REPUBLIC OF THE UNION OF MYANMAR

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

CQHP

GUIDELINES FOR HIGHRISE BUILDING CONSTRUCTION PROJECTS (ELECTRICAL)

February, 2017

COMMITTEE FOR QUALITY CONTROL OF HIGH-RISE BUILDING CONSTRUCTION PROJECTS

GUIDELINES FOR ELECTRICAL WORKS

GUIDELINE I

Local Professional Engineer (LPE)

All designs on High-Rise Building (HRB) by a foreign firm/company shall be duly endorsed / countersigned by a Local Professional Engineer (LPE) when submitting the HRB Project to CQHP.

To qualify for evaluating and endorsing designs for a foreign firm/company on Electrical Installation system for a (HRB), a (LPE) shall meet the following requirements.

1. Holder of Professional Engineer (Building Services).

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GUIDELINE II

SITE INSPECTION (FIELD WORKS)

1. General Requirements at Site
   - 1.1 Project Organization Chart
   - 1.2 Electrical and Other Drawings
   - 1.3 Work schedules
   - 1.4 Safety Provisions
   - 1.5 Temporary Electrical Installation for Construction Works
2. Inspection Check List (Advisory Service only)
   - 2.1 Preliminary Survey
     - 2.1.1 High Tension Incoming Way and High Tension Receiving
     - 2.1.2 Application for Power Requirements to Power Supply Authority
     - 2.1.3 (a) Application for Telephone, Fax, Internet, Satellite TV connection etc. to Myanmar Post and Telecommunication Department and relevant departments
       (b) Establishment of Telecom Network with respect to Information and Communication Technology (ICT) infrastructure including equipment and network installation, CCTV,MATV, TRIPLE PLAY NET WORK, CATV, WLL, frequency allocation, transmission line of sight for building height etc, the Myanmar Post & Telecommunication Department shall be consulted (M). Communication room (known as switch room) should be located at the basement or suitable floor inside the building (R). 24 hours AC power supply is necessary for a no-break communication system (M). Underground telephone cable trenching (approaching the building) needs to be demarcated for connection of external network and must be adequately spaced from commercial power supply (M).

2.2 Material and Equipment Planning

2.2.1 Materials locally available

2.2.2 Materials from foreign import

2.3 Works Supervision Personnels

2.3.1 Myanmar Local Engineer (s) and Technician (s)

2.3.2 Foreign Engineer (s) and Technician (s)

2.4 Code of Practice and Regulation followed ;such as IEC, BS, CP5, MNBC , Local Guide Line. etc.

2.5 Any alteration from Main Design Drawing in carrying out the actual Installation will be corrected in line with Para 2.4

2.6 Test Certificates, List of Fittings, Completion Drawings and Report complete with Electrical Maintenance and Operation Program together with Electric Energy Tariff meter reading both for Normal and Generator Supply are to be given.

Note ; M Stands for mandatory.

R Stands for strongly recommended.

S Stands for suggested

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GUIDELINE III

GENERAL REQUIREMENTS FOR DESIGN

1. Rules and regulations adopted for design, installation and operation shall be in accordance with IEC, CP 5, SS 555, I.E.E. Rules and Regulations, British Standard, MNBC and Local Rule and Regulations. (M)
2. English language shall be used in the design. (M)
3. Preferably International Standard of Units, SI, should be used in the design. (R)
4. Design drawing size shall not be smaller than A3 size and it should be readable (M).
5. Abbreviations, legend, symbols are as per recommendation to be used in the drawing. (R)
6. Nominal low voltage supply system is 400/230 Volt 3 Phase, 4 Wire, 50 Hz. (M)

CHECKING OF ELECTRICAL INSTALLATION DESIGN

1. High Tension Receiving and Transformer Circuit Connection Diagram and Design Drawings shall be in accordance with Rules and Regulations and Code of Practices adopted in Myanmar. (M)

1.1 Proposed Designed Voltage Rating of incoming including H.T. overhead line or underground cable and its capacity shall be clearly shown. (M)

1.2 Overcurrent and Ground fault protection provided in High Tension Receiving.

(a) Either built-in overcurrent and Ground Fault trip protection shall be provided in the circuit breaker or overcurrent and Ground Fault trip relay with protection current transformer operated system shall be provided separately. (M)

(b) Protection provided for transformer should be as per attached detail schedule and drawing (Table, III-1) (R).

(c) Transformer used inside the high-rise building shall be dry type, oil free.

2. Low Tension Receiving and Distribution System, Circuit Diagrams and Design Drawings shall be in accordance with Rules and Regulations adopted in Myanmar (Fig. III-2) (R), (Fig.III-3) (R).

2.1 For load of 100 - 500 Amp (50 - 315 kVA); > 500 - 1600 Amps (> 315 - 1000 kVA) : > 1600 - 3000 Amps (> 1000 - 2000 kVA); > 3000 Amps (> 2000 kVA); required overcurrent and ground fault trip and Earth leakage ratings are as per detail attached schedule (Table. III - 2) (R).

2.2 Mention how much percent of total load is needed to take the emergency load by stand-by Electric Generator in the event of Normal power supply failure and also explain the essential load. (R)

2.3 Typical Low Voltage interconnection between different sources of supply and stand-by Generator Power Supply should be as per attached Drawing (Fig.III - 1) (R).

