimum size of conduit used in the installation shall be 20mm diameter.

h. Separate conduits shall be provided for extra low voltage circuits.

i. Inspection-type conduit bends, elbows and tees shall not be permitted

j. Standard conduit and draw-in boxes and covers shall comply with the appropriate British Standard and in addition shall be galvanised malleable cast-iron or steel. Draw-in conduit and cables entering the boxes shall be installed in accessible positions

k. All boxes and conduit accessories shall be fully weatherproof when used in outdoor locations. Weatherproof boxes and conduit accessories shall also be used in locations other than outdoors when so specified or as directed by the "Engineer".

l. All draw boxes and junction boxes shall be of ample size to permit the cables to be drawn in and out. They shall be made of galvanised malleable iron with jointing surfaces machined to ensure a dust-tight joint. All circular boxes shall be provided with long spouts, internally threaded, incorporating a shoulder for proper butting of the conduit and a tapped 5mm hole in the base to accept a solid brass earth terminal.

m. The ends of all conduits shall be reamed to remove all burrs or sharp edges after the screw threads have been cut. All dirt, paint or oil on the screwed

threads of the conduit, sockets and accessories shall be removed before installation.

n. The ends of the conduit shall butt solidly in all couplings. Where they terminate in fuse-switches, fuse boards, adaptor boxes, non-spouted switch boxes etc., they shall be connected thereto by means of smooth bore male brass bushes, compression washers and sockets. All exposed threads and all bends shall be painted with an aluminium spirit paint after installation. Exposed metal shall be similarly treated.

o. All conduits shall be kept 80mm clear of water, gas and other services. All necessary equipotential bonding shall be installed including that for piped services, in accordance with the IEE Wiring Regulations.

p. Particular care shall be taken to ensure that no water is allowed to enter the conduit at any time and all conduits shall be arranged with adequate ventilation and drainage. Inaccessible junction boxes will not be allowed.

q. The ends of conduits laid or set in formwork prior to concreting shall be temporarily sealed off with a coupler and a solid brass plug.

r. All bends are to be made on Site to suit site conditions. An adequate number of suitably sized hot-dip galvanised cast iron draw-in boxes shall be provided in conduit runs to enable cables to be drawn in easily and without damage. Draw-in boxes shall be fitted after every two bends, or after a maximum straight run of 15m. Tees, elbows and sleeves when used, shall be of type reviewed without objection by the “Engineer”.

s. All conduits shall be swabbed through before wiring is commenced and cables shall not be drawn into any section of the system until all conduits and draw boxes for that particular section are fixed in position.

t. Where conduit crosses expansion joints, the Contractor shall allow for the installation of expansion couplers at the position of the expansion joint and at right angles to it. Allowance shall be made for running an earth wire between each terminal fitted in the nearest conduit boxes at each side of the coupler. All flexible metallic tubing shall be galvanised water-tight pattern fitted with sweated brass adaptors. Typical details are given in the drawings for surface mounted conduit installation.

u. Wiring shall be carried out on the looping-in system and no joints other than at looping-in points will be allowed.

v. No cables installed in conduit shall be laced.

15.0 INTERFACES

15.1 Interfaces

The Contractor shall interface the design and construction of the Works with that of other contractors, principally the Contractors for the Designated Contracts as defined in the General Conditions of Contract. The Contractor shall keep the "Engineer" fully informed in respect of such interfaces, such information being given to the "Engineer" in a manner and form and at such intervals as stated in the Contract or as required by the "Engineer".

Contract Package for:

Signaling, Communications and Train Control

This contract provides for signaling and automatic train control systems including equipment in the station control rooms and the Operation Control Centre (OCC) such as train mounted control equipment, relay room equipment, independent telephone networks including automatic switching centers and exchanges, main trunk cables, direct telephone lines, communication equipment, emergency telephones, closed circuit television, radio communication and all ISMS system.

Automatic Fare Collection

This contract provides for the revenue control system at stations, including automatic ticket vending machines, barriers, manual control and checking equipment and electronic linkages to station control rooms and the Central Control room.

Rolling Stock

This contract provides for air-conditioned rolling stock in rakes of up to 6 coaches.

Civil, E&M, TVS and ECS

The Contract provides for Civil and E&M works including the stations & tunneling. The E&M works include stations lighting, 415V AC distribution, fire detection and protection system's contract comprises of ventilation, station air-conditioning and ISMS system. Tunnel ventilation system and associated SCADA is in TVS contract.

The Contractor shall co-ordinate with these Contractors for design as well as installation related issues as part of his interface responsibilities the relevant Contractors shall be referred to as Designated Contractors in this specification.

Integrated Station Management System (ISMS).

The Contractor shall co-ordinate with the ISMS contractor for requirements related to remote monitoring and control system etc. to be provided in Station Control Room.

15.2 Interface Responsibilities

The responsibility for specification and provision of the requirements for the works which interface with Designated Contractor's equipment are tabulated below.

The Appendix "A" describes the interface requirements between Designated Contractors, which includes Civil Contracts, E&M Contract etc. and this Contract.

This Appendix shall be read in conjunction with the relevant clauses of the Employer's Requirements. The Contractor shall be responsible for ensuring that all requirements of the specifications pertaining to interfaces are properly satisfied.

This Appendix outlines the interfacing requirements during the execution of the Works. However, the requirements herein specified are by no means exhaustive and it remains the Contractor's responsibility to develop, update and execute jointly an Interface Management Plan (IMP) after the commencement of the Works and throughout the execution of the Works to ensure that:

a) All interface issues between the contractor and the Designated Contractors are satisfactorily identified and resolved; and

b) All the construction tolerances at the interface shall meet the requirements of the respective specifications relating to the interface points.

c) Where details of the contractor’s design of this contract are required to enable the Designated Contractor to implement interface works, the Contractor shall provide the Designated Contractors with the necessary information including, but not limited to, those described in the summary table appended to this requirement. The level of information provided shall be in sufficient detail to enable the Designated Contractors to design and / or construct the required interface works.

The Contractor shall take a lead in developing the Interface Management Plan. The IMP will be prepared in conjunction with the Designated Contractors to cover all aspects of the implementation of the interface works required. The IMP will define the interface works necessary to complete all the works in this contract and is not limited to those listed in the summary table attached.

Should it appear to the “Engineer” that the progress of the Works, Works Programme or the Three Month Rolling Programme does not conform with the IMP, the Contractor shall be required to revise all such programmes and plans such that they do reflect the progress of the Works, are mutually consistent and conform to other provisions of the Contract.

The Contractor shall review the details of interface works and notify the “Engineer” of any amendments to the summary table required in the process of his works. Unless such requests are reviewed without objection by the

"Engineer", the Contractor shall design and construct the works in accordance with the provisions outlined in the Appendix "A".

15.3 Scope of Work of Interface Management Plan (IMP)

The information and scope of works to be provided by the Contractor include but are not limited to those outlined in the Appendix A. The Appendix A only defines those tasks at the interface point and is not a complete itemization of the Scope of Work

The Designated Contractors shall liaise with the Contractor in the design, installation, testing and acceptance of works.

The Contractor shall provide all access and attendance necessary in accordance with the contract requirements to enable the Designated Contractors to complete those activities defined under the summary table attached to this interface specification in a timely manner.

