SAFETY REGULATIONS

FOR

WORKING ON ELECTRICAL

EQUIPMENTS

Issued by-

ELECTRICAL INSPECTOR

TO

GOVERNMENT OF INDIA

FOR

EAST COAST RAILWAY

REGULATIONS FOR SAFE WORKING ON
ELECTRICAL EQUIPMENT

In order to guide the workers and staff in following the correct and uniform procedures on this Railway, keeping safety of the personnel and equipment upper most in mind, the Regulations for safe working on Electrical Equipment has been compiled and issued. Most of the accidents and other failures on electrical account happen due to non-observance and violations of basic rules for safety prescribed in the Statutory Acts & Rules.

Every endeavor has been made to present all the important aspects in a single booklet and all the staff concerned should make the fullest use of the same. These instructions by themselves should not be construed as complete and exhaustive but are meant only to serve as a guide to certain extent. Ignorance of such Statutory Rules and Acts, though not featuring in this publication, can be no excuse for acts of omission on the part of the concerned Technical Staff.

It has been our experience that most of the electrical accidents and hazards occur due to negligence and shortcut methods. It is, therefore, essential that the staff concerned should be always diligent and well conversant with the various safety rules, procedures and precautions.

Concerned officers and Senior Subordinates are requested to see that all the authorized staff are made fully conversant with the various provisions/instructions contained in this booklet, and ensure that the instructions and procedures laid down are adopted and followed with immediate effect in letter and in spirit.

Every Office and Depot should have a record copy available for ready reference at any time.

REMEMBER – SAFETY FIRST.

Electrical Inspector
To
Government of India
&
Chief Electrical Engineer
East Coast Railway

Bhubaneswar
……., 2015

EAST COAST RAILWAY
ELECTRICAL DEPARTMENT
REGULATIONS FOR SAFE WORKING ON
ELECTRICAL EQUIPMENT
****

SECTION – I

DEFINITIONS-In these Indian Electricity rules, 1956, unless the context otherwise requires,-

1.01 **Act**: - The 'Act' means the Indian Electricity Act, 1910.

1.02 **Accessible**: - Within physical reach without the use of any appliance or special effort.

1.03 **Ampere**:- A unit of electric current and is the unvarying electric current which when passed through a solution of nitrate of silver in water, in accordance with the specification set out in Annexure I, deposits silver at the rate of 0.001118 of a gramme per second; the aforesaid unit is equivalent to the current which, in passing through the suspended coil of wire forming part of the instrument marked "Government of India Ampere Standard Verified" when the suspended coil is in its sighted position, exerts a force which is exactly balanced by the force exerted by gravity in Calcutta on the counter balancing iridio-platinum weight of the said instrument.

1.04 **Annexure**:-An Annexure to these rules.

1.05 **Apparatus**:-Electrical apparatus and includes all machines, fittings, accessories and appliances in which conductors are used.

1.06 **Authorized person**: - A person authorised under rule 3. A person who is duly authorized to perform the duties appertaining to his employment. The works which an authorized person is authorized to carry out are defined in Certificate of Competence vide Appendix-II.

1.07 **Bare**: - Not covered with insulating materials.

1.08 **Cable:** - A length of insulated single conductor (solid or stranded) or of two or more such conductors, each provided with its own insulation, which are laid up together. Such insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

1.09 **Flexible cable**:-A cable consisting of one or more cores each formed of a group of wires, the diameter and the physical properties of the wires and the insulating materials being such as to afford flexibility.

1.10 **Caution Notice**: - A notice attached to live equipment calling attention to the danger involved in touching or interfering with such equipment.

1.11 **Circuit**: - An arrangement of conductor or conductor for the purpose of carrying current and forming a system or a branch of a system.

1.12 **Circuit Breaker**: -A device, capable of making and breaking the circuit under all conditions, and unless otherwise specified, so designed as to break the current automatically under abnormal conditions.

1.13 **Concentric cable**:- A composite cable comprising an inner conductor which is insulated and one or more outer conductors which are insulated from one another and are disposed over the insulation of, and more or less around, the inner conductor;

1.14 **Conductor**: -Any wire, cable, bar, tube, rail or plate used for conducting energy and so arranged as to be electrically connected to a system.

1.15 **Conduit**: - Rigid or flexible metallic tubing or mechanically strong and fire resisting non-metallic tubing into which a cable or cables may be drawn for the purpose of affording it or them mechanical protection.

1.16 **Covered with insulating material**:- Adequately covered with insulating material of such quality and thickness as to prevent danger.

1.17 **Cut out**: - Any appliance for automatically interrupting the transmission of energy through any conductor when the current rises above a pre-determined amount, and shall also include fusible cut-out.

1.18 **Danger**:- Danger to health or danger to life or any part of body from shock, burn, or other injury to persons, or property, or from fire or explosion, attendant upon the generation, transmission, transformation, conversion, distribution or use of energy.

1.19 **Danger Notice**: - A notice attached to dead equipment to convey a warning against such equipment being made alive.

1.20 **Dead**: - At or about earth potential and disconnected from any live system provided that apparatus separated from a life conductor by a spark gap shall not be deemed to be "dead".

N o t e: - The terms 'dead' is used only with reference to current carrying parts when these parts are not alive.

1.21 **Distribution System**: - A system of electrical equipment by means of which electrical energy in the form of alternating or direct current is distributed over a given area.

1.22 **"Earthed" Or "Connected with Earth"**:– Connected with the general mass earth in such a manner as to ensure at all times an immediate discharge of energy without danger.

1.23 **Earthing Connection**: - A metallic conductor for connecting electrical equipment to earth.

1.24 **Electrical Equipment**: - Any apparatus which is used for generation, transmission or utilization of electrical energy.

1.25 **Electrical Apparatus**: - Includes all machines, appliances, and fittings in which conductors are used or of which they form a part.

1.26 **Electrical Mains or Mains**: - Any wire, conductor for or other means used for conveying, transmitting or distributing energy.

1.27 **Enclosed sub-station**:-Any premises or enclosure or part thereof, being large enough to admit the entrance of a person after the apparatus therein is in position, containing apparatus for transforming or converting energy to or from a voltage at or above medium voltage (other than transforming or converting solely for the operation of switchgear or instruments) with or without any other apparatus for switching, controlling or otherwise regulating the energy, and includes the apparatus therein;

1.28 **Enclosed switch-station**:-Any premises or enclosure or part thereof, being large enough to admit the entrance of a person after the apparatus therein isin position, containing apparatus for switching, controlling or otherwise regulating energy at or above medium voltage but not for transforming or converting energy(other than for transforming or converting solely for the operation of switchgear or instruments), and includes the apparatus therein.

1.29 **Flameproof enclosure**: - means an enclosure for electrical machinery or apparatus that will withstand, when the covers or other access doors are properly secured, an internal explosion of the inflammable gas or vapour which may enter or originate inside the enclosure, without suffering damage and without communicating the internal flammation (or explosion) to the external inflammable gas or vapour in which it is designed to be used, through any joints or other structural openings in the closure.

1.30 **Feeder:** - A conductor connects (a) generating station with a sub-station or feeding point or (b) a substation with a feeding point.

1.31 **Guarded**: - Covered, shielded, fenced or otherwise protected by means of suitable casing, barrier, rails or metal screens to remove the possibility of dangerous contact or approach by persons or objects to a point of danger.

1.32 **Hand-held portable apparatus**:- An apparatus which is so designed as to be capable of being held in the hands and moved while connected to a supply of electricity.

1.33 **Inspector**: - An electrical inspector appointed under section 36.

1.34 **Installation**:-Any composite electrical unit used for the purpose of generating, transforming, transmitting, converting, distributing or utilizing energy.

1.35 **Intrinsically safe**: - As applied to apparatus or associated circuits shall denote that any sparking that may occur in normal working is incapable of causing explosion of inflammable gas or vapour.

1.36 **Increased safety type'C'**:-A method of protection by which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of occurrence of arcs and sparks in apparatus which does not produce arcs or sparks in normal service.

1.37 **Insulator or Insulating Material**: - Material which offers relatively high resistance to the passage of an electric current.

1.38 **Isolator**: - A switch for disconnecting a circuit under no load conditions only.

1.39 **Lighting arrestor**:- A device which has the property of diverting to earth any electrical surge of excessively high amplitude applied to its terminals and is capable of interrupting follow current if present and restoring itself thereafter to its original operating conditions.

1.40 **Linked switch**:-A switch with all the poles mechanically linked so as to operate simultaneously.

1.41 **Live**: - means electrically charged.

1.42 **Live Equipment**: - Equipment which is electrically live. Electrical equipment is alive when a potential difference exists between it and earth or when it is connected to another conductor or circuit in which such a potential difference exists.

Note: - In the case of an overhead electric supply line the space between the top of the pole and a distance of two meters below the bottom conductor is to be regarded as 'Live Equipment'.

1.43 **Linesman**: -A person authorized to inspect and work on overloads lines and switches in relation therewith.

1.44 **Metallic covering**: - Mechanically strong metal covering surrounding one or more conductors.

1.45 **Neutral Conductor**:-Conductor of multi-wire system, the voltage of which is normally intermediate between the voltages of the other conductors of the system and shall also include return wire of the single phase system.

1.46 Non-licensee:- A person generating, supplying, transmitting or using energy to whom any of the provisions of Part III of the Act apply.

1.47 **Occupier**:-The owner or person in occupation of the premises where energy is used or proposed to be used.

1.48 **Officer appointed to assist the Inspector**:-An officer appointed under rule 4A.

1.49 **Ohm**:-A unit of electric resistance and is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14.4521 grammes in mass of an uniform cross-sectional area and of a length of 106.3 centimetres; the aforesaid unit is represented by the resistance between the terminals of the instrument marked "Government of India Ohm Standard Verified" to the passage of an electric current when the coil of wire, forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 30^{O}C.

1.50 **Open sparking**: - Sparking which owing to the lack of adequate provisions for preventing the ignition of inflammable gas external to the apparatus would ignite such inflammable gas.

1.51 **Operator**: - A person operating a substation or a Generating station.

1.52 **Overhead Line**: - An electric supply line which is placed above the ground and in the open air but does not include live rails of traction system.

1.53 **Overhead Equipment**: - Any electrical conductors run above the ground together with their associated fittings, insulators and other attachments, by means of which electrical power is transmitted or distributed.

1.54 **Permit – to - work**:- A form of declaration signed and given by an authorized person to a "person-in-charge" of a work to be carried out on or adjacent to any electrical equipment, for the purpose of making known to such person exactly what equipment is dead, earthed and safe to be worked on or adjacent to.

1.55 **Person-in-charge**:- A supervisor in-charge to carry out a work on or adjacent to an electrical equipment who shall :-

(a) not be below the rank of mistry in case of Low Voltage and Medium Voltage system.

(b) not be below the rank of a charge man in case of High Voltage system.

1.56 **Portable apparatus**: -An apparatus which is so designed as to be capable of being moved while in operation.

1.57 **Portable hand lamp**: - A portable light-fitting provided with suitable handle, guard and flexible cord connected to a plug.

1.58 **Power (or Generating) station**: - A building complete with equipment installed for the generation and supply of electrical energy.

1.59 **Section**:-A section of the Act.

1.60 **Span**: - The horizontal distance between two adjacent supporting points of an overhead conductor.

1.61 **Street box**:- A totally enclosed structure, either above or below ground containing apparatus for transforming, switching, controlling or otherwise regulating energy.

1.62 **Supplier**:-A licensee, a non-licensee or any other supplier of energy, [including the Government.

1.63 **Switch**: - A manually operated device for opening and closing an electrical circuit or for changing the connection of a circuit.

1.64 **Switchboard**:-An assembly including the switchgear for the control of electrical circuits, electric connections and the supporting frame.

1.65 **Section Switch**:-A switch used for connecting or disconnecting adjacent sections of overhead equipment and or/transmission lines.

1.66 **Span**: - The horizontal distance between two adjacent supporting points of an overhead conductor.

1.67 **Switchgear**: - Shall denotes switches, circuit breakers, cut outs and other apparatus used for the operation, regulation and control of circuits.

1.68 **System**: - An electrical system in which all the conductors and apparatus are electrically connected to a common source of electric supply.

1.69 **Sub-stations**:- An assemblage of equipment installed for the supply of electrical energy and comprising of converting or transforming machinery, batteries or controlling apparatus etc. but no prime movers.

1.70 **Transportable apparatus**: - An apparatus which is operated in a fixed position but which is so designed as to be capable of being moved readily from one place to another.

1.71 **Transmission lines**: - Cables or bare overhead conductors by means of which electrical energy are transmitted between various points of a distributing system.

1.72 **Unauthorized person**: - A person who is not permitted to work on electrical equipment except under the personal supervision of an "Authorized person."

1.73 **Volt**: - A unit of electromotive force and is the electric pressure, which, when steadily applied to a conductor, the resistance of which is one ohm, will produce a current of one ampere.

1.74 **Voltage**:- The difference of electric potential measured in volts between any two conductors or between any part of either conductor and the earth as measured by a suitable voltmeter and is said to be:-

(a) 'Low':- Where the voltage does not exceed 250 volts under normal conditions subject, however, to the percentage variation allowed by these rules (by more than 6%, Rule 54).

(b) 'Medium':- Where the voltage does not exceed 650 volts under normal conditions subject, however, to the percentage variation allowed by these rules(by more than 6%,Rule 54)

(c) 'High':- Where the voltage does not exceed 33,000 volts under normal conditions subject, however, to the percentage variation allowed by these rules (by more than 6% on the higher side or by more than 9% on the lower side, Rule 54).

(d) 'Extra High':- Where the voltage exceeds 33,000 volts under normal conditions subject, however, to the percentage variation allowed by these rules (by more than 10% on the higher side or by more than 12.5 % on the lower side, Rule 54).

SECTION II

2.1 GENERAL RULES

2.1.1 **Warning to staff**: - Safety of the men should be considered first as a prime factor for the working. All Electrical equipment shall be regarded as being alive at all times and consequently dangerous to human life except in cases where the electrical equipment has been specially made dead in accordance with the provisions of these Rules.

2.1.2 **Ignorance of rules or orders not an excuse**: - Ignorance of rules or orders shall not be accepted as an excuse for mistakes. It shall be the duty of all the staff to make themselves acquainted with:-

(a) Rules for safe working on Electrical equipment.
(b) Indian Electricity Rules
(c) Departmental circulars, standing orders and instructions issued from time to time.

2.2 GENERAL INSTRUCTIONS FOR WORKING ON ELECTRICAL MAINS AND EQUIPMENT

2.2.1 **Precautions for working**:-

(i) Warning boards shall be attached on or adjacent to the electrical apparatus and at the limits of the zone in which work may be carried out.

(ii) Rubber gauntlets, if used during the work, shall be thoroughly examined to see whether they are in sound condition. Under no circumstances shall a person work with unsound gauntlets, mats, stools, platforms or other accessories and safety devices.

(iii) No live part should be within safe distance of a person working on live low and medium voltage mains so that he does not come in contact with it unless he is properly protected.

(iv) No person shall apply test voltage to any electric mains unless he has received a permit-to-work and has warned all persons working on the mains of the proposed applications of test voltage. If any part which will thus become alive is exposed, the person-in-charge of the test shall take due precaution to ensure that the exposed live portion does not constitute danger to any person. It should also be ensured before the application of test voltage that no other permit-to-work has been issued for working on these mains.

(v) Connecting Dead Mains to Live Mains: - When dead mains are connected to live mains, all connections to the live parts shall be made last and in all cases the phase sequence should be checked to ensure that only like phases are connected together. Before inserting fuses or links in a feeder or distribution piller controlling the cable on which a fault has been cleared, each phase shall first be connected through a test switch fuse.
(vi) The earths and short circuits, specified on permit-to-work shall not be removed or interfered with except by authority from the person-in-charge of the work.

(vii) The circuit opening devices shall be looked in the open position before the work on the mains and equipment is commenced. The locking devices shall be removed only by the person-in-charge and not until the work has

been completed, any short circuiting and earthing removed and the permit-to-work form duly returned and cancelled.

(viii) No work shall be carried out on any conductor except during day light hours unless ample artificial light is used.

(ix) No work shall be carried out on aerial lines or on poles under erection without the use of a ladder, or other supporting platform. The ladder must be of sufficient length to ensure safety.

(x) No person shall work on aerial lines when poles and conductors are wet after rain except under special supervision.

(xi) Men working on poles shall use safety belts or protect themselves by other means such as slings, ropes etc.

2.2.2 **Precautions for earthing**:-

(i) Examine earthing devices periodically and always prior to their use.

(ii) Verify that the equipment circuit is dead by means of discharging rod or potential indicator of approved type. The indicator itself should first be tested on live circuit before and after the verification.

(iii) Earthing should be done in such a manner that the persons doing the job are protected by earth connections on both sides of their working zone.

(iv) All the three phases and neutral should be effectively earthed and short circuited though work may be proceeding on one phase only.

2.2.3 **Responsibility of staff**:-Staff when at work shall always be under the person-in-charge who shall be responsible for all work being carried out correctly and in accordance with any special instructions specifically issued.

2.3 WORK ON ELECTRICAL EQUIPMENTS AND MAINTENANCE ON LOW AND MEDIUM VOLTAGE

2.3.1 **Shutdowns**: -As far as possible, prior intimation shall be given to all important consumers for planned shutdowns of long durations arranged for maintenance purposes.

2.3.2 **Emergency shutdowns**: - Supply to any equipment or feeder may be cut off by the "Authorized person" in the event of an emergency.

2.3.3 Unless a person is authorized to work on live, low and medium voltage mains and equipment, before commencing and for the whole time that work is being performed on any part of the electrical equipment or adjacent thereto, that part of the electrical equipment shall be made dead, short circuited and earthed. Every working party shall be protected by independent earths.

2.3.4 Only competent, experienced and authorized person shall work on live mains and apparatus, and such persons should take all safety measures as may be required under the Indian Electricity Rules, 1956.

2.3.5 After switching 'OFF' the supply and before touching the equipment or permitting staff to work on the equipment, the authorized person shall in the case of equipment energized at medium or low pressure, put on rubber gloves and test each and every phase conductor for voltage by means of either a Tension indicator or a "Test Lamp" which shall consist of two lamps of equal voltage and same voltage in series. The sum of the rated voltage of the test lamps shall not be less than the voltage under test.

2.3.6 Where work is to be carried out on live, low or medium voltage mains or apparatus, the following additional instructions shall be complied with:-

(a) No work shall be carried out by any person unless he is adequately protected from the risk of Electric shock by the use of rubber gloves or other approved equipment especially provided for the purposes.

(b) When a person is working on live mains or apparatus, he shall always be accompanied by a second person, who shall preferably be capable of rendering first aid and artificial respiration.

(c) When a man ascends a pole where the line is alive, he shall make use of a safety belt and rubber gloves, such work shall be carried out under the direction of an experienced person who is competent to supervise the specific work and who will remain present in the immediate vicinity for the whole time the work is in progress.

(d) The person in-charge shall examine the safety equipment before use by the workmen to ensure that it is in sound condition, and also that it is being properly used.

2.4 WORK ON HIGH VOLTAGE MAINS AND EQUIPMENT

2.4.1 All high voltage mains and apparatus shall be regarded as live & a source of danger and treated accordingly, unless it is positively known to be dead and earthed.

2.4.2 No work shall at any time be carried out on any live equipment except under instructions for hot line maintenance.

2.4.3 No person shall work or test or earth high voltage mains or apparatus except for thepurpose of connecting the testing apparatus etc. which is specially designed forconnecting to the live parts, unless covered by a permit to work and after proving the mains dead.

2.4.4 The operations of proving dead, earthing and short circuiting of any mains shall be carried out only by an authorized person under the instructions of the person in-charge. No person after receiving a permit to work, shall work on or in any way interfere with any high voltage mains or conduits carrying high voltage mains, except under the personnel instructions and supervision of the person in charge at the site of work.

2.4.5 **Earthing**: - When any high voltage main is to be earthed, the following procedure shall be followed:

(i) Before attempting to handle any high voltage equipment in order to fix proper earthing, a temporary earthing connection shall be fixed to the rail or earth and the other end shall be hooked over the electrical equipment by

means of an insulated rod and kept there until such time as a permanent earth has been fixed.

(ii) High voltage mains shall not be worked upon unless they are discharged to earth after making them dead and are earthed and short circuited with earthing and short circuiting equipment adequate to carry possible short circuit currents and specially meant for the purpose.

(iii) If a high voltage cable is required to be cut, a steel wedge or a spiking gun of approved design shall be carefully driven through it at the point where it is to be cut.

After testing the high voltage cable with D.C. voltage, the cable shall be discharged through a two Mega-ohms resistance and not directly, owing to di-electric absorption. The cable shall be discharged for a sufficiently long period to prevent rebuilding up of voltage.

Note: - Permanent earthing connection shall be fixed first to the rail or earth and afterwards to the electrical equipment. The clamp of the earthing connection shall be securely tightened to both ends.

2.4.6 **Removing earth connection**: - On completion of the work, removal of earthing and short circuiting devices shall be carried out in reverse order to that adopted for placing them i.e. the end of earthing device attached to the conductors of earthed mains or equipment shall be removed first and the other end connected to earth shall be removed last. The conductor shall not be touched after earthing device has been removed from it.

2.5 PERMIT TO WORK SYSTEM

2.5.1 If a work is to be carried out on or adjacent to the electrical equipment or on any part thereof, such work shall be done only when and for such time as the person in charge of the work is in possession of a written "permit to work" obtainable on application on Form No..ECoR/E1.

2.5.2 Before issuing permit to work in writing to person in charge of the working party, following procedure shall be followed:-

(i) **First step**:- Identify the electrical circuits feeding the equipment or the area concerned, remembering the possibility of alternative feeds as in the case of parallel feeders, or different supplies such as A.C. 3 phase, 4 wire bungalow supply mains, 230 volts street light mains, pump control mains etc. running on the same alignment or in close proximity to each other.

(ii) **Second step**: - Cut off the supply to the identified circuits or areas by opening the concerned control switches. In case of A.C. 400 volts, 3 phase, 4 wire circuits or 3 wire circuits, the neutral link should also be opened, as this is liable to assume a potential above earth under certain conditions.

(iii) **Third step**: - To prevent the lines being recharged in advertently, the switch concerned should be locked in the off position, or where this is not possible the control fuses in the switch should be removed and kept under lock and key. In case of circuit breakers, they should be racked out and locked. Lastly a "Men at work" caution Board should be hung up on each switch or circuit breaker concerned.

(iv) **Fourth step**: - To ensure that the supply has been correctly cut off, each and every conductor should be tested for supply by means of a testing device.

(v) **Fifth step**: - Finally to ensure safety under all conditions, mains and equipment concerned should be discharged, short circuited and earthed.

"Permit to work" shall be issued on form No. ECoR/E2 and shall be issued only by the person who is responsible for the operation of power supply on the distribution system.

2.5.3 A duplicate of every `permit to work' issued shall be retained in the office of the person issuing it for a period of at least 3 months except in case of accidents concerned records will be preserved till acceptance of the findings by the competent authority.

2.5.4 The permit will be issued not only to staff of other than the Electrical Department who might be working on structures for painting work adjacent to live electrical mains but also to electrical staff required to work on electrical equipment and overhead lines.

2.5.5 If there is more than one party working independently on/near the same equipment, separate `permits to work' shall be issued to the person in charge of each party at work.

2.5.6 Where an official himself has to work on an individual item of electric equipment, which is directly under his operation and control, it is not necessary to issue `permit to work', but all safety precautions must be strictly observed.

2.5.7 On completion of the work for which `permit to work' has been issued, the person in charge of the work should return the permit duly discharged to the issuing authority, who will on no account make the mains and equipment alive until person in charges of all the parties at work on or near the mains and equipment have returned the `permits to work' duly discharged. The mains and equipment shall be made alive by carrying out the operations in Para 2.5.2 in the reverse order.

2.5.8 In an emergency arising during the absence of the person in charge, an authorized Senior wireman, Linesman or Mistry, shall carried the work with intimation to his superiors immediately to avoid prolonged failures. The authorized staff should be trained by the person in charge as to the manner in which to carry out such emergency works.

2.5.9 **Log book for shut downs of 'permits to work'**: - A long book shall be maintained at substations switch houses etc. in which all the particulars regarding the shut downs, shall be maintained. The log book shall be maintained in preformat ECoR/E-8.

2.6 SAFETY DEVICES AND PRACTICES

2.6.1 **General safety devices**:-

(i) Rubber gauntlet, gloves, mats, boots, galoshes, insulated platforms, stools, safety belts, hand lamps, tower wagons and other special insulated devices shall be used, as required for working on electrical equipment and apparatus as a precaution against accidental electric shock.

(ii) Tools, insulated with brittle material or otherwise liable to have its Insulation damaged when in use, shall be used carefully. Tools with damaged insulation shall not be used.

2.6.2 **Duplicate keys for use in emergency**: - The duplicate keys of switchgear, distribution boxes, distribution pillars and isolating links etc. on the distribution system or substations as the case may be, shall be maintained in a central place so that in the case of a failure after working hours and authorized person can have access to the keys to effect necessary repairs and resume supply expeditiously. The keys shall be carefully labeled and kept in a glass fronted locked up box. The person in charge is responsible for the safety of the keys. If any key removed from the emergency key board, a record should be maintained in the log book, obtaining the signature of the party who removes the key as well as the time and the purpose for which the key is taken.

2.6.3 **Safety posters**:-

(i) Safety posters in the form of DO's and DON'T's instructions for the guidance of working staff should be exhibited at important location such as all substations and workshops.

(ii) A representative safety poster incorporating 'DO' and 'DON'T' instructions for general work is given Appendix-I.

2.6.4 **Certificate of competence and authorization**:-

(a) No work on the electrical equipment in the vicinity of electrical equipment (with the exception of the replacements of insulated bridge type fuses and lamps) shall be carried out by anyone, except an "authorized person" or under the direct supervision of an "authorized person".

(b) The supplier or the consumer or the owner or the contractor being under contract with the supplier or the consumer to carry out duties incidental to generation transformation, transmission, conversion, distribution or use of electric energy may authorize any person for the purpose of any or all of the duties listed in appendix-II and the certificate of competency shall be issued in the form prescribed in that appendix.

(c) A list of authorized persons, with name, trade designation etc. shall be kept at each central point such a substation. The list should also indicate the extent which each person is authorized to handle electrical equipment.

2.6.5 **Access to Electrical equipment**:-

(a) Adequate precautions shall be taken to prevent unauthorized persons gaining access to electrical equipment.

(b) No unauthorized person shall be permitted to have access to or to operate any switch or other apparatus which forms part of the electrical equipment or is used in connection therewith.

2.6.6 **Caution Notices**: - For medium, high and extra high voltages, a caution notice in Hind and Regional language shall be affixed permanently in conspicuous position on:

(a) Every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same.

(b) All supports of high and extra high voltage over head lines.

(c) Neon signs, X-ray and similar high frequency installations.

Provided where it is not possible to affix such notices on any generator, motor or transformer, or other equipment, they shall be affixed as near as possible thereto.

2.6.7 Portable equipments shall be thoroughly inspected once a month and it shall always be maintained in good working condition. Metallic cased portable tools such as electric drills, soldering irons, should be efficiently connected to earth by means of a separate conductor or braiding through a 3 pin plug. Efficient cable grips should be provided so that the internal connections are not disturbed when the cable is pulled.

2.6.8 **Working near cables**: - When excavations are being made adjacent to power cable routes adequate precautions shall be taken for safety of the staff and to avoid damage to the underground cables. Engineering staff and others working in the vicinity of the cable routes must use great care in excavating or disturbing the ground lest damage should be caused to the underground cables. Cable markers or indicators shall be placed along the cable route. Plans should be maintained indicating generally the position of the buried cables. Excavation must not be under taken until the vicinity of the cables has been ascertained from the Electrical Department and a representative of that department is present.

2.7 FIRES, FIRE FIGHTING AND FIRST AID

2.7.1 Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires, in addition to fire extinguishers suitable for dealing with electrical fires shall be conspicuously marked and kept in all the generating stations and substations. Fire extinguishers should always be kept in good working order.

2.7.2 In case of fire, do not throw water on live electrical equipment. It is dangerous. When using fire hose, make sure that the jet of water does not come in contact with live conductors. Don’t use a fire extinguisher on Electrical equipment unless it is clearly marked as suitable for the purpose. CTC (Carbon Tetrachloride) type extinguishers are suitable.

2.7.3 All electrical staff should be made familiar with fire fighting techniques and equipments used in it.

2.7.4 In the event of fire on or adjacent to electrical equipment, the effected equipment/apparatus should be carefully isolated from the source of Electrical Energy.

2.7.5 Any Railway servant, who may notice heavy sparking, fire, or breakdown on or near any overhead equipment, or substation etc. must immediately report to the nearest station or electrical official for taking necessary action to rectify the faults, if any.

2.7.6 All supervisors and authorized persons should be familiar with first aid and artificial respiration techniques.

2.7.7 **First Aid Boxes**: - First Aid Boxes shall be provided and maintained in every generating station and enclosed substation so as to be readily accessible during all working hours. The First Aid boxes shall be kept in charge of responsible persons who are trained in First Aid Treatment.

2.7.8 The person in charge should conduct drills in artificial respiration.

2.7.9 **Stretchers**: - Stretchers should be kept at all important electrical substations and power houses.

2.8 ELECTRIC SHOCKS

2.8.1 Instructions in English, Hindi and regional language regarding the treatment of persons suffering from electric shock, shall be exhibited in all Power Houses, Electrical Repair Shops and Substations. It is the duty of every person in charge to ensure this and to see that all authorized persons are thoroughly familiar with such instructions to be able to render artificial respiration. The instructions are given in appendix-III.

2.8.2 When a man has received a severe electric shock, his breathing usually stops. In accidents of this kind, speed may save the injured man's life. Hence, no time should be wasted in sending for a doctor, but the patient should not be neglected during this period.

2.8.3 (i) If the person is still in contact with apparatus that has given him shock switch off the electric circuit at once. If it is not possible to switch off the circuit quickly, no time should be lost in removing the body from contact with the live conductor.

(ii) The victim's body should not be touched with bare hands. Instead, rubber gloves should be worn. However, if the rubber gloves are not available, the victim should be pulled off from the live conductor by his coat, shirt etc. if they are not wet or with any other dry cloth or even dry newspaper folded into 3 or more thickness. Wooden rods or broom handle may also be used to raise the body or to detach from live conductor. A good plan is to stand on dry board or stool or on a new layer of thick newspaper bundles or even dry sacking and remove the victim from the live conductor.

2.8.4 The patient should not be placed in such a position which may bring pressure on the burns he may have sustained. He should also not be exposed to cold. Stimulants should not be administered unless recommended by a doctor. Cold water may be given in small quantities or asphyxia and smelling salts may also be administered in moderation.

2.8.5 Artificial respiration without interruption, until natural breathing is restored, should be continued. In case of severe shock respiration is seldom, established under an hour while 3 to 4 hours or more might be found necessary to restore normal breathing. It is, therefore, essential that in all cases of electric shock where the condition of the patient is doubtful or the patient is unconscious or not breathing, artificial resuscitation should be continued until death is diagnosed by a physician or until rigor mortis sets in.

2.8.6 Resuscitation should be carried on at the nearest possible place of accident. The patient should not be removed from this place until he is found breathing normally, and then also moved only in a lying position. Should it be necessary due to extreme weather conditions or other reasons to remove the patient before he is breathing normally, he should be kept in a prone condition, and placed on a hard surface or on the floor of a conveyance, resuscitation being carried on during the time that he is being moved.

2.8.7 When the patient revives, he should be kept lying down and not allowed to get up or be raised under any circumstances without the advice of a doctor. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as a tea spoonfull of aromatic spirits of ammonia in a small glass of water, or a drink of hot ginger, tea or coffee. The patient should then have any other injuries attended to and be kept warm, being placed in the most comfortable position.

2.8.8 Until the official enquiry is conducted, all material evidence should be preserved by the "person in charge" to facilitate the enquiry. Where restoration of supply is likely to obliterate marks on the premises or in any other way destroy evidence, the senior electrical official who first arrives at the site should carefully make notes and sketches and preserve the evidence as far as possible for production at the enquiry.

2.9 ELECTRICAL ACCIDENTS

2.9.1 An electrical accident is one which is caused directly or indirectly due to electrical causes. It includes electrical fires, all electric shocks and electric burns whether fatal or minor, and whether suffered by Railway servants or others.

2.9.2 **Observance of Rules**: - All accidents arising out of the use of electricity within the Railway premises are not only to be dealt with under the provisions of Railway Accidents Manual but also according to the procedure laid down under section 161 of Indian Electricity Act 2003 and Rule 44A of Indian Electricity Rules 1956, extracted below:

Section 161 of I.E. Act 2003:-

(1) "**Notice of Accidents and enquiries**:- If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with any part of the electric supply lines or other works of any person and the accident results or is likely to have resulted in loss of human or animal life or in any injury to a human being or an animal, such person shall give notice of the occurrence and of any such loss or injury actually caused by the accident, in such form and within such time as may be prescribed, to the Electrical Inspector or to such other person as aforesaid and to such other authorities as the appropriate Government may by general or special order, direct.

(2) The appropriate Government may, if it thinks fit, require any Electrical Inspector, or any other competent person appointed by it in this behalf, to enquire and report:

(a) as to the cause of any accident affecting the safety of the public, which may have been occasioned by or in connection with, the generation, transmission, distribution, supply or use of energy.

(b) as to the manner in, and extent to, which the provisions of this Act or rules and regulation made there under or of any licence, so far as those provisions affect the safety or any person, have been complied with.

(3) Every Electrical Inspector or other person holding an inquiry under sub-section (2) shall have all the power of a Civil Court under the Code of Civil Procedure, 1908 (5 of 1908) for the purpose of enforcing the attendance of witnesses and compelling the production of documents and material objects, and every person required by an Electrical Inspector or such other person as aforesaid to furnish any information shall be deemed to be legally bound to do so within the meaning of section 176 of the Indian Panel Code".

Note:

(1) The Chief Electrical Engineer, East Coast Railway is functioning as Electrical Inspector to the Central Government for Electrical installations in the premises of East Coast Railway. All matters in regard to the functions of Electrical Inspector shall be referred to him.

(2) The report of the accident in terms of sub-section (1) shall be submitted in form No. ECoR/E-4, which is the same form as prescribed in Annexure-XIII of the Indian Electricity Rules.

Rule 44A of Indian Electricity Rules, 1956

"Intimation of Accidents : If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with, any part of the electric supply lines or other works of any person and the accident results in or is likely to have resulted in loss of human or animal life or in any injury to a human being or animal, such person or any other person authorized of the State Electricity Board/Supplier, not below the rank of a Junior Engineer or equivalent shall sent to the Inspector a telegraphic report within 24 hours of the knowledge of occurrence of the fatal accident and a written report in form set out in Annexure –XIII of I.E. Rules 1956, within 48 hours of knowledge of occurrence of fatal and all other accidents"

2.9.3 **Reporting of accidents**: - Every electrical accident occurring within the Railway remises should be reported to the nearest Electrical official in charge. Immediately on receipt of this information, the electrical official in charge will proceed personally to the site of the accident and take the following steps promptly:-

(1) He should remove the casualty from the cause, render first aid and send for the doctor or take the casualty to a hospital or dispensary.

(2) If there is a breakdown of the overhead lines, he should cordon off the area so that no else may get injured.

(3) He should carry out preliminary investigation as to the cause of the accident and get fully particulars of the injury or damage suffered and advise the details in writing in such form and within such time as may be prescribed in Rule 44-A of I.E. Rules, 1956 to the Station Master, the Divisional Superintendent and the Electrical Inspector viz. the Chief Electrical Engineer and also to the local police authorities and the District Magistrate in case of accidents resulting in death of person or persons.

2.9.4 **Accident in Workshops**: - If the electrical accident has occurred within workshop premises, the Factory Act and Rules will also apply. The Electrical Officers/ official in charge of the shops will report the details of the accident to the Works Manager/Dy.C.M.E. (Shop) to enable him to comply with the provisions of the Factory Act. The Electrical Officer/official in charge of the Shops will simultaneously take action as per Section 161 of I.E. Act 2003 and Rule 44 A of Indian Electricity Rules 1956.

The manager of the Workshop shall send notice of the accident in the Form prescribed in the State Factory Rules to the following officials:

(a) The Chief Inspector of Factories.
(b) Inspector of Factories of the Region.
(c) The District Magistrate or the S.D.O.
(d) The local Police Station.
(e) The Superintendent of Police of the area.

2.9.5 **Enquiries in Electrical Accidents**:-

(i) In case of an accident resulting in loss of human life/grievous hurt or huge loss of property, an inquiry must be ordered at officer's level. The time schedule given in Railway Accident Manual must be adhered to in the conduct of enquiry. The enquiry report must be submitted to the Electrical Inspector within 14 days of the accident.

(ii) All Electrical accidents, other than those resulting in loss of human life/grievous hurt or huge loss of property will be enquired upon at the subordinate's level. The enquiry report must be submitted in such cases to the Electrical Inspector within 18 days.

SECTION III

3.0 SUB-STATIONS AND GENERATING STATIONS

3.1 SECURITY OF POWER SUPPLY

3.1.1 The sub-station and generating station staff shall constantly bear in mind that their first charge is to maintain an uninterrupted supply of power from their sub-stations, consistent with safe working of plant and safety to staff. All operations are to be directed accordingly and in compliance with these rules.

3.1.2 Persons not connected with Electric power supply, shall not be allowed inside the Electrical Sub-stations and power houses, without the approval of the person in charge.

3.1.3 Security of power supply equipment: - All structures and enclosures containing live equipment shall be kept closed and locked. The keys shall be kept in a box accessible only to authorized persons. Such boxes shall be fitted with glass fronts which may be broken in case of emergency.

3.1.4 All the feeders from a substation shall be named and numbered for proper identification.

3.1.5 The layout of the HT and LT distribution system shall be displayed at every substation in the form of a schematic diagram.

3.2 CONNECTION WITH EARTH

3.2.1 The frame of every generator, stationary motor and so far as is practicable, portable motor and metallic parts (not intended as conductors) of all transformers and any other equipment used for regulating or controlling energy and all medium voltage energy consuming equipment shall be earthed by the owner by two separate and distinct connections with earth.