3. Any Power Factor Improvement Capacitors Installed (S)

3.1 State estimated lagging power factor equipment kVA load, that is percentage inductive kVA load connected in the Electrical Installation and state also the installed Power Factor Improvement static capacitor kVAR capacity.

4. Design Electric Load Calculation (M)

4.1 Calculation divided in lighting, power, air-conditioning, water pump, lift load, etc. is required, and apply diversity factor, load factor according to the expected load demand in Kilowatt/kVA.

5. Proposed Transformer kVA Capacity Calculation (M)

5.1 From the load demand, select transformer kVA capacity and the quantity of transformer required. Explain the justification of Transformer/Transformers and the capacity selected.

6. Selection of Busduct, Cable, Busduct and Cable/Wire Sizes of Electric Feeders (M)

6.1 List the different types and sizes of Busduct and Cables/ Wire shown in the Design Drawing. Explain their application and location in accordance with their type and ampere rating.

7. Earthing System (M)

7.1 System of Earthing used shall be TT Earthing System, that is, all exposed conductive parts of an installation are connected to an earth electrode which is independent of the Source Earth (or) system if Earthing used shall be TN-S System, that is PE and N are seperate conductors (Fig.III - 4) (Fig.III - 5)

7.2 Direct Earthing of Neutral at transformer neutral point shall not be more than 2 ohms (M) (then only near the power source. (Fig.III - 4) (M) (or) System of Earthing used shall be TN-S System, that is PE and N are separate conductors (M))(Fig.III - 5)

8. Design Checking

8.1 Design checking of item 1.1 and 1.2 are subject to confirmation by Power Supply Authority. (M)

9. Electric Room

9.1 Enough space of Electric room for installation of switchgear, meter panel etc: Shall be provided in every floor along the line of vertical shall preferably near the lift shaft (M)

10. Rising Feeders

10.1 System of rising feeders should cater 4 levels per feeder or as appropriate and all the sub-meters installation, in the electric room.

11. Socket Outlets

11.1 Minimum number of socket outlets installed should be of (ONE) per 15 square meter (150 sqft) or as appropriate (S)

Socket outlet shall be of 3 pin type, third pin is to be connected to the earthing system (M)

12. Killowatt hour (KWH) Electric Energy Meter Installation.

12.1 Main-meter, measuring the consumption of electric energy for all units in a building which are used by multiple consumers should be installed at either in the Transformer H.T incoming or at L.T. out-going. (R)

Sub-meter, measuring the consumption of electric energy for a unit in a building which are used by multiple consumers whose electric power is taken through the Main-meter should be installed in the user duct compartment at the respective floor level. (R)

13. Electric Energy Conservation

13.1 Electric Energy Conservation scheme should be introduced in the design where applicable. (S)

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GUIDELINE IV

TESTING OF ELECTRICAL INSTALLATIONS

1. High Tension Receiving and Transformer

1.1 H.T. switchgear assembly and associated potential and current transformers, fuses, protective relays installation practice and Equipment shall be in accordance with pertinent Standards & Specification. (M)

1.2 Transformer should be in conformity with IEC-60076 standards (manufacturer's test certificate or equivalent is to be submitted) especially for use in High-Rise Building. (R)

Transformer used inside the high-rise building shall be dry type, oil free.

1.3 Detail testing of insulation test, earth test, ratio test, dielectric strength test, characteristic test, operational test, vector group test, etc. will be carried out by Government Inspection Department for 1.1 and 1.2 above. (M)

2. Low tension Receiving and Distribution

2.1 L.T. switchgear, fuses and protective relays shall be in accordance with pertinent Standards and Specification. (M)

2.2 Main receiving cables and distribution feeders shall be of required size and quality. (M)

2.3 The breaking capacities of protective devices, against fault current should be assessed for all installations. (attached table shows the minimum breaking capacities for general guidance only.) (Table IV-1) (R)

2.4 Type of Main Receiving and Distribution electric panels recommended should be of self-contained cubicle, floor-standing with a full front-face door and rear access, with cable entry preferably from the bottom. All electric panels shall be completely grounded. (M)

High Tension panel and Low Tension panel shall be separated and ventilation shall be provided properly. (M)

All control panel wiring and secondary control wiring in circuit breakers, control gear, etc. shall be made in a neat and systematic manner, with cable properly supported at all points to obtain free circulation of air. Wiring should be colour coded. Indicating lamps preferably with light emitting diode should be provided to indicate the stages of operation system. (R)

2.5 Quality and type of all metal conduit and trunking should comply with relevant British Standard or equivalent. Preferably all locally manufactured conduit and trunking should be of Unplastizied Polyvinyl Chloride conduit of standard quality. It shall be at least practically acceptable for use in embedding or passing through structural elements; such works shall be approved by the structural designer. (R)

3. The minimum site tests to be carried out on each completed section of the electrical installation shall be as follows:- (M)

3.1 Earthing Electrode and Earthing System Tests

3.2 Insulation Resistance Test

3.3 Continuity Test

3.4 Polarity Test to verify that single pole switches are installed in the phase or Live Conductor of each circuit and not in the neutral conductor

3.5 Insulation Resistance tests to earth and between conductors before and after fitting of lamps or equipment

3.6 Final sub-circuit earth fault loop impedance

3.7 Check correct CT ratio and polarity and correct operation of all protective gears and accuracies of all type of meters installed

3.8 Tests to prove correct operation of interlocks, tripping and closing circuits, indications, etc. including operation in conjunction with the stand-by generator, fire alarm circuits and lifts where applicable

3.9 Phasing tests

3.10 Battery tests on specific gravity, correct output voltage and charging equipment

3.11 Rotational tests on all motors

4. Testing of others as required

* Checking System and Testing of items 1.1 and 1.2 are subject to confirmation by Accredited Authority.