Where the Contractor's works are identified as failing to meet the requirements of the contract and which will impact the Designated Contractor's works, the Contractor shall submit the proposed remedial measures to the "Engineer" for review and shall copy the same to the Designated Contractors.

16.0 SITE ARRANGEMENTS

16.1 General

16.1.1 In addition to the general conditions and provisions of the Site as described in the General Specification, this Section of the Specification sets out the site arrangements, conditions and requirements for the delivery and installation of the Elevators supplied under this Contract. Contractor to establish at own cost the site office/site container for Phase-II project with mandatory amenities like Computer, Printer, light, Air-conditioning, proper sitting arrangement etc. with subject to approval of Engineer/Employer.

16.1.2 Methods and procedures may vary depending upon site conditions which shall be discussed and agreed with the "Engineer" during the planning and installation stage, but the Contractor shall make provision for alternatives in the methods and procedures provided that the basic criteria for delivery and installation as described below remain unchanged.

16.1.3 The conditions and requirements set out in this Section of the Specification shall not relieve the Contractor of his responsibility to deliver the equipment in time to meet the approved programme as defined in Chapter 21 of this Particular Specification and to install the Plant in accordance with the Specification.

16.2 Access and Power on Dates

16.2.1 The Contractor shall note that no exclusive possession of the Site will be granted. The Contractor will be required to work with the Designated Contractors, the Interfacing Contractors and other contractors.

16.2.2 The Contractor shall take note of the access and power on dates shown in the "Engineer" Preliminary Programme and Project Calendar. Except approved by the "Engineer", the Contractor shall not have exclusive access to the designated areas.

16.3 Works Areas

16.3.1 The Contractor shall coordinate with the Designator Civil Contractor for the works areas allocated within the site in which he may erect offices, workshops and stores. The area allocated for the Contractor and the period of availability are shown in Appendix 'C'.

16.3.2 The Contractor shall allow for transportation of all materials and equipment to the Works Areas and from the Works Areas to the Site.

16.3.3 The Contractor shall note that works trains are not intended for transportation of material and equipment except to those locations where road access would not normally be available. The Contractor shall coordinate with the relevant Designated Civil Contractors for delivery of major equipment by road access.

16.3.4 General attendance and other services will be made available at the Works Areas in accordance with the General Specification.

16.3.5 The Contractor shall be responsible for the cleanliness and tidiness of the Site after each period of work.

16.3.6 The period within which the area will be available to the Contractor is shown in Appendix 'C'. The Works Area shall be returned to the Employer no later than the date specified for the completion of the Works. The Contractor shall remove all facilities erected by the Contractor at the Works Areas before returning the Works Area to the Employer.

16.4 Delivery

16.4.1 General

Each escalator shall consist of truss, track, drive unit, steps, step chains, comb plates, handrails, driving machine, control cubicle, safety devices, balustrades, special tool kit for operation and maintenance and all other parts required to provide a complete escalator.

Each escalator shall be partially assembled, tested without handrail and balustrade decking at the Contractor's Works, and then dismantled and delivered in sections to site, unless otherwise agreed by the "Engineer". Provision shall be made to properly

secure the in-truss equipment during transportation, and during access into the Works Area. Allowance shall be made for the truss being tilted at an angle of 45^{o} to the horizontal when being delivered into the Works Area.

16.4.2 **Methods of Delivery**

The method of delivery of Escalators and Elevators to site shall be by road, and access to the Works Areas through a station entrance, and/or temporary access openings if provided, and via a route within the Site. The Contractor shall be responsible for arranging access into the Site with the Designated Contractors for the stations' works. The Contractor shall co-ordinate the routes and time of entry into the stations with the Designated Contractors. The delivery route within the stations shall be agreed between the Contractor and the Designated Contractors. The access plan of each station shall be submitted for the "Engineer" Approval. 30 days before starting the work.

The locations and size of the access openings and the size of working area around each opening will depend on site and local traffic conditions and shall be agreed by the "Engineer". The method of delivery for each station shall be governed by the overall installation programme of Kolkata East-West Metro and be subject to the "Engineer" Approval, whose decision shall be final.

16.4.3 Delivery, Access to and Through the Site

The Contractor shall make provisions to deliver his equipment by vehicles into the working area around the access opening. In the event that the working area is not large enough or the local traffic conditions cannot permit any container vehicle to gain access into a particular working area during normal working hours, the Contractor shall make arrangements to deliver the equipment by trucks and unload the equipment within a limited working area allocated by the "Engineer".

When it is unlikely that a mobile power crane can be used within the vicinity of the access opening due to restricted site conditions, the Contractor shall arrange to maneuver his Plant by smaller traction equipment from the unloading working area into the access opening and Works Areas.

Transportation, unloading and delivery equipment such as hoisting frames, gantries, lifting tackles, chain blocks, trolleys etc., required for delivery, shifting and equipment access to the Works Areas shall be provided by the Contractor, unless otherwise specified herein or as Approved by the "Engineer".

The Contractor shall provide a Schedule of major deliveries of Plant for each station to the "Engineer" at least 2 months prior to the first delivery.

Each escalator section shall preferably be hoisted into position in the well way immediately after delivery to Site. Long period of storage inside the station will not be allowed, unless written permission has been received from the "Engineer".

Each elevator shall preferably be hoisted into position in the Hoistway immediately after delivery to Site. Long period of storage inside the station will not be allowed, unless written permission has been received from the "Engineer".

The Contractor shall provide adequate means to protect completed architectural finishes during delivery and shall make good any damage caused by delivery of the equipment.

16.5 Installation

16.5.1 It is desirable that the installation time of Escalators and Elevators on Site shall be kept to a minimum and the proposed design shall take due account of this requirement.

16.5.2 The Contractor's attention is drawn to the restrictions on working area available on Site and shall make his own arrangements to store materials and equipment off-site or at the Depots until such time as they can either be incorporated into the Works or stored within the working area assigned to him.

16.5.2 The Contractor shall co-ordinate with the Designated Civil Contractor for the hoisting points and confirms acceptability before commencing installation. When it is not possible to provide such hoisting points due to its particular location. In such case, the Contractor shall provide suitable hoisting frame, gantries or the like for hoisting. Safe working load of such equipment shall be stated, and relevant testing certificates shall be submitted for the "Engineer" Approval.

16.5.3 All other lifting equipment such as lifting tackles, chain blocks etc., required for installation purposes shall be provided and installed by the Contractor.

16.6 Care of Works

16.6.1 The Contractor shall protect the equipment within his own reasonable control, particularly in normal construction site conditions such as dust, dirt, plastering and small particles which may possibly damage the equipment, stainless steel decking and panels, if they are not properly protected. Such damage, if occurring, shall not relieve the Contractor of his responsibility to repair and/or replace these parts, depending on individual conditions, to the satisfaction of the "Engineer".

16.6.2 The contractor shall provide adequate protection to the Escalators and Elevators during the Stop Work Period and before handing over of the complete installation to the Employer. The protection shall not be removed unless instructed by the

"Engineer".

16.7 Material Recovery

16.7.1 The Contractor shall remove all redundant materials and cables from Site. The Contractor shall handle all redundant equipment with care and deliver to a location designated by the "Engineer" where it shall be stored in a neat and orderly fashion.

16.7.2 Recovery work shall occur after the completion of every stage of the above-mentioned Works and as directed by the "Engineer".