3.2.2 All metal castings or metallic coverings containing or protecting any electric supply line or equipment shall be connected with earth and shall be so joined and connected across all junction boxes and other openings as to make good Mechanical and Electrical connection throughout their whole length.

Provided that where the supply is at low voltage this sub-rule shall not apply to isoland wall tubes or to brackets, electroliers, switches, fans, regulator covers or other fittings (other than portable hand lamps and portable and transportable apparatus) unless provided with earth terminal.

3.2.3 All earthing systems shall, before electric supply lines or apparatus are energized be tested for electrical resistance to ensure efficient earthing.

3.2.4 All earthing systems shall in addition be tested for resistance on a dry day during the dry season not less than once in two years.

3.2.5 A record of every test made and the result thereof shall be maintained for a period of not less than two years after the day of testing and shall be

available to the Inspector when required.Earth resistance and date of test should be indicated as far as possible on each earthing pit.

3.3 OPERATION OF ISOLATOR AND SELECTOR SWITCHES:-

3.3.1 Where isolators are in series with circuit breakers, the circuit breakers shall always be opened before opening the isolators and conversely the circuit breaker will be closed last. Interlocks may be provided to ensure this but the nonexistence of interlocks shall not be taken as an excuse for incorrect operation causing trouble.

3.3.2 When isolating or interconnecting switches are operated with hook rod sticks, care shall be taken to ensure that the insulation of hook rod is in good condition. Persons while operating switches by means of hook rods shall use insulated mats, stands or rubber gloves and shall not allow any part of their bodies to come into contact with other persons or parts of the switch gear on the building or structure supporting or containing such switch gear.

3.3.3 All switching operations in a substation or generating stations shall be solely performed by the operator on duty. He shall have a thorough knowledge of the connections and the working of all equipment in his charge.

3.3.4 The substation or generating station plant generally shall be operated as laid down in these rules and in accordance with the instructions on maintenance schedule, but operators will be expected to use their discretion in case of emergency since it is impossible to provide rules to meet all contingencies.

In no case should any operating rules or orders be departed from without adequate reasons as by so doing the operator takes full responsibility for the consequence of his action.

3.3.5 The log sheet maintained by an operator shall not only record periodical readings of the switch board instruments but also all maters which should be noted by next shift operator such as unusual occurrences shutdowns affected and switching operations yet to be done, defects noticed in the plants, important telephone messages or instructions received so that there may be no doubt as to the exact position of the various circuits. There shall be a clear handing over and taking over whenever there is a change in the operator.

SECTION IV

4. OVERHEAD EQUIPMENT AND TRANSMISSION LINES

4.1 WORKING ON STRUCTURES AND OVERHEAD EQUIPMENT.

4.1.1 Access to the overhead equipment shall generally be made only by ladders, trestles or similar means and not by the supporting structures.

All ladders and trestles shall always be kept in a good condition. In wet season, particular care should be taken to keep them dry.

4.1.2 No person other than authorized person/persons shall climb or work on any structure which carried live overhead equipment.

4.1.3 Before starting work above ground on a pole or a tower, the person/persons shall use safety belts.

4.2 METHOD OF MAKING EARTHS

4.2.1 Before attempting to touch or earth any part of the electrical equipment, it shall be tested to ensure that it is dead. The tests shall be made on the overhead equipment with the approved equipment, and the procedure shall be first to connect one end of the testing equipment circuit to the rail or other earth connection, and then to connect the other end of the testing equipment/circuit to the overhead equipment or conductors by means of insulated rods, care being taken to keep the testing circuit well clear of the body.

4.2.2 In case of three-phase lines all the three phases and the neutral shall be connected to each other and to earth.

4.3 WORKING OF CRANES

Whenever any mobile crane is required to work in the vicinity of overhead lines the supply to the lines shall be cut off and isolated and the lines earthed on both sides of the crane working site.

SECTION V

5. ENERGISATION OF ELECTRICAL EQUIPMENT

5.1 ENERGISATION OF HIGH/EXTRA HIGH VOLTAGE INSTALLATION.

5.1.1. No high voltage or extra high voltage installation shall be energized without the prior written approval of the Chief Electrical Engineer, East Coast Railway, in his capacity as "Electrical Inspector".

5.1.2 (i) Before making an application to the Chief Electrical Engineer for permission to energize a high voltage or extra high voltage installation, the Electrical Engineer shall ensure that the supply line and apparatus required to be commissioned are placed in position, duly tested and properly connected and examined. He should ensure that the provisions of the rule 65 to 69 (both inclusive) of the I.E Rules have been complied with, Extracts of these rules are given in the appendix IV.

(ii) After satisfying himself regarding the fitness of the installation for energisation, the Electrical Engineering-charge shall carry out necessary tests as required by the I.E. Rules and submit a report to the Chief Electrical Engineer, East Coast Railway. Whenever facilities for conducting some of the tests are not available, manufacturer's test certificates for the main equipment such as cables, switchgear, transformers etc. may be relied upon, and submitted with the report.

(iii) The Electrical Engineer shall then make a application along with the test reports and the form for "certificate of fitness" on form no. ECoR/E-5 and inspection report on form no.ECoR /E-11 duly filled in and signed.

(iv)The Electrical Inspector shall accord his approval for energizing the installation on Form No. ECoR/E-6. The approval of the Electrical Inspector may be communicated to the Electric Supply undertakings, if necessary.

5.1.3 No change in the H.T. Electrical equipment shall be made without intimation to and prior approval of the Electrical Inspector.

5.2 ENERGISATION OF MEDIUM VOLTAGE INSTALLATION.

5.2.1 No medium voltage installation shall be energised unless it is examined and tested by a supervisor not below the rank of a charge man. The Charge man concerned, energising such installation, shall carry out tests prescribed by the code of practices laid down by the Indian Standards Institution for the purpose and record the test results and the "Certificate of fitness" on the Form ECoR/E-5 in respect of each installation before energisation. A copy of the "Certificate of fitness" shall be sent to the Electrical Engineer-in-charge for counter signature and return before the installation is energised.

The Electrical Supervisor-in-charge of the jurisdiction will maintain the records of the test certificates and certificates of fitness and inspection report on form ECoR/E-10 in respect of each installation in his jurisdiction.

5.2.2 Test certificates, inspection reports and "Certificates of fitness" shall also be recorded for temporary installations, record of which shall be maintained for a period of at least one year after the de-energisation and dismantling of the temporary work.

5.3 ENERGISATION OF LOW VOLTAGE INSTALLATION.

5.3.1 The person-in-charge, energising such installation, shall carry out inspection and such installations as per the code of practice laid down by Indian Standards Institution and record the Inspection Report Form and "Certificate of fitness" in the Form ECoR/E-5. The certificate of fitness shall be forwarded to the Electrical Foreman/Shop Superintendent (Power), who will countersign the test certificate. The Electrical Supervisor-in-charge will kept a record of the test results and the certificate of fitness and inspection report on form No. ECoR/E-9 in his office for each energised installation.

5.3.2 The certificates inspection reports and "certificate of fitness" shall also be recorded for temporary installations record of which shall be maintained for a period of at least one year after the de-energisation and dismantling of the temporary work.

SECTION VI

6. PERIODICAL INSPECTION OF INSTALLATIONS

6.1 The Electrical installations already connected to the supply system, shall be periodically inspected and tested by the Electrical Supervisor-in-charge or his authorized assistants to ensure that they comply with the I.E. Rules and the code of practices laid down by the Indian Standards Institution. The installations shall be inspected and tested at least at intervals of periods mentioned below:

	Type of installation	**Interval of testing**
1.	All extra high voltage and high voltage installations.	Once in a year.
2.	All medium voltage installations.	Once in a year.
3.	All low voltage installations is in service buildings and public places such as clubs, institutes, schools, markets etc.	Once in two years.
4.	All low voltage installations for residential buildings.	Once in two years.
5.	Earthing arrangements for H.T. installations, sub-stations and generating stations.	Once in a year
6.	Earthing arrangement for allother installations including the low voltage installations in service buildings, public buildings and residential quarters.	Once in two years.

6.2 **Record of Tests and Inspections**: - Record of such tests and inspectionsof electrical installations shall be maintained in the office of the Electrical Supervisor-in-charge for a period of at least two years.

6.3 **Responsibility of the consumer**: - The occupants of the service buildings and residential quarters in the Railway area shall be responsible to ensure prevention of the mechanical damage to the electrical wiring, equipments and earthing arrangements provided in the building.

6.4 **Annual Safety certificates**: - Officers-in-charge of electrical installations in the Divisions and Workshops on the East Coast Railway shall record annually a certificate of maintenance and safety of electrical installations in their respective jurisdiction in the following forms :-

"It is certified that all the electrical installations in _____Division/Workshop were effectively maintained in a good and satisfactory condition and were regularly attended as and when due. It is also certified that

electrical installations have been tested and inspected as prescribed in the regulations for safe working and are in a safe and sound condition".

This certificate pertaining to the period from April to March of the financial year shall be forwarded to the Chief Electrical Engineer so as to reach him not later than 15th of April.

APPENDIX-I

SAFETY POSTER FOR PRECAUTIONS AGAINST ELECTRICALACCIDENTS

IMPORTANT: - Electrical shocks are easily received and are easily avoided. The risk is not always **APPARENT. BE CAREFUL.** Observe scrupulously the following DOs and DONOTs.

MAINS AND APPARATUS:

"DO"

1. Before replacing a lamp or handling a fan, make sure that the supply is switched off.

2. Use corrective size and quality of fuse wire when renewing blown fuse.

3. When removing fuse, pull out the supply end first and when replacing fuse, put in the supply end last.

4. Place a sign "Men Working" or other warning board on main switch before commencing work.

5. Before working on any circuit or apparatus, make sure that the controlling switches are opened and locked or the fuse holders have been withdrawn.

6. Always treat all circuits alive until you have proved them to be dead.

7. Cultivate the habit of turning your face away whenever an arc or flash may occur.

8. Guard against arcs as well as high voltage. Remember that burns from arcs may be very severe.

9. See that all splices and connections are securely made.

10. Use extreme care when breaking an inductive circuit as dangerously high voltage is likely to result.
11. Thoroughly discharge to earth all cables before working on the cores.

12. Test rubber gloves periodically.

13. Place rubber mats in front of electrical switchboards.

14. Prevent accumulation of gases in unventilated man holes. Varnishes emit flammable vapour.

"DON'T"

1. Do not connect single-pole switch or fuse in a neutral circuit. Always connect it in the live or phase wire circuit.

2. Do not renew a blown fuse until you are satisfied as to the cause of its blowing and also as to the removal of the cause.

3. Do not use copper or aluminum wire as-substitute for fuse wire.

4. Do not close any switch, unless you are familiar with the circuit which it controls and know the reason for its being opened.

5. Do not touch or tamper with any electrical gear or conductor, unless you have made sure that it is dead and earthed. High voltage apparatus may give shock or flash over even without touching.

6. Do not work on live circuits without the express orders of the person-in-charge. Make certain that all safety precautions have been taken and you are accompanied by a second person competent to render first aid and artificial respiration.

7. Do not disconnect earthing connection or render ineffective the safety gadgets installed on mains and apparatus, till you are at work.

8. Do not tamper with the meter boards and cut-outs, unless you are authorized to do so.

9. Do not expose your eyes to an electric arc. Painful injury may result even with short exposure.

10. Do not close or open a switch or fuse slowly or hesitatingly; do it quickly and positively. Do not turn your face and then grope for switch or fuse.

11. Do not use metal case flashlight around apparatus which is energised.

12. Do not place any part of your body in circuit either to ground or across the terminal when making a connection or operating.

13. Do not use wires with poor installation.

14. Do not touch an electric circuit when your hand are wet, or bleeding from a cut or an abrasion.

15. Do not work on energised circuits without taking extra precautions, such as the use of rubber gloves and wooden handles.

2. PORTABLE LAMPS AND APPLIANCES:

"DO"

1. Ensure that all single phase portable appliances are provided with 3 pin plug and socket connections and the metal work of the apparatus is effectively earthed.

2. Always use portable hand lamps of the insulated safety type and provided with a rubber, plastic or wooden handle and wire.

"DON'T"

1. Do not use a lamp in a metal holder fixed to the end of a loose flexible wire as a portable hand lamp.

2. Do not disconnect a plug by pulling the flexible cable or when the switch is ON.

3. Do not use kinked or perished cables for portable lamps and appliances.

4. Do not plug in any portable lamps or apparatus before making sure that the switch is OFF and that the wall plug is properly inserted in the socket.

3. FIRE:

"DO"

1. Disconnect the supply immediately in case of fire off or near electrical apparatus.

2. Make sure, when using hose that the jet of water does not come into contact with live apparatus.

3. Keep flammable material only in special containers and in fire-proof, rooms.

4. Wipe up oil as soon as possible, use sand to cover oil spots.

5. Be sure that your men are familiar with the location of fire fighting apparatus.

6. Organize precautionary fire drills.

7. Have sufficient number of fire extinguishers located in strategic position, so that they may be available for immediate use in various areas.

"DON'T"

1. Don't use fire extinguishers on electrical equipment, unless it is clearly marked as suitable for that purpose. Use sand or blanket instead.

2. Do not throw water on live electrical equipment in case of fire, it is dangerous.

3. ELECTRIC SHOCK:

"DO"

1. Remove the casualty from the cause, render first aid and send for doctor or take the casualty to a Hospital or dispensary.

2. Report all accidents, whether minor or major, non-fatal or fatal, immediately to the person-in-charge.

3. Study carefully and practice first aid treatment for injured persons.

4. Study carefully and practice regularly the instructions for resuscitation (artificial respiration) after electric shocks, displayed at every major electrical installation.

5. Whenever possible, use one hand only when working about an electrical circuit, even though it is supposed to be dead.

"DON'T"

1. Do not taken unnecessary risk with electricity. Low voltage, under certain circumstances, can be more dangerous than high voltage.

2. Do not leave the casualty in contact with live apparatus. Switch off current immediately.

3. Do not attempt to disengage a person in contact with a live apparatus which cannot be switched off immediately. Insulate yourself from earth by standing on rubber mat, or dry wooden board before attempting to get him clear. Do not touch his body. Pull him by clothes if they are dry or push him clear with a piece of dry wood.

4. Do not discontinue artificial respiration until recovery or death is certified by doctor. It may take even more than 2 to 3 hours for recovery.

5. Do not remove the body without the permission of police even after certificate of death by doctor.

6. WORKING ON OVERHEAD LINES:

"DO"

1. While working on poles, towers etc. do make use of safety belts.

2. See that employees working near live wires, work two meter below the lowest conductor.

3. Each working party shall have with them a portable earthing conductor, fitted with clips. It should be ensured that live conductors are discharged to earth by attaching earthing conductor to earth and to the live conductors near the point the party has to work.

"DON'T"

1. Do not work on high and extra high voltage overhead line without making sure that temporary earths have been attached at the point or points where work is to be carried out and the conductors earthed and

short circuited on each side of the section of the line on which the work is to be carried out.

2. Do not work on an overhead line which is alive at 230V or more, unless you are authorized to carry out the work and unless you are accompanied by a person competent to assist you.

3. Do not start climbing a pole, when there is already a person climbing the same pole, until the first man is in a safe position. When descending the lower man should reach the ground first before the other man starts descending.

4. Do not use a ladder without a lashing rope, or see that ladder should be held firmly by another person.

7. GENERAL SAFETY PRECAUTIONS:

"DO"

1. Preach and practice safety at all times. Good work can be spoiled by an accident.

2. Work deliberately and carefully. Haste causes many accidents. Be sure of what you are doing.

3. Examine before use all safety appliances, such as rubber gloves, mats, ladders, goggles, insulated pliers, etc. for their soundness.

4. Always add the acid or soda to water and not vice versa when mixing sulphuric acid or caustic soda and water.

5. Always report immediately to the person-in-charge or to any other proper authority any dangerous condition or a dangerous practice which you may observe.

6. Always be cautious while lifting or removing a heavy apparatus or material.

7. Warn others when they seem to be in danger near live conductor or apparatus.

8. Always be careful and take no chance against any possible accident.

9. Attend at once to all injuries however slight they may be.

10. Always obey the safety instructions given by the person-in-charge.

11. See that no radio aerials are under any electrical conductors. Staff should treat radio serials as live wire and they should warn their children against danger inherent in playing with the same.

"DON'T"

1. Do not wear loose clothing, metal watch straps, bangles or finger rings while working on electrical appliances. Do not hang clothes and such other things on electrical fittings.

2. Do not go carelessly near running belts on machines.

3. Do not remove danger notice plates or other signs or interfere with safety barriers or go beyond them.

4. Do not bring a naked light near battery. Smoking in the battery room is prohibited.

5. Do not allow visitors and unauthorized persons to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus.

6. Do not enter excavations which give out obnoxious smell.

7. Do not touch a circuit with bare fingers or hand or other make shift devices to determine whether or not it is alive?

APPENDIX II

CERTIFICATES OF COMPETENCE

1. All staff who are required to work on electrical equipment or overhead lines should be trained in their duties and after satisfactory test to confirm that they have understood the rules, they should be issued with a certificate of competence. All such staff shall be deemed to be "Authorized persons" in respect of duties specifically mentioned in the certificates.

2. No competency certificate is required for staff whose duties are restricted to train lighting and head light maintenance or other non electrical work such as carriage examination, washing etc. Staff required to paint electric posts should however be given "certificate of competence" as they may be required to work in the vicinity of live equipment.

3. Duties and jobs for which ' certificates of competence' have to be issued are indicated in the next page. The items which different staff are competent to handle and the authority competent to issue certificate of competence is indicated below.

4.

Category of staff	**Items which the staff is competent to handle**	**Authority competent to issue a certificate of competence**
Unskilled staff	1,2,3	Supervisor-in-charge
Semi-skilled staff	1,2,3,4,5,6,7	-do-
Skilled staff	1,2,3,4,5,6,7,8,9,10,11,12	-do-
Highly skilled staff and mistries	1,2,3,4,5,6,7,8,9,10,11,12,13	Senior Supervisor-in-charge
Supervisors	1,2,3,4,5,6,7,8,9,10,11,12,13,14	Assistant/DivisionalOfficer-in-charge

List of Duties/Jobs for which certificate of competence has to be issued.

1. To assist skilled/unskilled Electric staff in carrying out works on Electric Mains and equipment.

2. To clean and carry out works externally on Electrical Motors/Generators/Starters/Rectifiers and other electrical equipments provided work is carried out two meter below/away from live conductors.

3. Renewing lamps, fuses etc., which are away from live wires.

4. To change lamps and replace fuses in internal wiring installations.

5. To operate portable apparatus, and other low and medium voltage plants.

6. To open L.T. links etc. provided the link is below the lowest energised conductor.

7. To assist the skilled electrical staff in carrying out works on electrical mains and equipments.

8. To take shut downs/power blocks.

9. To undertake all operations and repair work on medium or low voltage mains and equipment except commissioning of a new low or medium voltage installation.

10. To test bare copper/aluminum conductors for pressure by means of lamps or other approved appliance and to discharge the lines and to fix earthing chains in position.

11. To issue **'Permit to work'** certificates on forms ECoR/E-2 & ECoR/E-3.

12. To ensure safety of works under/with him.

13. To undertake all operations and works on low, medium and high voltage mains and equipment (except commissioning a new H.V. installation or making material modification to existing H.V. installations).

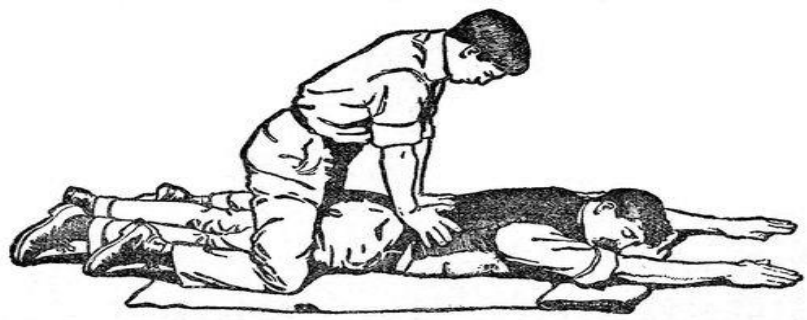
14. To undertake and supervise all operations and work on low, medium and high voltage mains and equipment (including commissioning).

APPENDIX III

ARTIFICIAL RESPIRATION

1. USUAL METHOD

(i) **First motion**: - Observe Fig. 1.



"EXPIRATION":- Knee over the patient, rest the hand flat on the small of his back, let your thumbs nearly touch, spread your finger on each side over his lower ribs as in the figure. Now lean firm but gently forward over patient, exerting the steady pressure downwards, still following Fig. 1.

(ii) **Second motion**: - Observe Fig. 2.

"INSPIRATION": - Rock yourself gently backward, but do not remove your hands, merely keep in positioning the next expiration pressure.

Continue these two movements successfully.

The double movement should be gone through about fifteen times per minutes. The object is to keep expanding and contracting the patient's lungs so as to initiate slow breathing. If the operator himself breathe is slowly letting the air out as he presses forward and drawing it in as he nicks backward he will naturally arrive at the proper rate and will understand the reasons of the movements.

Do not cease operations until natural breathing is re-established. It may take half an hour or even longer to produce any effect.

2. ALTERNATIVE METHOD

Should it be expedient to place the patient on his back? First loosen the clothes around chest and stomach. Then place a rolled up coat, or other improvised pillow beneath the shoulders so that the head fall backwards. The tongue should then be drawn forward.

(i) **First motion**: - The operator should kneel in the position shown byFig. 3, grasp the patte just below the elbows, and draw his arms over his head until horizontal, retaining them there for about two seconds.

(ii) **Second motion** :- Bring the patient's arms down on each side of the chest and pressing inwards upon it, leaning upon his arms in so as to compress his chest as Fig. 4, remain thus for two seconds, and then keep repeating the two motions at the same rate.

Note: - The lung-inflating effect in fig. 3 is much assisted if the arms be swung outwards as they are lifted. If more than one person be present the patient tongue should also be drawn out during each outward or on being inflating stroke (Fig. 3) and released during each ward or lung deflating stroke (Fig. 4)

FIG. 169. Production of Artificial Respiration.
(Second movement — expiration.)

3. **MOST EFFECTIVE METHOD** :-

Mouth to mouth method of Artificial respiration is the most effective method and can be continued for more than one hour by one person.

Lay the unconscious patient on his back preferably on a raised surface such as bench or a table. Kneel or sit on the side of the head (Fig. 5). Pinch the nostrils with the thumbs and inside fingers, take a moderately deep breath and breathe with the patient's mouth applying the mouth firmly to patient's mouth. It should be ensured that the mouth is firmly applied so that all the air enters the patient mouth (Fig. 6). It will be seen that the air enters without much resistance. Remove your head from the patient's face to allow the air come out. Breathe again into the patient's mouth. Repeat the cycle 12 to 15 times a minute. If the first-aider feel hesitant to apply the mouth directly, a piece of thin cloth with a handkerchief can be put over the patient's mouth and breathing can be carried on through this. It is important to keep the jaw titled well forwards to ensure that the tongue does not fall back and block the air passages. In a child it is not necessary to pinch the nostrils as the mouth of the first-aider will cover the mouth and nose of the child.

Note: -Be careful to avoid violent operation, as injury on the internal organs may take place from excessive and sudden pressure.

APPENDIX

EXTRACTS FROM INDIAN ELECTRICITY RULES

Rule 65.Testing, Operation and maintenance:-

(1) Before approval is accorded by the Inspector under rule 63, the manufacture's test certificates shall, if required, be produced for all routine tests as required under the relevant Indian Standard.

(2) No new HV/EHV apparatus, cable or supply line shall be commissioned unless such apparatus, cable or supply line are subjected to site tests as per relevant code of practice of the.

(3) No HV/EHV apparatus, cable or supply line which has been kept disconnected, for a period of 6 months or more, from the system for alteration or repair shall be connected to the system until such apparatus, cable or supply line are subjected to the relevant tests as per code of practice of the Bureau of Indian Standard.

(4) No withstanding the provision of sub-rule (1)& (3) (both inclusive) the inspector may require certain additional tests to be carried out before charging installation or subsequently.

(5) All apparatus, cable or supply line shall be maintained in healthy conditions and tests shall be carried periodically as per relevant code of practice of the Bureau of Indian Standard.

(6) Records of all tests, trippings, maintenance works and repairs of all equipments, cables and supply lines shall be duly kept in such a way that these records can be compared with earlier ones.

(7) It shall be responsibility of the owner of all HV and EHV to maintain and operate the installations in a condition free from danger and as recommended by the manufacture and/or by the relevant code of practice of the Bureau of Indian Standard and/or by the Inspector.

(8) Failure of transformers and reactors of 20 MVA and higher capacity shall be reported by the consumer and supplier of electricity within 48 hours of the occurrence of the failure, to the electrical Inspector and Central Electricity Board. The reasons of failure and measures to be taken to avoid recurrenceof failure shall be sent to the Electrical Inspector and Central Electricity Board within one month of the occurrence in the format given in Annexure XV.

Rule 66. Metal sheathed electric supply lines - Precautions against excess leakage:-

(1) The following provision shall apply to electric supply lines (other than overhead lines) of a supplier for use at high or extra high voltage.

(a) The conductors shall be enclosed in metal sheathing which shall be electrically continuous and connected with earth, and connected with earth, and the conductivity of the metal sheathing shall be maintained and reasonable precautions taken where necessary to avoid corrosion of the sheathing.

Provided that in case of thermoplastic insulated and sheathed cables with metallic armour, the metallic wire or tape armour shall be considered as metal sheathing for the purpose of this rule.

Provided further that this rule shall not apply to cable with thermo plastic insulation without any metallic screen or armour.

(b) The resistance of earth connection with metallic sheath shall be kept low enough to permit the controlling circuit breaker or cut-out to operate in the event of any failure of insulation between the metallic sheath and the conductor.

(c) Where an electric supply-line as aforesaid has concentric cables and the external conductor is insulated from the outer-metal sheathing and connected with earth, the external conductor may be regarded as the metal sheathing for the purposes of this rule provided that, the foregoing provisions as to conductivity are complied with.

(2) Nothing in the provisions of sub-rule (1) shall preclude the employment in generating stations, sub-stations and switch stations (including outdoor sub-stations and outdoor switch-stations) of conductors for use at high or extra-high voltages which are not enclosed in metal sheathing or preclude the use of electric supply-lines laid before the prescribed data to which the provisions of these rules apply

Rule 67. Connection with earth: (1) All non –current carrying metal parts associated with HV/EHV installation shall be effectively earthed to a grounding system or mat which will be:-

(a) limit the touch potential to a tolerable limit.

(b) limit the ground potential rise to a tolerable so as to prevent danger due to transfer of potential through ground, earthwires, cable sheath fences, pipe lines.

(c) maintain the resistance of earth connection to such a value as to make operation of protective device effective.

(1A) In the case of star-connected systems with earthed neutrals or delta-connected systems with earthed artificial neutral point:-

(a) The neutral point of every generator and transformer shall be earthed by connecting it to the earthing system as defined in rule 61(4) and herein above by not less than two separate and distinct connections:

Provided that neutral point of a generator may be connected to earthing system through an impedance to limit the fault current to earth:

Provided further that in the case of multi- machine system neutral switching may be resorted to ,for limiting the injurious effect of harmonic current circulating in the system;

Having its own electrode at the generating station and at the sub-station and may be earthed at any other point provided that no interference of any description in caused by such earthing:

(b) In the event of an appreciable harmonic current flowing in the neutral connection so as to cause interference with communication circuits, the generator or transformer neutral shall be earthed through a suitable impedance.

(c) In case of delta connected system the neutral point shall be obtained by the insertion of a grounding transformer and current limiting resistance or impedance wherever considered necessary at the commencement of such a system.

(1B) In case of generating sub-stations, Extra High Voltage sub-station and Extra High Voltage industrial installations, the system neutral earthing and protective frame earthing may be, if system design so warrants, integrated into common earthing grid provided the resistance to earth of combined mat does not cause to exceed the step and touch potential beyond its permissible values.

(2) Single-phase high or extra high voltage systems shall be earthed in a manner approved by the Inspector.

(3) In the case of a system comprising electric supply-lines having concentric cables, the external conductor shall be the one to be connected with earth.

(4) Where a supplier proposes to connect with earth and existing system for use at high or extra-high voltage which has not hitherto been so connected with earth, he shall give not less than fourteen days' notice in writing together with particulars to the telegraph authority of the proposed connection with earth.

(5a) Where earthing lead and earth connection are used only in connection With earthing guards erected under high or extra high voltage lines the cross a telecommunication line or a railway line, and where such lines are equipped with earth leakage relays of a type and setting approved by Inspector, the resistance shall not exceed 25 ohms.

(5b) Everyearthing system belonging to either the supplier or the consumer shall be tested for its resistance to earth on a dry day during dry season not less than once a year. Records of such tests shall be maintained and shall be produced, if required before the Inspector or any other officer appointed to assist him and authorized under sub-rule (2)of the rule 4A.

(5) In so far as provisions of rule 61 are consistent with the provisions of this rule, all connections with earth shall also comply with the provisions of that rule.

Rule 68. General conditions as to transformation and control of

Energy:

(1) Where energy at high or extra high voltage is transformed, converted, regulated or otherwise controlled in sub-stations or switch stations (including outdoor sub-stations and outdoor switch-stations) or street boxes constructed underground, the following provisions shall have effect.

(a) Sub-stations and switch-stations shall preferably be erected above ground, but where necessarily constructed underground due provisions for ventilation and drainage shall be made and any space in housing switch gear shall not be used for storage of any materials especially inflammable and combustible materials or refuse.

(b) Outdoor sub-stations except pole type sub-stations and outdoor switch stations shall (unless the apparatus is completely enclosed in a metal covering connected with earth, the said apparatus also being connected with the system by armoured cables) be efficiently protected by fencing not less than 1.8 meters in height or other means so as to prevent access to the electric supply lines and apparatus therein by a unauthorized person.

(c) Underground street boxes (other than sub-stations) which contain transformers shall not contain switches or other apparatus, and switches, cut-outs or other apparatus required for controlling or other purposes shall be fixed in separate receptacles above ground wherever practicable.

(2) Where energy is transformed, suitable provisions shall be made either by connecting with earth a point of the system at the lower voltage or otherwise to guard against danger by reason of the said system becoming accidentally charged above its normal voltage by leakage from a contact with the system at the higher voltage.

Rule 69. Pole type sub-station:- Where platform type construction is used for a pole type sub-station and sufficient space for a person to stand on the platform is provided, a substantial hand rail shall be built around the said platform and if the hand rail is of metal, it shall be connected with earth.

Provided that in case of pole type sub-station on wooden supports and wooden platform the metal hand rail shall not be connected with earth.

Form no. ECoR/E-1

ELECTRICAL DEPARTMENT
(Requisition for shutdown rule 2.5)

No. _____ Dt. _____

From _____ To _____

Requisition for shutdown of Electric Supply: -

Please arrange to switch off electric supply to the feeders equipment detailed below and arrange to issue me permit-to work (ECoR/E-2).

1. Shut-down required from _____ hrs. on _____ (date) to _____ hrs. on _____ (date).
2. Exact feeder or equipment for which shutdown is required:-
   _____
   _____
   _____
3. Purpose for which shutdown is required :-
   _____
4. The supply must be resumed only after you receive a line clear certificate from me on Form ECoR/E-3.

Station _____

Date _____

Signature _____
Designation _____

Received at _____ hrs. on _____ (date) by (name) _____
Designation _____

Form no. ECoR/E-2

ELECTRICAL DEPARTMENT

No. _____ Dt. _____

From _____ To _____

As per your requisition (Form no. ECoR/E-1), dated _____ Electric supply to the following feeders/equipment only has been switched off and the lines have been earthed, and they are safe to work upon. All other parts are alive.

Description _____

_____

Please arrange to complete your work in time and issue line-clear certificate' on Form ECoR/E-3 before _____ hrs. Please note that supply will not be resumed until the certificate on Form ECoR/E-3 is received by me from you.

Person-in-charge of control
&
Operation of power supply

Name_____ _____
Designation _____

Time _____

Date _____

Received at _____ hrs. on _____ (date) by _____ (name) Designation _____ Form ECoR/E-3 _____

issued at _____ hrs. on _____ _(date).

Form no. ECoR/E-3

(Line-clear certificate)
ELECTRICAL DEPARTMENT
(Advice for resuming Power supply of Rule 2.5)

No. _____ Dt. _____

From _____ To _____

CERTIFICATE FOR LINE CLEAR

Reference your form ECoR/E-2……..of……date……

1. Hereby certify that (i) my work in the locality …….has been completed.
2. That all my staff have been withdrawn and advised that it is no longer safe to work on the lines.
3. That all temporary earths and other connections made by me or by my men have been removed.
4. That all the lines are clear and supply may be resumed.

Signature _____
Designation _____

Time _____

Date _____

Received at _____ hrs. on _____ (date)_____

Supply restored at _____ hrs. on _____ _(date) _____

and everything found normal.

Signature _____
Designation _____

Form no.ECoR/E-4

EAST COAST RAILWAY
ELECTRICAL ACCIDENT REPORT (Rule 2.9)

1. Date and time of accident Place of Accident (Village/Town, Tehsil/Thana, District and State)._____

2. Place of accident (Village/Town, Tehsil /Thana, District and State)._____

3. System and voltage of supply, (Whether EHV/HV/LV Line, substation/generating station/consumer's installation/service lines/other installation). _____

4. Designation of the Officer- in-charge of the supplier in whose jurisdiction the accident occurred._____

5. Name of the owner/user of energy in whose premises the accident occurred._____

6. Details of victim(s):-

(a) Human:

(1). Sl.No._____

(2). Name._____

(3). Father's Name_____

(4). Sex of victim._____

(5). Full Postal Address._____

(6). Approximate age._____

(7). Fatal/Non fatal._____

(b) Animal:

(1). Sl.No._____

(2). Description of animal(s)._____

(3). Number(s)._____

(4). Name(s) of owner(s)._____

(5). Address(s) of owner(s)._____

(6). Fatal/non-fatal._____

7. In case the victim(s) is /are employee(s) of supplier:-

(a) Designation of such person(s).

(b) Brief description of the job undertaken, if any.

(c) Whether such person/persons was/were allowed to work the job?

8. In case the victim(s) is /are employee(s) of a licensed contractor:-

(a) Did the victim(s) posses any electric workman's permit(s), supervisor's certificate of competency issued under rule 45? If yes give number and date of issue and name of issuing authority.

(b) Name and designation of the person who assigned the duties of the victim(s).

9. In case of accident in the supplier's system, was the permit to work (PTW) taken?

10. (a) Describe fully the nature and extent of injuries, e.g. fatal disablement (permanent or temporary) of any portion of body or other injury, etc.
(b)In case of fatal accident, was the post mortem performed?

11. Detailed causes leading to the accident.
(To be given in a separate sheet annexed to this form).

12. Action taken regarding First Aid, Medical attendance etc. immediately after the occurrence of the accident.

13. Whether the District Magistrate &Police Station concerned have been notified of the accident (if so, give details).

14. Steps taken to preserve the evidence in connection with the accident to extent possible.

15. Name & designation(s) of the person(s) assisting, supervising the person(s) killed or injured.

16. What safety equipments were given to and used by the person(s) who met with this accident (e.g. rubber gloves, rubber mats, safety belts and ladders etc)?

17. Whether isolating switches and other sectionalising devices were employed to deaden the sections for working on the same? Whetherworkingsection wasearthed at the site of works?

18. Whether the work on live lines was undertaken by authorized person(s)? If so, the name and designation of such personmay be given.

19. Whether artificial resuscitation treatment was given to the person(s) who met with electric accident? If yes, for how long was it continued, before its abandonment?

20. Name and designations of persons present at and witnessed the accident.

21. Any other information remarks.

Place:

Time:

Date:

Signature:

Name:

Designation:

Address of the person reporting:

Form No.ECoR /E-5

EAST COAST RAILWAY

ELECTRICAL INSTALLATION FITNESS CERTIFICATE

(Rule 5)

The work of commissioning of_____at_____ _____ has been completed on date_____ against Est. No._____.

It is certified that the installation has been tested and inspected and that it complies with I.E. Rules in all respects. The test reports are enclosed.

Signatures_____

No._____Date_____SupervisorIncharge_____

Designation_____

Countersigned:

Signatures_____

Designation_____

FORM NO.ECoR/E-6

EAST COAST RAILWAY

No._____

Office of the Chief Electrical Engineer &
Electrical Inspector to the Govt. Of India

3rd Floor, ECoRSadan
Railkunj, C.S.Pur
Bhubaneswar - 751017

The Divisional Supdt.

Dated_____

Sub: Approval for energisation of high voltage installation comprising of _____

Ref: Your application No._____
Dt. _____ for approval.

In reference to your application under Sub-Rule 63(2) of the Indian Electricity Rules, 1956 and your report submitted along with the application, I am satisfied that the works executed comply with the provisions of the I.E. Rules.

In view of the work having been completed satisfactorily, I hereby accord my approval authorizing you to bring the high voltage installation mentioned in the subject above into beneficial use.

This approval is subject to any further additions and alterations being notified to the undersigned and prior approval obtained for any such change before the same are brought into use.

ELECTRICAL INSPECTOR TO
THE GOVT. OF INDIA FOR
EAST COASTRAILWAY AND
CHIEF ELECTRICAL ENGINEER

Form No.ECoR /E-7

EAST COASTRAILWAY
ELECTRICAL DEPARTMENT
Certificate of competency
(Appendix II)

Shri_____

Designation _____

Grade Rs._____ has been examined for his knowledge of Regulations for safe working on Electrical equipment and mains and he is authorized to carry out the jobs mentioned at items _____.

Signature with Designation of Authority competent to issue the certificate.

Designation _____

Place: _____

Date: _____

Note:-For items of jobs please see reverse.

List of Duties/jobs for which certificate of competence has to be issued

1. To assist skilled/unskilled Electric staff in carrying out works on Electric Mains and equipment.

2. To clean and carry out works externally on Electrical Motors/Generators/Starters/Rectifiers and other electrical equipments provided work is carried out two meter below/away from live conductors.