* Test Run of Electrical Installation should be conducted by Electrical Contractor, probably with full load.

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GUIDELINE V

CHECKING OF DESIGN AND TESTING FOR GENERAL WORKS

1. Electrical Motor Driven Water Pump, Motor Wiring, Water Level Control and Others

1.1 Proper 3 phase motor starter which can protect from overload, undervoltage and single phasing should be installed. The starter operating voltage shall be within the normal supply rating. (M)

1.2 A three phase or single phase motor wiring should be installed with the wire size based on rated full load current, but condition of the power supply available is to be considered. (R)

1.3 Automatic water pump operation by installing water tank level control switches can be installed, but overriding switch for manual control should also be provided. Insulation rating of level control switches and contacts should be of 400 Volt rating. (R)

2. Obstruction Light at Roof Level

2.1 Obstruction light or air traffic warning light installed at roof top level should be of weather proof and red coloured twin light fitting type which should be designed and manufactured particularly for this purpose only and in line with the International Civil Aviation Organization (ICAO) recommendation. (R)

3. Fire Protection System

3.1 Design Checking and Testing is to be done by Fire Department. Source of electric power supply is to be given by electrical contractor. Installation work is to be done by others. (M)

3.2 Fire protection, detection and fire alarm systems such as

(a) Automatic Fire Alarm (Smoke, Heat, Detector, etc)

(b) Manually operated Fire Alarms (Rotary; Hand Strikers; Bell; Whistles) are to be

installed. Details of requirements according to category of Building classification shall be the decision of the Fire Department. (R)

3.3 Fire extinguishing system shall be as mentioned in the Sanitary Guideline (CQHP) (R).

4. Related Technical Aspects (Telephone, Fax, Internet, Satellite T.V, Master Antenna and CCTV System, Building Management System BMS etc.)

4.1 (a) Design checking and performance test for the telecommunication instruments and other electronic devices are to be undertaken by corresponding government technical department. Installation work is to be done by others. (R)

(b) Source of electric power supply is to be given by electrical contractor.

5. Public Address System (P.A)

5.1 Design checking and testing is to be done by respective technician. Source of electric power supply is to be given by electrical contractor. Installation work is to be done by others. (R)

6. Security Door Lock System (R).

6.1 Design checking and testing is to be done by respective technician. Source of electric power supply is to be given by electrical contractor. Installation work is to be done by others.

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GUIDELINE VI

CHECKING OF INSTALLATION DESIGN AND TESTING OF ELECTRIC ELEVATORS AND OTHERS

1. Electric Elevator (M)

1.1 Location, type of building, purpose, shall be applied to Electrical Inspection Department as per approved Design drawing.

1.2 Type, speed, capacity (weight), overall weight and counter weight, size and weight of beam, plough steel rope, size and number and its test certificate, emergency governor, pit depth and overhead heights in consultation with Architect shall be given. (M)

1.3 The contractor shall construct the elevators as according to the approved drawing and any alteration shall be informed promptly. The elevators shall be erected in accordance with standard recommended practice. The final inspection will be done by the Department of Electrical Inspectorate. (M)

1.4 Provision of Fireman Lift is to be in accordance with the requirement of the Fire Department. (M), with and without attendant operation is recommended (R).
: Automatic and manual landing Door Device (ALD) shall be fitted to all lifts (passenger) installed (M). Fire rated feeder cable is to be used (M).

2. Escalator (M)

2.1 As per clause 1.1. (M)

2.2 Type, speed, inclinations, travel distance, width between balustrades, size of steps, carrying capacity (persons/hour), gear or chain type, emergency stop buttons at both ends, power source, automatic stopping device in case of chain breakage or oversag as standards shall be provided, Fire rated feeder cable is to be used. (M)

2.3 Alteration of proposed escalators and the final inspections shall be as per clause 1.3. (M)

3. Dumb Waiter

3.1 As per clause 1.1.(M)

3.2 Type, speed, size of cage, its stoppages and protective devices and positions shall be shown. (M)

3.3 Alteration of proposed dumb waiter and the final inspections shall be as per clause 1.3.(M)

4. Service Lift, Goods Lift, and Car Lift

4.1 As per clause 1.1. (M)

4.2 As per clause 1.2. (M)

4.3 As per clause 1.3. (M)

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GUIDELINE VII

CHECKING AND TESTING OF A.C. ELECTRIC GENERATOR

1. A.C. Electric Generator. Specifications and Manufacturer's Factory Test Data (M).

1.1 Test Data shall be given full details of;

(a) Engine Performance (M)

(b) Plant Protection such as failure to start, overload, high engine temperature, low oil pressure, overspeed, emergency shutdown etc. (M)

1.2 For automatic start and stop operation, system of Automatic Mains Failure (AMF) and Automatic Transfer Switch (ATS) operation shall be tested preferably with the designed load. (M)

1.3 In the course of test run of the generator, electromagnetic interference, telephone influence factor, noise level, vibration, efficiency of exhaust system, temperature rise of engine and alternator should be observed and they should be within the specified limit. (M)

2. Actual Gen-Set Output Capacity and Designed Load Capacity. (R)

2.1 Estimated design load capacity and actual carrying load of the gen-set should be compared to see that it can supply electric power efficiently.