17.0 PACKAGING, SHIPPING AND DELIVERY

17.1 General

17.1.1 All the stipulations laid down in the GS shall apply.

17.2 Packaging and Shipping

17.2.1 All equipment Goods and materials shall be properly inspected to ensure that there are no defects before shipment. An inspection tag bearing the words "INSPECTION PASSED" giving reference number to the inspection date and details to permit verification of inspection details shall be attached to those items inspected satisfactorily.

17.2.2 The four adjacent sides of each package shall be marked with permanent paint with the following information:

CONSIGNEE
COMMODITY
CONTRACT No
SHIPPING MARK

17.2.3 Appropriate caution notices such as "FRAGILE", "HANDLE WITH CARE", "KEEP DRY", KEEP UPRIGHT" along with visual display symbols internationally accepted shall be conspicuously displayed on the outside surfaces of boxes, crates and packages.

17.3 Delivery

17.3.1 The Contractor shall be responsible for transportation and delivery of materials to site or to the storage space and shall continue to be responsible for its safe storage, handling, erection and commissioning.

18.0 MAINTENANCE REQUIREMENTS

18.1 Maintenance

In addition to his obligations under the Conditions of Contract, the Contractor shall provide maintenance services throughout the Defects Liability Period (DLP) and also for the specified period for all the Escalators and Elevators supplied under the Contract. Maintenance work shall include attendance to all service calls, work described in approved Maintenance Schedule, and the followings:

18.1.1 All defects shall be remedied either when observed on the weekly service call or on an attendance to a service call. Service shall include all work necessary to maintain the entire elevator system in good working order at all times.

18.1.2 The Contractor shall maintain adequate quantity of consumable and contingent spare parts as per agreed list at site in order to minimize the shut down time due to repairs and maintenance. All parts rendered defective, including replacement of indicator lamps and programmable circuit board, shall be replaced by the Contractor. The list of these consumable & contingent spares (DLP spares), tools and mandatory spares are enlisted in appendix “E”. Any additional spares, tools and test equipment are required the same may be indicated by the Firm in their Technical Offer The employer may revise the list of spares at the time of submission of the Preventive Maintenance Schedule (PM) & Corrective Maintenance (CM) procedure, as mentioned in 17.1.10. These spares as per the approved list will be handed over by the Contract to the employer at the time of taking over of equipment / section in proportionate quantity and will be issued by the employer to Contractor during DLP based on actual consumption. The balance spares shall be the property of the employer and if any additional spares are required the contractor shall arrange the same without any extra payment. Mandatory spares provided to the Employer under the Contract will not normally be released to the Contractor for such purpose during DLP period.

18.1.3 The Contractor shall dispatch competent personnel to rectify stoppages at any time during the day or night when being called on by the Employer within a time of half an hour (maximum). Repairs shall be carried out on a 24 hours per day, 7 days per week basis until the faulty unit is put back in service.

18.1.4 The Contractor shall carry out periodic testing and examination of equipment safety devices as may be required by the provisions of any enactment in force relating thereto or of any enactment, regulations or by-laws of any local or other duly constituted authority which may be applicable to such tests and to provide such copies of the test certificates, duly signed by a Registered Elevator “Engineer” and Registered Elevator Contractor, as may be required. A master schedule of such planned tests shall be submitted to the Employer at least two months before commencement of the DLP.

18.1.5 The Contractor shall provide quarterly and half-yearly reports on the condition of the equipment in an agreed format. Such reports shall include event logs and performance data collected from the associated indicative panel stored on diskettes or other agreed medium, over the reporting period. Such data shall enable off-line individual and fleet statistical analysis to be performed on a Personal Computer supplied by the Contractor.

18.1.6 A report in duplicate shall be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored. The monthly summary of failure report along with the analysis giving details of nature of fault, remedial action taken etc in the approved format shall be provided.

18.1.7 Reports on routine visits are not required except where necessary to draw attention to defects of a minor nature, which could not be rectified during the routine visit. Records of each routine visit and call-out visit, together with details of the work done or action taken, shall be entered on a log book which shall be provided by the Contractor and retained in the location as decided by the “Engineer”.

18.1.8 Before the expiry of the Defects Liability Period, the Contractor shall perform a loading test for each elevator to re-confirm that the function of the system is being met and shall undertake corrective adjustment if necessary. This test may be incorporated into the half-yearly equipment survey maintenance works.

18.1.9 The Contractor shall provide a maintenance plan and a major component replacement programme for review and acceptance by the “Engineer” 90 days before the programmed commencement of the Defects Liability Period.

18.1.10 The Maintenance service shall include all Preventive/Scheduled & Corrective Maintenance. In this context, the Contractor shall submit a PM Schedule and CM procedure for Approval, 3 months before the commencement of the DLP.

18.1.11 In order to ensure that the system will meet the RAM targets and Customer Service requirements using the minimum resources, the Contractor shall conduct a detailed Maintenance Requirement Analysis to derive a complete list of preventive maintenance schedules and procedures under the Contract. The Maintenance Requirement Analysis shall identify for each system function the potential functional failures, the failure consequences and the appropriate maintenance approach. RAM analysis shall be submitted quarterly during 2 years DLP.

Based on the Maintenance Requirement Analysis, the Contractor shall indicate in the Maintenance Plan, the final preventive maintenance programme, the proposed skill and manning level, spares level and special tools require. The proposal shall be fully traceable to the maintenance Requirement Analysis output.

The Maintenance Requirement Analysis shall be submitted as part of the

maintenance plan, under the main contract tender submission. However, contractor will be allowed to defer submission of this Analysis, latest 12 months before the commencement of the Defect Liability Period, by presenting formal written request for such deferral.

18.1.12 Accommodation for Emergency Service Report Centre

An Office of approximately 10sq.m will be provided by the Employer as the emergency service report centre. The Premise will be located at (4-5 Places in the KMRC network) on the stations as determined by the Employer.

18.2 Employer's Maintenance Strategy

18.2.1 Maintenance Strategy

The Contractor shall ensure that the system designed, installed and commissioned is supportable throughout the service life of the System to address, as a minimum, the following:

Design errors in the System;

Operational changes;

Environment changes; and

Changes in infrastructure.

According to the maintenance strategy, all equipment and infrastructure supplied for the 'Project' must be designed for minimum or no maintenance. Maintenance activities required must be capable of being performed with little or no impact on the train service. In addition, the maintenance work systems shall ensure safety of personnel and equipment.

18.2.2 The Contractor, upon noticing any defects, deficiency in quality and quantity of spares and materials shall without delay, arrange for alternative source of supply and submit his proposal to the "Engineer" for review.

18.3 Maintenance during DLP

During the 2 years' DLP period, the contractor shall carry out all type of preventive and breakdown maintenance. The preventive maintenance would be done during non-traffic hours whereas breakdown maintenance would be done whenever breakdown occurs. The contractor should post his supervisor and maintenance staff at a key place (4-5 Places in the KMRC network) on the stations as determined by the Employer.

The acceptable response & attention time also needs to be mentioned for minor & major breakdowns.

18.3.1 **Maintenance Management System (MMS) and Maintenance Arrangement**

During non-operation time, sections of line will be closed for maintenance work. The minimum time for possession periods is 6 hours. Ideally, this time shall be the free time available for maintenance.

18.3.2 **Competency of Personnel**

During the DLP the Contractor shall depute sufficient trained and competent personnel for maintenance purpose.