3. Renewing lamps, fuses etc. which are away from live wires.

4. To change lamps and replace fuses in internal wiring installations.

5. To operate portable apparatus, and other low and medium voltage plants.

6. To open L.T. links etc. provided the link is below the lowest energized conductor.

7. Assist the skilled electrical staff in carrying out works on electrical Mains and equipment.

8. To take shut downs/power blocks.

9. To undertake all operations and repair work on medium or low voltage mains and equipment except commissioning of a new low or medium voltage installations.

10. To test bare copper/Aluminum conductors for pressure by means of lamps or other approved appliance and to discharge the lines and to fix earthing chains in position.

11. To issue 'Permit to work' certificates on forms ECoR/E-2 &ECoR/E-3.

12. To ensure safety of workers under/with him.

13. To undertake all operations and works on low, medium and high voltage mains and equipment (except commissioning a new H.V.installations or making material modification to existing H.V.Installations).

14. To undertake and supervise all operations and work on low, medium and high voltage mains and equipment (including commissioning).

EAST COAST RAILWAY
LOG BOOK OF SHUT-DOWNS OR PERMITS TO WORK
(Rule 2-5-9)

OFFICE..... PLACE.....

S. N	Shut down Requi-sition ECoRForm No. & Date	Shut Down required by	Shut down Requi-red on			Exa-ct line or equi-pment for which shut down is requ-ired	Pur-pose for which shut down is requ-ired	Time & Dt. of rec e-ipt of requi-sition	Power Failure/Shut Down effected			Line clear certify-ficate ECoR .No. & Date	Time & Dt. of re-sto-ra-tion of sup-ply	Remarks
			Dt.	From Hrs.	To Hrs.				From Hrs.	To Hrs.	Duration Hrs. & Mts.			

Form No.EC0R /E-9

MODEL FORM OF INSPECTION REPORT
INSPECTION REPORT
(Rule 5 & 6)
(Low Voltage Installations)

(Under Rule 46 of the Indian Electricity Rules, 1956)

(A). Report No._____

(B). Date of Inspection._____

(C). Challan no._____

(D). Dated._____

(E). Inspection fee Rs._____

(F). Date of last inspection._____

1. Consumer no._____

2. Voltage & system of supply._____

(a). Volts._____

(b). No of phase_____

(c). AC/DC._____

3. Type of wiring._____

4. Name of the consumer/owner._____

5. Address of the consumer/owner._____

6. Location of the premises._____

7. Particulars of installations._____

(I).	leakages on premises:		
		No.	Connected Load in KW
(1).	Light points		
(2).	Fan points		
(3).	Plug points		

(II). Other equipment's (Complete details to be given)

(1).

(2).

(3). Total connected load in KW._____

(4). Maximum current demand in Amps._____
(On the basis of total connected load).

(III). Generators (in case of consumer himself generating energy).
(1). _____

(2). _____

8.	General conditions of Installations:-	
IE Rules, 1956 reference	**Requirement**	**Report**
1	**2**	**3**
29.	(i). Is/are there any sign(s) of overloading in respect of any apparatus wiring	
	(ii). Condition of flexible cords, sockets, switches, plug points, cut-outs and lamp holders and such other fitting.	
	(iii). General condition of wiring.	
	(iv).State if any unauthorized temporary installation exists.	
	(v). State if sockets are controlled by individual switches.	
	(vi).Any other defects or condition which may be a source of danger.	
30.	Give report on the condition of service lines, cables, wires, apparatus and such other fittings placed by supplier/owner of the premises.	
31.	Has the supplier provided suitable cut-outs within consumer's premises, within enclosed fire proof receptacle?	
32.	(i).State if switches are provided on live conductors.	
	(ii).State if indication of a permanent nature is provided as per this rule so as to distinguish neutral conductor from the live conductor.	

	(iii). Whether a direct link is provided on the neutral in case of single phase double pole iron clad switches instead of fuse?	
33.	(i).State if earthed terminal is provided by the supplier.	
	(ii).Have three pin plugs been provided for plug points?	
	(iii).Report on efficiency of the earthing arrangement.	
49.	Leakage on premises: - State insulation resistance between conductors and earth in Mega ohms.	
50.	(i).State if linked switches of requisite capacity are provided near the point of commencement of supply.	
	(ii). State if the wiring is divided in suitable number of circuits and each circuit is protected by suitable cut-out.	
	(iii).State if supply to each motor or apparatus is controlled by suitable linked switch.	
	(iv).Has it been ensured that no live part is so accessible as to cause danger?	
61.	(i).Have the frame of every generator, stationary motor and so for as practicable portable motor and metallic parts (not intended as conductor) of all apparatus used for Regulating [Not applicable to isolated wall tubes or to brackets,electrolires, lamps and transportable apparatus) unless provided with earth terminal] or controlling energy been earthed by two separate and distinct connection with earth?	
	(ii).Is the earth wire free from any mechanical damage?	
	(iii).In case of conduit/lead cover wiring, has the conduit or lead cover been efficiently earthed?	
	(iv).If the consumer has his own earth electrode, state if it is properly executed and has been tested with satisfactory result.	
74 to 93.	OVER HEAD LINES:	
	(i).State if consumer has any overhead line near and so their condition with specific reference for relevant rule.	
	(ii).Is there any other overhead line near the	

	premises of the consumer which does not comply with rule 79 or 80?	
	(iii).Is guarding provided for overhead lines, if it is inside the factory, for road crossing and busy localities?	
	(iv).Any other remarks.	

Inspecting officer's Signature

Name._____

Designation._____

File No._____

Dated:_____

Copy forwarded to Electrical Inspector for_____ in accordance with rule 46(1) (b) of Indian Electricity Rules, 1956.

Signature._____

Name._____

Form No.ECoR/E-10

MODEL FORM OF INSPECTION REPORT

INSPECTION REPORT
(Rule 5 & 6)
(Medium Voltage Installation)

(Under rule 46 of the Indian Electricity Rules – 1956)

(A).	Report No._____				
(B).	Date of Inspection._____				
(C).	Challan no._____				
(D).	Dated._____				
(E).	Inspection fee Rs._____				
(F).	Date of last inspection._____				
1.	Consumer no._____				
2.	Voltage & system of supply._____				
(a).	Volts._____				
(b).	No of phase_____				
(c).	AC/DC._____				
3.	Name of the consumer/owner._____				
4.	Address of the consumer/owner._____				
5.	Location of the premises._____				
6.	Particulars of installations._____				
(I).	Motors :				
	Make	No	H.P.	Amps	Voltage
(1).					
(2).					
(3).					
(4).					
(5).					

(II).	Other equipments (with complete details) :				
(1).	_____				
(2).	_____				
(3).	_____				
	Total connected load in HP/KVA._____				
(III).	Generators (In case of consumer himself generating energy):				
(1).					
(2).	_____				
(3).	_____				
7.	General condition of the installations :-				
IE Rules, 1956 reference	**Requirements**				**Report**
1	**2**				**3**
3.	Is the list of authorised persons properly made and kept up to date duly attested?				
29.	(i). Is/are there any sign(s) of over-loading?				
	(ii).State if any unauthorized temporary installation exist.				
	(iii).Are the supply electric lines and apparatus so installed, protected, worked and maintained as to prevent danger?				
	(iv).Any other general remarks.				
30.	Service line and apparatus of the supplier on consumer's premises. Give report on condition of service lines, cables, wires and apparatus and such other fitting placed by supplier/owner on the premises.				
31.	Has the supplier provided suitable cut-outs within consumer's premises, in an accessible position? Are they contained within an adequately enclosed fire proof receptacle?				
32.	(i).State if switches are provided on live conductors?				
	(ii).State if indication of a permanent nature is provided as per this rule so as to distinguish neutral conductor from the live conductor.				
	(iii).Whether a direct link is provided on the neutral in case of				

	single phase double pole iron clad switches instead of fuse?	
33.	(i).State if earthed terminal is provided by the supplier?	
	(ii).Is the consumer's separate earth efficient?	
	(iii).Report on the efficiency of the earthing arrangement.	
34.	(i).Are the bare conductors in the building inaccessible?	
	(ii). Whether readily accessible switches have been provided for rendering them dead ?	
	(iii).Whether any other safety measures are considered necessary?	
35.	State if "Danger Notice" in Hindi and the local language of the district and the type approved by the Electrical Inspector is affixed permanently in a conspicuous position as per this rule.	
38.	State if flexible cables used for portable or transportable equipment covered under this rule, are heavily insulated and adequately protected from mechanical injury.	
44.	(i).State if instructions in [English or Hindi and local language of the district and where Hindi is the local language, in English and Hindi,] for restoration of per-sons suffering from electric shock have been affixed in a **"conspicuous place"**.	
	(ii). Are the authorised persons able to apply instructions for resuscitation of persons suffering from electric shock?	

49.	Leakage on premises : State insulation resistance between conductors and earth in Megohms.	
50.	(i). Whether a suitable linked switches/circuit breakers is placed near the point of commencement of supply so as to be readilyaccessible and capable of being easily operated to completely isolate the supply?	
	(ii).Whether every distinct circuit is protected against excess energy by means of a suitable circuit breaker or cut-out?	
	(iii).State if a suitable linked switch/circuit breaker is provided near each motor or apparatus for controlling supply to the motor or apparatus.	
	(iv). State if adequate precautions are taken to ensure that no live parts are so exposed as to cause danger.	
51.	(i).State the condition of metallic coverings provided for various conductors. (ii)(a). State whether clear space of 90 cm. is provided in front of the main switch board.	
	(ii)(b).State whether the space behind the switch board exceeds 75 cm.in width or is less than 23 cm ?	
	(ii)(c).In case the clear space behind the switch board exceeds 75 cm. state, whether a passage way from either end of switch board to a height of 1.80 metre is provided.	
61.	(i). Has the neutral conductor at the transformer been earthed by two separate and distinct connections with earth.	
	(ii).Have the frame of every generator, stationary motor and so far as practicable portable motor and metallic parts (not intended as conductors) of all transformers and any other apparatus used for regulating or controlling energy and all medium voltage energy consuming apparatus been earthed by two separate and distinct connection with earth ?	
	(iii).Have the metal casings or metallic covering containing or protecting any electrical supply line or apparatus been properly earthed and so joined and connected across all junction boxes as to make good mechanical and electrical connection?	
	(iv).State if consumer's earth electrode is properly executed and has been tested with satisfactory results.	

	(v).Is the earth wire free from any mechanical damage?	
74.	Overhead lines:	
	(i). State if consumer has any overhead line and if so their conditions with specific 74 to 93reference to relevant rules.	
	(ii).Is there any other overhead line near the premises of the consumer which does not comply with rule 79 or 80?	
	(iii).Is guarding provided for overhead lines if it is inside factory, or road crossing & busy localities?	
	(iv).Any other remarks.	

Inspecting officer's Signature

Name._____

Designation._____

FormNo.EC0R/E-11

MODEL FORM OF INSPECTION REPORT
INSPECTION REPORT
(Rule 5 & 6)
(High and extra high Voltage Installations)
(Under Rule 46 of the Indian Electricity Rules 1956)

(A).	Report No._____
(B).	Date of Inspection._____
(C).	Challan no._____
(D).	Dated._____
(E).	Inspection fee Rs._____
(F).	Date of inspection._____
1.	Consumer no._____
2.	Voltage & system of supply:_____
(a).	Volts._____

(b).	No of phase_____					
(c).	AC/DC._____					
3.	Name of the consumer/owner._____					
4.	Address of the consumer/owner._____					
5.	Location of the premises._____					
6.	Particulars of installations._____					
(I).	Motors :					
	Make	No	H.P.	Amps	Voltage	
(1).						
(2).						
(3).						
(II).	Transformers:					
	Make	No	KVA	Power Factor	Voltage	
					H.V.	L.V.
(1).						
(2).						
(3).						
(II).	Other equipments (complete details to be furnished) :					
(1).	_____					
(2).	_____					
(3).	_____					
(IV)	Total capacity in HP/KVA._____					
(III).	Generators (In case of consumer himself generating energy):					
(1).						
(2).	_____					
7.	General condition of the installations :-					
IE Rules, 1956 reference	**Requirements**					**Report**
1	**2**					**3**

3.	(i).Is the list of authorised persons properly made and kept up to date duly attested?	
	(ii).Whether the authorised persons are competent for the work assigned to them?	
29.	(i). Is/are there any sign(s) of over-loading in respect of any apparatus?	
	(ii).State if any unauthorized temporary installation exists.	
	(iii).Whether H.V. motors and controlling equipment are being overhauled periodically and result recorded in a register?	
	(iv).Whether the transformer oil samples are being tested periodically and result recorded in a register?	
	(v).Whether suitable lighting arrestors have been provided near the the transformers for protection against lighting?	
	(vi).Whether earth resistance is being measured periodically and results recorded in a register?	
	(vii).Any other defect or condition which may be source of danger.	
	(viii)).Any other general remarks.	

30.	Service line and apparatus of the supplier on consumer's premises. Give report on condition of service lines, cables, wires, circuit breaker, isolating switches, protective recording and integrating apparatus and such other fitting placed by supplier/owner on the premises.	
31.	Has the supplier provided suitable cut-outs within consumer's premises, in an accessible position? Are they within an adequately enclosed fire proof receptacle?	
33.	(i).State if earthed terminal is provided by the supplier?	
	(ii).Is the consumer's separate earth efficient?(State the earth resistance, if measured).	
	(iii).Report on the efficiency of the earthing arrangement.	
34.	(i).Are the bare conductors (if any) in the building inaccessible?	
	(ii). Whether readily accessible switches have been provided for rendering them dead ?	
	(iii).Whether any other safety measures are considered necessary?	
35.	State if "Danger Notice" in Hindi and the local language of the district and the type approved by the Electrical Inspector are affixed permanently in a conspicuous position as per this rule.	
36.	Whether the practice of working on live line and apparatus is adopted? If so, have the safety measure been approved by the Electrical Inspector?	
41.	State if the circuits or apparatus intended for operating at different voltage(s) are distinguishable by means of indication(s) of permanent nature.	
42.	Whether all circuits and apparatus are so arranged that there is no danger of any parts(s) becoming accidently charged to any voltage beyond the limit of voltage for which it/they is/are intended?	
43.	(i).In case of generating and enclosed sub-stations, have fire buckets, filled with clean dry sand, been conspicuously marked and kept in convenient situations in addition to fire extinguishers suitable for dealing with electric fires?	
	(ii). State if "First" Aid boxes or cupboards conspicuously marked and properly equipped are provided and maintained .	
	(iii).Is some staff trained in First Aid Treatment?	

44.	(i).State if instructions in [English or Hindi and local language of the district and where Hindi is the local language, in English and Hindi,] for restoration of persons suffering from electric shock have been affixed in a **"conspicuous place"**.	
	(ii). Are the authorised persons able to apply instructions for resuscitation of persons suffering from electric shock?	
49.	Leakage on premises : State insulation resistance between conductors and earth in Megohms.	
50.	(i). Whether if linked switches of requisite capacityare provided nearthe point of commencement of supply.	
	(ii).State if wiring is divided in a suitable number of circuits and each such circuit is protected by suitable cut-out.	
	(iii).State if supply to each motor or apparatus is controlled by suitable linked switch?	
	(iv). Has it been ensured that no live part is so accessible as to cause danger.	
51.	(i).State the condition of metallic coverings provided for various conductors. (ii)(a). State whether clear space of 90 cm. is provided in front of the main switch board.	
	(ii)(b).State whether the space behind the switch board exceeds 75 cm.in width or is less than 23 cm ?	
	(ii)(c).In case the clear space behind the switch board exceeds 75 cm. state, whether a passage way from either end of switch board to a height of 1.80 metre is provided.	
64.	(i).State if all conductors and apparatus including live parts thereof are inaccessible.	
	(ii). State if all windings of motors or other apparatus are suitability protected..	
	(iii). State the method adopted to guard lower voltage circuits in transformer(s) becoming accidently charged over its/their normal voltage.	
	(iv).State in case of transformers or switches or static converters involving the use of more than 2.275 litres of oil in one chamber, if suitable oil soak pits are provided.	

	(iv).Where 9,000 litres or more of oil is used in any one oil tank,has provision been made for draining away or removal of oil which may leak or escape from such tank(s)?	
	(vi).State if trenches inside sub-station containing cables are filled with non-inflammable material or completely covered with non-inflammable slabs.	
	(vii).Are conductors and apparatus so arranged that they may be made dead in sections for carrying out work thereon?	
66.	In case of metal sheathed electric supply lines, are the metal sheaths connected with earth properly.	
67.	(i).Have the frame of every generator, stationary motor, and so for as practicable portable motor and metallic parts non intended as conductors of all transformers & any other apparatus used for regulating or controlling energy and all high voltage energy consuming apparatus been earthed by two separate and distinct connections with earth?	
	(ii).Is the earth wire free from any mechanical damage?	
	(iii). Have two separate and distinct connections with earth, each having its own electrode, been provided for earth neutral point ?	
	(iv). Have the metal casing or metallic covering containing or protecting any electric supply line or apparatus been properly earthed and so joined and connected across all junction boxes as to make good mechanical and electrical connection throughout their whole length ?	
68.	Is the outdoor (except pole type) sub-station efficiently protected by fencing not less than 1.8 metres in height?	
69.	(i).Where platform type construction is used for pole type sub-station, has sufficient space for a man to stand on the platform beenprovided?	
	(ii).Has hand rail been provided and connected with earth? (If metallic and if substation has not been erected on wooden support?)	
70.	Has suitable provision been made for immediate and automatic discharge of every static condenser or disconnection of supply?	
	Overhead lines:	
74.	What is the maximum size of the conductors of overhead lines used? State the type of conductors.	

77.	Are clearances above ground of the lowest conductor of overhead lines including service lines, as per I.E. Rules?	
80.	(i).On the basis of maximum sag, are vertical clearance where the high or extra-high voltage line passes above or adjacent to any building or part of a building as per this rule?	
	(ii).On the basis of maximum deflection due to wind pressure, are horizontal clearances between the nearest conductor and any part of such building as per this rule?	
81.	Where conductors forming parts of system at different voltages are erected on same supports, has adequate provision been made to guard against danger to linemen and others from the lower voltage system being charged above its normal working voltage by leakage from or contact with higher voltage system ?	
87.	Where overhead lines cross or are in proximity to each other have they been suitability protected to guard against possibility of their coming in contact with each other.	
88.	(i).Has every guard wire, been properly earthed at each point at which its electrical continuity is broken?	
	(ii).What is the type and size of guard wire?	
90.	(i).Are the metal supports of overhead lines and metallic fittings attached thereto permanently and efficiently earthed?	
	(ii).Has each stay wire(except in case where an insulator has been placed in it at a height not less than 3 meters from ground) been similarly earthed?	
91.	(i).Has the overhead line been suitability protected with a device for rendering the line electrically harmless in case it breaks? What type of device is used?	
	(ii). Whether anticlimbing devices have been provided for each of the high voltage and extra high voltage supports?	
92.	(I).Has the owner of overhead lines adopted efficient means for diverting to earth any electrical surges due to lightening in every overhead line which is so exposed as to be liable to injury from lightening? What types ofmeans are used?	
	(ii).Has earthing lead from lighting arrestors been connected to a separate earth electrode?	
93.	Are unused overhead lines been maintained in safe mechanical conditions?	

Any other remarks.

Dated: Inspecting officer's_____

Signature_____

Name_____

Designation_____

File No._____

REGULATIONS FOR POWER LINE CROSSINGS OF RAILWAY TRACKS

(ISSUED BY RAILWAY BOARD IN 1987)

I-GENERAL

1. Definitions

1.1 The following terms wherever occurring in the Regulations shall, unless excluded by or repugnant to the context, have the meaning attributed thereto as under: -

"Chief Electrical Engineer" means the officer designated as such by the Zonal Railway or his successors in office or on whom his duties devolve.

"Power line crossing" means an electrical overhead line or under-ground cable placed across railway track(s) for the transmission and/or distribution of electrical energy. It may also be referred to as a "Crossing" in these Regulations.

"Electrical Inspector" means the officer appointed by the appropriate Government under Section 36 of the Indian Electricity Act, 1910, to exercise the powers and perform the functions under the said Act. On the Zonal Railway, the Chief Electrical Engineer is the Electrical Inspector.

"Owner" means the owner of an electrical crossing.

"Railway" means the Zonal Railway administration in whose territorial jurisdiction the electrical crossing is located or proposed to be located and includes the Chief Electrical Engineer, the **Divisional Railway Manager (Electrical)** of the Zonal Railway Administration.

"Writing" includes all matters written, typewritten or printed either in whole or in part.

2. Scope:

2.1 The regulations apply to electrical overhead lines and/or underground cables crossing railway tracks operated by the Indian Railways, Railway Companies and Port Commissioner's Railways, including assisted and private sidings on which rolling stock of Indian Railways may work, unless any special section or railway tracks are exempted from these Regulations by specific written orders of the Electrical Inspector.

Notes:

(i) if any existing crossing infringes the provisions of the Regulations at the time of its issue, the infringement(s) shall be treated as permissible infringement(s) provided that necessary relaxation has been granted in respect of the clearances under clause 21 thereof.

(ii) The Regulations do not apply to crossing(s) of railway track(s) laid underground/inside tubes and tunnels.

(iii) The Regulations do not also apply to Railway Traction systems (1500 V d.c. and 25 kV, 50 Hz a.c. Single phase) whose feeders/conductors/wires run along or across the tracks for traction purposes.

(iv) On sections proposed to be electrified on or to be converted to suit 25 kV, 50 Hz ac single phase traction system", the crossing existing at the time of electrification/conversion proposed shall be specially studied with a view to avoiding modifications to the extent possible without jeopardizing safety. If any modifications are considered essential to obtain the minimum clearances, specified in clause 21 thereof, they shall be carried out.

(v) In special cases, where the Electrical Inspector has specifically permitted reduction in clearances under clause 21 thereof, a clear declaration to this effect shall be recorded in the CERTIFICATE OF COMPLIANCE (in the form at Annexure II) to these regulations**.**

3. Approval of Works by the Railway:

3.1 (i) Designs, Drawings etc.:

Before the Owner commences any work on a crossing, he shall obtain the approval in writing, of the Railway for the proposed location, the detailed design and the method of execution of the crossing. For this purpose, the data designs, calculations and drawing(s) relating to the crossing shall be furnished by the owner to the Railway as stipulated in Annexure A.4.01 to these Regulations. On receipt of written approval from the Railway, the owner shall execute an Agreement in the Form at Annexure A.4.02 to these Regulations.

ii) Construction

The owner shall notify the Railway in writing at least 15 days in advance of the date on which he will commence the work of construction of the crossing. The Chief Electrical Engineer, or his representative, may, if he so desires, inspect the site/work of the crossing during its construction to ensure that it is being constructed in accordance with the approved designs and drawings. Only good quality of materials shall be used in the construction of the crossing which shall be executed in a workman-like manner.

iii) Bringing crossing into use:

Prior to bringing the crossing into use, the owner shall:

a) Notify the Railway in writing at least 15 days in advance of the date the crossing is intended to be brought into use.

b) Submit to the Railway a CERTIFICATE OF COMPLIANCE, (in the form at Annexure A.4.03 to the Regulations) to the effect that the works have been constructed in compliance with the Regulations and in conformity with the design(s) and drawing(s) approved by the Railway. Only on receipt of written approval from the Railway, the crossing shall be energized and brought into use.

4. Compliance with Indian Electricity ACT, 1910 and Indian Railway ACT, 1890 and Rules made thereunder etc.

4.1 Except as otherwise provided for in the Regulations the contents of relevant sections of the Indian Electricity Act, 1910 the Indian Railways Act, 1890 and the rules made under these Acts and as amended from time to time and the relevant provisions of *Indian Railways Schedule of Dimensions for Broad Meter and Narrow gauges together with the latest amendments* thereto shall apply to the crossing.

5. Compliance with Indian Standard Specifications:

5.1 All materials used in the construction of the crossing shall comply with the latest Indian Standard specification(s) relevant and where these are not available, with the latest British standard specification(s) relevant.

6. Works to be executed by the Railway:

6.1 The disturbance of any rail, road or ground or any attachment to any railway structure as may be necessary for the placing and/or maintenance of the crossing shall be effected by or under the direct supervision of the Railway and any conduit, culvert or similar work passing under Railway premises shall be constructed by the Railway in such manner and of such materials as it may approve of and the entire cost of such works shall be borne by the owner of the crossing.

7. Method of Crossing - overhead line or underground cable:

7.1 For tracks already electrified or to be electrified in the foreseeable future:

All low, medium and high voltage up to and including 11 kV crossing(s) shall normally be by means of underground cable(s). While for voltages higher that 11 kV, crossings may be by overhead lines or underground cables, the use of underground cable to the extent possible would be advantageous, particularly for 22 kV and 33 kV systems.

8. Protection of Communication Lines:

8.1 The crossing shall in no way interfere with or endanger any Railway communication lines. Approval given by the Railway for placing of any crossing shall not be construed as affecting in any way the requirements of the Indian Post and Telegraphs Deptt. in regard to the protection of their communication lines.

8.2 The crossing shall also comply with the stipulations in the "Code of Practice for the protection of Telecommunication lines at crossings with overhead power lines other than Electric Traction Circuits" issued by Central Electricity Authority, Telecommunication Directorate, Power and Telecommunication Coordination Committee (PTCC Unit), Government of India, B-67/19 Safdarjung Enclave, New Delhi-29 and the latest amendments if any, thereto.

9. Maintenance of Crossing:

9.1 No, work, whatsoever, on any crossing shall be undertaken by the Owner without obtaining the consent in writing from the Railway. All such works shall be carried out under the direct supervision of the Railway.

9.2 The crossing shall always be maintained in a state of good repair so as to reduce hazards to life and property. It shall be inspected by the Owner at interval not exceeding 12 months in order to determine its fitness for service. Defects, if any, noticed or as pointed out by the Railway shall be rectified by the owner expeditiously. The decision of the Railway in regard to defects noticed and rectification(s), if any, to be done by the owner shall be final and binding on the owner.

9.3 The crossing span as well as two adjacent spans on either side of the overhead line crossing shall be kept free by the owner from any trees and branches which, if they fall on these spans, would foul with the overhead line. The growth of bushes and wild vegetables shall not be permitted on either side of the overhead line for the same reason.

9.4 Wheregalvanized steel structures support the crossing span, they shall be maintained free of rust, corrosion, etc.

9.5 If at the instance of the Railway, the crossing is to be shifted or modified or dismantled, the work shall be carried out by the owner at the cost of the Railway. However, in those cases where the need for such works on account of Railway's anticipated developments/requirements was foreseen in time and the owner had agreed in writing prior to the construction of the crossing to meet the cost of such works. Such works shall be carried out on a priority basis by the owner within a fixed schedule, as mutually agreed upon between the owner and the railway and to the satisfaction of the electrical Inspector. The Railways shall have the right to claim compensation for any loss and/or inconvenience caused if there is avoidable delay in completing the works.

10. Defects and Failures :

10.1 (i) All defects/failures like snapping of conductors in the crossing span, breaking of insulator string in the overhead line crossing or any defect that is likely to affect the safe movement of the railway traffic or the safety of the railway property or personnel shall be reported forthwith by the owner to the Station Master on duty at the railway station on both sides of the crossing as well as to the Chief Electrical Engineer, the Divisional Railway Manager(Electrical), the Electrical Inspector and the Director (Transmission), Central Electricity Board, S.907, SevaBhavan, R.K. Puram, New Delhi - 66. A detailed report of the failure or defect shall also be sent to the Chief Electrical Engineer, the Divisional Railway Manager, the Divisional Railway Manager (Electrical), the Electrical Inspector and the Director (Transmission), Central Electricity Board, New Delhi as soon as possible - preferably within 48 hours of the first report.

(ii) In the event of an accident to Railway's tracks/rolling stock in the vicinity of an overhead line crossing, the owner shall, if required by any official acting on behalf of the Railway, expeditiously switch off the overhead line and effectively connect the conductors to earth as long as is necessary to enable Railway's cranes if any, to work safely in the area.

II OVERHEAD LINE CROSSINGS

11. Angle of crossing

11.1 An overhead line crossing shall normally be at right angles" to the railway track. In special cases a deviation of up to 30 degree may be permitted. Deviations larger than 30 degree shall have to be specifically authorized by the Electrical Inspector of the Railway.

12. Structures

12.1 Steel poles/masts fabricated steel structures or reinforced or pre-stressed concrete poles either of the self-supporting type or guyed type conforming in all respects to the Indian electricity Rules, 1956 (as amended, up to November 1984) and complying with the latest editions of Codes of Practice, IS:800-1962 for "Code of Practice for use of structural steel in general building construction, IS:875-1964 for "Code of Practice for structural safety of buildings; loading standards" and IS:456-1978 for "Code of Practice for plain and reinforced concrete" shall be used on either side of the track to support the crossing span. *These structures shall be of the terminal type*. For arriving at the crippling load, the wind loads as detailed in the latest edition of 1S.802 (Part-I)-1977 for "Loads and permissible stresses" shall be adopted. The steel structures shall normally be galvanised in accordance with IS: 2629-1966 for "Recommended practice for hot-dip galvanising of iron and steel."

12.2 The minimum distance of the structures (supporting the crossing span) from the center of the nearest railway track shall be equal to the height of the structure in meters above normal ground level plus 6 meters. In special circumstances, the Electrical Inspector may permit a lesser distance being adopted subject to any conditions he deems fit to impose.

12.3 The crossing span shall be restricted to 300 m or to 80% of the normal span for which the structures are designed, whichever is less.

13. Wind pressure

13.1 The maximum wind pressure for design of the structure shall be as prescribed in 1S:802 (Part-1)-1977 for load and permissible stresses.

14. Temperature

14.1 The maximum and minimum temperatures for design of the conductors and other wires shall be as prescribed in the latest edition of IS:802 (Part-1, Clause-4) with necessary correction for conductor maximum temperature.

15. Provision for Ice/Snow Loading:

15.1 Where provision has to be made for ice and/or snow loading, it shall be

determined in the light of local conditions with the approval of the Railway.

16. Factor of Safety

16.1 The factor of safety of all structures, conductors, guards", guys and ground wires used in the crossing shall be as stipulated in the Indian Electricity Rules, 1956 (as amended in November 1984) and the relevant Codes of Practice.

17. Clearance between the overhead line & railway track:

17.1 An overhead line crossing over railway track already electrified shall be located at the middle of overhead equipment span supported by two adjacent traction masts/structures. *The distance between* any of the crossing conductors and the nearest traction mast or structure under the most adverse conditions shall not be less than 6m.

Note: If, in unavoidable circumstances, the crossing span cannot be so located, the minimum clearance between any of the crossing conductors of the crossing and the nearest traction mast or structure shall be not less than that specified for buildings in Rule 80 of the Indian Electricity Rules, 1956 (as amended up to November 1984).

17.2 No overhead line crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.

17.3 Vertical Clearance (Advance Correction Slip No. 18):
1.Clause 17.3 (ACTM Vol.II,Pt. II),Appendix –IV (Regulation for POWER Line Crossing of Railway Tracks1987)

SN	Overhead crossing voltage	Minimum clearances from buildings/ structures (AS PER IE rule1956. CL 80)	CLEARANCES REQUIRED FOR 25 KV traction17.3(a)Vertical clearances in mm for new power line crossing /or alteration to existing crossing of Railway track-The minimum height above rail level of the lowest portion of any conductor of crossing ,including guard wire, under condition of maximum sag shall be as follows:				
			Min.clearance between highest traction conductor & lowest crossing conductor (IE rule1956 CL87)	Minimum clearances required from rail level(Clearances as IE rule1956)		Clearances for double stack container (stock height 7100 mm)	
				At fixed structure(IE rule1956.CL 80)	At mid span(IE rule1956.CL 87)	At fixed structure(IE rule1956.CL 80)	At mid span(IE rule1956.CL 87)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	up to 11 KV	By cable.					
2	Above 11KV	3700	2440	14660	12384	16360	14084

	&Up to 33 KV						
3	Above 33 KV & up to 66 KV	4000	2440	14960	12384	1660	14084
4	Above 66 KV & up to 132 KV	4600	3050	15560	12994	17260	14694
5	Above 132 KV & up to 220 KV	5500	4580	16460	14524	18160	16224
6	Above220 KV & up to 400 KV	7300	5490	18260	15434	19960	17134
7	Above 400 KV & up to 500 KV	8200	7940	19160	17884	20860	19584
8	Above 500 KV & up to 800 KV	10900	7940	21860	17884	23560	19584

17.3(b): Vertical clearance for existing crossings:

SN	Over Head crossing Voltage	Minimum clearance on existing non- electrified routes from rail level (as per IE rule1956.CL 80)	Minimum clearance on existing electrified routes from rail level (as per IE rule1956.CL 80)
1	**2**	**3**	**4**
1	up to 11 KV	By cable	
2	Above 11 &Up to 33 KV	10860	14100
3	Above 33 & up to 66 KV	11160	14100
4	Above 66 & up to 132 KV	11760	14600
5	Above 132& up to 220 KV	12660	15400
6	Above220 & up to 400 KV	14460	17900
7	Above 400 & up to 500 KV	15360	19300
8	Above 500 & up to 800 KV	18060	23400

Note:

(i) While calculating the above clearance, Railways high tension lines running over the 1500 V DC traction structure in some sections have not been taken into consideration. Where such high tension lines exist, the height above the rail level of the highest high tension line shall he taken into account for calculating the clearances.

(ii) The working of a Railway crane under an overhead line crossing shall normally be avoided. If it becomes absolutely essential for a crane to work under such a crossing, the minimum clearance required to be maintained between the highest working point of the jib and the lower crossing conductor shall be as under:

SN	Normal System Voltage (kV)	Min. Safe clearance (In metre)
1	33	1.50
2	66	2.00
3	110	2.25
4	132	2.50
5	220	3.50
6	400	6.00
7	500	7.25
8	800	11.50

(iii) All heights/clearances are in mm and under maximum sag conditions.

(iv) For non-electrified, lines where new power line crossing is to be provided/existing crossing to bealtered, column 5 & 7 of the table in para 17.3 (a) shall be applicable.

(V)For electrified lines, where new power line crossing is to be provided/existing crossingto be altered, clearances in para 17.3 (a) shall be applicable.

(vi)Clearance given in column 6 & 8 of table 17.3 (a) can be adopted if the OHE structure/fixed structure is beyond 6000 mm of nearest conductor of overhead crossing.
(vii) If the crossing is provided with a guarding, a minimum clearance of 2000 mm shall be maintained between the bottom of the guard wire and highest traction conductor.

(viii) Power line crossings in yard and station areas shall be avoided.

(ix) In case of existing power line where return conductor or feeder wire is not likely to be provided, height of super mast i.e. 2250mm to be reduced from the clearances ofpara17.3 (a).

18. Minimum clearances between crossing conductors and any railway structure

18.1 The minimum vertical and horizontal clearances to be maintained between any of the crossing conductors and any railway building and/or structure, other than traction masts and structures and overhead equipment, under the most adverse conditions shall be as specified in Rule 80 of the Indian Electricity Rules, 1956 (as amended up to Nov.'84).

19. Minimum vertical clearance between power line crossings

19.1 The minimum vertical clearances to be maintained between any of the power line crossings at the same or at different voltages shall be as specified in Rule 87 of the Indian Electricity, 1956 (as amended up to November 1984.)

19.2 Separate guarding shall be provided above the lower power line in all cases except when the voltage of the higher line is 33 kV and above. *Where such guarding is provided, the clearance from the guard wires to the lower power line shall be not less than 2m and to the upper power line not less than 1.5m.*

20. Clearance between power line & communication line

20.1 The minimum clearance to be maintained between a power line and a communication line shall be as prescribed in the "Code of Practice for the Protection of telecommunication lines at crossings with overhead power lines other than Electrical Traction Circuits" (latest edition) issued by Central electricity Authority, Telecommunication Directorate, Power and Tele-communication Coordination Committee (PTCC Unit), Govt. of India.

21. Relaxation by the electrical inspector:

21.1 It is desirable to provide maximum possible clearances in the case of power line from highest traction conductor used for electric traction. Based on the clearance study, reduced clearances, with approval of EIG, and subject to observance of clearances in Clause 21.2Column 4 of Table in Pam 17.3 (a) may be adopted.

Voltage	Broad, Meter& Narrow gauge (in meter)
up to 11 KV	By cable.
Above 11KV &Up to 33 KV	2.440
bove 33 KV & up to 66 KV	2.440
Above 66 KV & up to 132 KV	3.050
Above 132 KV & up to 220 KV	4.580
Above220 KV & up to 400 KV	5.490
Above 400 KV & up to 500 KV	7.940
Above 500 KV & up to 800 KV	7.940

21.2 Such reduced clearances would be subject to any special safeguards that may beprescribed by EIG while granting these relaxations.

21.3 Wherever feasible special design of traction overhead equipment, return conductor,25 kV feeder or other power line on traction mast/structure should be developed keepingin view the need for economy and other requirements, if any.

21.4 The relaxation to adopt reduced clearances shall not he applicable for new power line crossings.

21.5 Any alteration to the existing overhead power line crossings shall be done to provide the clearances prescribed in para 17.3(a).

Note: (i) The minimum clearances have been derived with an allowance of 2.0 m for maintenance. This allowance may also be reduced by the Electrical Inspector of the Railway, keeping in view the yard remodeling, shifting of structures etc.

22. Insulators

22.1 A double set of strain insulator strings shall be used in crossing span in conjunction with a yoke plate where necessary as illustrated in sketch No. 1 attached to these Regulations. Each string of such strain insulators shall have one insulator more than the number used in a normal span of the overhead line. The factor of safety of each string of insulators under the worst conditions shall not be less than 2. The arrangements of power line crossing shall generally be as shown in sketch Nos. 1, 2& 3 attached to the Regulations.

23. Guarding

23.1 All overhead power line crossings up to and including 33 kV - provided with guarding under the power line. Guarding need not necessarily be provided for overhead- power line crossings of voltages above 33 kV if the transmission/distribution line is protected by circuit breakers of modern design with total tripping times of 0.20 seconds for voltages below 220 kV and 0.10 seconds for voltages of 220 kV and above, from the time of occurrence of the fault to its clearance. Wherever guarding is adopted for the crossing span, cradle guards shall also be provided.