3. Ability to take Maximum Load from No-load Starting (M)

3.1 At the instant of normal power supply failure how much percent of electric load (block load) can the generator take in one step should be guaranteed and should be tested at site. (M)

4. Ability to take maximum percentage unbalance load (R)

4.1 For a 3 phase 4 wire 400/230 volt 50 Hz Gen-set, out of unbalance load in 3 phases in percent shall be stated by Gen-set manufacturers and it should be within the specified limit. It should also be tested at site. (R)

5. EMC (Electromagnetic Compatibility) Factor (R)

5.1 Requirement for this is as stated in 1-3 above.

6. Telephone Influence Factor(R)

6.1 Requirement for this is as stated in 1-3 above.

7. Noise level (R)

7.1 Requirement for this is as stated in 1-3 above.

8. Generator Location (M)

8.1 In case the Gen-set has to be installed at the roof-top or in between the floors of a high-rise building, explain the justification of the installation together with special features and necessary Protections Provided in line with standards for it and structural engineer's approval will be needed. (M)

8.2 Provision of diesel driven A.C Electric Generator and fire pumps are to be in accordance with the requirement of the Fire Department and it is to be standards.

8.3 Generator Room must have adequate air ventilation and have fire safety standards.

8.4 Generator shall be able to take over the designed load which shall be inclusive of emergency load (M); and addition either maintained or nonmaintained emergency light together with portable type emergency light should also be used as necessary(R).

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GUIDELINE VIII

CHECKING OF EXTERNAL ELECTRICAL INSTALLATION DESIGN AND TESTING

1. Previous items of checking and testing from Guideline IV which are applicable for external electrical installation

1.1 Design shall be checked and installation shall be tested, such as overhead line or underground cable way as standard. (M)

2. Any other items of checking and testing for the external electrical installation

2.1 Design shall be checked and installation shall be tested, such as swimming pool, tennis court lighting etc.(M)

2.2 Regular checking and testing of the electrical installation should be made for safety of fire and electric shock for the people yearly or as and when required.

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GUIDELINE IX

ELECTRIC LIGHTING AND ILLUMINATION

1. Internal Electric Lighting of Building (R)

1.1 Design of internal electric lighting of building should be within the standard illumination level required and care should be taken not to overdesign the illumination to the area to be illuminated. Standard service illuminance in lux or lumen per sq.ft. should be given in the design according to the recommendation given in the Code of the Illuminating Engineering Society or any other relevant applicable standard. (R)

2. External Electric Lighting of Building (R)

2.1 External electric lighting of building such as road way, compound, fencing, entrance, gate, security lighting etc should be of water proof type and all light fittings and metal posts have to be grounded wherever applicable. External lighting feeder cable should be protected either by fuses or circuit breakers or earth leakage circuit breaks and in addition every light fitting may be protected individually. Point by point method of design illumination calculation should be provided as necessary. (R)

3. Design of Internal Building Illumination Level (R)

3.1 Calculation of illumination level designed by Average Illuminance Calculation Method should be applied to those important rooms, halls, shopping area, etc. (R)

4. Measured Illumination Level (R)

4.1 Lighting level in lux or lumen per sq.ft. of the installed light fitting should be measured by light meter preferably at night time or at actual lighting time intended and should be compared with the designed illumination level. (R)

5. Emergency Exit Light

Emergency Exit Light should be installed in case of Power outage, fire hazard and emergency cases:

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GUIDELINE X

CHECKING AND TESTING OF TEMPORARY ELECTRICAL INSTALLATIONS AT CONSTRUCTION SITES

1. Items of checking and testing from GUIDELINE IV which are applicable for temporary electrical installations shall be applied and conducted every 3 months or as required. (M)
2. All main, secondary and final sub-circuit switch board shall be fitted with 500 mA, 300 mA, 100 mA, 30 mA earth leakage sensitivity circuit breaker respectively to protect the personal equipment (PPE) from electric shock and electric fire. (M)
3. Assign competent person to check that every protective device is operating preferable every day before commencement of the work. (M)
4. Indicate clearly the location of switches and alarms which are to be opened or closed in case of emergency (e.g electric shock to personnel or electric fire).(M)
5. Person assigned for the safety of the temporary electrical installations shall maintain the wiring, switches, equipment, etc., so that there is no insulation failure of cables, equipment, faulty switches, etc., through use of construction equipment. Daily report shall be submitted to the Project Engineer. (M)
6. Safety helmet, hand gloves, belt, boots, safety glasses, portable electric fire extin-guisher etc., complete with essential hand tools for electrical workers shall be provided at site. (M)
7. Safety sign board, (danger board) and resuscitation diagram together with first aid box shall be kept in a place distinctly known and easily accessible to every worker.
8. In case of any kind of emergency, the contact telephone numbers and addresses, e.g. Fire Dept, nearest Electric Power Supply Authorities, Hospital, Police Station , Authorized Person , etc., shall be shown. (M)

9. Emergency drill, fire drill shall be exercised periodically as necessary.(M)
10. Work Site if turning out as a hazardous area all electrical installation must be fully aware for safety and necessary protections are to be provided.