Such persons shall have their generic competence established and must demonstrate their specific competence and knowledge in the particular systems, environment and procedures.

The Contractor shall provide evidence of specific competence and knowledge, which shall include:

- Assessment and certified training in particular applications and operations;
- Recording of competence and work in the license holder's logbook; and
- receiving or in receipt of sufficient and current exposure to the area of work that the holder is licensed for.

Routine spot checks on licensing may be carried out from time to time by the "Engineer" qualified personnel on the proficiency of the Contractor staff.

In the event of a failure, the Contractor shall undertake the management and investigation necessary to identify and rectify the cause.

18.3.3 **Testing and Re-commissioning of System and Equipment**

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required. Any such modification shall be submitted for review by the "Engineer".

18.3.4 **Temporary Alterations to Restore Service**

The Contractor shall undertake any temporary modifications necessary to maintain service. Any such modification shall be submitted for review by the "Engineer".

18.3.5 **Discrepancies between Installation and Design Records**

Should the Contractor discover inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall correct all such errors within two weeks.

18.3.6 **Communications**

The Contractor shall ensure that adequate communication facilities are provided to its staff during the DLP.

18.3.7 **Location of Staff**

The Contractor shall be responsible for locating staff such that the Contractor meets its obligations.

18.3.8 **Storage of Equipment and Materials during the Maintenance Period**

The Contractor shall ensure that no equipment is stored along the trackside.

The Employer will provide defined storage locations for the support of the different levels of Maintenance.

The Contractor shall satisfy itself and the "Engineer" that the storage locations for equipment and materials will meet the performance requirements of this PS.

18.3.9 **Maintenance Regimes**

The Contractor shall produce a maintenance regime for the equipment that shall comprise two constituent parts, corrective and routine/preventative maintenance.

Corrective maintenance shall be available 24 hours per day, able to respond to all foreseeable circumstances.

The maintenance regime shall cover all parts and equipment of the system designed, installed and commissioned by the Contractor.

The Contractor shall take into account the requirements of the operations and maintenance when determining and proposing its maintenance regime.

18.3.10 **Scope and Hours of Coverage**

The regime and structure of corrective maintenance shall be robust in design.

The Contractor shall provide full 24 hour On-Call coverage and shall be such that initial response and rectification of failure are in accordance with the following:

- Assistance for first line corrective maintenance within 30 minutes, upon request of first line maintainer;
- 24 hour from notification for second line maintenance where spare parts replacement is involved; and
- Within 2 weeks including transportation time for third line maintenance where replacement or repair of component from factory is involved. Any extension to this time shall be agreed with the "Engineer" and a replacement provided.

All elements of First Line preventative maintenance shall be carried out and completed during non-traffic hours without interrupting train services. Similarly, all elements of second line & third line maintenance also needs to be completed during non- traffic hours.

18.3.11 **Failure Investigations**

The Contractor shall conduct failure investigations.

Disputes between the Contractor and other Contractors will be resolved by the "Engineer".

The Contractor shall make available to the Employer all test and failure data as required.

18.4 Software Support

18.4.1 General

The Contractor shall submit to the "Engineer" for review, the software support plan at least 90 days before commencement of software installation.

Employer will have the right, for multiple use of the Software. Employer at his discretion may download the software on multiple PCs as per the requirement. For this purpose, no specific password, Key Number etc should be required from the Contractor / Software firm.

All changes, bug fixes, updates, modifications, amendments, new versions shall not result in any non-conformance with this Specification.

The Contractor shall submit all new versions to the "Engineer" for review at least 2 weeks prior to their installation.

The new versions of software shall not degrade the operation of the System.

18.4.2 **Security Obligations**

Within 14 days of the installation of any software into the Permanent Works by the Contractor, the Contractor shall submit to the "Engineer" for retention by the Employer two backup copies of the software, which shall include any specified development tools required for maintenance of the software, including, but not limited to, editors, compilers and linkers.

Any software item delivered by the Contractor to the "Engineer" pursuant to the above Paragraph shall not be translated or modified by the Employer without the prior consent of the Contractor unless:

- the owner of the software becomes insolvent or has a receiving order made against it or makes an arrangement or assignment or composition with or in favor of its creditors (including the appointment of a committee of inspection) or goes into liquidation or commences to be wound up or has a receiver, liquidator, trustee or similar officer appointed over all or any part of its undertaking or assets or if distress, execution or attachment is levied on, or if an encumbrancer takes possession of, any of its assets or any proceeding or step is taken which has an effect comparable to the foregoing in any relevant jurisdiction; or

- The owner of the software ceases to trade; or
- the owner of the software assigns copyright in the software and the Contractor fails within 60 days of such assignment to procure in favor of the Employer, a license from the new owner in the same terms as that required by the Contract;

  or
- The Contractor is in breach of any of his obligations under the Contract.

18.4.3 **Error Correction**

The Contractor shall inform the "Engineer" immediately when a fault is discovered within delivered software or documentation.

On receipt of a request from the "Engineer" for identification or further diagnosis of a failure or fault, the Contractor shall provide appropriate resources.

The Contractor shall provide written details as to the nature of the proposed correction to the "Engineer".

18.4.4 **Training**

The Contractor shall provide training for Employer's staff to enable the Employer to make proper use of any new versions.

18.4.5 **Fixes or Patches**

The Contractor shall notify the Employer promptly of any fixes or patches that are available to correct or patch faults.

The Contractor shall detail any effect such fixes or patches are expected to have, upon the System.

18.4.6 **New Versions**

The Contractor shall ensure that all new versions are fully tested and validated on the simulation and development system prior to installation.

The Contractor shall ensure that all new versions are fully tested and commissioned once installed on the Site.

The Contractor shall deliver to the Employer any new version, together with the updated Operation and Maintenance Manuals.

The Employer shall not be obliged to use any new version and that shall not relieve the Contractor of any of its obligations.

Any effect upon the performance or operation of System that may be caused by a new version shall be brought to the Employer's attention.

18.4.7 **Routine and Corrective Maintenance Procedures**

Routine and corrective maintenance procedures shall be supplied for all equipment. The format shall be as follows:

- Uniform format and layout irrespective of equipment supplier;

- Color coding for each activity;

- Cross referenced to the Operation and Maintenance Manuals; and

- Document control information.

18.4.8 **Operation Activities**

All operational activities shall comply with the Employer's safety rules, and requirements of the Operation and Maintenance Manuals. The Contractor shall recommend in detail the frequencies for preventive and corrective maintenance, and what items of work are to be carried, including but not limited to the following;

- Step-by-Step procedure to carry out the task;
- Diagrams and flow charts for illustration, if applicable;
- Precautions for the maintenance personnel to follow; and
- Estimated duration and manpower required.

19.0 SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

19.1 General

19.1.1 The Contractor shall note the requirements stipulated in the General Specification.

19.1.2 The Contractor shall supply all spares, special tools and test equipment to facilitate the maintenance, repair and overhaul of the Elevators and Escalators effectively and efficiently while ensuring their performance to a high standard of safety and reliability consistent with the requirements as detailed in this Specification. The list of Mandatory spares, DLP spares, tools and test equipment has been provided in Volume -5. Any additional spares, tools and test equipment are required the same may be indicated by the Firm in their Technical Offer.