23.2 The minimum height above the rail level to the lowest level of any cradle guard or guard wires under conditions of maximum sag shall not be less than the values specified in clause 18. In special cases, however, the Electrical Inspector of the Railway may permit lower heights under the provisions of clause 21 of the Regulations.

23.3 The minimum height between any guard wire and a live crossing conductor under the most adverse conditions shall not be less than 1.5m.

24. Anti-Climbing Devices and Warning Notices

24.1 Where the voltage exceeds 650V, the supporting structures, (of the overhead line crossing) on railway land shall be provided with anti-climbing devices. Besides, suitable caution/warning notices shall be erected on all such structures, in the languages as may be prescribed for the purpose. The anti-climbing devices and the caution/warning notices shall be approved by the Railway.

25. Protection from Moving Road Vehicles

25.1 Supporting structures, (of the overhead line crossing) including guys, adjacent to roadways shall be so located that the danger of their being struck by moving road vehicles is avoided or reduced to the minimum. Wherever required, guard rails,

suitably painted to make them conspicuous, shall be provided for the purpose.

26. Communications Lines

26.1 The owner of a communication line shall provide adequate safety devices so that no damage is caused in the event of snapping of conductors of a power line crossing. In addition to the safety devices, the owner shall also provide necessary surge absorbers in the system to guard against the effects of surges caused during switching operations or system faults.

26.2 Overhead communication lines may be permitted to be supported on the structures used for the crossing span of a power line crossing, provided the owner of both lines is the same. The factors of safety for conductors and insulators the clearances above rail level and the method of supporting such crossings shall be not less than those specified for power line crossing.

27. Earthing

27.1 (i) Each structure on either side of the crossing span supporting the transmission/distribution line conductors shall be earthed effectively by two separate and distinct earths and connections. At least one separate earth electrode shall be provided for each earth connection.

(ii) All guard and stay wires shall be properly clamped to the structures connected to earth so as to maintain proper electrical continuity to earth.

(iii) Where struts are provided, they shall also be effectively connected to earth separately as well as to the main structure earths.

(iv) Where the earth resistance of the independent tower/structure is higher than 10 ohms, the owner shall take necessary steps to improve the earth resistance either by providing multiple earth electrodes or by suitably treating the soil surrounding the earth electrode or by resorting to counterpoise earthing. The method of earthing the transmission/distribution line structures etc. for the crossing span shall be approved by the Railway.

(v) The earths shall be inspected and tested annually on a hot dry day and results thereof furnished to the Railway for verification and record. If the earth resistance is found to be high, i.e. above 10 ohms, steps shall be taken to reduce it and an advice given to the Railway.

(vi) The cross-section of the earth conductor/connections for the earthingsystem shall be adequate for the application. They shall not be damaged or overheated or melt while carrying the short circuit current.

28. Fire Hazards

28.1 Structures supporting the crossing span shall be so placed, guarded and maintained as to be least posed to bush, grass, rubbish and building fires as is possible.

III CABLE CROSSINGS

29. Cable Crossing

29.1 As far as possible cable crossings shall make use of any existing culverts, sub-ways etc. where track(s) already equipped for electric traction on 25 kV Hz single phase ac system, the crossing shall be provided at location at least 5 meters away from any traction sub-station or switching station or mast or structure erected or proposed to be erected by the Railway for the purpose of supply and distribution of power to the on overhead equipment. The exact locations of such traction sub-station or switching station or mast or structure in any particular area shall be obtained by the owner from the Railway.

30. Type of Cables

30.1 The owner shall specify and obtain prior approval of the Railway for the type of cable he intends to for the crossing. It shall preferably be armoured. Where cables are suspended from supports and not laid - protective pipe, they shall be of the armoured and sheathed type.

31. Cathodic Protection

31.1Cathodic protection of the cables shall not be adopted without the specific prior approval of the Railway.

32. Method of Laying

32.1Where the cable is laid under railway track(s) it shall be laid through cast iron pipes or spun concrete pipes of suitable diameter and strength. In order to avoid disturbance to the railway track/formation in case become necessary to lay additional cable(s) in future, it would be advantageous to provide protective pipes adequate (larger) diameter initially to cater for additional cables. The specifications for the pipes to be used will be submitted to the Railway for approval. The pipe shall be laid at not less than one meter below the formation level. It shall be possible to withdraw the cable(s) for repairs or replacement without disturbing the way track or formation. Long lengths of pipe shall be laid with a gradient to facilitate drainage of water if any. The pipe shall be laid up to the railway boundary at both ends or up to the point as prescribed by the railway. The laying of the cable in the Railway premises shall be in accordance with the latest edition of - 255-1967 "Code of Practice for Installation and Maintenance of Power Cables".

32.2 The cable of11KV to 220KV may be laid through HDPE (High Density polyethylene) pipe. The HDPE pipe shall conform to the Indian Standard Specification IS: 4984-1995. As per classification of IS: 4984-1995, the following class pipe is suitable for crossing under Railway track.

Material Grade & Class	Description	Nominal Diameter(mm)	Wall thickness of Pipes(mm)	
			Minimum	Maximum
PE-80 & PN-4	HDPE (High Density polyethylene)	160	6.2	7.1

In addition to the above, the specification for HDPE pipe, to be used, shall be submitted to the Railway for approval.

33. Works carried out under or near Railway Track

33.1 Where the cable is to be laid under a railway track(s) the use of cast iron or spun concrete pipe for protection of the cable is obligatory and such pipe shall be laid in accordance with the contents of clause-7.

The armouring and sheathing of the underground cable laid across or near any electrified railway track be earthed by independent earths at the two sealing ends of the cable. No further earthing of the armouring and sheathing of the cable shall be done within 500meter of the electrified track. The scheme and method of earthing shall specifically be approved by the Railway.

34. Structures on which cable ends are supported and terminated

34. 1 Where the ends of a cable of an underground crossing are terminated on structures for connection to an overhead line, such structures shall comply with the Regulations in so far as they are applicable to overhead line crossings in respect of structures.

35. Marking of Crossings

35. 1 Each cable crossing shall be indicated by at least two cast iron cable markers, one at each end of the crossing, within the railway boundaries. The cable marker shall be fixed at both ends of the underground crossings. They shall be of a design approved by the Railway. The following information shall be clearly marked on the markers:

ELECTRICAL CABLE	- Volts
NUMBER	- Cables
DANGER	- In English, Hindi and the vernacular of the district.
DEPTH OF CABLE	- Below track level.
DEPTH OF CABLE	- Below ground level between the toe of bank and railway fencing.

Annexure I

DATA, DESIGNS, CALCULATIONS AND DRAWINGS TO BE FURNISHED BY OWNER

The following data, designs, calculations and drawings together with the application for the proposed power line crossing incorporating the particulars as detailed below - all in duplicate shall be furnished by the owner to the Divisional Railway Manager (Electrical) for approval by the Electrical Inspector of the Railway.

I. Overhead line crossings

a) Data and designs

1. Location of the proposed crossing, the names of railway stations on either side of the crossing, the distance of the crossing from the nearest railway station, the painted numbers of Telegraph poles and or traction mast or structures between which the crossing is proposed to be located and the exact location in relation to such poles or masts or structures.

Note: The alignment of the crossing should, as far as possible be at the mid-point of the span between adjacent traction masts or structures in the case of electrified tracks. (See CI.18.1 of the Regulations).

2. Particulars of the overhead line, including voltage, frequency, number of phases, size of conductors etc. and whether the neutral is earthed or not and if earthed, the type of earthing.

3. Wind pressure adopted.

4. Temperature data adopted.

5. Particulars of ice/snow loading, if any, adopted.

6. Factors of safety adopted in the designs, for conductors, structures, guard wires/cross wires if provided, earth-wire, stay wire, insulator-strings, etc.

7. Design calculations of structures and foundations for the crossing span, communication lines or guarding, if any.

Note: If the structures and foundations are of standard type used for the transmission/distribution line concerned, the detailed design calculations shall be furnished.

8. Calculations leading to the minimum values under worst conditions of the following:

i) Vertical clearance between the lowest crossing conductor, communication lines and/or guarding and the different railway tracks in the crossing span.

ii) Vertical clearance between the lowest crossing conductor, Communication lines and/or guarding and railway's conductors of the traction system or other conductors

if any.

iii) Horizontal clearance to railway mast/structure /building, if any.

iv)Lateral clearance to the nearest Railway mast/structure/building, if any.

Note: Full particulars of the number, size, material and characteristics of various wires and conductors shall be furnished. .

9. Particulars of insulators, bridling of the conductors.

10. Details of guarding, size of guard and cross wires and their characteristics. A (detailed drawing showing the guarding arrangement, if provided, shall be given.

11. Size and characteristics of guy wire, if provided, and the number of supports.

12. Details of earthing indicating the earth electrode, size of earthing connection, method of connection to the support and the method of artificial soil treatment if proposed. Details of counterpoise earthing, if contemplated, shall be furnished.

13. Details of protection against moving road vehicles.

14. Particulars of anti-climbing devices, if provided, and warning and caution notices.

15. Detailed scheme of protection for the transmission/distribution line including particulars of relays, operating times etc. and particulars of circuit breakers, if any.

b) Drawings

1. Layout and site plan of the proposed crossing indicating railways boundaries.

2. Longitudinal elevation of the crossing. The drawing shall indicate full particulars of one span on either side of the crossing span with various clearances with respect to the Railway track(s). The drawing shall show the cross-section of the railway formation and tracks.

3. Drawing for warning and caution notices.

Note:

i) All drawings shall be in standard sizes as prescribed in the latest edition of 15:696-1972 "Code of practice for General Engineering Drawings".

ii) All drawings are to be endorsed with a certificate as given below:

"I hereby certify that the details of the equipment provided are designed with the object of minimizing danger in the event of breakage/fault and in accordance with recognized modern Engineering Practice", and signed by the owner.

II. Underground cables

a) Data and designs:

1. Location of the proposed cable crossing, the names of the railway stations on either side of the crossing the distance of the crossing from the nearest railway station, the painted numbers of telegraph poles or traction

masts or structures between which the crossing is proposed to be located and the exact location in relation to such poles or masts or structures.

2. Supply system particulars, particulars of cables, their number, size and number of cores, voltage, type of insulation, armouring etc.

3. Full particulars of the protective pipe for the crossing.

4. Method of earthing of the cable armouring and sheathing, if any.

5. Method of making the cable crossing for identification.

6. Design calculation for masts/structures for supporting and terminating cable (s), and drawings to show that the masts/structures would not foul the railway track(s) in the event of their failure in so far as movement or railway vehicles is concerned.

b) Drawings

1. Layout and site plan including route, location of structures, if any, for supporting and terminating the cable and railways boundaries.

Note: Earths in the vicinity (upto 100m all round) of the crossing shall be distinctly indicated.

2. Drawings showing cable/crossing marker.

Note: i) All drawings shall be in standard size as prescribed in the latest edition of 1S:696-1972 "Code of practice for General Engineering Drawings".

ii) All drawings are to be endorsed with a certificate as given below:

"I hereby certify that the details of the equipment provided are designed with the object of minimizing danger in the event of breakage/fault and in accordance with recognized modern Engineering Practice".

III. Overhead line crossings and underground cables

Along with a reproducible print, eight copies of the drawings showing the completed power line crossing shall be furnished to the Railway along with the "Certificate of Compliance (as at Annexure –III to the Regulations).

Annexure II
AGREEMENT FOR ERECTING AND MAINTAINING AN

OVERHEAD POWER LINE CROSSING OVER AND ACROSS RAILWAY TRACKS.

AN AGREEMENT made this----------day of----------two thousand and---------- BETWEEN THE PRESIDENT OF INDIA acting through the Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the----------Railway administration (hereafter called "the Railway") of the one part and----------(hereinafter referred to as "the owner" of the other part.
WHEREAS the owner wishes to erect an electric overhead line and carry out the works connected therewith for transmission of distribution of electrical energy over and across the railway tracks and/or land at kilometrage----------in the section----------at----------railway station, of the Railway, the said overhead line where it crosses the railway tracks and/or land works connected therewith hereinafter referred to as the "crossing". Now IT IS HEREBY AGREED AS follows:

1. General: The Railway will permit the owner as from the----------day of----------20_____, to lay the crossings as per Drg. No.----------approved by the Railway hereunto attached as Annexures, and in compliance with Regulations for Power line crossing of Railway tracks hereunto attached as Annexures hereinafter referred to as the Regulations, for the purposes hereinbefore mentioned subject to the terms and conditions hereinafter contained.

2. Permission to erect and maintain the crossing: The Railway will, subject to the provisions of clause 3 hereinafter contained, permit the owner to erect and maintain in accordance with the Regulations the crossing over and across the Railway tracks and/or land at the place(s) shown on the said drawing and to execute all repairs in connection therewith when necessary from time to time and all such works shall be executed at the cost of the owner at such times as may be permitted and to the satisfaction of the Railway in all respects.

Provided that if shifting of or modifications to or dismantling of the crossing is required for the proper functioning of the Railway and is to be carried out by the owner as desired by the Railway, the costs of such works shall be borne by the owner.

3. Railway to carry out protection works: In the event of it being necessary in the opinion of the Railway to support or protect the railway tracks and/or land or works during the-erection of the crossing or the execution of any repairs thereto or any removal thereof the work of supporting of or protecting the railway tracks or land and resorting the tracks and/or land to its original condition or such part of the said work as the Railway shall deem fit will be carried out by the Railway at the cost of the owner in all respects. The amount of such costs will be determined by the Railway in its absolute discretion and will be paid by the owner to the Railway on demand. The owner will deposit with the Railway prior to the carrying out of the said work by the Railway to be the cost of the work required to be done and the amount of the said deposit will be set off against the said cost to be determined as aforesaid and the balance paid as aforesaid.

4. Cost of Supervision of works: All works in connection with the matters referred

to in clauses 2,3 and 6 will be subject to such supervision by the Railway as may be considered necessary by the Railway and the owner will pay to the Railway on demand all costs of such supervision including the cost for the staff required to look after the safety of the railway tracks and/or land while all or any of such works are/work is in progress The costs of such supervision and other costs as aforesaid shall be determined by the Railway in its absolute discretion.

5. Access: Neither the owner nor his employees will at any time enter upon the railway land for any purpose whatsoever in connection with the crossing as aforesaid without the consent in writing of the Railway.

6. Modification, shifting or removal of crossing: If for convenience of operation, unsatisfactory maintenance or for any reason whatsoever the Railway desires special maintenance, repairs, modification, shifting or removal of the crossing the owner will, subject to the provisions of clause 3 hereof carry out such works or such portion thereof from the date of notice issued by the Railway and to the satisfaction of the Railway within a reasonable period determined by the Railway in its absolute discretion as the Railway shall not under provision of clause 3 hereof proposed to carry out the work. If the owner so desires he may re-erect the same at this own expense but to the satisfaction of the Railway in all respects on such other land or track of the Railway as it may in its absolute discretion consider suitable and available for the purpose. In the event of the crossing being so re-erected the land on which the same is re-erected will be used and occupied upon the terms of the Agreement, mutatis mutandis as if the same has originally been subject to this Agreement.

7. Termination of Agreement by the Railway: The Railway may be any time (and from time to time) be' at liberty in its absolute discretion to suspend temporarily and/or terminate this Agreement and all or any of the privileges hereby granted upon the expiration of three months' notice in writing of its intention to do so being left at or sent to the registered office of the owner/and not withstanding that the owner may have executed any work of a permanent or temporary character and incurred expenses in the execution thereof. The owner shall not be entitled to any damages or compensation by the reason of such termination or suspension.

8. Same as otherwise provided in this contract, all notices to be given on behalf of the President of India and all other actions to be taken on his behalf may be given or taken on his behalf by the Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway.

9. Termination of Agreement by the owner: The owner may on giving to the Railway one month's notice in writing terminate this Agreement and such notice shall be sufficiently served if sent by registered post to the Chief Electrical Engineer/Divisional Railway Manager/ Divisional Railway Manager (Electrical) of the Railway or left at his office.

10. Termination of Agreement for default: In the event of the Railway giving notice under Clause 7 hereof for special maintenance, repairs, modification, shifting or removal of the crossing and the owner failing within the time stipulated to carry out the said works except such position thereof as the Railway may propose to carry out under the provisions of clause 3 hereof or in the event of the owner committing any other breach of this Agreement or any part thereof, the Railway shall be entitled in its absolute discretion (notwithstanding the provisions of clause 8 hereof) to

terminate this Agreement and all and any of the privileges hereby granted upon the expiration of three months' notice in writing of its intentions to do so being given in the manner provided in clause 7.

11. Removal of crossing: Prior to the termination of this Agreement and subject to the provisions of clause 3 hereof the owner will at his own cost remove the crossing from the property of the Railway and restore the land to its original condition to the satisfaction of the Railway in all respects. In the event of the owner failing to remove the said crossing and restore the land to its original condition in the manner hereinbefore provided the Railway will be entitled at its option immediately after the termination of this Agreement to carry out the work of removal of the crossing and restoration of the land without being responsible for any loss or damage whatsoever to the said crossing or any part thereof. In such an event the owner will pay to the Railway on demand all costs incurred by the Railway in connection with such work including supervision charges, the amount which will be determined by the Railway in its absolute discretion. The said crossing and the materials used in connection therewith and belonging to the owner will be and remain the property of the owner but the Railway will be entitled to retain the same but without any liability therefore until the amount of such costs as aforesaid have been paid by the owner to the Railway.

12. Indemnity: The said crossing will be used at the sole risk and responsibility of the owner. If at any time owing directly or indirectly to such use or to the existence of the said crossing or to the carrying out of the work of erection and/or repair and/or removal of the said crossing and restoring the land to its original condition or to the exercise by the owner of any privileges hereby granted or to nay other cause arising out of the operation of the Agreement any damage will be caused to the Railway or to the permanent way and works, Rolling Stock or any other property of the Railway or if in consequence of any of the matters aforesaid or of any default in fulfilling any of the conditions of this Agreement or of any negligence on the part of the owner or any person connected with him, any claim or damage or loss be substantiated by any person or persons against the Railway the Owner will upon demand pay forthwith and make good the same and shall also make good to the Railway all costs and expenses which it may incur in regard to any such claim or damage or loss as aforesaid. In the event of three being any dispute as to what specific loss and/or damage has been caused by reason of any of the matters aforesaid such dispute will be referred to the" Chief Electrical Engineer of the Railway, whose decision thereon shall be final and binding.

13. Railway Accidents: The Railway shall not be responsible for any damage to the crossing and other property of the owner due to any accident in the working of the Railway doe to any cause whatsoever.

14. Sub-letting: The owner will not sub-let, transfer or assign this Agreement or any of the privileges hereby granted without the previous consent in writing of the Railway.

15. Limitation of rights: Nothing herein contained will be construed as conferring upon the owner or his permitted assignee any rights over the property of the Railway.

16. Cost of Agreement: All costs and expenses incidental to the preparation and completion of these presents including Stamp duty will be borne and paid by the

owner.

In witness whereof the parties have hereunto set and subscribed their respective hands and seals the day, month and years respectively mentioned against their respective signatures.

(Seal of the Owner)

(Signature)

Signed at----------by Shri----------

for and on behalf of the Owner in the presence of:

1. Name

Address

1. Name

Address. (Signature of Witness)

(Signature)

Signed at----------by Shri----------
-------- for and on behalf of the Owner in the presence of:

1. Name

Address. (Signature of Witness)

1. Name

Address. (Signature of Witness)

Notes. 1. In the case of Railway Companies or Port Commissioners Railways, the term Chief Electrical Engineer wherever occurring In this Agreement may be replaced by the designation of the Officer on whom the duties of the Chief Electrical Engineer devolve.

2. The agreement should be signed on behalf of the President of India by an officer duly authorised under Article 299 (1) of the Constitution of India.

Annexure II

AGREEMENT FOR ERECTING AND MAINTAINING AN UNDERGROUND POWER LINE

CROSSING ACROSS AND UNDER RAILWAY TRACKS.

AN AGREEMENT made this _____day of _____ two thousand and _____ BETWEEN THE PRESIDENT OF INDIA, acting through the Chief Electrical Engineer/the Divisional Railway Manager/ Divisional Railway Manager (Electrical) of the Railway Administration (hereinafter called " the Railway") of the one part and (hereinafter referred to as "the owner" of the other part. WHEREAS the owner wishes to lay an underground cable and carry out works connected herewith for transmission or distribution of electrical energy across and under the railway tracks and/or land at kilometrage----------in the section----------at----------Railway station, of the Railway the said cable and works connected therewith hereinafter referred to as the "crossing". NOW IT IS HEREBY AGREED as follows:

1. General: The Railway will permit the owner as from the _____day_____20_____, to lay the crossings as per Drg. No_____approved by the Railway, hereunto attached as Annexures and in compliance with Regulations, for power line crossings of Railway Tracks, hereunto attached as Annexure hereinafter referred to as the Regulations, for the purposes hereinbefore mentioned, subject to the terms and conditions hereinafter contained.

2. Permission to lay and maintain the crossing: The Railway, will, subject to the provisions of clause 3 hereinafter contained permit the owner to lay, keep and maintain in accordance with the Regulations the crossing under the Railway tracks and/or land at the place(s) shown on the said drawing and to execute all repairs in connection therewith when necessary from time to time and all such works shall be executed at the cost of the owner at such time as may be permitted and to the satisfaction of the Railway in all respects.

Provided that if shifting of or modifications to or dismantling of the crossing is required for the proper functioning of the Railway and is to be carried out by the owner as desired by the Railway, the costs of such works shall be borne by the Railway except in these cases where the need for such works on account of Railway's anticipated development/requirements was foreseen in time and the owner had agreed in writing prior to the construction of the crossing to meet the costs of such works.

3. Railway to carry out protection works: In the event of it being necessary in the opinion of the Railway to support or protect the railway tracks and/or land or works during the laying of the crossing or the execution of any removal thereof the work of supporting or protecting the railway tracks or land and /or laying or removing the encasing protective pipe to carry the crossing cable and restoring the tracks and/or land to its original condition or such part of the said work as the Railway shall deem fit will be carried out by the Railway at the cost of the owner in all respects. The amount of such costs will be determined by the Railway in its absolute discretion and will be paid by the owner to the Railway on demand. The owner will, if required deposit with the Railway prior to the carrying out of the said

work such sum of money as may be estimated by the Railway to be the cost of the work required to be done and the amount of the said deposit will be set off against the said cost to be determined as aforesaid and the balance paid as aforesaid

4. Method of laying: The cable shall be laid as indicated in the said drawing and shall be carried through an encasing pipe in such manner that the cable can be laid, withdrawn and/or maintained without interfering with or endangering the railway tracks and/or land. The costs of providing and laying such encasing pipe for the crossing shall be borne by the owner as aforesaid.

5. Cost of supervision of works: All works in connection with the matters referred to in clauses, 2,3,4,7 & 11 will be subject to such supervision by the Railway as may be considered necessary by the Railway and the owner will pay to the Railway on demand all costs of such supervision including the cost for the staff, required to look after the safety of the railway tracks and/or land while all or any of such works are/ work is in progress The costs of such supervision and other costs as aforesaid shall be determined by the Railway in its absolute discretion.

6. Access: Neither the owner nor his employees will at any time enter upon the railway land for any purpose whatsoever in connection with the crossing as aforesaid without the consent in writing of the Railway.

7. Modification, shifting or removal of crossing: If for convenience of operation, unsatisfactory maintenance or for any reason whatsoever the Railway desires special maintenance, repairs, modification, shifting or removal of the crossing the owner will, subject to the provisions of clause 3 hereof carry out such works or such portion thereof from the date of notice issued by the Railway and to the satisfaction of the Railway within a reasonable period determined by the Railway in its absolute discretion as the Railway shall not under provision of clause 3 hereof proposed to carry out the work. If the owner so desires he may relay the same at his own expense but to the satisfaction of the Railway in all respects on such other land or track of the railway as it may in its absolute discretion consider suitable and available for the purpose. In the event of the crossing being so re-erected the land on which the same is re-erected will be used and occupied upon the terms of the Agreement mutatis mutandis, as if the same has originally been subject to this Agreement.

8. Termination of Agreement: The Railway may at any time (and from time to time) be at liberty in its absolute discretion to suspend temporarily and/or terminate this agreement and all or any of the privileges hereby granted upon the expiration of three months' notice in writing of its intention to do so being left at or sent to the registered office of the owner and notwithstanding that the owner may have executed any work of a permanent or temporary character and incurred expenses in the execution thereof. The owner shall not be entitled to any damages or compensation by the reason of such termination or suspension.

9. Same as otherwise provided in this contract, all notices to be given on behalf of the President of India and all other action to be taken on his behalf may be given or taken on his behalf by the Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway of left at his office.

10. Termination of Agreement by the Owner: The owner may on giving to the Railway one month's notice in writing terminate this Agreement and such notice

shall be sufficiently served if sent by the registered post to the Chief Electrical Engineer/Divisional Railway Manager/Divisional Railway Manager (Electrical) of the Railway or left at his office.

11. Termination of Agreement for default: In the event of the Railway giving notice under clause 7 hereof for special maintenance, repairs, modification, shifting or removal of the crossing and the owner failing within the time stipulated to carry out the said works except such portion thereof as the Railway may propose to carry out under the provisions of clause 3 hereof or in the event of the owner committing any other breach of this Agreement or any part thereof, the Railway shall be entitled in its absolute discretion (notwithstanding the provisions of clause 8 hereof) to terminate this Agreement and all and any of the privileges hereby granted upon the expiration of six months' notice in writing of its Intentions so to do being given in the manner provided by clause 7.

12. Removal of crossing: Prior to the termination of this Agreement and subject to the provisions of clause 3 hereof the owner shall at his own cost remove the crossing from the property of the Railway and shall restore the land to its original condition to the satisfaction of the Railway in all respects. In the event of the owner failing to remove the said crossing and restore the land to its original condition in manner hereinbefore provided the Railway will be entitled at its option immediately after the termination of this Agreement to carry out such work of removal of the crossing and restoration of the land without being responsible for any loss or damage whatsoever to the said crossing or any part thereof. In such an event the owner will pay to the Railway on demand all costs incurred by the Railway in connection with such work determined by the Railway in its absolute discretion. The said crossing and the materials used in connection therewith and belonging to the owner will be and remain the property of the owner but the Railway will be entitled to retain the same but without any liability therefor until the amount of such costs as aforesaid have been paid by the owner to the Railway.

13. Indemnity: The said crossing will be used at the sole risk and responsibility of the owner. If at any time owing directly or indirectly to such use or to the existence of the said crossing or to the carrying out of the work of erection and/or repair and/or removal of the said crossing and restoring the land to its original condition or to the exercise by the owner of any privileges hereby granted or to any other cause arising out of the operation of this Agreement any damage will be caused to the Railway or to the permanent way and works, Rolling stock or any other property of the Railway or if in consequence of any of the matters aforesaid or of any default in fulfilling any of the conditions of this Agreement or of any negligence on the part of the owner or any person connected with him, any claim or damage or loss be substantiated by any person or persons against the Railway, the owner will upon demand pay forthwith and make good the same and shall also make good to the Railway all costs and expenses which it may incur in regard to any such claim or damage or loss as aforesaid. In the event of there being any dispute as to what specific loss and/or damage has been caused by reason of any of the matters aforesaid such dispute will be preferred to the Chief Electrical Engineer of the Railway, whose decision thereon shall be final and binding.

14. Railway Accidents: The Railway shall not be responsible for any damage to the crossing and other property of the owner due to an accident in the working of the Railway due to any cause whatsoever.

15. Sub-letting: The owner will not sub-let, transfer or assign this Agreement or any of the privileges hereby granted without the previous consent in writing of the Railway.

16. Limitation of rights: Nothing herein contained will be construed as conferring upon the owner or his permitted assignee any rights over the property of the Railway.

17. Costs of Agreement: All the costs and expenses incidental to the preparation and completion of these presents including stamp duty will be borne and paid by the owner.

In witness whereof the parties have hereunto set and subscribed their respective hand and seals the day, month and year respectively mentioned against their respective signatures.

(Seal of the Owner)

(Signature)

Signed at----------by Shri----------for and on behalf of the owner in the presence of:

1. Name
   Address (Signature of witness)

2. Name
   Address (Signature of witness)

Signed at----------by Shri----------for and on behalf of the President of India, in the presence of:

1. Name
Address (Signature of witness)

2. Name
Address (Signature of witness)

Note: 1. In the case of Railway Companies or Port Commissioner's Railway, the term Chief electrical Engineer wherever occurring in this Agreement may replaced by designation of the officer on whom the duties of the Chief Electrical Engineer devolve.

2. The agreement should be signed by and on behalf of the President of India by an officer duly authorized under Article 299(1) of the Constitution of India.

Annexure III

CERTIFICATE OF COMPLIANCE

It is hereby certified that the electrical overhead line/underground cable crossing No _____at km_____on the section _____of the Division of the_____at
Railway has been constructed in compliance with Indian Electricity Act, 1910 and Indian Railways Act, 1890, and the rules made thereunder and as amended from time to time and the Regulations for power line crossings of Railway Tracks, 1987. The crossing has also been constructed in accordance with the drawings approved by the _____Railway and the Electrical Inspector of the _____Railway, the reference of which are given below:

SN	Drawing No.	Title of the Drawing	Location of Crossing	Reference under which drawing is approved	Approving
1.					
2.					
3.					

2.* It is also hereby certified that the overhead line crossing specially released as per clause 22.4 of the 'Regulations for Power Line Crossing of Railway Tracks, 1987' would be modified by the owner, on an approved design whenever Railway will require to modify such crossings due to introduction of electric traction on the section of the Railway.

Alongwith a reproducible print eight copies of the drawings showing the completed power line crossing is/ are enclosed.

(Seal of the owner) Signature

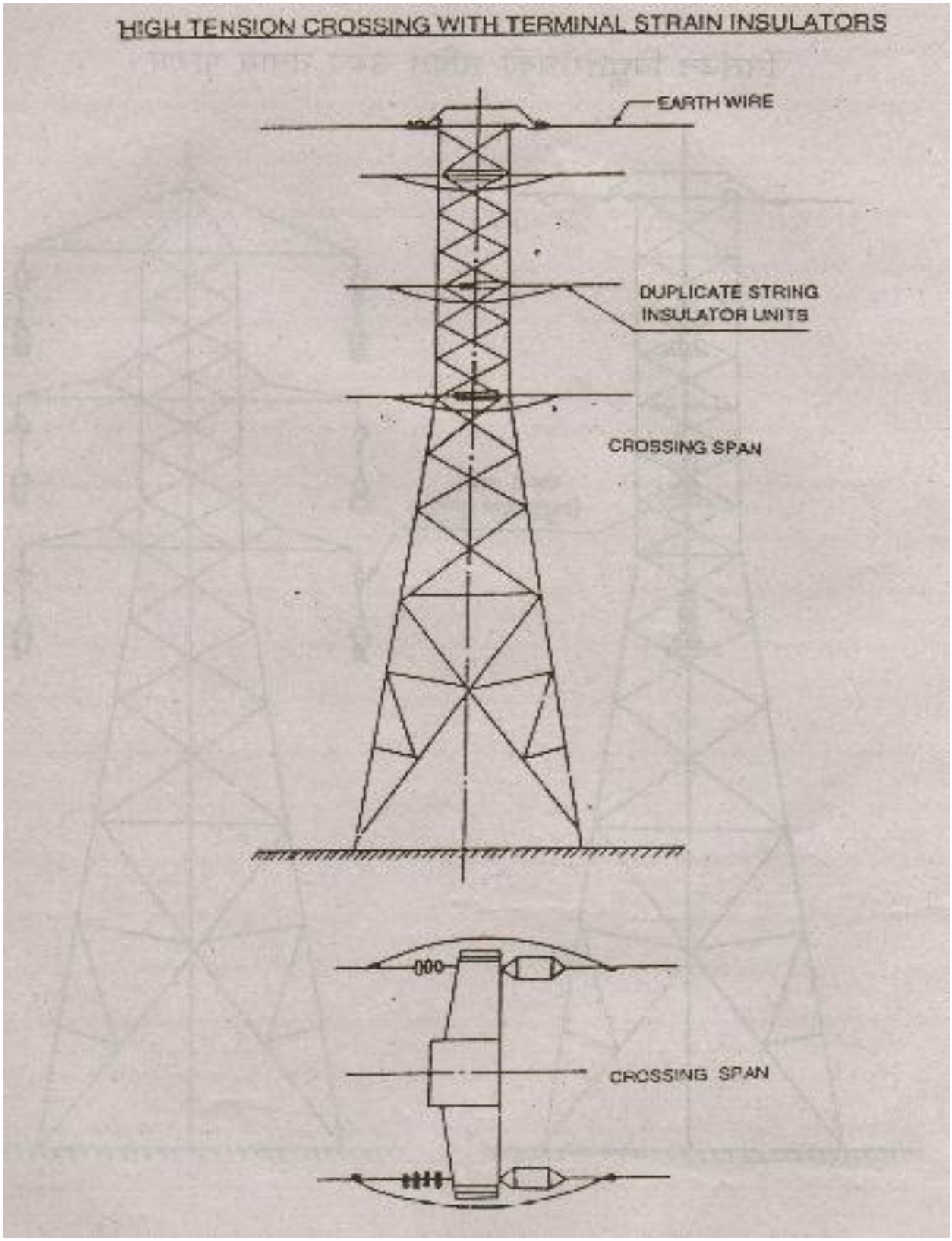
(Name of the owner)

Date_____

Place_____

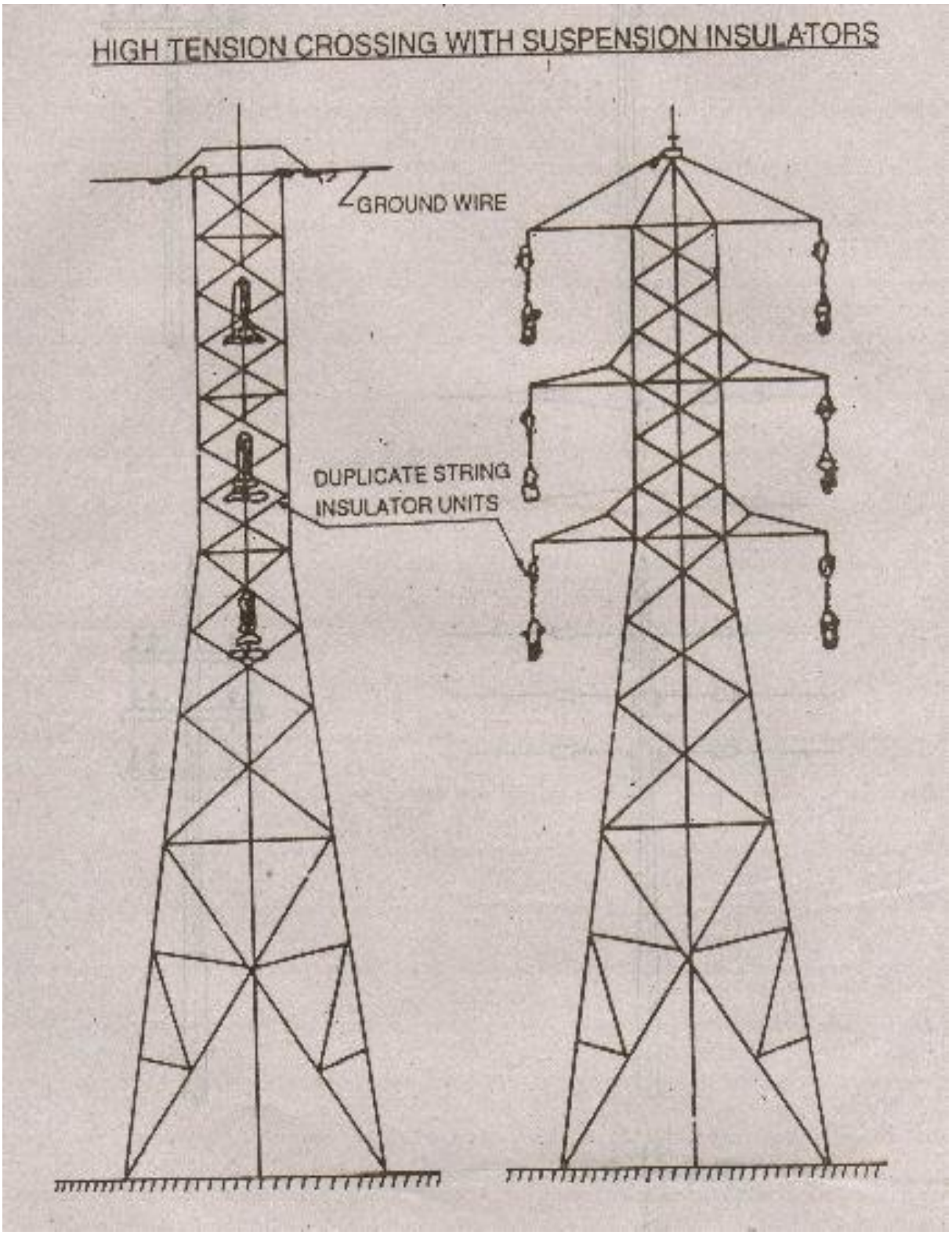
* Strike off, if not applicable.

$ The location of the overhead line crossing or underground cable will be identified by indicating the kilometerage with the painted number of the traction masts/structures and/or telegraph posts, as available, between which the overhead line or underground cable crossing is located.