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GUIDELINE XI

CHECKING AND TESTING Of BUILDING LIGHTNING ARRESTER INSTALLATIONS

1. Lightning Arrester Finial (R)

1.1 Lightning arrester finial or air termination should be connected to the selected reinforcing bars in the number of positions on the roof as required. Typical drawing is shown in Fig. XI - 1. (R)

2. Downtake Conductor and Roof Level Earth Bonding (R)

2.1 Through the selected reinforcing bars, the downtake conductor should be welded at every end of the standard length, probably inside concrete column, and should finally be connected to the test terminal at ground level. (R)

3. Test Terminal (R)

3.1 One end of insulated copper earthing lead wire is to be connected at test terminal.

4. Earthing Lead (R)

4.1 The other end of the earthing lead wire shall be connected to earth electrode which is embedded underground.

5. Earth Electrode Rod/Plate (R)

5.1 Earth electrode rod/plate shall be of copper rod or copper plate of standard sizes and approved type. (M)

6. Downtake copper conductor (R)

Separate downtake copper conductor preferably may be used.

7. Lightning Arrester (R)

7.1 Building lightning arrester installation shall be conventional type in accordance with British Standard Code of Practice for protection of structures against lightning, or SS 555 Singapore Standard.

8. Aerial (Antenner) earthing (R)

8.1 The masts of television or broadcasting aerial and satellite dishes installed on the roof shall be earthed. (R)

9. Other methods (R)

9.1 The use of methods other than conventional type for the installation of lightning arrester is not recommended. (M)

10. Earth electrode resistance (M)

10.1 All earthing electrodes shall be tested for its resistance to earth. Test result as a whole shall not be more than 10 ohms. (M)

11. Regular testing of earthing electrodes (M)

11.1 All earthing electrodes shall be tested and the result recorded at least yearly before the rainfall season. Continuity of lightning arrester path from finials at roof top to earth electrode buried underground shall be checked for possible break, disconnection and poor joints. (M)

12. Earthing for communication services.

12.1 Communication earthing must be separated from electrical power supply (M). Rating of earth resistance shall be less than 1 ohm and as required(M). Building lightning arrester system shall be installed to the required safety standard for internal network (M).

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GUIDELINE XII

COMMISSIONING, OPERATION, MAINTENANCE AND REPAIRS OF COMPLETED ELECTRICAL INSTALLATION WORKS

1.	High Tension Receiving and Transformer	To be handed over to Electric Power Supply Authorities, Operation and maintenance should be done by Electric Power Supply Authorities.
2.	Low Tension Receiving and Distribution System.	Operation and maintenance should be done by consumer.
3.	Water Pump motor and others	- do -
4.	Obstruction Light at Roof Level	- do -
5.	Fire Protection System	Operation and maintenance in general shall be done by consumer; repairs should be done by others.
6.	Operation and Maintenance (Telephone, Fax, Internet, Satellite, CCTV, CATV, etc)	Operation should be conducted by consumer (M). Maintenance and repairs should be undertaken by authorized licensee from Post and Telecommunication Department (M).
7.	Elevator, Escalator, Dumb Waiter, Service Lift, Goods Lift.	Operation should be done by consumers; maintenance and repairs by others.
8.	A.C. Electric Generator	- - -do -
9.	Public Address system (PA)	-do -
10.	Building Lightning Arrester	Operation and maintenance should be done by consumer.
11.	Security Door Lock System	-do -
12.	Commissioning of the above is to be done by authorized person together with installation contractor and the client. (M)	

RECOMMENDED SYMBOLS (R)

Conductors

PEN	Protective Earthed Neutral.
cpc	Circuit Protective Conductor.
S	Cross-sectional area of live conductor.
Sp	Cross-sectional area of protective conductor.

Current

I_a	Current causing automatic operation of a protective device in a specified time.
I_b	Design or load current.
I_n	Nominal rating or setting of protective device.
I_z	Current-carrying capacity of the circuit conductor.
I_2	Current causing the effective operation of an overload devices (with overload current.)
I_r	Earth fault current = Uo/ Zs.
I_p	Prospective short circuit current. Also used to indicate a 3 phase symmetrical short circuit current.
I_{pp}	Prospective short circuit current between two phases.
I_{pn}	Prospective short circuit current between phase and neutral conductor.
$I_{delta\,(a)}$	Earth leakage current.
$I_{delta\,(n)}$	Rated residual operation current of an RCD.
I_t	The tabulated current required for a conductor.
I_{tab}	The actual tabulated current for a conductor given in the tables.
mA	Milliamp (0.001 A)

Voltage

V_L	Line Voltage.
V_{ph}	phase voltage.
U_o	Nominal Voltage to earth.
mV	millivolts (0.001 V)

Devices

FBA	Factory built assembly.
gG	General purpose fuse having the full range breaking capacity also suitable for motor protection.
gM	A full range breaking capacity fuse suitable only for motor protection.
MCB	Miniature circuit breaker.
MCCB	Moulded case circuit breaker.
RCD	Residual current device.
RCCB	Residual current circuit breaker.