19.1.3 All spare parts shall be identical to the equivalent installed items and strictly interchangeable, be suitable for use in place of the original parts fitted and comply with this Particular Specification and the tests specified therein.

19.1.4 They shall be suitably marked and numbered for easy identification and shall be packed for long storage in wooden boxes in suitable groups for easy maintenance. While necessary parts shall be coated in protective material to prevent deterioration.

19.1.5 In the event that rectification and/or modifications are introduced to any part of the equipment which are deemed necessary by the "Engineer" in order to comply with the Specification requirement, the Contractor shall modify and replace all spare parts and/or special tools whether delivered or otherwise.

19.1.6 The Contractor shall guarantee that the test equipment supplied shall be well calibrated in accordance with manufacturer's instruction. Appropriate calibration certificates shall be required by the "Engineer" for checking prior to carry out testing

and commissioning.

19.2 Spares

19.2.1 **Commissioning Spares**

The Contractor shall recommend and provide a list of commissioning spares with sufficient quantities to ensure the successful completion of the testing and commissioning activities.

19.2.2 **Mandatory spares**

The contractor shall submit the list of the mandatory spares required to maintain all the equipment supplied for the Works in good working order at all times during its life cycle with his technical proposal. These spares as per approval of employer shall be handed over in proportionate quantity three months before the expiry of DLP of the section.

19.3 Test Equipment

19.3.1 Not Used.

19.3.2 Portable Test Equipment

Portable lap top computer shall be provided to allow rapid verification of satisfactory operation of a sub-system, assist in trouble shooting and isolating sub-system failures. Portable lap top computer shall not require any mechanical or electrical disconnection to or within the sub-system under tests.

Four set of laptop computer for the entire contract specified at clauses 19.3.2 shall be provided by the Contractor. The detailed specifications for Lap Top to be got approved from the “Engineer.”

19.4 Special Tools

19.4.1 The Contractor shall supply all necessary tools for normal as well as emergency rescue operation and for maintenance purpose including tools such as brake releasing devices and hand winding devices, all other keys for the key operated switches such as the key to open the Auxiliary Switch Cabinet, 3 set of keys for each elevator and escalator each shall be provided by the Contractor at the time of handing over to Employer for trial Operations.

19.4.2 The Provision of the special tools used during erection testing and commissioning under this part of the Particular Specification shall be deemed to have been included in the Contract and shall be handed over to the Engineer when the elevator and escalator installations are completed.

19.4.3 Certain items of these special tools shall be fixed on to a shadow board or housed in

a container mounted at an approved location. Details of the arrangement will be given to the Contractor by the Engineer during the installation stage.

19.4.4 The Contractor shall supply one complete set of any special tools for each type of Elevators and Escalators per station that are necessary for routine maintenance to be carried out. These tools shall be supplied in a suitable hard wood or steel tool box.

19.5 Availability of Consumable Spares during Defect Liability Period

19.5.1 Pursuant to Sub-section 17.1 of this Specification, the Contractor shall ensure availability of adequate consumable and contingent spares required to maintain all the equipment supplied for the Works in good working order at all times during the Defects Liability Period as per agreed list in at site. Any spares consumed including but not limited to oil, grease, cleaning compound, and light bulbs, etc., during the DLP shall be provided by the Contractor.

19.5.2 The Contractor shall submit a list of consumable spares with quantities, brand name, model no., serial/order code for the Approval of "Engineer" prior to purchase. The Contractor shall be held responsible to keep all said spares within India and shall deliver them to the destination as soon as practicable.

19.6 Not used

19.7 Second Sourcing for Non-Proprietary Items

19.7.1 The Contractor shall identify principal source suppliers that can supply the Mandatory Spares. For non-proprietary items the contractor shall submit the list of alternate / second source of suppliers.

19.7.2 The Contractor shall ensure that second-source supplier information is maintained up to date up to a period of 15 years after taking over of whole works. The Contractor will provide support to the Employer to a reasonable extent regarding the second-source supplier information throughout the service life of the system.

19.7.2 The Contractor shall make the second-source supplier information available to the "Engineer" at the time of submission of the final design and taking over of the works.

19.8 Long Lead Times

19.8.1 The Contractor shall identify the lead times for all spare parts. Parts with long lead times shall be identified in the spares list.

19.9 Routine Change

19.9.1 In the event that any item of the supply requires to be routinely changed or calibrated, regardless of whether it appears in the spares list or not, it shall be identified to the "Engineer" together with the routine change interval.

19.10 Shelf Life

19.10.1 In the event that any of the spares identified have a particular life or storage requirement, this shall be made known to the "Engineer" with the submission of the spares list, including the necessary action for disposal or storage.

19.11 Recommended Spare parts for Ten years

The Contractor shall furnish the details of recommended Spare parts needed for maintenance during the next years beyond the DLP.

20.0 TRAINING AND TRANSFER OF TECHNOLOGY

20.1 General Requirements

20.1 This section of the specification covers the requirements for a Training Program to train the Employer's maintenance, operations and training personnel. The training Program shall enable the staff to operate, service, enhance, maintain, and interact with, the hardware, software, and firmware, such that the elevator systems and associated equipment will perform in accordance with the specifications of this contract.

The Contractor shall provide comprehensive training to the Employer's staff, including Employer's training Instructors. The Contractor shall provide competent training instructors, training manuals, all necessary aids and materials in support of all training courses. The training manuals shall be submitted in original plus five hard copies and in electronic format.

The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possesses good communication skills.

The training instructors shall be competent staff of the Contractor, or the subcontractors or the equipment manufacturers.

20.1.2 The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at place of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be subject to review by "Engineer".

20.1.3 The training courses and/or sessions shall include system performance requirements and all major equipment and works designed, by the Contractor.

20.1.4 The Contractor shall provide full-time on-Site management and co-ordination of the entire training programme to ensure the continuity of classes, and proper distribution of training materials, and be responsible for interfacing with the instructors.

20.1.5 The training courses shall be delivered to all relevant Employer's staff, including instructors, operation and maintenance engineering staff.

20.1.6 The training shall cover a holistic view of operation & maintenance of complete Escalator system. It should also cover, man-power requirement, job description, maintenance infrastructure requirements including tools, test-instruments, spares etc.

20.1.7 Audio-visual aids, class room training, site visits, on the job training and Trainer's kit for training on trouble shooting to be used.

20.2 Scope of Training

The training shall be provided by the Contractor to the Employer's personnel in design, manufacturing, testing, system architecture and installation practices related to Elevators. This will cover training in India and abroad including training at manufacturing facilities.

20.3 Training Programme

20.3.1 **Elevators**

Contractor shall submit a training programme for imparting training to KMRC employees with batches of approximately 20 trainees for Elevator systems in following areas:

S. No	Description	Total Period (Trainer working days)	Remarks
1	Manufacturing facilities, testing methods and procedures, Working Metro installations. Short Module course on System description, architecture etc., for Elevators.	20	During manufacturing at factory premises and other locations.
2	Installation and site testing practices for Elevators	25	During installation & commissioning phase
3	Operation and maintenance practices for Elevators including trouble shooting, fault diagnosis and emergency handling.	100	At suitable locations

20.3.1 **Escalators**

Contractor shall submit a training programme for imparting training to Kolkata East-West Metro employees with batches of approximately 20 persons for Escalator systems in following areas.