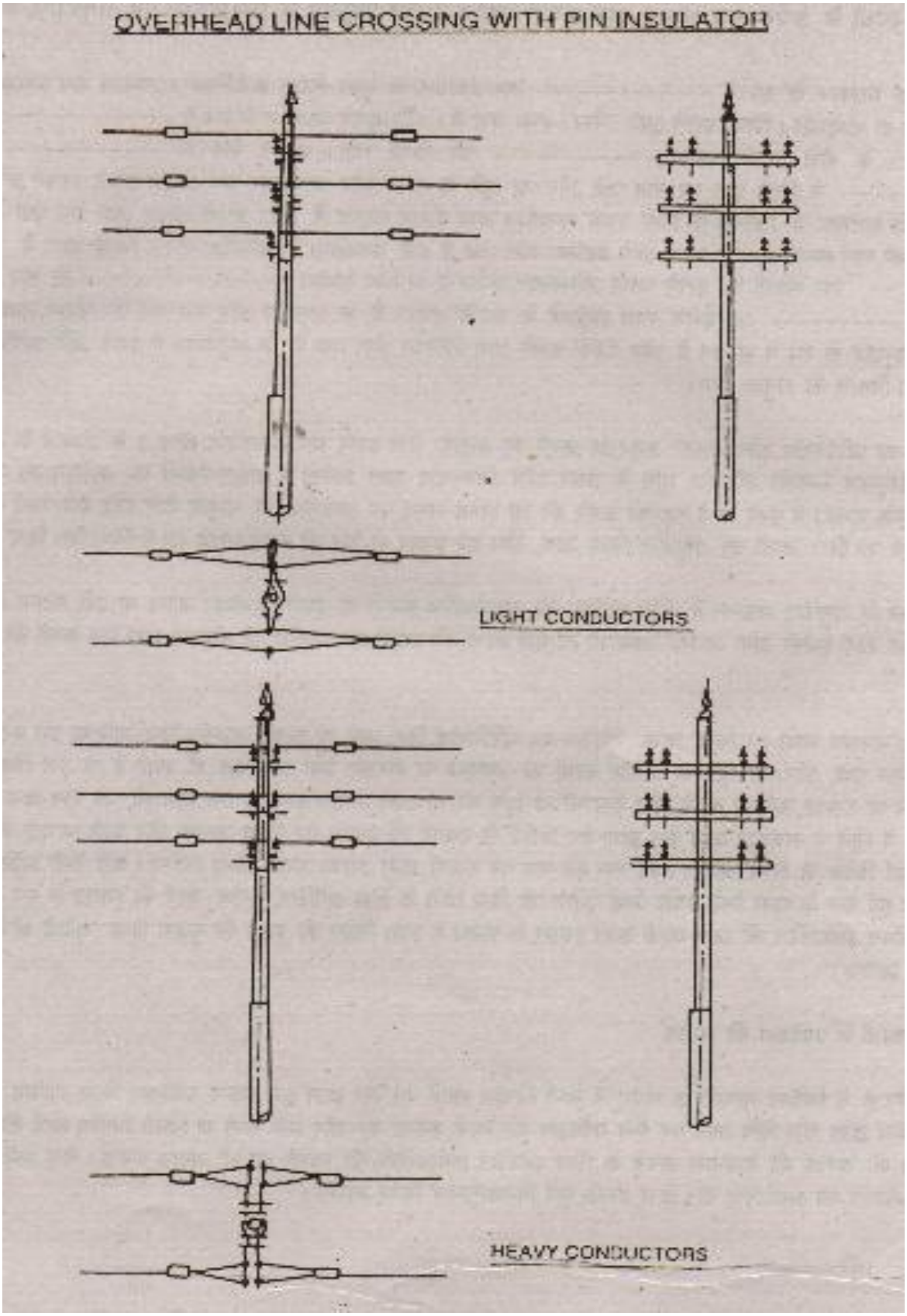
HIGH TENSION CROSSING WITH TERMINAL STRAIN INSULATORS

SKETCH-1



HIGH TENSION CROSSING WITH SUSPENSION INSULATORS

SKETCH-2



OVERHEAD LINE CROSSING WITH PIN INSULATOR

SKETCH-3

2.9 ELECTRICAL ACCIDENTS

2.9.1 An electrical accident is one which is caused directly or indirectly due to electrical causes. It includes electrical fires, all electric shocks and electric burns whether fatal or minor, and whether suffered by Railway servants or others.

2.9.2 **Observance of Rules**: - All accidents arising out of the use of electricity within the Railway premises are not only to be dealt with under the provisions of Railway Accidents Manual but also according to the procedure laid down under section 33 of Indian Electricity Act 1910 and Rule 44A of Indian Electricity Rules 1956, extracted below:

Section 33 of I.E. Act 1910:-

(4) "Report of Accidents and enquiries:- If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with any part of the electric supply lines or other works of any person and the accident results or is likely to have resulted in loss of human or animal life or in any injury to a human being or an animal, such person shall give notice of the occurrence of any such loss or injury actually caused by the accident, in such form and within such time as may be prescribed, to the Electrical Inspector and to such other authorities as the appropriate Government may in general or special order direct.

(5) The appropriate Government may, if it thinks fit, require any Electrical Inspector, or any other competent person appointed by it in this behalf, to enquire and report:

(a) as to the manner in, and extent to, which the provisions of the Act or any license or rules there under so far as those provisions affect the safety or any person have been complied with.

(b) as to the cause of any accident affecting the safety of the public, which may have been occasioned by or in connection with the generation, transmission, supply or use of energy.

(6) Every Electrical Inspector or other person holding an inquiry under sub-section (2) shall have all the power of a Civil Court under the Code of Civil Procedure, 1968 for the purpose of enforcing the attendance of witnesses and compelling the production of documents and material objects, and every person required by an Electrical Inspector or such other person as aforesaid to furnish any information shall be deemed to be legally bound to do so within the meaning of section 176 of the Indian Panel Code".

Note:

(3) The Chief Electrical Engineer, East Coast Railway is functioning as Electrical Inspector to the Central Government for Electrical installations in the premises of East Coast Railway. All matters in regard to the functions of Electrical Inspector shall be referred to him.

(4) The report of the accident in terms of sub-section (1) shall be submitted in form No. ECoR/E-4, which is the same form as prescribed in Annexure-XIII of the Indian Electricity Rules.

Rule 44A of Indian Electricity Rules, 1956 – (amended up to 1970)

"Intimation of Accidents : If any accident occurs in connection with the generation, transmission, supply or use of energy in or in connection with, any part of the electric supply lines or other works of any person and the accident results in or is likely to have resulted in loss of human or animal life or in any injury to a human being or animal, such person or any other person authorized by the State Electricity Board in this behalf shall send to the Inspector a telegraphic report within twenty four hours of the knowledge of occurrence of the fatal accident and a written report in form set out in Annexure –XIII of I.E. Rules 1956, within forty eight hours of knowledge of occurrence of fatal and all other accidents"

2.9.3 **Reporting of accidents**: - Every electrical accident occurring within the Railway remises should be reported to the nearest Electrical official in charge. Immediately on receipt of this information, the electrical official in charge will proceed personally to the site of the accident and take the following steps promptly:-

(4) He should remove the casualty from the cause, render first aid and send for the doctor or take the casualty to a hospital or dispensary.

(5) If there is a breakdown of the overhead lines, he should cordon off the area so that no else may get injured.

(6) He should carry out preliminary investigation as to the cause of the accident and get fully particulars of the injury or damage suffered and advise the details in writing in such form and within such time as may be prescribed in Rule 44-A of I.E. Rules, 1956 to the Station Master, the Divisional Superintendent and the Electrical Inspector viz. the Chief Electrical Engineer and also to the local police authorities and the District Magistrate in case of accidents resulting in death of person or persons.

2.9.4 **Accident in Workshops**: - If the electrical accident has occurred within workshop premises, the Factory Act and Rules will also apply. The Electrical Officers/ official in charge of the shops will report the details of the accident to the Works Manager/Dy.C.M.E.(Shop) to enable him to comply with the provisions of the Factory Act. The Electrical Officer/official in charge of the Shops will simultaneously take action as per Section 33 of I.E. Act 1910 and Rule 44 A of Indian Electricity Rules (quoted above).

The manager of the Workshop shall send notice of the accident in the Form prescribed in the State Factory Rules to the following officials:

(f) The Chief Inspector of Factories.
(g) Inspector of Factories of the Region.
(h) The District Magistrate or the S.D.O.
(i) The local Police Station.
(j) The Superintendent of Police of the area.

2.9.6 **Enquiries in Electrical Accidents**:-

(iii) In case of an accident resulting in loss of human life/grievous hurt or huge loss of property, an inquiry must be ordered at officer's level. The time schedule given in Railway Accident Manual must be adhered to in the conduct of enquiry. The enquiry report must be submitted to the Electrical Inspector within 14 days of the accident.

(iv) All Electrical accidents, other than those resulting in loss of human life/grievous hurt or huge loss of property will be enquired upon at the subordinate's level. The enquiry report must be submitted in such cases to the Electrical Inspector within 18 days.

GOVERNMENT OF INDIA (भारत सरकार)
MINISTRY OF RAILWAYS (रेल मंत्रालय)
(RAILWAY BOARD) (रेलवे बोर्ड)

No.2021/EEM/180/11 New Delhi, Dated: 09.11.2021

General Managers
All Indian Railways &
Production units

Director General, RDSO, Lucknow

General Manager(Const)NF Rly., Guwahati
General Manager, CORE, Allahabad

Director General, NAIR, Vadodara

Sub: Scale of electrical fittings for the existing staff quarters-Standardization thereof.
Ref: Board's letter No.2006/Elect(G)/180/11/Pt. dated 21.06.2016.

The policy guidelines for electrical scale of fittings for existing staff quarters were circulated in past vide Board's letter dated 21.06.2016 under reference above.

2. In super session of the letter under reference above, it has been decided that the revised scale of electrical fittings for the existing staff quarters shall be as per details enclosed in Annexure. These guidelines will be applicable for all the existing staff quarters. However, revised scale of fittings for existing quarters should be provided when re-wiring of a quarter is being undertaken.

3. This letter supersedes all the earlier instructions issued on the subject to the extent they are not in conformity with these instructions.

This issues with the concurrence of Finance directorate and approval of Board (M/TRS).

09/11/2021

(Sumit Garg)
Director Elect. Engg. (PS)
Railway Board
Phone:011-23389112
Email-rbelectricaleem@gmail.com

GOVERNMENT OF INDIA/BHARAT SARKAR
MINISTRY OF RAILWAYS/RAIL MANTRALAYA
(RAILWAY BOARD

No. 2016/Elect(G)/150/9 New Delhi, dt. 08.03.2018

General Managers,
All Indian Railways & PUs

Sub:- Energy Efficiency guidelines for all new Railway Buildings

Ref:- BEE's letter No. 09/06/07/IMPL/ECBC/2510-12 dt.29.05.17

Energy efficiency guidelines for redevelopment of Railway stations and other buildings have been developed with Super ECBC compliance, i.e. **40% more energy savings against ECBC compliant as per new Energy Conservation Building Code (ECBC) 2017. This code has been developed by Bureau of Energy efficiency (BEE)** which has been set up under the Energy Conservation Act 2001 with a mandate to initiate programmes and schemes in India for energy efficiency.

2. These Super ECBC guidelines have been developed with a goal to minimize energy demand through climatic responsive building design and energy efficient technologies. They could also harvest renewable energy on-site through a combination of technologies like solar, geo-thermal, biomass, wind etc. These guidelines include in its scope the building envelop and fenestration, comfort systems, control, electrical systems and renewable energy systems also. The detailed guidelines developed by BEE are enclosed*.

3. These guidelines shall be made part of scope of work/specification for all new buildings that will be constructed in future having area more than 2500 sqm. However, in the cases of buildings having area less than 2500 sqm, these guidelines should be made "desirable" and Residential buildings/complex less than 2500 sqm area will not be covered under scope of ECBC 2017 concept.

4. This issues with the approval of Board (MTR & ME).

*DA

08/3/18
(Punit Agrawal)
Director Elect.Engg.(PS)
Railway Board

No. 2016/Elect(G)/150/9 New Delhi, dt. .03.2018

Copy to: PEE's of all Zonal Railways- For information and necessary action please.

08/03/18
(Chander Shekhar)
Joint Director(L&A)
Railway Board

Copy to : i) PCEE's of all Zonal Railways- For information and necessary action please.
ii) CMDs of all Railway PSUs

08/3/18
(Punit Agrawal)
Director Elect.Engg.(PS)
Railway Board

अभय बाकरे, आईआरएसईई
महानिदेशक

ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ENERGY IS LIFE
CONSERVE IT

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)

BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

F.No. 09/06/07/IMPL/ECBC/2510-12

Date: May 29, 2017

To
Shri Ghanshyam Singh, IRSEE
Member (Traction), Railway Board,
Room No.212, Rail Bhawan,
New Delhi-110001

Subject: Energy Efficiency guidelines for Redevelopment of Safdarjung Railway Station for SuperECBC compliance.

This has reference to the discussions held between Ministry of Railways and the officials of Bureau of Energy Efficiency (BEE).

BEE was set up under the Energy Conservation Act 2001 with the mandate to initiate programmes and schemes in India on Energy Efficiency. The building sector has been found to be a key potential area for implementing energy conservation measures. BEE has recently developed Energy Conservation Building Code (ECBC) 2017 with an objective to promote higher standards in Energy Efficient buildings. Under the new code ECBC 2017, following categories are included:

i. ECBC compliance building as per new code.
ii. ECBC plus having 20% more efficiency.
iii. Super ECBC building having about 40% energy savings against item 1 above.

Super ECBC buildings are designed and developed with a goal to minimize energy demand through climatic responsive building design and energy efficient technologies. They could harvest renewable energy on-site through a combination of technologies like solar, geo-thermal, biomass, wind, etc. to become Near Zero establishments.

M/o Railways is requested to incorporate the specifications for SuperECBC compliant buildings in the redevelopment of Safdarjung Railway Station for creating exemplary Energy Efficient Railway Stations. BEE is willing to support this endeavor of M/o Railways by providing technical assistance. Following documents are attached for your kind perusal:

a. Technical Assistance proposal from Bureau of Energy Efficiency
b. Specifications for SuperECBC compliant Railway Station buildings
c. Case Studies of ECBC compliant buildings

M/o Railways may also consider Implementation of SuperECBC measures in all future redevelopment of Railway Stations with the above technical assistance.

Yours sincerely,

A Bakre 29/5/17

(Abhay Bakre)

Encl: a/a

Copy to:
1. Shri R. K. Chaudhary, Advisor (Station Development) Railway Board, Rail Bhawan, New Delhi.
2. Shri Sudhir Garg, EDEEM, Railway Board, Rail Bhawan, New Delhi.

चौथा तल, सेवा भवन, आर०के०पुरम, नई दिल्ली-110 066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066
टेली/Tel.: 91(11) 26178316 (सीधा/Direct) 26179699 (5 Lines) फैक्स/Fax: 91(11) 26178328
ई-मेल/E-mail: dg-bee@nic.in, abhay.bakre@nic.in वेबसाईट/Web-site : www.beeindia.gov.in

TECHNICAL ASSISTANCE FOR REDEVELOPMENT OF SAFDARJUNG RAILWAY STATION

Technical Assistance for Redevelopment of Safdarjung Railway Station

1 BACKGROUND

Built environment is a significant contributor to the global warming due to extensive emission of greenhouse gases (GHGs) from the buildings. Building sector accounts to about 35 percent of total energy used in India. The project aims to assist the redevelopment of Safdarjung Railway Station at New Delhi for Energy Conservation Building Code (ECBC) compliance, through a comprehensive and integrated approach.

The new ECBC 2017 standard sets stringent minimum energy efficiency standard for new buildings. Super ECBC buildings aim towards a near zero target and are 30-40% more efficient than ECBC. Super ECBC buildings are designed to be amongst the most energy efficient on any global scale. With addition of renewable energy on-site, Super ECBC buildings can easily become Net Zero. Pilot projects can showcase the performance and cost-benefit of such buildings in order to accelerate transition to Super ECBC standards. The demonstration can showcase the advantages of energy efficient buildings at the same time also incorporate the state of the art of building products, technology and building energy management tools.

2 SUPPORT OFFERED BY BEE

Project will support by providing technical assistance for incorporating energy efficiency measures. The scope of work includes following tasks:

- ✓ Task 1. Provide specifications for ECBC compliant equipment to assist in preparation of tender document
- ✓ Task 2. Evaluate and endorse building design drawings, specifications for ECBC compliance. Assess baseline EPI based on building simulation
- ✓ Task 3. Monitor construction progress, provide guidance and recommendations to align with ECBC
- ✓ Task 4. Review As-built drawings and equipment, confirm compliance to design
- ✓ Task 5. Monitor, verify performance data in terms of EPI

3 DELIVERABLES AND MILESTONES

The Task based deliverables and milestones will be as follows:

	Task	**Deliverable**
1	Task 1 report: Provide specifications for ECBC compliant equipment	• Report enclosing equipment specifications for ECBC compliance • Assist in preparation of tender document o Support in tender evaluation process
2	Task 2 report: Evaluate, endorse building	• A report to be developed that should have details of o Proposed design drawings incorporating

	design drawings, specifications for ECBC compliance and estimate Baseline EPI	mandatory provisions of ECBC o Load calculations with list of approved equipment and material specifications o Input and output compliance report of simulation modelling of Standard Design and Proposed Design as per Whole Building Performance method specified in ECBC
3	Task 3 report: Monitor construction progress, provide guidance and recommendations to align with ECBC	• A task report to be developed that should include details of o construction progress status with details of support provided o validated specification sheets of materials and equipment that building developers have procured and installed
4	Task 4 report: Review As-built drawings and equipment, confirm compliance to design	• A task report to be developed that should include details of o Endorsement of As-built drawings matching with approved design drawings, material and equipment specification o ECBC compliance/conformity check report as specified in Appendices of ECBC
5	Task 5 report: Acquire, verify performance data and demonstrate reduction on baseline EPI	• Perform annual energy audit and prepare a task report that should include details of o Building EPI data

4 ELEMENTS OF A SUPER ECBC BUILDING:

There are five basic critical elements of a successful Net-Zero Energy Building that include building design, efficient lighting and HVAC technologies, renewable energy, energy efficient appliances and plug loads, and finally, the behavior and lifestyle of the building occupants in favor of energy conservation.

1. Building Design: The most critical and cost-effective step for reducing energy consumption in a building starts with a climatic responsive building design process. A zero energy building design departs from conventional construction practices and combines innovative strategies that include natural ventilation, passive heating and cooling, day-lighting, high performance windows, insulation and thermal mass.

2. Energy Efficient Systems: After optimization of energy consumption through architectural design features, a Super ECBC building incorporates energy efficient building systems/technologies for lighting, heating and cooling to provide occupant comfort with minimal energy usage. Super ECBC buildings are also designed to make optimal use of all energy sources- including waste heat; for example, using refrigerator exhaust to heat domestic water, hot water heat recycling, combined heat and power etc.

3. Renewable Energy: Going beyond Super ECBC, NZEB's harvest energy from renewable energy to meet their electricity and heating or cooling needs. The choice of renewable technologies is carefully made after evaluating many parameters that include available renewable sources, efficiency, cost, etc., and examples include micro-generation, solar, wind, biofuels, hydro etc. The diurnal and seasonal fluctuations in demand may be

managed by using thermal storage and/or and staying connected to the electric grid, which allows a NZEB to use grid power when facing an energy deficit and exporting electricity to the grid when there is a surplus.

4. Energy Efficient Appliances: Super ECBC buildings should also incorporate the usage of highly energy efficient appliances such as office equipment, consumer electronics and other plug loads. The management of these appliances is also carefully monitored to avoid phantom loads and wastage of energy during times when appliances are not in use.

5. Occupant Behavior: Super ECBC buildings can be made operationally successful through modification of occupant behavior and finding an optimal programming for thermostats, lighting levels, hot water temperatures, etc.

Table 3. Key Specifications of Super ECBC building Office building

Building envelope			
Roof insulation	0.2	W/m2K	In all climatic zones
Wall insulation	0.22	W/m2K	In all climatic zones
Vertical Fenestration			
SHGC	0.27		
U Value	3	W/m2K	
VLT	0.27		
Comfort Systems and Controls			
Chiller (Water Cooled)	COP ranges from 5.8 to 6.7 depending on the size of chiller		
Fan efficiency	70%		
Motor Efficiency	IE4		
Chilled Water Pump (Primary & Secondary)	14.9	W/ kWr with VFD on secondary pump	
Condenser Water Pump	14.6	W/ kWr	
Pump Efficiency	85%		
Cooling tower	0.017	kW/kWr	
Alternately, system efficiency	0.2	kW/ kWr	
Mandatory piping and ducting insulation			
Lighting and Controls			
Use of LEDs	Lighting power density requirement is 50% more efficiency compared to ECBC level		
Use of lighting controls			
Electrical and Renewable Systems			
Most energy efficient transformers as per IS 1180			
Motor efficiency	IE4		
DG set	5 Star BEE star rated		
Power factor correction	0.99		
Power distribution loss	1%		
RE generation	4%		

Energy Efficiency Guidelines for Redevelopment of Safdarjung Railway Station

---

Specifications for SuperECBC Compliance

Draft Report v1.0
5/26/2017

Prepared by Bureau of Energy Efficiency, Ministry of Power, Government of India

Table of Contents

1 Purpose

The purpose of these guidelines is to provide requirements for the energy-efficient design and construction of Safdarjung Railway Station buildings.

1.1 Precedence

The following codes, programs, and policies will take precedence over the Code in case of conflict:

(a) State or Central Government notified statutory act or rules on safety, security, health, or environmental issues,

(b) Bureau of Energy Efficiency's Standards and Labelling for appliances and Star Rating Program for buildings, provided both or either are more stringent than the requirements of this Code,

(c) Any policy notified as taking precedence over this Code, by Central, State, or Local Government.

1.2 Reference Standards

The National Building Code of India (NBC) is the reference standard for lighting levels, heating, ventilating, and air conditioning (HVAC), thermal comfort conditions, natural ventilation, and any other building materials and system design criteria addressed in this Code.

2 Building Envelope

2.1 Building Envelope Sealing

Following areas of the building envelope, of all except naturally ventilated buildings or spaces, shall be sealed, caulked, gasketed, or weather-stripped:

(a) Joints around fenestration, skylights, and door frames

(b) Openings between walls and foundations, and between walls and roof, and wall panels

(c) Openings at penetrations of utility services through roofs, walls, and floors

(d) Site-built fenestration and doors

(e) Building assemblies used as ducts or plenums

(f) All other openings in the building envelope

(g) Exhaust fans shall be fitted with a sealing device such as a self-closing damper

(h) Operable fenestration should be constructed to eliminate air leakages from fenestration frame and shutter frame

2.2 Roof

Roofs shall comply with the maximum assembly U-factor of 0.20 W/m2K. The roof insulation shall be applied externally as part of structural slab and not as a part of false ceiling.

2.3 Opaque External Wall

Opaque above grade external walls shall comply with the maximum assembly U-factor of 0.22 W/m2K.

2.4 Vertical Fenestration

For all climatic zones, vertical fenestration compliance requirements shall comply with the following:

(a) Maximum area weighted U-factor is 3 W/m²K. The U-factor shall include both frame and glass for effective U-factor

(b) Minimum allowable Visual Light Transmittance (VLT) is 0.27

(c) Vertical fenestration shall comply with the following:

i. Maximum SHGC Non-North - 0.27

ii. Maximum SHGC North - 0.50

2.5 Skylights

Skylights shall comply with the following:

(a) maximum U-factor – 4.25 3 W/m²K

(b) maximum SHGC requirements – 0.35

2.6 Vegetated and Cool Roof

All roofs that are not covered by solar photovoltaics, or solar hot water, or any other renewable energy system, or utilities and services that render it unsuitable for the purpose shall be either cool roof or vegetated roof.

a) For compliance to cool roof, roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.60 and an initial emittance no less than 0.90. Solar reflectance shall be

determined in accordance with ASTM E903-96 and emittance shall be determined in accordance with ASTM E408-71 (RA 1996).

b) For compliance to vegetated roof, roof areas shall be covered by living vegetation.

3 Comfort Systems and Controls

3.1 Natural Ventilation Air Quantity Design Requirements

Naturally ventilated building or spaces in a mixed-mode ventilated building that are naturally ventilated shall:

(a) Comply with guidelines provided for natural ventilation in National Building Code of India

(b) Have permanent roof or wall openings, windows, doors, louvres to the outdoors, or other apertures for ventilation, the openable area of which shall not be less than 5% of the floor area of the naturally ventilated space. Openable area shall be calculated on basis of free unobstructed area through the opening.

(c) Have BEE 5 star rated ceiling fans, if provided with ceiling fans

The design guidelines on natural ventilation stated in the relevant section of NBC should be referred to achieve the requirements on natural ventilation.

3.2 Mechanical Ventilation Air Quantity Design Requirements

Buildings that are ventilated using a mechanical ventilation system or spaces in mixed-mode ventilated buildings that are ventilated with a mechanical system, either completely or in conjunction with natural ventilation systems, shall:

(a) install mechanical systems that provide outdoor air change rate as per National Building Code of India

(b) have a ventilation system controlled by CO sensors for basement carpark spaces with total car park space greater than or equal to 600 m^2.

3.3 Demand Control Ventilation

Mechanical ventilation systems shall have demand control ventilation if they provide outdoor or fresh air greater than 1500 liters per second, to a space greater than 50 m^2, with occupant density exceeding 40 people per 100 m^2 of the space, and are served by one or more of the following systems:

(a) An air side economizer

(b) Automatic outdoor modulating control of the outdoor air damper

3.4 Chillers

Chillers shall meet or exceed the minimum efficiency requirements presented in Table 3-1 under ANSI/ AHRI 550/ 590 conditions. The application of air-cooled chiller is allowed in all buildings with cooling load less than 530 kW. For buildings with cooling load equal to or greater than 530 kW, the number of air-cooled chiller shall be restricted to 33% of the total installed chilled water capacity.

Table 3-1 Minimum Energy Efficiency Requirements for water cooled Chillers

	SuperECBC Building	
Chiller Capacity (kWr)	COP	IPLV
<260	5.8	7.1
≥260 & <530	6.0	7.9
≥530 &<1050	6.3	8.4
≥1050 &<1580	6.5	8.8
≥1580	6.7	9.1

3.5 Unitary, Split, Packaged Air-Conditioners

Unitary air-conditioners shall meet or exceed the efficiency requirements presented in Table 3-2. EER shall be as per IS 8148 for all unitary, split, packaged air conditioners greater than 10 kWr.

Table 3-2 Minimum Requirements for Unitary, Split, Packaged Air Conditioners in SuperECBC Building

Cooling Capacity (kWr)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 5 Star
>10.5	3.9 EER	3.4 EER

*Table 3-3 Minimum Efficiency Requirements for VRF Air conditioners for ECBC Building**

		For Heating or cooling or both	
Type	Size category (kWr)	EER	IEER
VRF Air Conditioners,	< 40	3.28	4.36
Air cooled	>= 40 and < 70	3.26	4.34
	>= 70	3.02	4.07

3.6 HVAC Controls

3.6.1 Timeclock

Mechanical cooling and heating systems shall be controlled by timeclocks that:

(a) Can start and stop the system under different schedules for three different day-types per week,

(b) Are capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and

(c) Include an accessible manual override that allows temporary operation of the system for up to 2 hours.

3.6.2 Temperature Controls

Mechanical heating and cooling equipment shall be installed with controls to manage the temperature inside the conditioned zones. Each floor or a building block shall be installed with at least one control to manage the temperature. These controls should meet the following requirements:

(a) where a unit provides both heating and cooling, controls shall be capable of providing a temperature dead band of 3°C within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum

(b) where separate heating and cooling equipment serve the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling

3.6.3 Occupancy Controls

Occupancy controls shall be installed to de-energize the ventilation and/or air conditioning systems when there are no occupants in:

(a) each guest room

(b) Each toilet with more than 2 water closets and/ or 3 urinals

(c) Each conference and meeting room, of size more than 80 m^2

3.6.4 Fan Controls

Cooling towers shall have fan controls based on wet bulb logic, with either:

(a) two speed motors, pony motors, or variable speed drives controlling the fans, or

(b) controls capable of reducing the fan speed to at least two third of installed fan power

3.6.5 Dampers

All air supply and exhaust equipment, having a Variable Frequency Drive (VFD), shall have dampers that automatically close upon:

(a) Fan shutdown, or,

(b) When spaces served are not in use

(c) Backdraft gravity damper is acceptable in the system with design outdoor air of the system is less than 150 liters per second, provided backdraft dampers for ventilation air intakes are protected from direct exposure to wind.

(d) Dampers are not required in ventilation or exhaust systems serving naturally conditioned spaces.

(e) Dampers are not required in exhaust systems serving kitchen exhaust hoods.

3.6.6 Centralized Demand Shed Controls

Buildings shall have a building management system. All mechanical cooling and heating systems with programmable logic controller (PLC) to the zone level shall have the following control capabilities to manage centralized demand shed in noncritical zones:

(a) Automatic demand shed controls that can implement a centralized demand shed in non-critical zones during the demand response period on a demand response signal.

(b) Controls that can remotely decrease or increase the operating temperature set points by four degrees or more in all noncritical zones on signal from a centralized control point

(c) Controls that can provide an adjustable rate of change for the temperature setup and reset

The centralized demand shed controls shall have additional capabilities to

i. Be disabled by facility operators

ii. Be manually controlled from a central point by facility operators to manage heating and cooling set points

3.6.7 Supply Air Temperature Reset

Multi zone mechanical cooling and heating systems shall have controls that automatically reset the supply-air temperature in response to building loads or to outdoor air temperature. Controls shall reset the supply air temperature to at least 25% of the difference between the design supply air temperature and the design room air temperature.

3.6.8 Chilled Water Temperature Reset

Chilled water systems with a design capacity exceeding 350 kWr supplying chilled water to comfort conditioning systems shall have controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outdoor air temperature.

3.6.9 Variable Air Volume Fan Control

Fans in Variable Air Volume (VAV) systems shall have controls or devices that will result in fan motor demand of no more than 30% of their design wattage at 50% of design airflow when static pressure set point equals one-third of the total design static pressure, based on manufacturer's certified fan data.

3.7 Piping and Ductwork

3.7.1 Piping Insulation

Piping for heating, space conditioning, and service hot water systems shall meet the insulation requirements listed in Table 3-4. Insulation exposed to weather shall be protected by aluminum sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above, or be painted with water retardant paint.

Table 3-4 Insulation Requirements for Pipes in SuperECBC Buildings

Operating Temperature (ºC)	**Pipe size (mm)**	
	< 40	>=40
	Insulation R value (m^2-ºK/W)	
Heating System		
94°C to 121°C	1.5	1.5
60°C to 94°C	1.0	1.3
40°C to 60°C	0.7	1.1
Cooling System		
4.5°C to 15°C	0.7	1.2
< 4.5°C	1.5	1.5
Refrigerant Piping (Split Systems)		
4.5°C to 15°C	0.4	0.7
< 4.5°C	1.5	1.5

3.7.2 Ductwork and Plenum Insulation

Ductwork and plenum shall be insulated in accordance with Table 3-5.

Table 3-5 Ductwork Insulation (R value in m^2K/W) Requirements

Duct Location	**Supply ducts**	**Return ducts**
Exterior	R -1.4	R -0.6
Unconditioned Space	R -0.6	None
Buried	R -0.6	None

3.8 System Balancing

Compliance documents shall include a written balance report from a third-party commissioning consultant.

3.9 Condenser Location

Condensers shall be located such that the heat sink is free of interference from heat discharge by devices located in adjoining spaces, and do not interfere with other such systems installed nearby.

3.10 Fan Efficiency

Supply, exhaust, and return or relief fans with motor power exceeding 0.37 kW shall meet or exceed the minimum energy efficiency requirements specified in Table 3-6

Table 3-6 Mechanical and Motor Efficiency Requirements for Fans in SuperECBC Buildings

System Type	***Fan Type***	***Mechanical Efficiency***	***Motor Efficiency (As per IS 12615)***
Air-handling unit	Supply, return and exhaust	70%	IE 4

3.11 Pumps

Chilled and condenser water pumps shall meet or exceed the minimum energy efficiency requirements specified in Table 3-7. Requirements for pumps in district chiller systems and hot water pumps for space heating are limited to the installed efficiency requirement of individual pump equipment only. To show compliance, calculate the total installed pump capacity in kilo watt and achieve the prescribed limits per kilo watt of refrigeration installed in the building.

Table 3-7 Pump Efficiency Requirements for SuperECBC Building

Equipment	*SuperECBC Building*
Chilled Water Pump (Primary and Secondary)	14.9 W/ kW_r with VFD on secondary pump
Condenser Water Pump	14.6 W/ kW_r
Pump Efficiency (minimum)	85%

3.12 Cooling Towers

Cooling towers shall meet or exceed the minimum efficiency requirements specified in Table 3-8. Buildings shall have additional VFD installed in the cooling towers.

Table 3-8 Cooling Tower Efficiency Requirements for ECBC, ECBC+, and SuperECBC Buildings

Equipment type	*Rating Condition*	*Efficiency**
Open circuit cooling tower Fans	35°C entering water 29°C leaving water 24°C WB outdoor air	0.017 kW/kW_r *0.31 kW/ L/s*

3.13 Economizer

Each individual cooling fan system shall include either:

(a) An air economizer capable of modulating outside-air and return-air dampers to supply 50 percent of the design supply air quantity as outside-air.

(b) A water economizer capable of providing 50% of the expected system cooling load at outside air temperatures of 10°C dry-bulb/7.2°C wet-bulb and below.

3.13.1 Partial Cooling

Economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the cooling load.

3.13.2 Controls

Air economizer shall be equipped with controls

(a) That allow dampers to be sequenced with the mechanical cooling equipment and not be controlled by only mixed air temperature.

(b) capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage.

(c) High-limit shutoff shall be specified.

3.14 Variable Flow Hydronic Systems

3.14.1 Variable Fluid Flow

HVAC pumping systems having a total pump system power exceeding 7.5 kW shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to an extent which is lesser or equal to the limit, where the limit is set by the larger of:

(a) 50 per cent of the design flow rate, or

(b) the minimum flow required by the equipment manufacturer for proper operation of the chillers or boilers.

3.14.2Isolation Valves

Water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 3.7 kW shall have two-way automatic isolation valves on each water cooled air-conditioning or heat pump unit that are interlocked with the compressor to shut off condenser water flow when the compressor is not operating.

3.14.3Variable Speed Drives

Chilled water or condenser water that have pump motors greater than or equal to 3.7 kW shall be controlled by variable speed drives.

3.15 Energy Recovery

All systems of capacity greater than 2100 liters per second and minimum outdoor air supply of 70% shall have air-to-air heat recovery equipment with minimum 50% recovery effectiveness.

At least 50% of heat shall be recovered from diesel and gas fired Generator sets. Gas and oil fired boilers shall meet or exceed the minimum efficiency requirements specified in Table 3-9.

Table 3-9 Minimum Efficiency Requirements for Oil and Gas Fired Boilers for SuperECBC building

Equipment Type	Sub Category	Size Category	Minimum FUE
Boilers, Hot Water	Gas or oil fired	All capacity	85%
FUE - fuel utilization efficiency			

4 Service Hot Water Heating

4.1 Solar Water Heating

Building shall have solar water heating equipment installed to provide at least 60% of the total hot water design capacity. Exception: Systems that use heat recovery to provide the hot water capacity required as per the efficiency level or building size.

4.2 Heating Equipment Efficiency

Service water heating equipment shall meet or exceed the performance and minimum efficiency requirements presented in available Indian Standards

(a) Solar water heater shall meet the performance/ minimum efficiency level mentioned in IS 13129 Part (1&2)

(b) Gas Instantaneous water heaters shall meet the performance/minimum efficiency level mentioned in IS 15558 with above 80 per cent Fuel utilization efficiency.

(c) Electric water heater shall meet the performance/ minimum efficiency level mentioned in IS 2082.

4.3 Other Water Heating System

Supplementary heating system shall be designed to maximize the energy efficiency of the system and shall incorporate the following design features in cascade:

(a) Maximum heat recovery from hot discharge system like condensers of air conditioning units,

(b) Use of gas fired heaters wherever gas is available, and

(c) Electric heater as last resort.

4.4 Heat Traps

Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a non-recirculating system shall have heat traps on both the inlet and outlet piping.

5 Lighting and Controls

5.1 Automatic Lighting Shutoff

At least 90% of interior lighting fittings in building shall be equipped with automatic control device. Additionally, occupancy sensors shall also be provided in:

(a) All habitable spaces less than 30 m2, enclosed by walls or ceiling height partitions;

(b) All storage or utility spaces more than 15 m2 in all building types with

(c) Public toilets more than 25 m2, controlling at least 80 % of lighting fitted in the toilet. The lighting fixtures, not controlled by automatic lighting shutoff, shall be uniformly spread in the area;

(d) in all conference rooms

Automatic control device shall function on either:

(a) A scheduled basis at specific programmed times. An independent program schedule shall be provided for areas of no more than 2,500 m^2 and not more than one floor; or,

(b) Occupancy sensors that shall turn the lighting off the lighting fixtures within 15 minutes of an occupant leaving the space. Light fixtures controlled by occupancy sensors shall have a wall-mounted, manual switch capable of turning off lights when the space is occupied.

Exception: Lighting systems designed for emergency and firefighting purposes.

5.2 Space Control

Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing an occupant. Each control device shall

(a) control a maximum of 250 m^2 for a space less than or equal to 1,000 m^2, and a maximum of 1,000 m^2 for a space greater than 1,000 m^2.

(b) have the capability to override the shutoff control required in § 5.1 for no more than 2 hours, and

(c) be readily accessible and located so the occupants can see the control.

Exception: The required control device may be remotely installed if required for reasons of safety or security. A remotely located device shall have a pilot light indicator as part of or next to the control device and shall be clearly labeled to identify the controlled lighting.

5.3 Control in Daylight Areas

Luminaires, installed within day lighting extent from the window, shall be equipped with either a manual control device to shut off luminaires, installed within day lit area, during potential daylit time of a day or automatic control device that:

(a) Has a delay of minimum 5 minutes,

(b) can dim or step up to 50% of total power.

Overrides to the daylight controls shall not be allowed. Building shall have centralized control system for schedule based automatic lighting shutoff switches.

5.4 Exterior Lighting Control

(a) Lighting for all exterior applications shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.

(b) Lighting for all exterior applications, shall have lamp efficacy not less than 100 lumens per watt unless the luminaire is controlled by a motion sensor.

(c) Façade lighting and façade non-emergency signage of Shopping Complexes shall have separate time switches.

Exemption: Exterior emergency lighting.

5.5 Exit Signs

Internally-illuminated exit signs shall not exceed 5 Watts per face.

5.6 Interior Lighting Power

The installed interior lighting power shall not exceed the interior lighting power allowance of 4.6 W/m2.

5.7 Exterior Lighting Power

Connected lighting power of exterior lighting applications shall not exceed the lighting power limits specified in Table 5-1. Trade-offs between applications is not permitted.