Impedance and Resistance

R_1 (Z_1)	Resistance (impedance) of phase conductor form the origin to the end of final circuit.
R_2 (Z_2)	Resistance (impedance) of the protective conductor from the origin to the end of final circuit.
R_a	The Sum of resistances of earth electrodes.
R_b	The resistance of the earth electrode for an exposed conductive part.
R_A	The Sum of the resistance of the earth electrode and of the protective conductors connecting it to exposed conductive parts.
Z_E	Impedance of the phase/earth loop external to the installation or of system up to the point under consideration.
Z_{inst}	Phase earth loop impedance in the installation (i.e excluding external earth loop impedance).
Z_s	Phase earth loop impedance from the source of energy to the end of a final circuit. Called the system impedance and is equal to U_o / I_f or $Z_s = Z_E + Z_{inst}$ or $Z_s = Z_E + R_1 + R_2$ or $Z_s = Z_E + Z_1 + Z_2$
Z_p	Impedance (or resistance) of one phase.
Z_{pn}	Impedance (or resistance) of phase and neutral.
Z_{pp}	Impedance (or resistance) of two phase.

Systems

T	Source of energy directly connected with earth, or installation directly connected with earth.
N	Installation's exposed conductive parts connected to the source earth.
C	Protective conductor connecting the installation's exposed conductive parts to the source earth, the protective conductor being combined with the neutral.
S	Protective conductor connecting the installation's exposed conductive parts to the source earth by a separate conductor.
I	The source of energy is either not connected with earth, or is connected to earth through a high impedance.
TN-C	Combined neutral and protective conductor system.
TN-S	Separate neutral and protective conductor system.
TN-C-S	Neutral and protective conductor combined from the source to the origin of the installation, and separate within the installation.
TT	System earthed at source, but installation is earthed locally, (i.e no protective conductor from source to origin).
IT	Source isolated from earth or through an impedance, installation earthed locally.

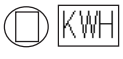
LEGEND

33/11 /6.6/0.4 kV transformer

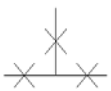
Circuit breaker

Isolator/Switch

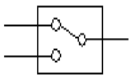
Metering C.T



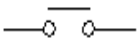
kWh meter



Two-on, one-off mechanical and electrical interlock



4-pole change over

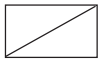


Contactor

Generator

3-phase 4-wire

Live & neutral



Distribution board

Fuse

Link

Miniature circuit breaker/Moulded Case Circuit breaker

13 A socket outlet

Detail of Guideline III item No.1(R)
Table III - Detail Data of H.T. Receiving for the Transformer and Required Accessories Installation should be as follows:

Transf. capacity KVA range 33/11/6.6/0.4kV	Cooling system of Transf	Trans. H.T Receiving control switch gear type+rating 33/11/6.6kV	Transf. L.T Main switch	Location of Transf.	Transf standard accessories with the following	Remark
50-315 kVA	(Outdoor) ONAN (Oil Natural, Air Natural (indoor) dry type	Disconnecting switch, Fuse, Lightning Arrester preferably with Earth Fault Trip and VCB	M.C.C.B (Moulded Case Circuit Breaker)	Out door or Basement or Ground Floor or service floor	For Oil Type Pressure Relief Device; Oil conservator, dehydrating breather with silicagel	
>315-1000 kVA	-do-	Circuit Breaker OR OIL FUSED LOAD BREAK SWITCH or VCB	MCCB or A.C.B (Air Circuit Breaker)	Outdoor or Basement or Ground Floor or Service floor	For Oil Type Press. Relief Device, Oil conservator, Dehydrating breather with silicagel Buchholz Relay	
>1000- 2000 kVA	-do-	Circuit Breaker of approved type Over current and Ground Fault protection	A.C.B	Outdoor or Basement or Ground Floor or Service floor	For Oil Type Press. Relief for Oil type Device, Oil conservator, Dehydrating breather with silicagel Buchholz Relay	
>2000 kVA	-	-	-	-	-	At the Description of MEPE

Note (1) Above Data need final confirmation by Power Supply Authority.
(2) Location of Transformer inside High Rise Building is to be dry type.(M)

Detail of Guideline III item No.2(R)

Table III - 2 Detail Data of L.T. Main Receiving and Final Sub-Circuit Rating and Protection Schedule should be as follows:

L.T. Main Receiving Switch Ampere Range	L.T Main Receiving Switch Protection with Earth Leakage	Individual Room of Final sub-circuit Main switch with Earth Leakage Protection Type	D.B. (Distribution Board) location	Remark
100-500 Amp (50-315 kVA)	100-500 A MCCB 4P 500 mA	Single Phase 100 mA OR 3 Phase 4 wire 100 mA.	In and no. of out going capacity and rating to be within practical limit, etc.	Primarily 30mA Earth Leakage Protection is recommended
>500-1600 Amp (>315-1000 kVA)	>500-1600 A ACB 4P adjustable over current and Ground Fault Trip	Single Phase 100 mA OR 3 Phase 4 wire 100-500 mA	In and no. of out going capacity and rating to be within practical limit, etc.	Primarily 30mA Earth Leakage Protection is recommended
>1600-3000 Amp (>1000-2000 kVA)	>1600- A-3000A 4P adjustable over current and Ground Fault Trip	Single Phase 100 mA OR 3 Phase 4 wire 100-500 mA.	In and no. of out going capacity and rating to be within practical limit, etc.	
>3000A (>2000 kVA)	-	-	-	Specific Discussion will be made for this between designer and power supply authority

Table. IV-1 Minimum Breaking Capacities of Overcurrent Protective devices (R)

Types of Supply of which the protective devices are connected	Current rating of back-up fuses (if provided) to BS 88 or equivalent	Minimum three phase breaking capacities of the protective devices
(i) Supply directly taken from the transformer within the premises in which the installation is situated.	no back-up fuse fitted	40 kA
	not exceeding 160 A	4.5 kA (with back-up fuses)
	exceeding 160 A but not exceeding 400 A	23 kA (with back-up fuses)
(ii) Supply tapped from busbar rising mains (for cable rising mains, the breaking capacities may be smaller in value depending on the design)	not exceeding 160 A	4.5 kA (with back-up fuses)
	exceeding 160 A but not exceeding 400 A	23 kA (with back-up fuses)
	no back-up fuse fitted	not less than the prospective fault current
(iii) Supply taken from electricity supplier's service box or overhead line	not exceeding 160 A	4.5 kA (with back-up fuses)
	exceeding 160 A but not exceeding 400 A	18 kA (with back-up fuses)

Note: The single phase breaking capacity should be assessed by registered electrical engineers of the appropriate grade or Professional Engineer (Electrical).