S. N	Description	Total Period (Trainer Working days)	Remarks
1	Design of Escalators	15	During the Design Stage
2	Manufacturing facilities, testing methods and procedures, Working Metro installations. Short Module course on System description, architecture etc., for Escalators. Training in O & M in operational Metro where similar system functions.	25	During manufacturing at factory premises and other locations.
3	Installation and site testing practices for Escalators	25	During installation and commissioning phase
4	Escalator control & monitoring system, troubleshooting, fault diagnosis, emergency handling, etc.	30	At existing installation in other Metros or similar sites.
5	Overall view of Escalator system, Operation and maintenance practices for Escalators, Maintenance infrastructure, PM & CM, CBM (vibration etc.)	100	At suitable locations

Total trainer working days shall be at the description of employer and contractor shall submit the programme as and when asked during any stage of contract.

20.4 Training Plan

The Training Program shall be prepared and submitted by the Contractor as per requirements of GS.

20.5 Training Courses

20.5.1 The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, and firmware, software. Each Course shall be specific, and shall consist of classroom, hands-on, or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan.

20.5.2 All station operation & security staff needs to be trained in emergency handling.

20.5.3 All training aids shall be used during training followed by practical & demonstrations.

20.5.4 Trainer's kit may be used for imparting training in trouble shooting.

20.5.5 The Contractor shall provide training courses for each of the sub-systems, including, but not be limited to:

(i) Elevator Control and Function system

(ii) Elevator drive system

(iii) Elevator Control & monitoring system

The Contractor shall provide training courses for each of the sub-systems, including, but not be limited to:

(i) Escalator structure and support

(ii) Escalator drive and braking system

(iii) Escalator Control & monitoring system

Different types of training courses of each subsystem shall be provided for staff from different disciplines. Operations training courses shall be provided for the operations staff. Maintenance courses shall be provided for maintenance staff. The Employer's Training Instructors shall attend all types of training courses such that the Employer's Training Instructors shall be able to subsequently train the Employer's additional staff in future in all aspects of operation and maintenance of the System.

Training is also required to be given to all station operating staff in emergency operations & small recoveries and to identify the defects so that maintenance teams can be called.

20.6 Operations Training Courses

The operations training courses shall be developed to provide all necessary knowledge and skills for operations staff of the Employer to operate the system under normal and emergency situations and recovery from minor or simple faults. In particular, the training course shall include the following as minimum:

- Overview of the Escalator Systems;
- Brief description of the operation principle each of the Subsystems;
- Operational features and functions;
- Familiarisation and use of all man-machine interfaces involved;
- Reading and interpretation of system status and alarm messages or indications;
- Normal operating procedures;
- Operating procedures under emergency situations;

- Procedures for recovery from minor or simple faults; and
- Use of Operation and Maintenance Manuals and documentation.

Particular exercises shall be included in the operations training course for each trainee to operate and manage the system under normal and emergency operating conditions and simple fault recovery.

20.7 Maintenance Courses

The maintenance courses shall be developed to provide all necessary knowledge and skills:

1) To perform full maintenance, including preventive/corrective maintenance and condition based maintenance on the Escalator Systems and use of CM techniques like vibrations.
2) To perform system Engineering management including system parameter configuration, enhancement, adjustments and provision of new equipment and components.
3) Man-Power requirement.
4) Maintenance infra-structure requirement.

The Contractor shall determine the content of the courses and the courses shall include the following as minimum:

- Overview of the Escalator Systems;
- System features and functions;
- Operation principles;
- Description of system components;
- Test and commissioning procedures;
- Use of test equipment and special tools;
- Reading and interpretation of alarm indications, messages and print-outs;
- Preventive maintenance procedures;
- Fault diagnosis, troubleshooting and corrective maintenance procedures;
- Equipment settings and parameters configuration;
- Use of equipment manuals, Operation and Maintenance manuals, circuit diagrams and wiring schematics;
- Methods and procedures to provide new circuits, system expansion and enhancement;
- Data, software backup and loading; and
- Use of software such as peripheral control and configuration, utility, database structure, generation and modification.
- Practical exercises shall be provided for each trainee to practise the following as minimum:
- Use of test equipment and special tools;

- Preventive maintenance;
- Fault diagnosis and troubleshooting with induced faults set by the Contractor to simulate real-life situation; and
- Faulty modules or cards replacement and restore the system to normal operation.
- CM techniques.
- CM based maintenance (CBM), Maintenance Requirement Analysis (MRA), Reliability centred maintenance, FMECA, RAMs etc.

20.8 Training Materials

Audio-visual Training Aids, Interactive Training Video CD, Training Materials, and Training Devices (like Trainer's kit) shall be of durable construction and shall become the property of the Employer on approval of the Training Demonstration, or on approval of the Final Deliverables, as applicable. For every lecture, training manual is to be given well in advance before commencement of training.

The Contractor shall provide all Training Aids, Interactive Training Video CD, Training Materials, Training Devices, Special Tools, fixtures, models, or other equipment required to train Course participants.

Training Manuals are a convenient source document for use in the field. However, for every lecture handout with Interactive Training Video CD, will also be required to be given.

Training Manuals shall be separate from Operation and Maintenance Manuals.

The Contractor shall prepare Training Manuals bi-lingual (i.e. in Hindi and English both) as per requirement of the project and submit them to the Employer for review and approval at least 60 days prior to the start of the Training Demonstration.

Throughout the Contract and DLP, it shall be the responsibility of the Contractor to supply the Employer with all changes and revisions to the Training Manuals.

Training Manuals shall become the property of the Employer.

The Contractor shall provide the master and five hard copies of the Training Manual as directed by "Engineer" for each course/subject.

The Employer reserves the right to copy all Training Manuals for use in Training Courses.

The contractor shall give complete training plan for each category of O&M staff well in advance before commencement of training which shall contain training details, training methods, training aids, profile of instructors etc. At least one copy of the training manual shall be submitted 3 months before the commencement of the training.

The Contractor shall, for each course, distribute two sets of trainer's guides for the trainers, one set of training handout for each trainee, two sets of trainer's guides and three additional sets of training handout to the Employer before the commencement of the training course. Electronic copy of Trainer's guide & Training manual will be required to be provided.

All the training materials shall be accurate and match with the actual design of the System. All types of audio/visual aids shall be used during the training. The O&M staff shall be trained to cater all types of emergency situations.

20.9 Training Records

The Contractor shall keep records on the attendance of trainees.

The Contractor shall devise a system, standards in assessing the level of knowledge, understanding of the course content and proficiency of the trainees. The system and standards shall be submitted to the Employer for review four weeks before the commencement of the training course.

The Contractor shall issue appropriate training certificate to the trainees who pass the assessment and have over 80-90% attendance. At the end of successful training, contractor shall issue competency certificates to O & M staff of various levels.

20.10 Training of Employer's Training Instructors (ETI)

20.10.1 The objective of this training is to enable the Employer's Training Instructors to be competent to deliver future courses for other employees of the Employer.

20.10.2 The Contractor shall provide training to the Employer's Training Instructors on the various Systems. Aspects covered shall include, but not be limited to, the following:

Basic Operating & Features and functional principles of the Escalator Systems
System design aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination;
Details of major equipment and components used in the System;
System operation and maintenance management procedures;
Control and monitoring systems for Escalators;

Trouble shooting, faults, failure analysis & remedial action, PM, CM & CBM, first

level, second level & third level maintenance.