Table 5-1 Exterior Building Lighting Power for SuperECBC Buildings

Exterior lighting application	*Power limits*
Building entrance (with canopy)	5.0 W/m^2 of canopied area
Building entrance (w/o canopy)	45 W/ linear m of door width
Building exit	30 W/lin m of door width
Building façade	2.5 W/m^2 of vertical façade area
Emergency signs, ATM kiosks, Security areas façade	0.5 W/m^2
Parking areas (covered/ basement)	1.1 W/m^2
Driveways (covered/ basement)	1.5 W/m^2
Driveways and parking (open/ external)	0.8 W/m^2
Pedestrian walkways	1.0 W/m^2
Stairways	5.0 W/m^2
Landscaping	0.25 W/m^2
Outdoor sales area	4.5 W/m^2

6 Electrical Systems

6.1 Transformers

6.1.1 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50 per cent and full load rating.

Permissible total loss values shall not exceed

(a) 5 per cent of the maximum total loss values mentioned in IS 1180 for oil type transformers in voltage class above 11 kV but not more than 22 kV

(b) 7½ percent of the maximum total loss values mentioned in above IS 1180 for oil type transformers in voltage class above 22 kV and up to and including 33 kV

(c) values listed in Table 7.1 for dry type transformers

Table 6-1 Dry Type Transformers

Rating (kVA)	***Impedance (percent)***	**Max. losses (W)**	
		50 % Load	100% Load
16	4.5	120	400
25	4.5	175	595
63	4.5	300	1,050
100	4.5	435	1,500
160	4.5	570	1,700
200	4.5	670	2,100
250	4.5	920	2,700
315	4.5	955	2,750
400	4.5	1,150	3,330
500	4.5	1,430	4,100
630	4.5	1,745	4,850
1000	5	2,620	7,000
1250	5	3,220	8,400
1600	6.25	3,970	11,300
2000	6.25	4,790	14,100
2500	6.25	5,900	17,500

Table 6-2 Permissible Losses for Oil Type Transformers. Total losses for oil type transformers should confirm with Indian Standard IS 1180.

Rating (kVA)	***Impedance (percent)***	**Max. losses (W)**	
		50 % Load	100% Load
16	4.5	120	400
25	4.5	175	595
63	4.5	300	1050

100	4.5	435	1500
160	4.5	570	1700
200	4.5	670	2100
250	4.5	920	2700
315	4.5	955	2750
400	4.5	1150	3330
500	4.5	1430	4100
630	4.5	1745	4850
1000	5	2620	7000
1250	5	3220	8400
1600	6.25	3970	11300
2000	6.25	4790	14100
2500	6.25	5900	17500

6.1.2 Measurement and Reporting of Transformer Losses

All measurement of losses shall be carried out by using calibrated digital meters of class 0.5 or better accuracy and certified by the manufacturer. All transformers of capacity of 500 kVA and above would be equipped with additional metering class current transformers (CTs) and potential transformers (PTs) additional to requirements of Utilities so that periodic loss monitoring study may be carried out.

6.2 Voltage Drop

Voltage drop for feeders shall not exceed 2% at design load. Voltage drop for branch circuit shall not exceed 3 per cent at design load.

6.3 Energy Efficient Motors

Motors shall also comply with the following:

i. Three phase induction motors shall conform to Indian Standard (IS) 12615 and shall fulfil the following efficiency requirements:

ii. Buildings shall have IE 4 (super premium efficiency) class motors

iii. All permanently wired polyphase motors of 0.375 kW or more serving the building and all permanently wired polyphase motors of 50kW or more serving the building shall have a minimum acceptable nominal full load motor efficiency not less than levels specified in the latest version of IS 12615.

iv. Motors of horsepower differing from those listed in the table shall have efficiency greater than that of the next listed kW motor.

v. Motor horsepower ratings shall not exceed 20 per cent of the calculated maximum load being served.

vi. Motor nameplates shall list the nominal full-load motor efficiencies and the full-load power factor.

vii. Motor users should insist on proper rewinding practices for any rewound motors. If the proper rewinding practices cannot be assured, the damaged motor should be replaced with a new, efficient one rather than suffer the significant efficiency penalty associated with typical rewind practices. Rewinding practices from BEE guideline for energy efficient motors shall be followed.

viii. Certificates shall be obtained and kept on record indicating the motor efficiency. Whenever a motor is rewound, appropriate measures shall be taken so that the core characteristics of the motor is not lost due to thermal and mechanical stress during removal of damaged parts. After rewinding, a new efficiency test shall be performed and a similar record shall be maintained.

6.4 DG Sets

DG sets in buildings shall have:

(a) minimum 5 stars rating in SuperECBC Buildings

6.5 Power Factor Correction

All 3 phase shall maintain their power factor at the point of connection as follows:

(a) 0.99

6.6 Check-Metering and Monitoring

(a) Services exceeding 1000 kVA shall have permanently installed electrical metering to record demand (kVA), energy (kWh), and total power factor. The metering shall also display current (in each phase and the neutral), voltage (between phases and between each phase and neutral), and total harmonic distortion (THD) as a percentage of total current.

(b) Services not exceeding 1000 kVA but over 65 kVA shall have permanently installed electric metering to record demand (kW), energy (kWh), and total power factor (or kVARh).

(c) Services not exceeding 65 kVA shall have permanently installed electrical metering to record energy (kWh).

Table 6-3 Sub Metering Requirements

	120 kVA to 250 kVA	**Greater than 250 kVA**
Energy kWh	Required	Required
Demand kVA	Required	Required
Total power factor	Required	Required
HVAC system and components	Required	Required
Lighting (interior and exterior) *	Not required	Required
Domestic hot water	Not required	Required
Plug loads	Not required	Required
Renewable power source	Required	Required

6.7 Power Distribution Systems

The power cabling shall be sized so that the distribution losses do not exceed

(a) 1 per cent of total power usage

Record of design calculation for the losses shall be maintained. Load calculation shall be calculated up to the panel level.

6.8 Uninterruptible Power Supply (UPS)

In all buildings, UPS shall meet or exceed the energy efficiency requirements listed in Table 6-4.

Table 6-4 Energy Efficiency Requirements for UPS for ECBC, ECBC+, SuperECBC building

UPS Size	Energy Efficiency Requirements at 100% Load
kVA< 20	90.2%
20<=kVA <= 100	91.9%
kVA > 100	93.8%

7 Renewable Energy Systems

All buildings shall have provisions for installation of renewable energy systems in the future on rooftops or the site.

7.1 Renewable Energy Generating Zone (REGZ)

A dedicated REGZ equivalent to at least 25 % of roof area or area required for generation of energy equivalent to 4 per cent of connected load of the building shall be provided in all buildings. The REGZ shall be free of any obstructions within its boundaries and from shadows cast by objects adjacent to the zone.

7.2 Main Electrical Service Panel

Minimum rating shall be displayed on the main electrical service panel. Space shall be reserved for the installation of a double pole circuit breaker for a future solar electric installation.

7.3 Demarcation on Documents

The following shall be indicated in design and construction documents:

(a) Location for inverters and metering equipment,

(b) Pathway for routing of conduit from the REGZ to the point of interconnection with the electrical service,

(c) Routing of plumbing from the REGZ to the water-heating system and,

(d) Structural design loads for roof dead and live load.

GUIDELINES ON ENERGY EFFICIENT LIGHTING DESIGN FOR INSTALLATIONS OVER INDIAN RILWAYS

The primary objective of the Energy Conservation Building code 2007 published by Bureau Of Energy Efficiency (BEE) , is to set out the minimum energy-efficient design standards for lighting installations without imposing any adverse constraint on building functions. The Guidelines on Energy Efficiency of Lighting Installations (Guidelines) issued by RDSO is aimed to achieve lighting level as stipulated in the ECBC Code meeting Efficiency Standards. The intention of these Guidelines is to provide guidance to comply with the **ECBC Code**, and general recommended practices for Energy Efficiency and Conservation on the Design, operation & maintenance of lighting installations.

The direction to achieve energy efficient lighting depends on both the technological factors and the operational factors of the lighting system. Among them, the operational factors should prevail the technological factors, and should be considered by building owners as first priorities because the effort or cost for implementing good housekeeping measures is usually lower than that for implementing the technological measures. On the other hand, the advantages of energy efficient design and equipment may be easily offset by improper operation & maintenance of the original system. For existing installations, new technologies have provided plenty of options to retrofit into more energy efficient installations with attractive payback periods.

The ECBC Code stipulates control at both microscopic level and macroscopic level. There is the minimum allowable luminous efficacy for the former, and the maximum allowable lighting power density for the later.

1.0 Minimum Allowable Luminous Efficacy

This controls the choice of lamps. Different lamp manufacturers supply lamps of different efficacy characteristics, and different lamp models of the same manufacturer could also have different efficacy characteristics. Compliance with the ECBC Code requirement will mean the lamp of whatever make or model does have a certain “minimum” efficacy performance, which could also lend to a more readily compliance with the Lighting Power Density (LPD) requirements. Designers should base upon their overall design requirements such as color rendering, color temperature as well as energy efficiency to choose the most appropriate type of lamps.

1.1 Maximum Allowable Lighting Power Density (LPD)

This controls the maximum allowable power per square meter in a given space The Code itself does not specify the illumination levels, which should have be confirming to illumination levels depending upon activity and space as per relevant standards. The designer can exercise his discretion and manipulate this flexibility in determining the illumination level according to his need, and there may be reiterations in order to arrive at a LPD value meeting the Code requirement.

To add architectural feature to a space, sometimes fixed decorative lights e.g. recessed up lights for the purpose in addition to general lighting are used, and designers should allow suitable margin in the LPD of the general lighting to make room for the decorative lights.

In some designs, there are two lighting systems serving the same space, one to provide the general illumination to the space, and the other to provide the added illumination for the accent or task. An example is the fixed lighting in an office to provide an illumination level of 300 lux and lighting on desks to provide additional illumination, resulting at 500 lux at the working plane, the desk top. In this case, the office will have two levels of illumination, 300 lux at areas away from the desk and 500 lux at the desktop

2.0 Approaches to Comply with ECBC Code

2.1 Calculations

For compliance with the Code, checking for compliance against the Minimum Allowable Luminous Efficacy values would be straight forward, as the lumen values are normally shown in catalogues or available upon request from lamp suppliers, and the lamp performance in this regard is merely the quotient of dividing lumen by wattage of the lamp.

The requirement on Interior Lighting Control is only a matter of placing adequate number of operating switches for the lighting systems. The Maximum Allowable Lighting Power Density values on the other hand require some calculation. This parameter is a consolidated indication of the lighting equipment's efficacy and the design illumination level, and designers could have a pretty large room to maneuver and obtain a balance between the two dimensions. The formulation of a lighting scheme that complies with the Maximum Allowable Lighting Power Density requirements may require reiterations on different alternative lighting designs.

To calculate the Lighting Power Density, there are two approaches:

2.2 Forward Approach

This is the most straight forward approach, whereby the lighting designer first layouts the luminaires in a space according to their photometric performances, calculate the total circuit power and divide this by the area of the space, and finally compare the quotient with the values of Maximum Allowable Lighting Power Density given in the Lighting CODE.

2.3 Backward Approach

This is the reverse of the Forward Approach. Designers first find the value of the Maximum Allowable Lighting Power Density of the space under consideration and then multiply this by the space area to obtain the maximum allowable installed power for the lighting system. The designer then obtains the number of fittings by dividing this allowable installed power by the power of the luminaires. This value is finally compared with the quantity of luminaires obtained by the basic lumen calculation method to see whether the lighting scheme will work or not.

2.4 Choice of Lamp Type & Associated Control Gear:

A lamp's efficacy basically determines how efficient electrical energy is converted into light output. The higher the luminous efficacy, the lower the wattage will be. Designers should specify energy efficient lamps, for example T5 or T8 fluorescent lamp rather than T12 lamp, compact fluorescent lamp instead of incandescent lamp etc. Another undesirable effect in low efficacy lamp is the amount of heat produced by the lamp as a result of inefficiency will increase the air conditioning load of the space. Thus the air conditioning equipment will consume more electricity to remove the generated heat. Though the electricity consumed by the air conditioning equipment is not to be calculated in the Lighting Power Density, it will increase the overall electricity consumption of the building.

2.5 Choice of Lighting System and Luminaires :

The Utilization Factor is a characteristic of both the room and the luminaires. It will significantly affect how much light from the lamp(s) can reach the horizontal working plane. It is therefore desirable to choose lighting equipment of higher Utilization Factor. The computation of Utilization Factor is fairly tedious as it involves the determination of direct light components and the reflected components from the ceiling, the wall surfaces and the floor. Luminaire manufacturers usually publish pre-calculated table(s) of Utilization Factors for their products.

The Utilization Factor increases with the Room Index (RI), which is defined by:

$$RI = \frac{L \times W}{(L + W) \times H}$$

Where
L = Length of room
W = Width of Room
H = Height of luminaires above working plane

Higher Room Index merely means high area to perimeter ratio and/or lower mounting height of the luminaires. The high area to perimeter ratio means that the room should be a narrow rectangular corridor shape.

Apart from this fittings with reflectors have much higher Utilization Factor then fittings with opal and prismatic diffusers. The difference can be as high as 70-80%, which is very significant. Thus in new installations, designers should specify reflector lamps whenever feasible.

Besides the Utilization Factor, the space to height ratio requirement of the luminaire will also affect the Lighting Power Density of the installation. The space to height ratio determines the number of fittings that will be required to obtain a reasonable uniformity despite of the Utilization Factor. The values of Utilization Factor are usually computed based on a nominal space to height ratio . The smaller the nominal space to height ratio, the larger the number of luminaire fittings will be required to maintain uniformity, thus increasing the power requirement of the lighting installation. Fluorescent light fittings usually have lower Utilization Factors but a higher value of nominal space to height ratio when comparing with down light fitting. Typical figure of nominal space to height ratio for fluorescent fittings are in the range of 1.5 to 2 while that for down light fittings are around 0.5. It means that if down light fittings are to be used for general lighting purpose; the number of fittings required for uniformity reason will be about 3 – 4 times than fluorescent fittings.

The choice of appropriate control gear also help to reduce the Lighting Power Density especially when the designer intends to use lamps of lower power ratings which make the control gear power loss a significant “overhead” of a luminaire’s total power.

2.6 Choice of Power Rating of Lamps:

For same type of lamp and luminaire model, the choice of appropriate lamp wattage can have significant effect in the Lighting Power Density. Generally, the efficacy of a lamp increases with its power rating. For example, the efficacy of a 7W compact fluorescent lamp is around 57 while that for a 55W one is around 87. Furthermore, the energy loss in control gear will become a significant portion for smaller power rating lamps because the number of fittings required to be installed

is much more than other lighting scheme using higher power rating lamps. However, one should always take care of the problem of glare and uniformity when using lamps of high power rating. The two factors together will produce a significant effect on the power density.

2.7 Maintenance of the Luminaire and Lamp:

In calculating the number of light fittings required for a particular space, designers should also assess the future maintenance condition of the installation. The basic lumen method equation has allowed a margin in the factor LLF to be added to the design to allow for loss in dirt accumulation in the luminaire, lumen depreciation of lamp, burnt out of lamp, and dirt on room surfaces etc . This add-on margin always results in over design when the luminaires and room surfaces are in good conditions. In some extreme cases, the margin can be as high as 40-50%, which means that the installation is over design for 40-50% at its initial operating period. A reduced margin can reduce the number of luminaires needed to achieve the required illumination level thus lowering down the Lighting Power Density. In a pragmatic way, the improved maintenance practice should be adopted to minimize this over design during initial period.

3.0 DESIGN CONSIDERATIONS

Energy is the product of power and time. The energy cost of a lighting installation depends on its connected power (Watts or kilo Watts) as well as its operation time (hours). The factors related to power or connected load of a lighting system are discussed here, whilst the factors that affect operating time of the system are discussed in Section 4.

3.1 Factors Affecting Energy Consumption of Lighting Installations:

The connected power of a lighting installation is affected by the following factors :

3.1.1 Luminous Environment

- Illumination levels required for different tasks;
- Space area;
- Color rendering;
- Visual comfort.

3.1.2 Physical Environment

- Physical dimensions;
- Room surfaces reflectance;
- Furnishing and obstructions.

3.1.3 Lighting Equipment Characteristics

- Efficacy, average lamp life, color characteristics and lumen depreciation of light sources;
- Light distribution, efficiency and glare control of luminaires;
- Wattage loss and control gear loss of ballasts.

As regards the operation hours of a lighting installation, the following factors need to be considered :

- Availability of daylight (if an automatic lighting control system is installed to allow efficient use of daylight);
- Occupancy schedule;
- Maintenance schedule of a lighting installation.

A multi-illumination level design could be considered to achieve more energy saving.

3.2 General Principles of Achieving Energy Efficient LightingInstallations:

Generally, the design criteria are :

- Light sources of high luminous efficacies;
- Lamp control gears of low energy losses;
- luminaires of high light output ratios;
- room surfaces of high reflectance;
- optimum mounting height.

However, the energy efficiency criteria interact with other lighting effect criteria, and appropriate trade-offs may be necessary.

3.3 Selection of Lighting Equipment

From energy efficiency point of view, it is recommended to choose light sources with high luminous efficacies. Nevertheless, such energy criterion should be compatible with other lighting design criteria. In many applications, the optical features (e.g. color temperature, color rendering index, light distribution curve, etc.) are frequently the lead criteria in choosing lamp types and lamp efficacy may impose a secondary consideration.

3.3.1 Selection of Light Sources

Light sources used today in artificial lighting can be divided into two main categories : incandescent and gaseous discharge. The gaseous discharge type of lamp is either low or high pressure. Low-pressure gaseous discharge sources are

the fluorescent and low-pressure sodium lamps. Mercury vapor, metal halide and high-pressure sodium lamps are considered to be high-pressure gaseous discharge sources.

3.3.2 Major Types of Light Sources

3.3.2.1 Incandescent Lamps (GLS)

Incandescent Lamps or General Lighting Service Lamps (GLS) have the lowest range of lamp efficacies of the commonly used lamps. Incandescent Lamps should in general not be used for a large area or where a more efficient light source could serve satisfactorily. GLS do not have good lumen maintenance throughout their life. This is the result of the tungsten being evaporated off the filament during heating and being deposited on the bulb wall, thus darkening the bulb wall and reducing the lumen output.

3.3.2.2 Tungsten Halogen Lamps (TH)

Tungsten Halogen (Quartz) Lamps also work on the same principle of GLS. However they do not suffer from the tungsten evaporation problem of GLS because they use a halogen regenerative cycle so that the tungsten driven off the filament is being deposited back on to the filament rather the bulb wall. Thus, tungsten halogen lamps may retain lumen outputs in excess of 95 % of initial values throughout their lifetime.

3.3.2.3 Tubular Fluorescent Lamps (TFL)

Fluorescent lamps now range from about 30 lm/W to 100 lm/W. The color spectrum of the light emitted is more complete than other vapor discharge lamps. Lamp manufacturers have recently made significant progress in developing fluorescent tubes that have much more superior color rendering properties. This has enlarged the areas for application of fluorescent tubes. Besides, manufacturers have also developed tubular fluorescent lamps of different color temperatures to suit different requirements. On the other hand, new fluorescent tubes have more and more energy efficient. The series of T8 fluorescent tubes is much more energy efficient than its predecessor the T12 or T10, and T5 more energy efficient than T8.

3.3.2.4 Compact Fluorescent Lamps (CFN, CFG)

Compact fluorescent lamps open up a whole new market for fluorescent sources. These lamps permit design of much smaller luminaires, which can compete with incandescent and mercury vapor in the market of lighting fixtures having round or square shapes. Products in the market are available with either built in control gear (CFG) or separate control gear (CFN).

3.3.2.5 Metal Halide Lamps (MH)

Metal Halide Lamps have a lamp efficacy range of approximately 75-125 lm/W. They are more energy efficient than mercury vapor lamps but less energy efficient than high pressure sodium lamps. However, they normally require a longer re-strike time (around 15-20 minutes at 21 o C) to restart after being switched off.

Manufacturers have developed different type of MH , They all work in same principles except there is slight difference in optical performance due to slight difference in the lamp components.

3.3.2.6 High Pressure Sodium Lamp (HPSV)

High Pressure Sodium Lamps have very high efficacy (up to 140 lm/W). In addition, they have the advantages of good lumen maintenance and long average lamp life that make such lamps ideal sources for industrial and outdoor applications where color discrimination is not critical. It is possible to attain a quite satisfactory color rendering by mixed usage of high pressure sodium lamps and metal halide lamps in proper proportions. Since both sources have relatively high efficacies, the loss in energy efficiency is not significant by making this combination. There are also different types of HPSV lamps, Like the MH, they have slight difference in optical performance.

3.3.2.7 Low Pressure Sodium Lamp (LSSV)

Low Pressure Sodium Lamps provide the highest efficacy of light sources for general lighting with range up to 180 lm/W. It is a good light source for applications where color rendering is not important, and a high wattage lamp is not required.

3.3.2.8 Mercury Vapor (MVL)

Mercury Vapor Lamps operate in quartz arc tube. The internal surface of the outer elliptical bulb is coated with a phosphor, which converts ultra-violet radiation from the discharge into light. MBF lamps are usually used in industry for low initial cost where color rendering is not a major factor. In terms of energy, the efficacy of MVL is less than HPSV.

3.3.2.9 Light Emitting Diode (LED)

LED is a semiconductor chip supported by a reflector and encapsulated with an epoxy lens for controlling light distribution. Contrary to conventional lamps, the LED lamp has no filament or breakable glass bulb. Color of light output depends on the semiconductor materials used in the chip which require different voltages to enable electron flow. Common light colors available are red, red-orange, amber, green cyan, blue and white. LED tends to have a longer service life (50,000 hours). LED Lamps provide the efficacy range up to 140 lm/W.

3.3.2.10 Induction Lamp

The induction lamp operates based on the principle of induction. The lamp has a primary coil. With the passing through of an alternating current in the primary coil, a current will be induced in the mercury vapor inside the lamp, the vapor playing the role of the secondary coil. The induced current circulates through the vapor, causing acceleration of free electrons, which collide with the mercury atoms and bring electrons to a higher orbit. Electrons from these excited atoms fall back from this higher energy state to the lower stable level and consequently emit ultraviolet radiation, which interact with the fluorescent powder coated inside the lamp to convert to visible light. The induction lamp has long operation life, good color rendering and high efficacy, and is a good candidate for high wattage HID

luminaire (80W & above per lamp) that has difficult access such as high bay lighting, sports arena lighting and outdoor lighting. However, care should be taken on the induced electromagnetic interference.

3.3.3 Optical Characteristic of Major Types of Light Sources

The main optical characteristics in choosing the light source are :

- color temperature of the light source
- color rendering requirement of light source

Table 3.3.3a - gives typical color temperatures of major types of light source:

SL NO	COLOR TEMP (K)	TYPE OF LIGHT SOURE
1	6500	TFL
2	5200	MH
3	4000	TFL,MH
4	3800	MH
5	3500	TFL
6	3300	MVL
7	3200	TFL
8	3000	MH, TH
9	2900	TFL
10	2700	TFL,GSL
11	2200	HPSV
12	2000	HPSV

TABLE 3.3.3a – Color Temperature of Various Types of Light Source

Table 3.3.3b - gives a brief description of the color rendering performance.

S.No.	Minimum	Description
i	Class 1A	Excellent color quality. Where accurate color matching is required (e.g. color printing inspection)
ii	Class 1B	Very good color quality. Where accurate color judgment or good color rendering is required for
iii	Class 2	Good color quality. Where moderate color rendering is required, good enough for merchandising
iv	Class 3	Poor color quality. Where color rendering is of little importance. Color can be distorted but marked distortion is not acceptable
v	Class 4	Very poor color quality. Color rendering is of no importance and severe distortion of colors is acceptable

Table 3.3.3b – Color Rendering Performance Classes

Table 3.3.3c gives a color rendering guide for each of the major light sources described above :

S.No.	Class	Type
i	1A	TFL,GLS, TH
ii	1B	TFL,MH
iii	2	TFL,MH, HPSV
iv	3	TFL, MH

Table 3.3.3c – Color Rendering Guide

3.3.4 Energy Characteristic of Major Types of Light Sources

With different working principles, different types of light source have different energy performance characteristic. When considering the energy performance of light sources, two aspects should be considered:

- the efficacy of the lamp
- the lumen maintenance of the lamp

Figure 3.3.4a shows the efficacy comparison of some major types of lamps. One should note that the comparison is based on the total circuit watts, which give an overall system efficacy of the lighting. The comparison is also based on initial lumen output as the lumen maintenance characteristic of different type of lamps is different:

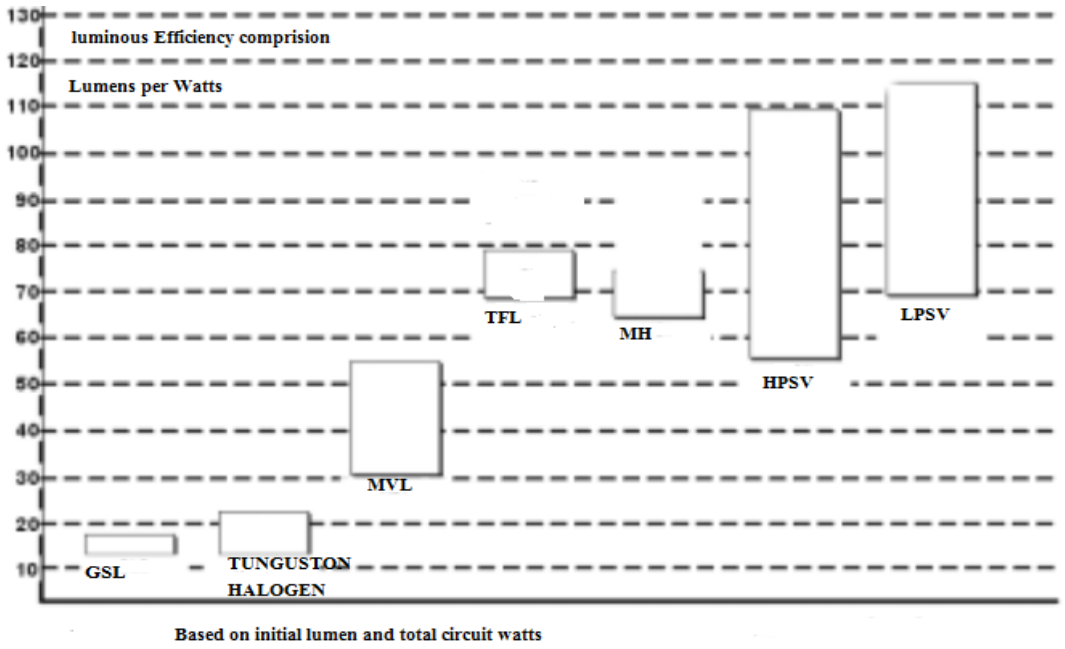


Figure 3.3.4a – Luminous Efficacy Comparison of Light Sources

The lumen maintenance describes the depreciation in lumen output of the lamp throughout the average lamp life of the lamp source. GLS lamps usually fail before there is significant decline of output. Thus it is usually sufficient to indicate the life survival of the GLS lamps. It should be noticed that the dirt would also depreciate the lumen output of the lamp. However, in mentioning the lumen maintenance the dirt effect is not taken into consideration. Figure 3.3.4b is a typical figure of the lumen maintenance curve, and one should aware that there may be slight differences in the depreciation behavior for same type of lamp from different manufacturers. In designing the lighting system, the designer should check with the manufacturer the actual lumen maintenance characteristic of the lamp source.

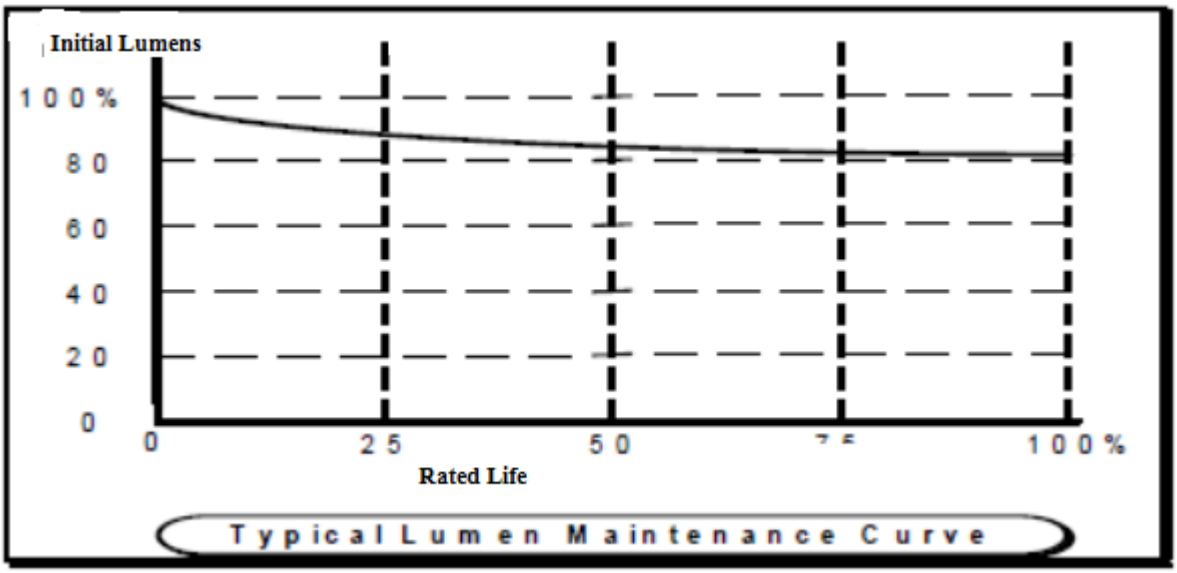


Figure 3.3.4b – Typical Lumen Maintenance Curve

In general at the rated life of operation, SON usually depreciates to about 80%, MH to about 60%, MVL 50% and TFL 70-80%. Choosing suitable lamp source can avoid the need of extreme over design at the initial lumen in order to compensate for the light depreciation during the operation life span. Over design will affect the compliance to the "Lighting Power Density" requirement of the Code.

3.3.5 Ballast Selection

All high intensity discharge lamps (HID) and fluorescent lamps need ballasts to perform properly. The ballasts consume power and affect lumen output of discharge lamps. Low loss ballasts are available for fluorescent lamps to provide higher operating efficiencies, with some providing maximum power savings with reduced lamp lumen output.

3.3.6 Major Types of Ballast

3.3.6.1 Electromagnetic Ballasts

This category represents the more or less traditional, copper-iron control gear for lamps. They usually consist of a choke and a capacitor for power factor correction. The initial cost for installing electromagnetic ballasts is relatively low compared with electronic type ballasts. However, this low capital cost may be at the expense of both inferior energy performance as well as the light output quality. Electromagnetic ballasts can be used with fluorescent lamps as well as high pressure discharge lamps.

3.3.6.2 Electronic Ballasts

These ballasts have the potential for lowest ballast loss. Using electronic ballasts in fluorescent lamps can enhance significantly system efficiency as well as enhancing light output quality. Economic analysis generally reveals a higher initial cost for systems employing electronic ballasts but a lower operating cost. The total annual owning and operating cost for these systems is usually lower than that with electromagnetic ballasts. Another advantage of using electronic ballasts is the overall air conditioning load that is reduced due to lower heat generation from the ballasts.

3.3.7 Energy Performance of Ballasts

3.3.7.1 Electromagnetic Ballasts:

Electromagnetic ballasts in fluorescent tubes can be classified into:

3.3.7.2 Standard Ballasts:

They have high loss steel cores. Typically, the ballast loss of standard ballast comprises about 17% of fluorescent system power. They are not recommended for new lighting installations or even to replace broken down ballasts individually.

3.3.7.3 Energy Efficient Ballasts:

Also named as low loss ballast in the market. These ballasts use a better grade of steel in the cores and the ballast loss is around 75% that of standard ballasts. Lower loss also resulted in lower luminaire temperature. These barely comply with the ballast loss requirements in the Code.

3.3.7.4 Electronic Ballasts:

Electronic ballasts usually have lower ballast loss when comparing with electromagnetic ballasts. They normally operate the fluorescent lamps at a much higher frequency then the main 50Hz frequency. The result of operating the fluorescent lamps at higher frequencies can significantly enhance the lumen/Watt of the lamp output as fluorescent lamps are sensitive to the operating frequency. Figure 3.3.7 shows a typical fluorescent lamp's output with respect to the operating frequency:

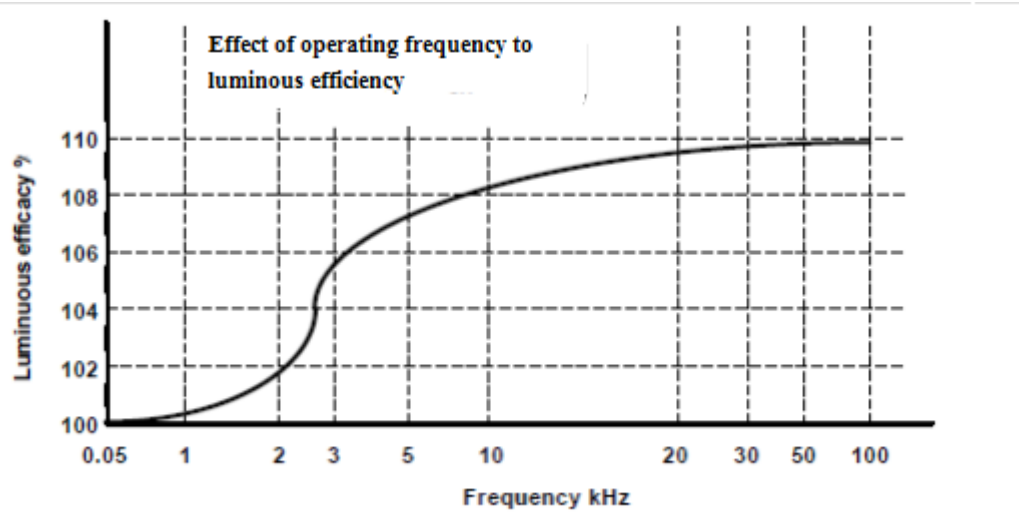


Figure 3.3.7 – Effect of Operating Frequency to Luminous Efficacy

It is worth noticing that the efficacy of the lamp can be improved by about 10% when fluorescent lamps are operated at higher frequencies. The graph shows that the gain is less marked at a frequency in excess of 30kHz, thus in real world applications, electronic ballasts usually operate at a range near this region. The improved efficacy of the lamps implies that the wattage required to produce the same lumen output is reduced. An energy saving of up to 25% can be achieved when all the benefits are taken into consideration.

3.3.7.5 Power Factor of Ballasts

From energy point of view, the measured wattage does not represent the true electricity consumption. A low power factor will result in considerably larger currents being required as indicated in the VA figures. These larger currents have a considerable “wattless” component but may lead to higher losses in the whole supply network. With power factors as low as 0.4 this current ratio can be 2.5 (VA/W) and the wasted power would then be an additional 44% above the measured power.

3.4 Selection of Luminaire:

By selecting an appropriate luminaire that results in a reasonable illuminance, minimum direct glare, reflected glare and veiling reflections, both of the task visibility and productivity can be improved.

An important consideration of lighting efficiency is the Utilization Factor (UF). This is a measure of the efficiency with which the luminaire distributes the lumens generated by the light source to the working plane.

Other factors that affect the efficiency that light can reach a particular surface are:

- luminaire dirt depreciation (LDD),
- room surface dirt depreciation (RDD),
- lamp lumen depreciation (LLD), and
- lamp failure factor (LFF).

most lighting manufacturers publish tables of UF for their own luminaires. Basically, the UF for a luminaire depends on:

- the geometric shape of the room space,
- the reflectance of the room services,
- the orientation of the surfaces, and
- the physical design of the luminaires.

Though the Lighting CODE does not specify the minimum UF, the Power Density itself does however control the choice of luminaire. Using a luminaire with a low UF will result in requiring a large number of luminaires in the lighting system that thus exceed the Lighting Power Density limit.

3.5 Basic Lumen Method Equation:

The following equation can obtain the number of luminaire required to produce an average illuminance Es on a particular surface:

$N = (E_s \times \text{Area of surface}) \div (F \times n \times LLF \times UF)$

and **$LLF = LLD \times LFF \times LDD \times RDD$**

where

N is the number of luminaires
n is the number of lamps per luminaire
F is the initial bare lamp flux
LLF is the total light loss factor
UF is the utilization factor for the reference surface s
LLD is the lamp lumen depreciation
LDD is the luminaire dirt depreciation
LFF is the lamp failure factor
RDD is the room surface dirt depreciation

This equation is the basic lumen method equation. In addition to this equation, designer should also check the Space to Height Ratio (SHR) of the luminaire to ensure the calculated system has an acceptable uniformity :

$SHRAX \times SHRTR \leq (SHRMAX)^2$ SHRAX ≤ SHRMAX xSHRTR≤ SHRMAX TRSWT ≤ SHRTR/2 SWA ≤ SHRAX/2

where SHR_{AX} is the SHR at the axis of the luminaire SHR_{TR} is the SHR along the transverse direction SWT is the SHR along transverse direction for fitting next to a wall SWA is the SHR along the axis of the luminaire next to a wall SHR_{MAX} is the maximum allowable SHR

The maintainability of the luminaires must be considered as it relates to power and energy efficiency. A luminaire is only cleaned when it is being re-lamped. With the introduction of longer life lamps, many up to 24,000 hours rated life, re-lamping may not occur for several years. Without maintenance, dirt accumulates on the luminaire, greatly reducing the illuminance. In the above equation, the LLF mainly concerns the maintenance of the luminaire as well as the room surfaces. Thus a comprehensive and effective maintenance and cleaning programmed can reduce the number of luminaires required to achieve the required illuminance.