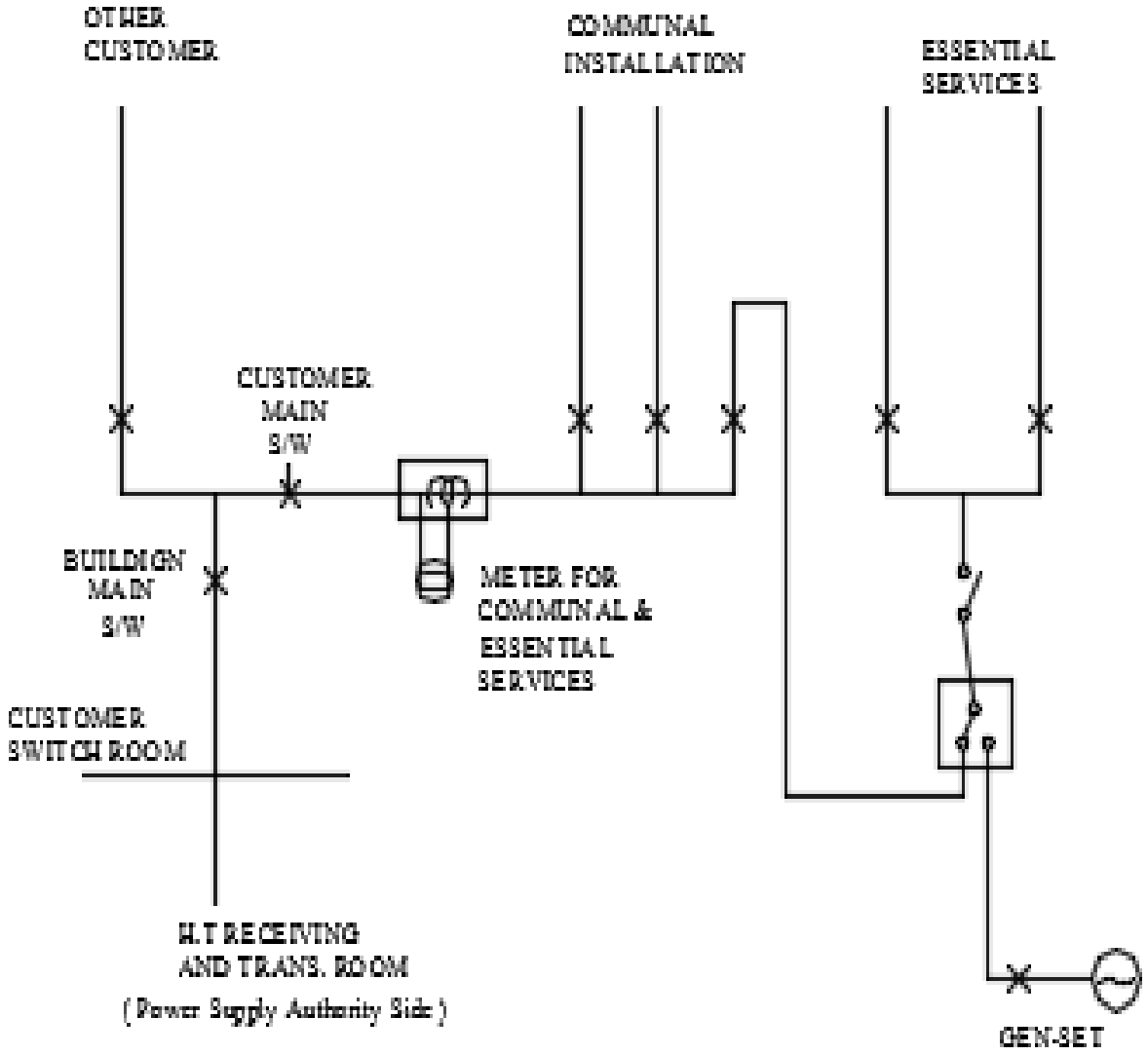
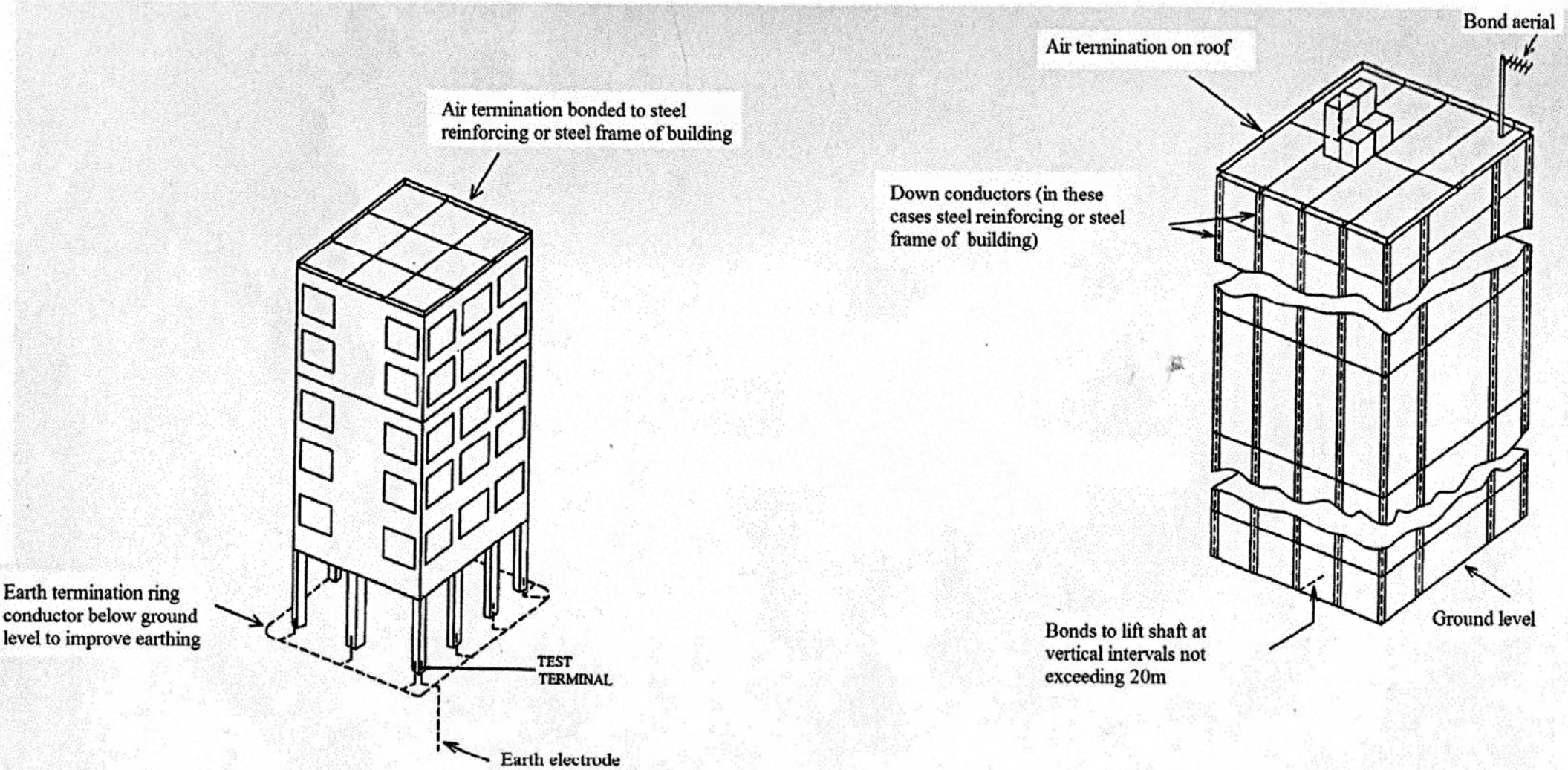


Fig III-1 (R) METERING ARRANGEMENT FOR BUILDING POWER SUPPLY (ESSENTIAL SERVICES FROM STAND-BY GENERATOR) TYPICAL DRAWING



Note: Air termination mesh should be not greater than 10m x 20m.
Down conductors should be not more than 10m apart.

Lightning protection system for tall buildings (over 20m high) showing air terminations, down conductors, bonds to projections above roof (including bonds to lift motor room and lift shaft)

(Typical drawing)
Fig.X1-1 (R)