20.11 Transfer of Technology (TOT)

The Contractor shall submit the detailed plan of transfer of technology along with MOU with suitable Indian companies or company having proven track record and are working in related areas for all major systems/subsystems.

TOT shall be essential and shall include system assembly, installation, maintenance and software modification/customization and training of Indian Company's personnel to cover;

All configuration/application programmes for Elevator system for:

Engineering of extensions and up gradations of stations.

Re-engineering to suit changed application conditions.

Incorporation of additional features.

Incorporation of optional facilities.

Addition /Modifications to equipment and components

Maintenance of Elevators.

Change in parameters of any of the Escalator and Elevator equipment in stations.

The Transfer of Technology may require involvement of Indian Company's personnel in design, manufacturing, testing and installation of Escalator and Elevator Sub-Systems during the Contract period. The Contractor shall undertake to supply or make arrangement with the original manufacturer to supply additional equipment required for replacement or up-gradation of the Escalator and Elevator systems in future. The Contractor shall undertake to provide to the above Indian Company, during the life of the equipment ordered technical assistance in the form of additional drawings, maintenance practices and technical advice.

21.0 OPERATION AND MAINTENANCE DOCUMENTATION

21.1 General

21.1.1 The Contractor shall provide Operation and Maintenance manuals bi-lingual (i.e. in Bengali and English both) Interactive Training Video CD, for use by supervisory, operating and technical staff of Employer.

21.1.2 Requirements of submission have been furnished in Chapter 11 of GS.

21.1.3 Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps. Most manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. Where alternative sizes are proposed, (e.g. A5/A6 pocket

books of schematic wiring diagrams) these shall be submitted for review of Engineer. The binding shall allow for all subsequent changes and additions to be readily effected.

21.1.4 Information shall be provided in pictorial form wherever possible and shall include step-by-step instructions and views of the particular equipment including exploded views. Programmable equipment shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and system modification to be undertaken at any time.

21.1.5 The Contractor shall provide clarifications and amendments to the Operation and Maintenance manuals as necessary during the Defects Liability Period. Updates shall be provided for the originals and all copies.

21.1.6 The first draft of operation & maintenance manuals are to be provided at least 60 days before the installation commences. The same should be corrected as per Engineer's comments and finally be submitted during installation and commissioning.

21.1.7 Hard copy as well as electronic copy should incorporate colour photos, colour sketches and drawings in pictorial form wherever possible.

21.2 Operation Manuals

21.2.1 The Contractor shall provide operation manuals explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings and any necessary operating limits of the Equipment and Sub-systems shall be provided. The Operation Manuals shall focus on operation aspects under normal and emergency conditions. The operation manual shall be supplied at the same time when training manuals are supplied.

21.3 Maintenance Manuals

20.3.1 The Contractor shall provide particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

20.3.2 The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the "Engineer".

21.3.3 The maintenance manual shall also include an illustrated parts catalogue of all plant supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance staff. The catalogue shall comprise 2 sub-sections.

21.3.4 The first shall be an alphanumeric parts list, which shall include the following information: ~

(i) Part number
(ii) Description
(iii) Name of manufacturer
(iv) Quantity and Unit
(v) Part number of next higher assembly (usually a line replaceable unit).
(vi) Cross-reference to figure number.
(vii) Category: e.g. consumable, line replaceable unit, repairable.
(viii) Life-expected life Mean time between failure or mean distance between failure where available.
(ix) General or specific purpose

21.3.5 The second is a series of illustrations to indicate the location of each replaceable item which shall be clear and progressive with exploded views to enable parts to be identified easily by cross-reference with the alpha-numeric list.

21.3.6 Maintenance Manual shall include the following;

21.3.6.1 Maintenance planning, Maintenance management, Maintenance Requirement Analysis like Reliability centered maintenance scheduled and breakdown maintenance, FMCEA etc.

21.3.6.2 PM, CM, CBM & condition monitoring techniques i.e. during installation, vibration levels are required to be noted down which becomes reference for vibration limits.

21.3.6.3 Infrastructure required for the maintenance.

21.3.6.4 Man power requirement

21.3.6.5 Maintenance check sheets for I line, II line & III-line maintenance.

21.3.6.6 Illustration of lift's components, sub-assemblies, assemblies etc with a sketch.

21.3.6.7 Detailed explanation of safety items.

21.3.6.8 Detailed coverage of trouble shooting.

21.3.6.9 Reliability Centre maintenance (RCM), Maintenance Requirement Analysis, condition Monitoring based Maintenance & Reliability, availability & maintainability data's.

21.3.6.10 Job Description & scope of work for comprehensive annual maintenance.

21.4 Annual Maintenance Contract (AMC)

- The Contractor shall provide the Annual Maintenance Contract Services for 10 years after completion of DLP of 2 years for all Lifts & Escalators of four underground stations of Kolkata Metro East West Project (Phase 1).
- The Contractor shall ensure the Services and its obligations in accordance with Good Industry Practice and with the skill, care and diligence to be expected of an appropriately qualified and professional maintenance staff experienced in carrying out maintenance work (including preventative maintenance) for the Lifts and Escalators of a similar type, nature and complexity to the Lifts & Escalators.
- The Contractor undertakes that the lifts & escalators shall meet the Service Performance Targets. The Maintenance Contractor shall comply with all requirements relating to Possession as set out in Clause 7 and shall pay all compensation as provided in Clause 8 if it fails to fulfil such requirements.
- The Contractor shall set up and operate the organisation for Annual Maintenance Contract within the principles of ISO 9001.
- Spares, tools and tackles shall be provided.
- The Contractor shall provide the Employer with plans, programmes and other documents relating to the performance of the Services in accordance with the requirements.
- The Contractor shall maintain a team of appropriately qualified/ skilled, trustworthy and experienced personnel in sufficient numbers and mix of skills to satisfy the requirements.
- The Contractor shall also be required to comply with the physical fitness and other standards and if required by the Employer provides evidence of such compliance.
- The Contractor shall fully comply with the safety considerations (relating to its personnel, personnel of Designated Contractors, personnel of the Employer and the public) and shall perform the Services so as to minimise the danger of injury to any such person in line with the SHE Conditions and the Rule Book.
- The Contractor shall ensure compliance with all Applicable Laws, including laws relating to local Labour employed by it, during the performance of its obligations under the Services.
- The Contractor acknowledges that while it has to keep itself in full readiness to undertake any repair or maintenance work at any point of time during the day, most of the inspection, repair and maintenance services shall be required to be provided after the operating hours when normal revenue service operations would not be undertaken.
- The Contractor shall, on a daily basis, submit the reports to the Employer in an previously agreed format /content about the performance of the Lifts & Escalators as required by the Employer.