3.6 Power Quality of Lighting Equipment

The Power Quality in a lighting system affects the efficient usage of electrical energy. With the increasing usage of more sophisticated lamp equipment that incorporate electronics switching devices, the power quality consideration should be paid more attention in a lighting design. A device with ideal power quality characteristics should neither distort the supply voltage nor affects the voltage-current phase relationship. Most incandescent lighting systems, which can be considered as a pure resistive load, do not reduce the power quality of a distribution system because they have sinusoidal current waveforms that are in phase with the voltage waveform. Other lamp sources such as fluorescent, HID and low voltage incandescent lighting system that use ballasts or transformers, may have distorted current waveforms. Such distortion in phase displacement can reduce the efficiency of the alternating current circuit by generating excessive reactive powers that derate the capacity of the distribution circuitry.

there is always a requirement in the supply rules of the power distribution companies that request the connected load to maintain a power factor not less than 0.85. Most electronic ballasts for full-size fluorescent lamps are equipped with filters to reduce current distortion. Some electronic ballasts for compact fluorescent lamps have high current distortion, but contribute little to voltage distortion because of their relatively low power consumption in a distribution system. Traditional magnetic ballasts for fluorescent and HID lamps typically have lagging current due to their inductive nature. In order to meet the power factor requirement, some magnetic ballasts are fitted with capacitors that reduce the lag displacement between current and voltage, which eliminates excessive reactive power.

Harmonics

Another power quality concern is the harmonics. A harmonic is a wave with a frequency that is an integer multiple of the fundamental, or main wave. All distorted waveform can be described by the fundamental wave plus one or more harmonic components. Highly distorted current waveforms contain numerous harmonic components. The even harmonic components (second order, fourth-order, etc.) tend to cancel out each other's effects, but the odd harmonics tend to

add in a way that rapidly increase distortion because the peaks and troughs of their waveforms often coincide. The measurement of harmonics is most commonly in terms of total harmonics distortion (THD). Devices with high current THD contribute to voltage THD in proportion to their percentage of a building's total load. Thus, high wattage devices can increase voltage THD more than low wattage devices. It is recommended that designers should include filters to minimize THD when specifying electronic ballasts.

Power factor is a measure of how effectively a device converts input current and voltage into useful electric power. It describes the combined effects of current THD and reactive power from phase displacement. A device with a power factor of unity has 0% current THD and a drawn current that is perfectly in phase with the voltage. Resistive loads such as incandescent lamps have power factors of unity. Magnetic and electronic ballasts for fluorescent lamps usually have integral provisions to reduce harmonics and correct power factors.

Poor power quality can damage the distribution system as well as the devices operating in the system. It is not uncommon to experience neutral conductor heating or even nuisance circuit breakers tripping due to poor power quality in high rise buildings. In a system with no THD, the neutral wire should carry no current. High current THD devices can send odd harmonics onto the voltage supply, which do not cancel each other out. They add up on the neutral conductor, and if the current exceeds the conductor's rating, the neutral conductor can overheat and may result to the extreme in a fire hazard. Voltage distortion can also shorten the life of utilities' transformers and cause capacitor banks to fail. Reactive power derates capacity of the distribution system, which limits the amount of active power that a utility can deliver. This may be a problem during periods of peak demand.

Designers should specify high power factor ballasts (power factor > 0.9) for buildings with sensitive equipment, such as hospitals. Almost all of the electronic ballasts currently available are high power factor with current THD less than 20%.

4.0 OPERATION & MAINTENANCE CONSIDERATIONS

Energy is the product of power and time. The factors related to power or connected load of a lighting system are considered in Section 3. This section presents the design factors that affect operating time of a lighting system.

Energy consumption can be reduced by controlling the number of operating hours. Turning off the light when it is not needed will reduce energy consumption. The lighting system, should, whenever practical, be designed to provide a reduced light level during cleaning periods, and a mean for turning off lights by room or floor as the cleaning staff moves through the building. All spaces that are not used continuously should have local or automatic switching, allowing lights to be turned off when the space is not in use.

4.1 Automatic Switching

Automatic on/off systems, occupancy sensors, time clocks or energy management systems, save energy by preventing light from being left on when not needed. The automatic on/off controls can be designed according to the occupancy schedule. Additional energy can be saved through the use of Manual On/Automatic Off Systems, by which occupants turns lights ON in his work space at the beginning of the day, or when needed. At the end of the day, all lights can be turned off using a central control switch. Occupancy sensors can be used to save energy in areas where employees are not present for a portion of a day. Such sensors should not be activated to turn lights ON in a space where daylight is sufficient for part of the occupied hours

4.2 Daylight Utilization

The introduction of daylight into an interior space will not, by itself, save energy. Lighting control devices should be used to enable the substitution of daylight for artificial lighting when adequate day lighting is available. Either dimming or switching controls can be effective in maintaining suitable interior illumination levels.

The effective use of day lighting requires the proper design of building fenestration that can capture day light penetration.

The correct placement of sensors to control electric lights is critical to balancing lighting quality and energy saving. Automatic sensors should be located in a manner such that the portion of the lighting zone being controlled experiences fairly uniform daylight illuminance levels. Also, the electric light levels nearer to the fenestration elements are lower than the levels at interior core locations.

Electric lighting systems should be designed to be compatible with the day lighting system in respect of luminance ratios, controls and color rendition. This co-ordination helps to enhance the daylight quality and improve user acceptance of the energy saving features.

4.3 Multiple Visual Task

Some lighting systems are designed for the most critical task performed in the space. However, the task may be performed only a few hours per day or only by a limited number of workers. Energy is wasted if the lighting system remains at the critical level all the time or in every area. Task-ambient lighting is a feasible design solution for a multiple task environment. The ambient lighting system provides sufficient light for the general space or for the less critical task. On the other hand, a task light supplements the ambient light for more critical tasks. Often, task lights are left ON during the night. To avoid this type of energy waste, the task-ambient system should be wired and controlled so that individual task lights

must be physically switched ON by occupants as needed, but can be turned off manually or automatically at the end of the day.

It is recommended to adopt a lower ambient illumination level with higher task illumination levels for different task locations.

4.4.0 Lighting Control Strategies

4.4.1 Types of Control :

Generally, there are two major types of lighting control :

- ON/OFF Control, and
- Level Control

4.4.1.1 ON/OFF Control

The basic ON/OFF control equipment is the switch, which is available in the following configurations :

4.4.1.1.1 AC Snap Switches

Normally, a large space is divided into several zones, each of which is controlled by one or more than one switches. In addition, the switches should be circuited in a way to suit specific functions of the space. For a space with more than one entrance, 2-way, 3-way or 4-way switches should be used to provide control at each entrance. Separate controls should be provided for task lighting at each luminaire locations.

4.4.1.1.2 Time Switches

For near-window or exterior applications, it is necessary that timing of operation adjusts with the season. There are some other applications, such as storerooms, where people enter the space for short periods of time and forget to turn off the lights. The prerequisite for such a system to work is to have a predictable operating schedule.

4.4.1.1.3 Photocells

The use of photocells is popular for near-window or outdoor lighting. Photocells can also be used for automatic lighting control of an indoor space. When crucially mounted at a proper location, a photocell will read the level of lighting, incorporating daylight influence, and automatically adjust the artificial lighting level of a single or a group of luminaires. Lighting system must be installed with dimmers in order not to induce abrupt change of lighting level. Under certain circumstances, manual overriding switches may be necessary when space functions or personal requirements change. A properly designed and

commissioned daylight system can cut lighting operating hours up to 50% and reduce electricity use. Daylight dimming success relies on photocells placement and the amount of window area and ambient light available. Individual zone conditions, including building orientation, window coverings and other obstacles that prevent daylight from entering, must be considered. Daylight systems can be installed with occupancy sensors or timer control.

4.4.1.1.4 Occupancy Sensors

Occupancy sensors can reduce a building's lighting energy by turning lights off in unoccupied spaces. Energy savings may not be realized if the sensors are improperly installed or are disabled by dissatisfied occupants. These sensors are typically infrared type or ultrasonic sensors. Infrared sensors detect motion when the heat source moves from one zone to another. The sensor must have a direct line of sight to the occupants to detect motion. Relatively small movements, such as typing on a keyboard, may not be sufficient to cross a zone and trigger the sensor. Ultrasonic sensors emit high-frequency waves in the range of 25-40kHz. These waves bounce off objects in the room and return to the sensors. Objects moving in the space shift the frequency of the returning signals and this shift is detected by the sensors. Ultrasonic sensors can detect small movements and do not require a direct line of sight to occupants, but wind-blown curtains or papers can trigger the sensor incorrectly. New generation of occupancy sensors utilize dual technology to solve this 'drapery problem'. For instance, while an ultrasonic sensor would sense the movement of drapery and want to turn the lights on, the infrared sensor would not sense a movement of heat and would override the ultrasonic signal. Another dual technology control incorporates a microphonic sensor, which 'listens' for minute sounds, such as the turning of pages, even though an occupant would not show any appreciable movement in the room.

4.4.1.1.5 Level Control:

- **Dimmers**

Solid-state dimmers are available for incandescent, fluorescent and HID lamps. Generally, solid-state, high frequency ballasts are used for fluorescent and HID lamps to facilitate the dimming operation. The dimmer modules used in the high-power lighting systems are suitable for interfacing with time clocks, photocells or computers.

When the dimmers are connected with an automatic energy-control system, substantial energy saving can be made. Such automatic dimming system has the following advantages

compensate for the wasted power due to lamp lumen depreciation and luminaire dirt depreciation
use of daylight

Normally, dimmable lighting systems are expensive and, may not be applicable for every installation. It is recommended to use dimmers only where it is anticipated that lighting level control is needed.

- **Micro-processor Control**

Micro-processor control can be applied to a lighting system, from a standalone system in a single space to the entire system in a building. It is usually connected with controlling devices such as timers, photo-sensors etc. to provide the desired lighting group/system performance. It offers great flexibility to lighting control. The typical control functions include :

- Automatic daylight compensation control,
- Automatic compensation for lamp lumen depreciation and luminaire dirt depreciation,
- Scheduling of lighting operations to minimize the operating hours, and
- Fine tuning of lighting level to suit actual requirements.

- **DALI Control**

Digital Addressable Lighting Interface (DALI) is an international standard under IEC 60929 that guarantees the exchangeability of dimmable electronic ballast from different manufacturers. The DALI was developed to overcome the problems associated with the analogue 1-10V control interface for dimming of electronic ballasts. It provides a simple and digital way of communication among intelligent components in a local system. The DALI does not centralize the intelligence of DALI-interface control devices, meaning that many of the set points and lighting values, such as individual address, group assignment, light scene values, fading times etc are stored with the individual ballast, and each luminaire could be individually addressed and programmed to its designated lighting group, scene and switch settings.

There are control standards other than the DALI in providing the interface platform, in particular for equipment and devices of the same manufacturer.

5.0 OPPORTUNITIES FOR RETROFITS IN EXISTING LIGHTING SYSTEMS:

5.1 Energy Efficiency plus Side Benefits

From economical point of view, retrofitting existing lighting system of less energy efficient equipment into new energy efficient equipment does not only reduce its operating costs. As some of the retrofitting options also improve the light quality, the side benefits can lie beyond the saving in electricity costs alone. Usage of more energy efficient equipment also means that the illumination level can be increased with the same electricity consumption. Some other side benefits may be:

5.1.1 Reduced Operating Costs:-

- Reduces energy and demand costs because of improvement in energy efficiency,
- Reduces air-conditioning costs, depending on lamp type,
- Increase Productivity:-
- Reduces visual fatigue and absenteeism,
- Reduces errors and improves work performance, &
- Saves time spent on redoing work;

5.1.2 Better Quality Control:-

- Decreases waste of source materials and energy due to lower error rate, &
- Increases effectiveness of visually oriented quality control procedures;
- Heightened Safety and Security
- Reduces safe harbors for vandals, muggers, and other lawbreakers,
- Eliminates shadows that can mask hazards, &
- Highlights particular hazards or provides more illumination where people must work with sharp or heavy objects, near exposed moving equipment, or in areas subject to liquid spills;

5.1.3 Improved Visual Environment

- Creates lively visual environment,
- Improves working conditions,

Optimally designed retrofits will typically exceed reasonable rates of return. Decision-makers should discern the difference between costs and investments in dealing with these retrofitting works. That is, to treat lighting retrofit as an investment rather than a cost of expenditure. If lighting retrofit is treated as a cost of expenditure, decision-makers will easily fall into the trap of which-option-is-cheapest logic in making retrofit decision that may sometimes hinder designers to use energy efficient equipment of a higher cost. Lighting retrofit when treated as an investment will shift decision-makers' logic from focusing on which-option-is-cheapest to which-option-is-the-best. The added benefit is an image of being "politically correct" as well because of their positive environmental impact.

5.2 Retrofit Options

Evaluation of various retrofit options can be made in terms of their payback periods. Some of the retrofit options that worth to be considered by decision-makers and designers are:

5.2.1 Ballasts for Fluorescent Lamp

The T5/T8 lamp with electronic ballast combination is practically the most popular choice. Electronic ballasts are energy efficient, produce less heat load for the air conditioning system, and eliminate flicker and hum. Products are available for compact fluorescent and full-size lamps, connecting up to four lamps at a time. 3lamp and 4-lamp ballasts reduce material and energy costs, as compared to 2-lamp ballasts, because fewer units will be required. Fewer ballasts can also increase the overall system efficiency as the gear loss for a 4-lamp electronic ballast is typically less than the sum of the gear loss of four 1-lamp electronic ballasts. However, as the cabling between the ballast and the lamps shall be well screened for electrical safety as well as to restrict the electromagnetic interference to acceptable limit, the multiple lamp on single ballast arrangement are usually applied to lamps in the same luminaire.

5.2.2 Fluorescent Lamp & Luminaire

The T8 lamp with electronic ballast combination provide a light level comparable to the T12 with electromagnetic ballast system, and has the benefit of consuming up to 40% less electrical energy. The tri-phosphor coating improves the T8's color rendering characteristic as well as its efficacy. Also, the T8 lamp has some 50% longer lamp life then the T12. With the advantage of T8, the T5 has even an efficacy of some 10% higher.

Most T8 lamps can operate on conventional electromagnetic ballast, and can be used to directly replace T12 lamps to capture the T8's higher efficacy of some 10%. It is however worth noticing that not all electromagnetic ballasts and T8 could harmoniously work together, and a trial of a few selected luminaire should be conducted before large scale replacement of the same luminaire models. Should the simple replacement does not work out, the ballast in the luminaire will have to be replaced with one suiting T8 as well.

Whilst T8 lamp could replace T12, T5 can normally not replace T8, as the T5 requires its own high frequency ballast that is different from that of a conventional T8. Also, the T5 tube is slightly shorter in length than the T8, and the holding end-caps on the luminaire have to be spaced differently. As such, a retrofit of existing lighting of T8 or T12 to use the new T5 will require the replacement of the ballast and likely the entire luminaire as well, thus resulting in higher cost of retrofit.

To avoid retrofitting the luminaire when switching from T8 or T12 on electromagnetic ballast to T5 on electronic ballast, there is the Plug & Enhance (PnE) technology. The PnE technology introduces a quasi-electronic ballast (QEB) in the tube replacement. The QEB is an electronic device that is attached as an end cap or inside a fitting, which works with the original electromagnetic ballast to light up the fluorescent tube. With the QEB, a T5 can be fitted direct in place of

the T8 or T12, and the overall efficiency after replacement is similar to a simple T5 on electronic ballast arrangement. A short circuit component is required to replace the original starter for some system though.

5.2.3 Compact Fluorescent Lamp

Compact fluorescent lamps are an excellent replacement to incandescent lamps; they are more efficient, have longer average lamp life and provide good color rendering. Smaller models and additional improvements in technology have significantly increased their applications – from down lights to floodlights to task light and even to exit signs. Compact fluorescent lamps are available as either equipped with integral ballast or separate lamp and ballast units, in combination with common screw-in adapters (e.g. E27 adapters) for incandescent retrofits.

Although compact fluorescent lamps emit light in a diffuse manner and require special devices for dimming, high-bay compact fluorescent lamps systems can be good alternatives to high intensity discharge systems in applications with mounting heights up to 9m. The advantages of using compact fluorescent lamps include: instant-on (minimal warm-up time require), instant-restrike, high color rendering index, high efficacy and multiple light-level capabilities. Six to nine high-bay compact fluorescent lamps are typically housed in one luminaire, the two- or three-lamp ballasts can provide separate switching for multiple light-level control. This is an alternative arrangement if dimming is required.

Screw-in compact fluorescent lamps that can be dimmed with conventional incandescent dimmers are also available. THD from electronically ballasted compact fluorescent lamps can exceed 30%, though low-harmonic units are available. Compact fluorescent lamps with magnetic ballast typically produce THD of 15 to 25%, which is acceptable in most applications. Technological improvements and cost reductions in compact fluorescent lamp electronic ballasts make them economically viable, providing instant starting; three-lamp capabilities; reduce flickers, hum, size and weight; and efficacy increases of 20%. Though the electronic compact fluorescent lamp system costs several times what a comparable incandescent costs, the lift-cycle cost is usually worthy of consideration.

Applications requiring incandescent performance, such as tight beam control, dimming, or optimal color rendering, may not be a good candidate for compact fluorescent lamps retrofit. Instead, some may consider the use of halogen lamps, which are more efficient and last longer than standard incandescent.

5.2.4 Fluorescent Luminaire Reflector

Sometimes replacing rather than retrofitting the luminaires can be more economical and cost effective, especially where there is a change of the lighting system requirements. New luminaires can optimize efficiency, visual performance, technology compatibility and aesthetics. If it is decided to go for retrofitting,

reflectors can be a very simple and cost effective option. Luminaire efficiency is increased because less light is trapped and wasted within the luminaire fitting. The effectiveness of the reflector depends on its geometrical shape, coating material and the efficiency of the luminaire. Reflector installation can usually reduce the number of fluorescent lamps in three- and four-lamp luminaires for the same light output levels. The remaining lamps in a typical , say 300x600mm, luminaire may need to be relocated to maximize light output and uniformity. In combination with higher output fluorescent lamps and electronic ballasts, light output may be increased significantly with suitable reflectors.

Old and degraded luminaires that cannot be rectified by cleaning alone are generally excellent reflector retrofit candidates. To determine if reflectors are appropriate, prepare a reflector trial mock up. Begin by cleaning a few luminaires, install reflectors in half of the cleaned luminaires and compare light levels with clean luminaires where reflectors were not installed. Shielding devices are usually installed in luminaires to control uncomfortable glares. Inefficient shielding devices will degrade even the most efficient lamps and ballasts. Balancing visual comfort (glare control) and luminaire efficiency should be the key to achieve success in reflector retrofit. Deep-cell parabolic louvers provide good glare shielding and an efficient distribution of light. Low-glare clear lens optimize photometric efficiency while providing sufficient glare control. Opal diffusers and small-cell louvers are generally considered not efficient shielding devices.

5.2.5 High-intensity Discharge Lamp

Metal halide and high pressure sodium lighting systems offer high-quality lighting and among the highest efficacies of all lighting systems. Besides outdoor and industrial applications, metal halide and high pressure sodium systems are now commonly found in indoor applications such as office, retail and other commercial spaces. Both systems offer low to moderate life-cycle costs and different range of wattages, good average lamp life, good color rendering index and superb system efficacies. In general, higher wattage systems provide better efficacies. However, higher wattage systems require higher mounting height to control the uncomfortable glare and the uniformity of the light output.

High-intensity discharge lamp ballasts are designed to operate only the specific type of lamps and range of wattages. Specially designed metal halide and high pressure sodium lamps may be operated from mercury-vapor ballasts. Whilst many new high intensity discharge luminaires are incorporated with electronic ballasts, the ballasts of many installed luminaires are electromagnetic type. Electronic ballasts are smaller, lighter, and can improve color control and improve lamp life, but may not significantly increase the luminaire efficacy.

High-performance metal halide systems use a new kind of metal halide lamp and a dedicated magnetic ballast with a built-in starter or an electronic ballast. They offer up to 25% efficiency increase over conventional metal halide systems,

extended lamp life, stabilize color and reduce restrike time. New, low-wattage, high color rendering index compact metal halide lamps offer light quality comparable to incandescent lamps, though having longer warm-up and restrike times as well as dimming limitations.

Instant-restrike model of standard high pressure sodium lamp are suggested for use with occupancy sensors. Where improved color rendering is desirable, deluxe and white high pressure sodium lamps provide a broad range of performance alternatives. Efficacy is sacrificed for quality with the deluxe and white high pressure sodium lamps. Deluxe model offer efficacies comparable to standard metal halides lamps. White high pressure sodium lamps with integral reflectors are also available; they are less efficient than a compact metal halide but better than a halogen lamp.

5.2.6 Lighting Control

5.2.6.1 Switching

The simplest retrofit for lighting control is to provide lighting control switches at appropriate locations. An example is lighting control switches located suiting the layout of the office such that occupants can easily access and operate these switches. Though frequent switching shortens the lamp operating life, effectively applied controls can increase the years of lamp calendar life, which is in fact what the owner has to pay for.

The Lighting CODE provides a guideline on the area per switch in an office space, so that the number of switches could be determined easily in a lighting design.

5.2.6.2 Timer

Typical operation is on at night time and off at day time. A timer set to ON from 6:30pm to 6:30am, during winter cannot turn off the lighting system on a summer day at 7:3 0pm, and switch of at 5:30 am a time that is still fine without artificial lighting. Under the circumstance, the timer should be re-set at least two times annually to suit the sun summer/winter set/rise times, or consideration should be given to introduce a photo sensor control or astrological timer in place of simple timer .

5.2.6.3 Photocell

Upon falling below the design illumination level, the photocell turns on the luminaire to serve the space. A photocell, however, will still unnecessarily turn on the lighting that is meant only for people working in the space. Under the circumstance, consideration could be given to introduce occupancy control.

5.2.6.4 Occupancy Sensor

Occupancy, or motion sensors are generally accepted as an effective energy-saving device, which however must accompany with proper setting, placement & selection. The sensors should have adjustable sensitivity setting to ensure detection of normal activities without picking up false signals. It should also be equipped with time-delay setting to control the length of time for luminaires to

remain on without motion being detected. Manual-on or two-level options can also be considered. Trial and mock up installations are a good idea. Intermittently occupied spaces – such as offices, restrooms and conference rooms – are good candidates while common space, such as reception areas or main hallways, might be less suitable.

Wall-mounted units might be specified for small spaces that do not have obstacles to signal detection. Ceiling-mounted units are recommended for larger spaces, irregularly shaped rooms and those with partitions. Infrared units are most sensitive to lateral motion while ultrasonic units detect motions directly toward or away from the unit. Dual-technology modules are sensitive to both type of motion. System using microphonic sensor is also available. Another option is to provide personal control of fluorescent lighting with an infrared remote control that dims fixtures individually or in groups.

5.2.6.5 Dimming

A typical application is for spaces at building perimeter with fenestration, whereby the lamp output could be adjusted based on the brightness of available daylight. For some energy-conscious spaces, the minimum illumination levels required at different times of the day may be different, and dimming could be applied for the purpose to adjust the lighting levels in accordance to the activity levels. An example is the higher level at commencing of work at 8:30am & 2:00pm, reduced level at 10:30am to 12:30pm & 3:30pm to 5:30pm, and low level at 12:30pm to 2:30pm.

Panel-level dimming systems are designed for high-intensity discharge and fluorescent systems. Panel-level dimming uniformly dims circuits of luminaires by modifying current or voltage waveform. Bi-level switching systems, or capacitive switching, render full or partial light output to fluorescent and high-intensity discharge systems according to input from sensors, switches or timers. Tri-level systems may also be considered.

Daylight dimming provides energy savings of up to 40% while dimming down to as low as 20% of full output. Daylight dimming can enhance lighting quality by maintaining a constant, uniform light level and providing greater light-level flexibility to the occupant. Generally, the periphery area within 4m of a window has good potential for daylight utilization but it also depends on the building's surrounding environment. An assessment on the amount of daylight available from the window can determine its feasibility and its effectiveness. Furthermore, these systems can automatically compensate for lumen depreciation. Daylight systems must be fully commissioned before handover to the building users for correct functioning.

----------***----------*****----------**

सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

भारत सरकार
रेल मंत्रालय

TECHNICAL SPECIFICATION FOR STAND-ALONE WIND + SOLAR PHOTOVOLTAIC HYBRID POWER GENERATING SYSTEM FOR LEVEL CROSSING GATES

लेवल क्रासिंग गेटों के लिए स्टैन्ड–एलोन विन्ड +सोलर फोटोवोल्टेक
हायब्रिड पावर जनरेटिग प्रणाली हेतु तकनीकी विशिष्टि

Specification No. RDSO/PE/SPEC/PS/0124 (Rev. '1') -2014
विशिष्टि सं0 आरडीएसओ/पीई/स्पेक/पीएस/0124–2014 (रिवी.1)

S N	Amendment		Revision		Reason
	Number	Date	Number	Date.	
1.	'1'	20.09.2010	-	-	Clause 6.2.14 deleted as duplicated Clause 9.0 (Guarantee/Warranty) and Annexure-3 (Eligibility Criteria for bidding) deleted as per Railway Board's letter No. 2006/Elect.(G)/150/9/Pt. dated 10.09.2010.
2.	-	-	'1'	14.02.2014	Rationalized the spec. and major editorial changes to improve its readability and clarity.

ISSUED BY
RESEARCH DESIGNS AND STANDARDS ORGANISATION
MANAKNAGAR, LUCKNOW – 226 011

जारीकर्ता
अनुसंधान अभिकल्प और मानक संगठन
मानक नगर, लखनऊ – 226 011

Approved by
द्वारा अनुमोदित

17.02.2014

Executive Director (EM)
कार्यकारी निदेशक (ऊर्जा प्रबन्धन)

Prepared by	Issued by
JE/EM	DIR (EM)

I N D E X

SPECIFICATION FOR STAND-ALONE WIND + SOLAR PHOTOVOLTAIC HYBRID POWER GENERATING SYSTEM FOR LEVEL CROSSING GATES

1.0 FOREWORD

The Wind and Sun are inexhaustible, reliable and non-polluting sources of power. Concerns over global climate change and resource scarcity make Wind + Solar photovoltaic (SPV) with battery backup an attractive power supply solution. The Wind Solar Hybrid (WSH) generating system is particularly suited for remote locations where grid electricity supply is either not available or is erratic. For manned Level Crossing Gates in non-RE sections, WSH system is an excellent solution. It will greatly help towards the safety of road-rail intersections.

2.0 SCOPE

This specification covers general and technical requirement of Stand-alone Wind Solar Hybrid generating system for power supply to manned Level Crossing Gates in non-RE sections. A pre-condition to technical feasibility of WSH is that the site should have at least 4.17 m/s annual average wind speed.

3.0 REFERENCE STANDARDS

IS: 12834:1989 (reaffirmed 2000)	Solar Photovoltaic Energy Systems – Terminology
IEC: 61215 (2005)	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC: 60904-1(2006)	Photovoltaic Devices - Part-I: Measurement of Photovoltaic current-Voltage Characteristic
IEC: 61701	Salt mist corrosion testing of photovoltaic (PV) modules
IEC: 60068	Environmental testing
IS: 9000	Basic environmental testing procedure for Electronic and electrical items.
IEC -61400 -12-1	Power performance measurement of wind turbines.
IEC -61400 -2	Safety and function test and Duration test of wind turbines.
ASTM – B-117	Salt spray testing standard.

Note: Latest version of the standards shall be referred to

4.0 SYSTEM DESCRIPTION:

Wind Solar Hybrid generating system (WSH) shall consist of the following elements:

i) Wind Turbine (WT) to convert Wind energy to electricity.

ii) Hot dip galvanized MS tower with necessary accessories for mounting of WT.

iii) SPV Module to convert solar radiation directly into electricity.

iv) Module mounting structure of galvanized MS sections (SPV modules can be mounted on the WT tower, if feasible).

v) Battery bank to store the electric energy generated by WSH generating system.

vi) Following charge controllers/ chargers will be provided:

a) Solar charge controller (SCC) for receiving DC power from solar panels and delivering DC power supply to charge the battery.

b) Wind charge controller (WCC) for accepting multi-phase AC input from wind generator and delivering DC power supply to charge the battery.

c) A grid supplied charger that can accept 140-260 Volts, single phase, 50 Hz AC supply and deliver DC power supply to charge the battery (it will be an optional item i.e. not to be supplied unless specifically called for in the tender).

vii) LED based luminaires along with fixture and (in respect of outdoor luminaires) mounting pole

viii) Fan

ix) Interconnecting wires, cables and hardware.

In their offer, the firm should furnish a clause-by-clause confirmation of compliance to the spec. and also the specific information called for in Annex-4 of the spec.

5.0 GENERAL REQUIREMENTS

5.1 All wiring, enclosures and fixtures that are mounted outdoor must be resistant to high humidity conditions, corrosion, insect and dust intrusion.

5.2 Metal equipment cases and frames in the system shall be well grounded.

5.3 The main components shall be integrated in such a way as to allow replacement (in case of failure) with a similarly functioning component of a newer design or a different brand.

5.4 Suitable resettable isolating and overcurrent protection arrangements shall be incorporated. Toggle switches shall also be provided for switching 'on' and 'off' of individual equipments.

5.5 Proper sealing arrangements at the points of cables entering the enclosures (if any)/ buildings should be incorporated. Though not mandatory, contractors are however encouraged that the cables

entering into the enclosures should be sealed with modular EPDM based cable sealing and protection system based on multi-diameter technology.

5.6 Electronic components used in controller or elsewhere in the system shall generally meet the requirements mentioned as follows (documentary evidence in support of the same should be given):

i) All capacitors shall be rated for max. temperature of 105° C.

ii) Resistances shall preferably be made of metal film of adequate rating having a tolerance of not more than 5%.

iii) Switching devices such as transistors, IGBTs, MOSFETs, etc. shall have minimum junction temperature of 150°C.

iv) Devices shall have adequate thermal margin at ambient temp. of 55°C

v) Fibre glass epoxy of grade FR 4 or superior shall be used for PCB boards having a nominal board thickness 1.6mm and copper cladding thickness of 70 microns for power cards and 35 microns for control cards. Both track width and spacing between the tracks shall be 0.5 mm nominal and in no case shall be less than 0.3 mm. Assembled PCBs shall be given a conformal coating.

5.7 Wiring inside the Goomti should be routed through conduit pipes suitably clamped. Cables leading to outdoor lighting poles must not afford direct or easy access to non railway persons. Cable crossing underneath the tracks shall be at a minimum depth of one meter with respect to earth formation level of track.

6.0 TECHNICAL REQUIREMENT

Irrespective of the voltage level generated directly by WT or SPV, the nominal voltage at the output of charge controllers/ grid supplied battery charger, shall be 12V DC. Though not mandatory, firms are encouraged to provide a text type display (in Regional language/ English) so that the gateman can easily read/ infer the battery's state of charge.

6.1 System load

6.1.1 Load on the WSH shall comprise of the following:

i) 2 nos. 5W (nominal) LED based luminaires with fixtures, one inside Goomti and one outside Goomti under shed.

ii) 1 no. 20W (nominal) fan inside Goomti.

iii) 2 nos. 15W (nominal) LED based luminaires with fixtures, one on each side of the track. The 15W luminaires shall be mounted on individual poles.

6.1.2 The design of WSH is based on the following factors:

i) Battery autonomy: 2 days
ii) Operation period for indoor lighting: almost 20 hours.
iii) Operation period for outdoor lighting: almost 12 hours.
iv) Operation period for fan: almost 24 hours (in summer)
v) Solar Insolation: 5 peak sun hours/day
vi) Minimum annual average wind speed of 4.17 meters/sec.

6.2 Wind Turbine (WT)

6.2.1 The WT must have undergone IEC 61400-12-1 type testing for power performance measurement and IEC 61400-2 type testing for safety from an accredited test house such as Govt. of India's Centre for Wind Energy Technology (CWET), NREL, etc. Further, the offered WT should also have regular empanelment from CWET. The CWET certified power rating of WT, as per IEC 61400-12-1, should be minimum 600W.

6.2.2 All exposed/external parts of WT shall be suitably coated for prevention of corrosion in harsh marine environment. Although it is not mandatory for now, manufacturers however are encouraged to get the WT type tested for salt spray test as per ASTM B-117 for a minimum period of 1,000 hours, if they have not already done so. In case of bulk tenders, zonal railways can consider specifying that the contractor furnish this type test certificate (refer item 4(i) of Annexure-3).

6.2.3 The manufacturer will need to furnish evidence that the WT being supplied is same as the one type tested as per IEC 61400-12-1 and IEC 61400-2. Although it is not mandatory for now, manufacturers however are encouraged to create the necessary testing infrastructure for enabling the purchaser to verify the IEC 61400-12-1 certified power (watts) vs. rotational speed (RPM) in steps of 100 RPM, prior to dispatch. In case of bulk tenders, zonal railways can consider specifying that the contractor make available a test facility for carrying out such verification.

6.2.4 Suitable protection such as furling mechanism, pitch control of blades or electromagnetic braking shall be provided for protection of WT against high velocity wind, storms and over-speeding.

6.2.5 The WT shall be able to withstand wind speeds of 55 m/sec or 198 kmph.

6.2.6 Mounting Towers shall be of 15 meter height and made of hot dip galvanized mild steel. Galvanization thickness shall be of min. 85µm. If the systems are installed in coastal/ corrosive areas, the minimum galvanization thickness shall be 120µm. Unless the purchaser has

specifically asked for 120 µm thickness, normally 85 µm will be supplied. The turbine hub height shall be at least 5 meter above any obstruction within 200 meter radius. If at certain locations, tower height more than 15 m is required, then the same must be especially mentioned in the tender schedule (refer item 4 (iii) of Annexure-3). The tower has to be designed to withstand a minimum wind force of 55 m/s or 198 kmph (refer item 4(ii) of Annexure- 3).

6.2.7 WT shall be grounded properly. Towards this end, the contractor will supply and install an adequate number and size of IS: 3043-1987 compliant earthing kits.

6.3 SPV Modules

6.3.1 The solar module shall be an assembly of suitable inter-connected crystalline silicon solar cells. Imported SPV module or cell will not be accepted, unless MNRE's policy/ rules permit the same.

6.3.2 Minimum capacity of the solar panels installed shall be 160 Wp. Solar modules of minimum 80 Wp capacity shall be used.

6.3.3 Individual Solar PV Module should conform to IEC: 61215 Ed 2 or latest – Edition II, IEC : 61730 – I :2007, IEC : 61730 – II : 2007, manufactured in a plant certified under ISO 9001 : 2008 and also type tested by an accredited national/international testing laboratory. The Solar PV Module should be made from single/poly crystalline Silicon Solar Cell connected in series. PV modules to be used in a highly corrosive atmosphere (coastal areas, etc.) must qualify Salt Mist Corrosion Testing as per IEC 61701; this compliance and certification will not be required, unless the purchaser specifically asks for the same in the tender (refer item 2(i) in Annexure - 3).

6.3.4 The conversion efficiency of Solar PV Cells used in the module shall not be less than 15% and that of the module shall be not less than 13%.

6.3.5 Fill factor of the module shall not be less than 72%.

6.3.6 The solar module should have toughened, high transmissivity glass in front side of the module for improved visibility and protection against environmental hazards (rain, hail and storm) and weather proof TEDLAR/POLYSTER back sheet.

6.3.7 The transparency of toughened glass used shall be > 91%, when measured in actual sunlight by placing the glass plate perpendicular to the sun's rays through an air mass of 1.5. Certificate to this effect from a recognized test house or their own laboratory shall be submitted at the time of type approval.

6.3.8 The complete solar module shall be ensured for water-proof sealing in an anodized Aluminum frame.

6.3.9 The output terminals of the module shall be provided on the back of the solar PV module.

6.3.10 Terminal block shall be made of Noryl rubber or other suitable alternate materials with weatherproof design (minimum IP-65) and shall have a provision for opening for replacing the cables, if required.

6.3.11 The system shall be virtually maintenance free (except for cleaning the top glass of the solar panel depending on dust conditions at place of installation).

6.3.12 The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.

6.3.13 A bird spike shall be provided to avoid bird sitting on the solar module at the highest point of the array/module structure.

6.3.14 SPV module shall be highly reliable, lightweight and shall have a service life of more than 25 years. SPV modules shall have a limited power loss of not more than 10% of nominal output at the end of 10 years and not more than 20% at the end of 25 years.

6.3.15 Wherever more than one module is required, identical models shall be used.

6.3.16 The output of any supplied module shall not be less than the rated output and shall not exceed the rated power by more than 5Wp. Each module therefore has to be tested and its rating displayed.

6.3.17 The solar module shall be able to withstand the following environmental conditions normally encountered at site:

i) Temperature extremes ranging from -10°C to +85°C.
ii) Wind load: 200 km/h.
iii) Maximum mean hourly rainfall of 40 mm.
iv) Humidity level upto 95%.

6.3.18 Each PV module must use a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.

i) Name of the manufacturer of PV Module
ii) Name of the Manufacturer of Solar cells

iii) Month and year of the manufacture (separately for solar cells and module)
iv) Country of origin (separately for solar cells and module)
v) I-V curve for the module
vi) Peak Wattage, I_m, V_m and FF for the module
vii) Unique Serial No and Model No of the module
viii) Date and year of obtaining IEC PV module qualification certificate
ix) Name of the test lab issuing IEC certificate
x) Other relevant information on traceability of solar cells and module as per ISO 9000 series.

6.3.19 Marking:

Each module shall carry the following clear and indelible markings:

- Name, monogram or symbol of manufacturer;
- Type or model number;
- Serial number;
- Polarity of terminals or leads (colour coding is permissible);
- Open – circuit voltage
- Operating voltage.
- Maximum system voltage for which the module is suitable;
- Operating current
- Short circuit current
- Date & place of manufacture.
- Weight of the module

6.3.20 The Array Junction Box should preferably have maximum 08 inputs and 01 output with MOV/SPD and Terminal block.

6.3.21 Suitable markings shall be provided on the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification. Cable entry points shall be fitted with MC-4 Connectors.

6.3.22 The SPV modules shall normally be mounted on a structure which is designed to withstand a wind speed of 200 kmph. For this compliance, contractor's certificate of conformity will be accepted.

6.3.23 The array structure shall be made of hot dip galvanized MS angles of size generally not less than 35mmX35mmX5mm. The galvanization thickness shall be at least 85 microns. For coastal/ corrosive environments, the galvanization thickness shall be at least 120 microns. If the purchaser does not specify anything to the contrary, then galvanization thickness of 85 microns shall be provided (refer Item 4(ii) of Annexure-3).