APPENDIX A: INTERFACES

1. Interface Specification L&E Contractor and Civil as well as E&M Contractors.

Item No	Subject	Civil contractor responsibilities	Electrical Contractor responsibility	L&E Contractor responsibilities
1	**Elevator**	Design: · Establish elevator locations and requirement. · Consider & Plan water drainage and protection from rain. · Incorporate RMS panel location in SCR Room. Construction: – Provide shaft structure with proper drainage & access. · Provide lifting hooks/ beams at top of shafts as per the requirement of LE Contract and water proofing in pits. · Provide the load test reports of the hooks and the bracket location with RCC to hold the Guide rail as per the load requirement of elevator Contractor. · Ramp for access to ground floor Elevators · Sun Shade, Rain water protection & prevention from water ingress for Elevators to be installed in open area. · Certificate of shaft strength. · Stone work around the facia elevator in all landings beyond the 300mm widths. · Provide the shaft with whitewash. · Provide sump pit inside the lift pit and connection of drainage pit with lift sump pit for discharge of water. · Provision of pumping	Design: · Electrical power, Control Interfaces and system shall be developed. Construction: · Provide three phase power with dual earth duly terminated on a suitable Lift Isolator of the elevator as specified by lift contractor. – Provide cable tray conduit / trunking from lift controller to SCR for data cable. · Provide Lift Shaft with Fire protection measures. · Provide power cables from electric isolator if any to dedicated Lift/Escalator MCCB/ELCB panel.	Design: · Provide Civil Contractor with detailed requirements of shaft size, size of ventilation opening, lifting beams/hooks, water proofing and protection from rain, structural provision etc. If design of Lift by the design contractor is approved by Engineer/Employer before finalization of Lift GAD's, then in that case L&E contractor to design the load hook at their own cost. · Provide E&M contractor with all details of electrical load, shaft lighting and earthing requirements. · Inform the size of access necessary likely along the passage for moving the elevator for installation. · Co-ordinate fire safety requirement with firefighting systems. · Furnish design for monitoring and control panel. · To provide MCCB and ELCB as per requirement of Elevators outside the Lift Shaft. Construction: · To verify the load bearing capacity of civil structure at location of Guideway support and of the lifting Hooks beams before starting installation. If construction of Lift shaft/slab is completed by the civil contractor as per the approved design by Engineer/Employer before finalization of Lift GAD's then in that case L&E contractor to design, install etc the load hooks at their own cost for installation/hoisting as per L&E contractor requirement. · Provide elevator car and all mounting/ Guideway support and mechanism. · Provide and install telephone

Item No	Subject	Civil contractor responsibilities	Electrical Contractor responsibility	L&E Contractor responsibilities
		arrangement from drainage pit to nearest main drainage pit as per the location at station. · Ventilation Cut out with louvers. · Cable Entry Cut Out.		equipment in car, controller and SCR. · Provide data cable for control from station control room including requirements of ISMS contractor. · Provide all cabling within lift shaft. · Supply equipment control & monitoring panel with all accessories. · Minor Civil works like cutting of Iron bar/ Granite stone/ Concrete for mounting lift fixtures. · Provide shaft lighting and power sockets from separate single-phase power duly controlled by a switch provided outside the shaft. · Provide SS Architrave on all the landings. · Provide final whitewash inside the lift shaft. · Provide wire mesh inside the lift shaft for ventilation.

2. Interface Specification L&E Contractor and Integrated Station Management System (ISMS) Contractors.

Item No.	**Subject**	**L&E responsibilities**	**ISMS responsibilities**
1.	Elevator	Design; - PC based RMS software to jointly operate the functions of control & signaling for lifts in the SCR on the PC being provided by L&E Contractor. Construction: - Interfacing of elevator control and operating parameters available on **Ethernet /** RS-485 based protocol provided by Lift contractor at ITB in SCR with RMS. - ITB is in the scope of lift contractor.	Design: - Provision of lifts' control and operating parameters on RS-485 based protocol at ITB in SCR. Construction: - To wire the lifts' control and operating parameters on **Ethernet** / RS-485 based protocol at ITB in SCR with screened wires. ISMS Contractor is also responsible to interface for linking the elevator software from ITB in SCR to OCC

Note – 1: - In Underground Stations / Rail Corridor it will be ISMS Contractor

Note – 2: - Translation protocol between Escalator and Elevator software will be prepared by L&E contractor.

3. Interface Specification L&E Contractor and Civil as well as E&M Contractors.

Subject	Civil contractor responsibilities	Electrical Contractor responsibility	L&E Contractor responsibilities
Escalators	**Design:** · Identify escalator locations and sizes of escalators. · Define mounting and structural provisions for escalator assemblies, Co-ordinate access and delivery space provisions.	Design: · Electrical power, Control Interfaces and system shall be developed.	**Design:** · Co-ordinate details of mounting provisions, power supply, electric load and control requirements. · Define requirements and provide design details to Civil and E&M contractor for escalator's various requirements. · Furnish sizes for escalator controller enclosures, pit, support details and well way dimensions. · Co-ordinate fire safety requirement with firefighting systems. · Interface with Civil Contractor and Architect for location of suitable hoisting hooks and drainage arrangements.
Escalators	**Construction:** · Provide escalator structure including upper and bottom pits with the notches. The pits shall have gravitational drainage system. · Cut outs for laying of cables. · Providing and fixing of hoisting hooks. · Drainage Pit from the escalator should be away from the escalator pit for ease of cleaning. · The depth of the sump / drain pit should be more than the depth of Escalator pit for	**Construction:** · Provide three phase power with dual earth duly terminated on a suitable Isolator of the escalator as specified by escalator contractor. – Provide cable tray conduit / trunking from lift controller to SCR for data cable. · Provide Lift Shaft with Fire protection measures. · Provide water connection to escalator sprinkler system. · Provide Connection to Fire detector installed in the Escalators Pits from the Main Station Fire detection system. · Provide lighting, ventilation and power socket in the escalator control room if applicable. · Provide cast in	**Construction:** · Provide and install escalator units complete with claddings, finishes and operating mechanisms. · Provide lighting, ventilation and power socket in the escalator control room. · Provide and install control devices including cabling to SCR and Interfacing Terminal Cabinets for ISMS. · Plan escalator section / sizes considering local site conditions to facilitate easy transportation to installation location. · The gap between escalators and the sides of escalator and the adjoining walls/ parapet walls shall be provided with decking extensions by escalator

Subject	Civil contractor responsibilities	Electrical Contractor responsibility	L&E Contractor responsibilities
	effective drainage. · Wall should not be provided beside the escalator pit, to avoid obstruction in opening of covers of escalator pit for maintenance purpose.	conduits/race ways from escalator control room to escalator's nearest pit. · Provide cable tray from escalator control room to SCR for escalator data cable.	contractor. The Contractor shall allow a gap of approximately 15mm between the decking and the adjacent walls/ parapet walls. The gap shall be filled up by the Escalator Contractor with flexible sealant. · If construction of Escalator shaft/slab is completed by the civil contractor as per the approved design by Engineer/Employer before finalization of Escalator GAD's then in that case L&E contractor to design, install etc the load hooks at their own cost for installation/hoisting as per Escalator contractor requirement.

4. Interface Specification L&E Contractor and ISMS Contractors**.**

Item No.	Subject	ISMS responsibilities	LE responsibilities
1.	Escalators	Design; - PC based RMS software to operate the functions of control & signaling for escalators in the SCR on the PC being provided by ISMS Contractor. Construction: - Interfacing of escalator' control and operating parameters available on RS-485 based protocol provided by Escalator contractor at ITB (To be provided by Escalator contractor) in SCR with RMS.	Design: - Provision of Escalator' control and operating parameters on RS-485 based protocol at ITB in SCR. Construction: - To wire the escalator' control and operating parameters on RS-485 based protocol at ITB in SCR with screened wires. (ITB to be provided by Escalator contractor located at SCR).