6.3.24 The foundation for module mounting structure shall be preferably 1:2:4 RCC construction or any other combination based on the local

site conditions for which design details shall be submitted. The installation of SPV modules should not impact the waterproofing of the existing terrace structure. The contractor shall be responsible for restoring the waterproofing to its original condition and for provision of additional waterproofing in the areas where RCC blocks are secured onto the terrace.

6.3.25 Alternatively (at the option of firm), the SPV modules with structure can be mounted on a tower of the WT. However, if the modules are installed on the rooftop, the clearance between the lowest part of the module structure and the developed ground level shall normally not be less than 200 mm. However, in exceptional cases, lower clearances may be allowed on case to case basis.

6.3.26 Generally, fasteners shall be of stainless steel SS304. To prevent pilferage, anti-theft fasteners shall, in consultation with railway site engineers, be provided at appropriate locations.

6.3.27 For grounding of array structure, the contractor will supply and install an adequate number and size of IS: 3043-1987 compliant earthing kits.

6.3.28 The module junction boxes (if any) shall be certified as per IEC 61215. Else, they should have the same properties as mentioned for array junction boxes. If array junction boxes are used, they shall have the following properties:

a) The module/array junction boxes shall be dust, vermin- and waterproof and made of Polycarbonate - Glass Fibre Substance (PC-GFS) thermoplastic. The enclosure should be double insulated with protection class II as per IEC 61439-1. Material and the protection class shall be marked on the enclosure.
b) The enclosure shall have a transparent front lid for enabling easy visibly.
c) The enclosures shall have IP 65/66 protection in accordance with IEC 60529. Third party conformance certificate is required to be given for IP 65/ IP 66 degree of protection.
d) Burning Behavior: Base part of Polycarbonate Enclosure shall be UL-94-V-0 compliant and Lid part of PC Enclosure shall be UL-94-V-2 compliant.
e) The enclosures shall have IK 08 degree of protection for mechanical load.
f) The material used shall be halogen, silicon free conforming to RoHS directive 2002/95/EC.
g) The enclosure shall have a usage temperature rating of -10°C to 55°C.
h) The enclosure should be chemically resistant to acid, lye, petrol, mineral oil and partially resistant to benzene.
i) The material of the enclosure shall be UV stabilized.

Unless otherwise stipulated, the properties mentioned above should be demonstrated through datasheet of the manufacturer.

6.3.29 The SPV Module shall be tested as per Annexure 1.

6.4 Charge Controllers, grid supplied charger, etc.

6.4.1 Solar charge controller

The Solar Charge Controller (SCC) will comply the following requirements:

(i) Suitable for charging T-Gel type VRLA as well as LMLA battery.
(ii) Suitable for receiving input from 160Wp solar PV system and battery charging.
(iii) The charge controller should generally comply IEC 62509. Set point accuracy of ±3% and self consumption of 0.2% shall be allowed.
(iv) The charge controller should have IP 31 protection. Manufacturers are however encouraged to provide higher IP protection.
(v) Capable of handling 120% of module's rated current.
(vi) To be at least PWM based; manufacturers are however encouraged to offer MPPT technology.
(vii) Efficiency at rated output voltage and full load should not be less than 90%. Even at less than full load, efficiency should not be less than 86% for up to 30% full load.
(viii) Temperature compensated charging.
(ix) Provision of blocking diode, preferably a Schottky diode, to prevent the battery from discharging itself through the SPV system/ charge controller. The current capacity of the blocking diode shall be 50% higher than the short circuit current at STC. The peak inverse voltage (PIV) of the diode shall be at least equal to the open circuit battery voltage. In case any alternative to Schottky diode is proposed, then technical literature and evidence in support of successful working of the same should be submitted for the consideration of RDSO/ purchaser.
(x) On its SPV power source side, the charge controller shall be protected against lightning and surges. The SPDs/MOVs used shall be rated for at least 10KA at 8/20 µSec. The voltage rating of the SPDs/MOVs shall be at least 10% higher than the specified value of the SPV array.
(xi) Protection shall also be provided against the following: battery overload, battery overcharge, short circuit and reverse polarity. Resettable reverse polarity protection should be provided. Although not mandatory, manufacturers are encouraged to provide auto resettable reverse polarity protection.
(xii) Cable of adequate size shall be provided between panel and battery.

(xiii) The charge controller shall incorporate the bulk and float charging methods. Though not mandatory, manufacturers are however encouraged to provide equalization charging facility also.

(xiv) The charge controller shall have insulation resistance of at least 50 MΩ. The test is to be performed between shorted DC output terminals and earth, shorted DC/AC input terminals and earth and shorted DC output terminals and shorted DC/AC terminals.

(xv) The charge controller shall withstand a test voltage of 2,000V applied between DC line terminals and earth for one minute without any puncture and arcing.

(xvi) In case the master controller is not provided, then the charge controller should have the feature of load disconnect to protect the battery from deep discharge.

(xvii) The charge controller should comply the following (optional) environmental tests with the charge controller working at full load for at least last half an hour as per IEC 60068/ IS 9000. Environmental test results for SCC of identical or any higher capacity of similar design will be acceptable. Environmental test compliance will only be required, if specifically asked for in the tender (refer item 3 (ii) of Annexure-3). In respect of bulk procurements, railways should ask for the same in their tenders.

a) Dry Heat Test: 50°C±2°C for 16 hours
b) Damp Heat Test (Steady state): 40°C, 93% RH for 4 days
c) Damp Heat Test (Cyclic): 40°C, 93% RH for 6 cycles (duration of one cycle shall be 24hrs)
d) Cold Test: 0°C for 16 hours
e) Change of temperature Test: -10°C to 50°C for 3 cycles (rate of change of temperature shall be 3°C per minute)

In respect of the requirements as specified in respect of set point accuracy, self consumption and efficiency, the basic intent is developmental. So, the firm must endeavor to achieve the same either by developing their design in-house or (if they cannot or do not succeed in developing the same) by sourcing it from any reputed/ proven manufacturer based in India. In the event that even reputed manufacturers based in India are unable to meet those requirements, appropriate relaxation will be permitted by RDSO at design approval stage.

6.4.2 Wind charge controller

The Wind Charge Controller (WCC) will comply the following requirements:

(i) Suitable for charging T-Gel type VRLA as well as LMLA battery.

(ii) Suitable for receiving multi-phase AC input from the WT and delivering DC power supply for battery charging and for supplying to the load.

(iii) To be at least PWM based; manufacturers are however encouraged to offer MPPT technology.

(iv) No minimum limit for efficiency is being mandated for now; but manufacturers are encouraged to provide the highest feasible efficiency.

(v) Temperature compensated charging.

(vi) Provision of blocking diode, preferably a Schottky diode, to prevent battery from discharging itself through the WT/ charge controller. The current capacity of the blocking diode shall be 50% higher than the short circuit current at STC. The peak inverse voltage (PIV) of the diode shall be at least equal to the open circuit battery voltage. In case any alternative to Schottky diode is proposed, then technical literature and evidence in support of successful working of the same should be submitted for the consideration of RDSO/ purchaser.

(vii) To save the WT from over-speeding (in event of generated energy not being consumed) and consequential damage, a resistive dump load of adequate rating will be provided. If any alternative to dump load is offered by the tenderer, then he should furnish literature endorsing such a design and/or evidence of successful working of the same for at least two years.

(viii) Protection against the following: battery overload, battery overcharge, short circuit and reverse polarity. Resettable reverse polarity protection shall be provided. Although not mandatory, manufacturers are encouraged to provide auto resettable reverse polarity protection.

(ix) Rating of offered WCC shall be appropriate for the WT's power rating.

(x) On the WT power source side, the charge controller shall be protected against lightning and surges. The SPDs/MOVs used shall be rated for at least 10KA at 8/20 μSec. The voltage rating of the SPDs/MOVs shall be at least 10% higher than the specified value of the WT.

(xi) Though not mandatory, manufacturers are however encouraged to incorporate all charging methods in the WCC i.e. auto, bulk, float as well as equalization.

(xii) The charge controller shall have insulation resistance of at least 50 MΩ. The test is to be performed between shorted DC output terminals and earth, shorted DC/AC input terminals and earth and shorted DC output terminals and shorted DC/AC terminals.

(xiii) The charge controller shall withstand a test voltage of 2,000V applied between DC line terminals and earth for one minute without any puncture and arcing.

(xiv) In case the master controller is not provided, then the charge controller should have the feature of load disconnect to protect the battery from deep discharge.

(xv) Though not mandatory, firms are encouraged to offer WCC complying with the following environmental tests with charge controller working at full load for at least last half an hour as per IEC 60068/ IS 9000.

a) Dry Heat Test: 50°C±2°C for 16 hours
b) Damp Heat Test (Steady state): 40°C, 93% RH for 4 days
c) Damp Heat Test (Cyclic): 40°C, 93% RH for 6 cycles (duration of one cycle shall be 24hrs)
d) Cold Test: 0°C for 16 hours
e) Change of temperature Test: -10°C to 50°C for 3 cycles (rate of change of temperature shall be 3°C per minute)

6.4.3 Grid supplied charger (optional item)

If grid electricity supply is available at a level crossing gate, then the purchaser can (optionally) order a battery charger which would be fed from grid electricity supply. The charger will work with 140 – 260V, 50 Hz AC input, will be based on PWM technology and shall be suitable for charging the battery. The input to the charger shall be protected against lightning and surge. Unless specifically asked for by the purchaser in the tender, the aforesaid grid fed battery charger will not be supplied (refer item no. 3(i) of Annexure-3).

6.4.4 Integrated functioning of charge controllers and charger

It will be necessary that the aforesaid charge controllers as also the grid fed charger (if provided) maintain the battery to the highest possible State of Charge (SOC) while protecting the battery from deep discharge or extended overcharge. Even where a grid fed charger is provided, in as far as possible, renewable energy will be utilized for battery charging. But if the battery's state of charge drops below a point, then the battery would be charged through the grid power supply; it should be possible for the purchaser to set the battery voltage at which the grid fed charger will cut in. The charge controllers and grid fed charger (if any) should function in an integrated manner and without necessitating manual operation. Wherever necessary, a master controller (or functionality thereof) shall be provided towards this end. The controller shall have dusk to dawn switching for outdoor lighting.

6.4.5 Indications and meters

Relevant meters should be provided for voltage, current and indication for Low Battery, Battery on charge and Battery fully charged. Detailed scheme shall be submitted at design/ drawing approval stage.

6.5 Battery Bank:

6.5.1 Unless otherwise specified by the purchaser, Battery Bank shall be Tubular Gel Valve Regulated Lead Acid Battery (VRLA) type complying IEC 60896 21 & 22. Gel tubular VRLA battery (when compared to the other type of VRLA battery) offers higher life in terms of cycles as well as years, there is far lower probability of PCL 3 effect, far lower risk of

thermal runaway/ dry out failures and its capacity as well as internal resistance is relatively stable during lifetime. Flooded battery is not recommended as it generates acid fumes that may be hazardous to the health of gateman and moreover, it requires topping up. The purchaser may at his option decide to specify any other type of VRLA battery, if considered necessary (refer item 1(i) of Annexure-3).

6.5.2 Unless otherwise specified by the purchaser, the storage battery bank rating shall be 2 nos. 12V 120 Ah (C10). The purchaser can at his option, depending on site requirements, specify a higher or lower Ah capacity of the battery (refer item 1(ii) of Annexure-3).

6.5.3 T-gel type VRLA Battery shall have a design life expectancy of more than 5 years at 50% DOD at 27°C.

6.5.4 The permissible self-discharge rate for T-gel VRLA batteries shall be less than 2% of the rated capacity per month at 27°C.

6.5.5 The charging instructions shall be provided along with the batteries.

6.5.6 The T-gel type VRLA batteries shall be discharged up to 80% DOD.

6.5.7 Suitable Battery Box made of Polycarbonate or M.S fabricated with acid proof paint shall be provided to house the battery.

6.5.8 Make of the battery shall be finalized at the system design stage.

6.6 Battery Testing

Tubular Gel VRLA batteries shall have third party certifications for life test as per IEC 61427 for minimum requirement of 13 units @150cycles / unit equaling to 5 years life. All routine tests as per applicable standards shall be conducted on the batteries. Performance characteristics curves of the offered battery, as indicated below, shall be submitted:

i) Charging-discharging characteristics at various temperature and cell voltage.
ii) Self discharge at various ambient temperatures.
iii) Cell voltage vs. State of charge.
iv) Capacity vs. Rate of discharge.
v) State of charge vs. Sp. Gravity of electrolyte.
vi) Depth of discharge vs. No. of cycles.

6.7 LED Lamp and fixtures

Instead of designing/ manufacturing a luminaire especially for this application, a commercially available LED luminaire (or an improved

version of it) of good repute/ performance record, if available, will be preferable. Unless otherwise specified in the following sub-clauses, LED/ luminaire manufacturer's data-sheet/ conformance certificate will be accepted in lieu of tests.

6.7.1 Rated Voltage and Power: Voltage: 12V DC; Power: 15W (nominal) for outdoor and 5W (nominal) for indoor (power ratings are inclusive of driver losses).

6.7.2 Minimum efficacy of luminaires shall be 80 lumen/ W i.e. minimum 400 (for 5W)/ 1200 (for 15W) system lumens. Third party certificates for compliance can be accepted. Else, this is required to be demonstrated through a test.

6.7.3 For outdoor luminaires, LM 79 report is required to be submitted. Else, the same can be demonstrated through a test.

6.7.4 LED type – White High Powered LEDs with CCT range of 5500-6500 K temperature. Colour Binning should comply existing ANSI standard C78.377A. White Point Stability of LED should be within 7 McAdam Step. LED should be of SMD type only.

6.7.5 Colour Rendering Index (CRI) shall not be less than 70 (nominal).

6.7.6 LED efficacy shall be minimum 100 lm @ 350mA drive current to meet the required LUX level. Nominal viewing angle of the LEDs used in the 15 W luminaire shall be 120^{o}.

6.7.7 L70 life of LED shall be more than 50,000 hours at soldering point temperature of 85 deg C and at luminaire operating current. The life time projection should be based on LM-80 test data and corresponding TM21 projection method for the corresponding driving currents at which the LEDs are driven.

6.7.8 Junction to soldering point thermal resistance should be less than 10 degC/W for outdoor luminaires.

6.7.9 LED used shall be of NICHIA / OSRAM / SEOUL SEMICONDUCTOR / PHILLIPS LUMILEDS / LEDNIUM/ CREE make.

6.7.10 LED fixing arrangement for outdoor luminaire of 15 W: Mounted on metal core PCB fixed to aluminum heat sink.

6.7.11 The 15W LED Luminaire for outdoor application shall be mounted on 5 m height from ground level on galvanized 6 m MS pole with necessary accessories i.e. one luminaire on each side of the two poles on either side of the track.

6.7.12 Avg. illuminance delivered by outdoor luminaire shall be 4 lux at ground level (5m from the luminaire) and shall be measured using 9 point method as defined in Annexure-2. The ratio of minimum to average illumination shall be at least 0.4 and the transverse uniformity ratio i.e. minimum to maximum illumination shall be at least 0.33. Third party certificates for compliance shall be acceptable. Else, the same is required to be demonstrated through a test.

6.7.13 Indoor LED Fixture: ABS plastic/Aluminum fixture with acrylic cover.

6.7.14 Outdoor LED Fixture: Pressure die-cast LM6 housing with IP65 protection, having toughened glass/ UV stabilized polycarbonate cover.

6.7.15 The LED luminaire shall comply IEC 60598/ IS 10322. Third party certificates for compliance shall be accepted. Else, this shall be demonstrated through a test.

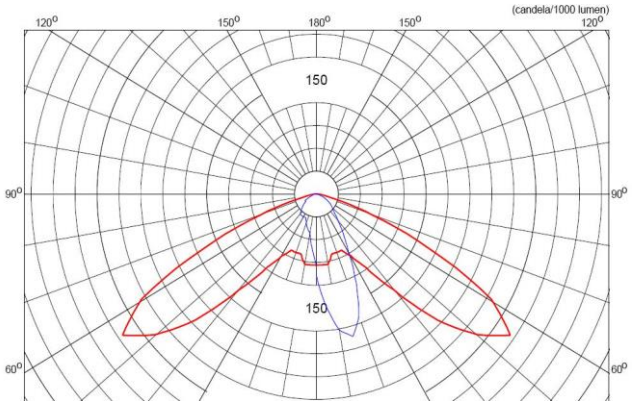
6.7.16 The temperature of the heat sink shall not be greater than 20°C above ambient temperature even after 6 hours of continuous operation. Further, soldering point temperature of the LEDs used in the luminaire shall also be demonstrated through a test.

6.7.17 The LED driver DC current regulation shall be better than 3%.

6.7.18 The LED controlgear shall comply to IS 15885 (Part 2 /Sec 13)/ IEC 61347-2-13 and IS 16104/ IEC 62384. Third party certificates for compliance shall be accepted. Else, this shall be demonstrated through a test.

6.7.19 Automatic dusk to dawn switching of the LED streetlights shall be integrated in the system. A separate switch and fuse arrangement for each LED light shall be provided inside the goomti for the purpose of safety and maintenance.

6.7.20 Typical light distribution for outdoor luminaire should be as per the following polar curve:



6.8 Fan

A DC wall mounted bracket fan shall be provided. A commercially available market product of good repute/ performance record will be preferable. Unless otherwise specified, fan manufacturer's data-sheet/ conformance certificate will be accepted in lieu of tests. Indicative technical parameters of the fan shall be as follows. But if it so happens that a commercially available market product of good repute/ performance record has somewhat different parameters, the same can also be accepted by the purchaser with the over-riding condition that the power consumption of fan will not exceed 25W in any case.

Voltage rating: 12V DC
Power: 20W (nominal)
Air flow: More than 0.25 m^3/sec.
Fan sweep: 300 mm
Motor insulation: F Class
Temp rise: less than 65° C above ambient.
Shroud shall be provided for protection.

6.9 Cables and Hardware

6.9.1 Cabling of the system shall be as short as possible to minimize the voltage drop in the wiring

6.9.2 Cable shall meet IS 1554 / 694 Part 1:1988 and shall be of 650 V/ 1.1 kV grade.

6.9.3 The module/ array wiring shall be water and UV resistant and suitable for Solar system application. The cables used shall be TUV 2Pfg 1169/08.2007 or VDE EPV 01:2008-02 or UL4703 certified.

6.9.4 All wiring must be sized to keep line voltage losses to less than 3% in each sub circuit and to allow the circuit to operate within the ampere rating of the wire.

6.9.5 Components and hardware shall be vandal and theft resistant. All parts shall be corrosion-resistant.

6.10 Protections

6.10.1 Adequate protection shall be incorporated under no-load conditions (i.e. when the system is ON and there is no load) from master controller output side.

6.10.2 If any other protection is necessary, the same will be deemed to be a part of the specification.

6.11 Marking:

Each WSH system shall carry the following clear and indelible markings on the controller:

- Name, monogram or symbol of system integrator;
- Type or model number;
- Serial number;
- Polarity of terminals or leads (colour coding is permissible);
- Output voltage.
- Max. power output
- Date of supply
- Battery type

  Total AH
  No./AH of batteries

7.0 INSTALLATION & COMMISSIONING:

The installation shall be done by the supplier/manufacturer who is responsible for system performance, direction of installation and structural stability. The supplier shall conduct a detailed site assessment. The installer shall obtain data specific to the site, rather than relying on general data.

8.0 DOCUMENTATION:

The supplier shall provide easy-to-use illustrated installation and operation manual in English and local language for easy installation and trouble-free usage. The manual shall contain complete system details such as array layout, schematic of the system, working principle, clear instruction on regular maintenance, troubleshooting of the system and emergency shutdown procedures.

9.0 LOG BOOKS

Railways shall maintain a logbook detailing inspection and operating activities. This logbook must be kept in a secure place and shall be

made available, whenever required for inspection. Testing of all protection devices shall be carried out at regular intervals (no longer than six months) by the customer and recorded in the logbook.

10.0 DESIGN APPROVAL

Design for complete system and sub-systems shall be approved by RDSO at design stage before manufacture of prototype conforming to this specification. The criteria for selection of sub-system / component shall be based on sound engineering practice conforming to the International/ Indian Standards wherever specific standard is not specified in this specification. The detailed calculation/simulated results shall be submitted in support of system/ sub-system rating. Adequate safety margin as stipulated in respective specification shall be used.

11.0 PROTOTYPE APPROVAL

The prototype system shall be offered to RDSO for testing and approval. For certain tests, the type testing authority i.e. RDSO may choose to rely upon previous type test reports/conformance certificates, as long as they pertain to similar design and comparable rating. However, the manufacturer cannot demand this as a matter of right.

Until the railways are able to issue their vendor list, they may in the interim period invite tender/ place order with the provision of accepting the material on the basis of firm's written clause-by-clause confirmation of the spec. and acceptance test alone, wherever this is considered necessary by CEE.

12.0 TESTS:

The manufacturer shall carry out routine tests at his works and shall maintain records for the same. Acceptance testing shall be carried out by the purchaser or his representative or by any agency deputed by the purchaser on his behalf.

12.1 Test on SPV Module:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	Refer Annexure 1
2.	Design Qualification	√	√	√*	IEC 61215 and Cl. 6.3.1 & 6.3.3

3.	Safety Test	√	√	√*	IEC 61730 and Cl. 6.3.3
4.	Photo Electrical Conversion Efficiency	√	√	√	By Sun simulator on each module and Cl. 6.3.4
5.	Fill Factor	√	√	√	By Sun simulator on each module and Cl. 6.3.5
6.	Transmitivity of Glass	√			As per Cl 6.3.7
7.	Rated output of module	√	√	√	By Sun simulator on each module and Cl. 6.3.2
8.	Module mismatch test	√		√	Refer Cl. 6.3.16
9.	Terminal block	√		√Ω	Refer Cl. 6.3.10
10.	Provision of Bird Spike	√		√	Refer Cl 6.3.13
11.	Provision of RFID tag with requisite details	√	√	√	Refer Cl 6.3.18
12.	Environmental tests	√		√**	Refer Clause 4.0 of Annexure 1
13.	Insulation Resistance	√		√	Refer Clause 5.6 of Annexure – 1
14.	Provision of Earthing	√		√	Refer Cl 6.3.27
15.	Warranty Certificate for the modules	√		√	Refer Cl 6.3.14
16.	Marking	√	√	√	Refer Cl 6.3.19

* Copy of the latest conformance certificates should be asked

Ω To be relied on datasheets and test reports

** If compliance has already been checked during type testing, the same will be relied upon, otherwise compliance will be ensured through physical tests

12.2 Tests on Module Mounting Structure:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Dimension	√		√	As per manufacturer's data sheet and Cl. 6.3.23
3.	Conformance on module structure withstand capability	√		√	Refer Cl 6.3.22
4.	Clearance between module and ground			√	Refer Cl 6.3.25
5.	Galvanization thickness	√		√	Refer Cl 6.3.23
6.	Foundation			√	Refer Cl 6.3.24
7.	Fasteners			√	Refer Cl 6.3.26

12.3 Tests on module junction box, Array sub-main and main Junction Box:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	Refer Cl 6.3.20, 6.3.21
2.	Material	√		√£	Refer Cl 6.3.28
3.	IP Protection	√		√£	Refer Cl 6.3.28
4.	Cable entry and markings			√	Refer Cl 6.3.21

£ To be relied on datasheets and test reports

12.4 Test on Solar Charge Controller:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Compliance to IEC: 62509	√		√a	Refer Cl. 6.4.1 (iii)
3.	Functionality and rating of the charge	√	√	√	Refer Cl. 6.4.1 (ii)

	controller				
4.	Auto, bulk, float and equalization charging of battery	√		√€	Refer Cl. 6.4.1 (xiii)
5.	PWM/ MPPT Technology	√		√ ɑ	Refer Cl. 6.4.1(vi)
6.	Capability for handling 120% of rated current	√		√ ɑ	Refer Cl. 6.4.1-(v)
7.	Insulation Resistance	√	√	√	Refer Cl. 6.4.1-(xiv)
8.	Efficiency	√		√€	Refer Cl. 6.4.1-(vii)
9.	Temp. Compensation	√		√ ɑ	Refer Cl. 6.4.1-(viii)
10.	Protection Tests	√		√€	Refer Cl. 6.4.1(xi)& (xvi)
11.	IP protection	√		√	Refer Cl. 6.4.1-(iv)
12.	Surge protection	√		√	Refer Cl. 6.4.1-(x)
13.	Self-Consumption Test	√		√€	Refer Cl. 6.4.1-(iii)
14.	Blocking Diode	√		√	Refer Cl. 6.4.1-(ix)
15.	Over Voltage Test	√		√***	Refer Cl. 6.4.1-(xv)
16.	Environmental Test	√		√ ɑ	Refer Cl. 6.4.1-(xvii)
17.	Suitability for both T-Gel VRLA as well as LMLA	√		√ ɑ	Refer Cl. 6.4.1-(i)
18.	Checking of electronic components	√		√π	Refer Cl 5.6
19.	Output to be cut-off on 80% DOD of battery	√		√	Refer Cl. 6.5.6
20.	Integrated functioning & charger functionality (if any)	√	√	√	Refer Cl. 6.4.3 & 6.4.4

ɑ If compliance has already been checked during type testing, the same will be relied upon, otherwise compliance will be ensured through physical tests

€ On random 5% of the samples or a minimum of 2 samples

*** On any one random sample

π To be relied on datasheets and test reports

12.5 Test on Wind Turbine

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Power Rating as per CWET/ accredited test house	√	√	√	As per Cl. 6.2.1
3.	Corrosion resistance	√		√¥	As per Cl. 6.2.2
4.	Power vs RPM curve	√			As per Cl. 6.2.3
5.	Protection against high velocity/ overspeeding	√	√	√	As per Cl. 6.2.4
6.	Mounting Structure and its galvanization thickness	√	√	√	As per Cl. 6.2.6
7.	Design calculation on tower wind withstand capability	√	√	√¥	As per Cl. 6.2.5
8.	Provision of earthing	√		√¥	As per Cl. 6.2.7

¥To verify test certificate

12.6 Tests on Battery:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Battery Type	√		√	Refer Cl. 6.5.1
3.	Battery Voltage and AH	√£		√£	Refer Cl. 6.5.2
4.	Battery Life	√£		√£	Refer Cl. 6.5.3
5.	Enclosure material	√	√	√	Refer Cl. 6.5.7

6.	Self-Discharge Test	√£		√ £	Refer Cl. 6.5.4
7.	Battery Characteristics	√£		√ £	Refer Cl. 6.6

£ To be relied on datasheets and test reports

12.7 Test on Wind Charge Controller

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Rating of WCC	√	√	√	As per Cl 6.4.2(ix)
3.	Efficiency	√	√	√€	As per Cl 6.4.2(iv)
4.	Type of charger	√	√	√ ¤	As per Cl 6.4.2(iii)
5.	Temperature Compensation	√		√ ¤	As per Cl 6.4.2(v)
6.	Provision of blocking diode	√	√	√	As per Cl 6.4.2(vi)
7.	Protection against				
a	Battery overvoltage	√		√	As per Cl 6.4.2(viii)
b	Short Circuit	√		√	
c	Reverse Polarity	√	√	√	
d	Lightning & surge protection	√	√	√	As per Cl 6.4.2(x)
e	Overspeeding	√	√	√	As per Cl 6.4.2(vii)
8.	Output to be cut-off on 80% DOD of battery	√		√	Refer Cl. 6.5.6
9.	Dump load	√	√	√	As per Cl 6.4.2(vii)
10.	Auto, bulk, float and equalization charging of battery	√		√€	Refer Cl. 6.4.2 (xi)
11.	Over Voltage Test	√		√***	Refer Cl. 6.4.2-(xiii)
12.	Environmental Test	√		√ ¤	Refer Cl. 6.4.2-(xv)
13.	Suitability for both T-Gel VRLA as well as LMLA	√		√ ¤	Refer Cl. 6.4.2-(i)

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
14.	Checking of electronic components	√		√ ¤	Refer Cl 5.6
15.	Integrated functioning & charger functionality (if any)	√	√	√	Refer Cl. 6.4.3 & 6.4.4

ª If compliance has already been checked during type testing, the same will be relied upon, otherwise compliance will be ensured through physical tests

€ On random 5% of the samples or a minimum of 2 samples

*** On any one random sample

¤ To be relied on datasheets and test reports

12.8 Tests on LED Lamp and Fixture:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Rated Power of the luminaire	√	√	√	Refer Cl. 6.7.1
3.	Light Intensity	√		√¥*	Refer Cl. 6.7.2
4.	Lumen efficacy of the luminaire	√		√ µ	Refer Cl. 6.7.2
5.	LED Type	√&		√&	Refer Cl.6.7.4, 6.7.5, 6.7.6, 6.7.7, 6.7.8, 6.7.9, 6.7.10
6.	LM-80 and TM-21 reports for L70 Life of LEDs	√&		√&	Refer Cl. 6.7.7
7.	Lux Level	√		√ µ	Refer Cl. 6.7.12
8.	LED Luminaire and its fixture	√		√	Refer Cl. 6.7.10, 6.7.11, 6.7.13 and 6.7.14
9.	IP Protection	√		√¥*	Refer Cl. 6.7.14
10.	Heat Sink and soldering point temperature	√		√ µ	Refer Cl. 6.7.16
11.	LED Driver Regulation	√		√	Refer Cl. 6.7.17
12.	LED Control Gear Compliance	√		√¥*	Refer Cl. 6.7.18
13.	LED luminaire testing	√		√¥*	Refer Cl. 6.7.15

14.	Dusk to Dawn Switching	√		√ µ	Refer Cl. 6.7.19
15.	LM-79 Compliant and polar curve	√¥*		√¥*	Refer Cl. 6.7.3 & 6.7.20
16.	Checking of electronic components	√		√ &	Refer Cl 5.6

¥* Checking of test reports

& Checking of datasheets

µOn random 5% of the samples or a minimum of 2 samples

12.9 Tests on Cables and Hardware:

S.N.	Name of Test	Type Test	Routine Test	Acceptance Test	Method
1.	Visual Examination	√	√	√	
2.	Voltage rating	√		√	Refer Cl 6.9.2
3.	Voltage Drop			√	Refer Cl 6.9.4
4.	Module/ array wiring	√		√	Refer Cl 6.9.3
5.	Type and size of cable connecting the charge controller	√		√	Refer Cl 6.4.1(xii)

Annexure - 1

Quality Testing of PV-Module

Modules used in solar panels shall have IEC 61215 Ed 2 or latest compliance certificate. The qualification testing procedure is defined in IEC 61215 Ed 2 or latest to examine the impact of mechanical, thermal and electrical stress on power output. The bidder shall submit appropriate type approval certificate for the offered solar modules from accredited test laboratory.

Method of Testing

1.0 Visual Inspection:

Each module shall be carefully inspected under an illumination of not less than 1,000 lux for the following conditions:

1.1 Racked, bent, misaligned or torn external surfaces.

1.2 Broken / cracked cells

1.3 Faulty interconnections or joints

1.4 Cells touching one another or the frame

1.5 Failure of adhesive bonds; bubbles or delaminations forming a continuous path between a cell and edge of the module

1.6 Faulty terminations and exposed live electrical parts

1.7 Junction box should have common terminals with suitable blocking diode to prevent reverse current flow.

2.0 Performance at STC: (Clause 10.1 of IEC 61215 Ed 2 or latest)

The current-voltage characteristics of the module shall be determined in accordance with IEC 60904-1 at a specific set of irradiance and temperature conditions. Performance of PV-Module shall be generally evaluated at Standard-Test-Conditions (STC) as defined in IEC 60904 standards:

i) Cell temp. of 25° C,
ii) Incident solar irradiance of 1000W/m2,
iii) Spectral distribution of light spectrum with an air mass AM=1.5

3.0 All PV modules supplied shall be accompanied with I-V curves (tested in the manufacturing unit, clearly indicating the serial number, batch number, date and country of origin).

4.0 Environmental Testing:

Following environmental test shall be conducted on offered module or on module of similar design, for initial clearance of the offered system.

Test	**Test Details**	**Actual test to be carried out at Govt. Recognized Lab or manufacturer premises as per standard**
Cold Test	Temp. (-) 10^0C Duration: 16 hrs.	IEC-68-2-1
Dry Heat	Temp. (+) 70^0C Duration: 16 hrs	IEC-68-2-2
Salt spray*	Temp. (+) 35^0C, RH 95% Duration: 2 hrs spray and 22 hrs conditioning No. of Cycle : 01	IEC-68-2-11 Test Ka
Wind	Pressure equivalent to an air velocity of 200 km/hr.	
Rain	Test as required in the mentioned standards	JSS: 55555 (Test No. 12)
Dust	Temp : 40°C, RH < 50% Duration – 1 hr	JSS: 55555 (Test No. 14)
Others	Electrical Isolation test Routine test	Shall be done at manufacturers place for every modules offered

***** If compliance to IEC 61701 has been asked by the purchaser, then this test will not be required.

Note- Before and after the environmental testing the solar modules shall be subjected to performance test on sun simulator and insulation resistance test, and no degradation of maximum output power shall not exceed 5% of the value measured before the test.

5.0 Acceptance Criteria:

The module is deemed to have passed the tests if the sample meets the following criteria:

5.1 There is no evidence of a major visual defect such as a cracked or broken window, bubbles or de-lamination in the encapsulant etc.

5.2 There is no cell breakage and no water infiltration into terminal boxes.

5.3 No sample exhibits any open circuit or ground fault.

5.4 No visible evidence of major defects that may affect performance of the module.

5.6 Insulation Resistance not less than 50M-ohm at 500 V DC.

5.7 Degradation of performance may not exceed 5% after each single test or 8% after the whole sequence.

Annexure - 2

MEASUREMENT OF STREET LIGHTING LUX LEVELS

9 point method –

Basics:

- Divide the section between two poles into 4 quadrants of equal size
- Measure the Lux levels at four corners of each quadrant
- Take the average of each quadrants
- Find the average of the all the four quadrants
- Distance between two poles shall be at 15 m and the width of the road is to be taken as the height of the pole i.e. 5 m.

Position	Pole 1	Mid-Point	Pole 2
Edge of the road near light	P1	P2	P3
Mid road	P4	P5	P6
opposite edge of the road	P7	P8	P9

Average Lux levels = (P1+P3+P9+P7)/16 + (P2+P6+P8+P4)/8 + (P5)/16

Annexure - 3

TECHNICAL DETAILS TO BE FURNISHED BY THE PURCHASER IN HIS REQUISITION/ TENDER

1. Battery

i) Battery type (see Cl. 6.5.1)

ii) Battery Capacity required in AH (see 6.5.2)

2. SPV Module

i) Is Salt Mist Corrosion Testing required (see Cl. 6.3.3) (Yes/No)

3. Charge controllers and Grid supplied charger

i) Is grid supplied charger required (see Cl. 4.0-vi-c and 6.4.3) (Yes/No)

ii) Is compliance required for environmental testing of Solar Charge Controller (see cl. 6.4.1 (xvii)) (Yes/No)

4. Wind Turbine and Support Structure:

i) Is the firm required to submit type test certificate for salt spray test as per ASTM B-117 for a minimum period of 1,000 hours? (Refer Cl. 6.2.2) (Yes/No)

ii) Galvanization Thickness (Refer Cl. 6.2.6 & 6.3.23(iii))

iii) Will the height of all towers be 15m? (Yes/No)?
If no, then mention number of towers >15m along with their height. This will also need to be mentioned in tender work schedule. (Refer Cl. 6.2.6)

Annexure - 4

TECHNICAL DATA TO BE FURNISHED BY THE TENDERER IN HIS OFFER

1. Wind Generator

i) Make and model no.
ii) Rating of Wind Generator
iii) Regular empanelment from C-WET?
(Yes/ No)

2. SPV Module

i) Make and model no.
ii) Power rating

3. Charge Controllers

Please provide detail for wind, solar charge controllers and master controller (if any); if the purchaser has asked for a grid supplied charger, then also provide details thereof)

i) Make and model no.
ii) Ratings

4. Battery

i) Make and model no.
ii) Battery type
iii) VAH rating of battery (mention voltage as well as AH)

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

RB/L&A/005/2012

No. 2012/LM (PA)/3/5 New Delhi, dt.11.09.2012

General Managers,
All Indian Railways

Sub: Comprehensive instructions for provision of Passenger Amenities at Stations

Railway Board had constituted a Committee of Executive Directors to review the norms for provision of passenger amenities. The terms of reference of the committee included a review of the norms for provision of Passenger Amenities viz., minimum essential, recommended and desirable amenities at stations prescribed vide Board's letters no. 94/LMB/2/175 dated 17.1.2007 and 15.02.2007, in view of the changing requirements and technological improvements in the country and suggesting measures for improving General Cleanliness and environment conditions at stations.

2. Accordingly, the Committee examined in detail the entire gamut of amenities provided at stations and reviewed the existing instructions on level of passenger amenities at stations and submitted a report, which has been approved by Board. Based on this report, revised comprehensive instructions on provision of passenger amenities (enclosed) have been prepared.

3. Salient features of the changes made with reference to Board's letters no. 94/LMB/2/175 dated 17.1.2007 and 15.2.2007 are as follows:

a) For the purpose of categorization of stations, criteria have been revised.
b) Adequate number of water taps to be provided and located suitably to serve passengers of general second class coaches. Push button taps to be provided at 'E' category stations with suitable alternate arrangements where piped water supply is not available. One tap at every alternate water booth to be designed to meet the requirement of persons with disabilities.
c) Provision of water coolers as per norms on platforms at 'A1' to 'D' category stations as Minimum Essential Amenity (MEA).

d) Induction of solar energy technology for improved lighting and segregation of lighting levels during "no train" and "train" periods.

e) Platform shelters to be suitably spaced to cover the area where general second class coaches stop. Norms for platform shelters for 'D' and 'E' category stations revised.

f) Escalators/elevators to be introduced at 'A1' category and escalators at 'A' category, 'C' category and stations of tourist importance under desirable amenities.

g) Travellator as ramp to be provided at 'A1' and 'A' category stations as desirable amenities.

h) Provision of standard signage has been extended to 'A' and 'B' category stations under Minimum Essential Amenities.

i) Dustbins to be provided at a spacing of 50 meters at 'A1', 'A' and 'B' category stations without obstructing the movement of passengers.

j) Washable aprons with water hydrants/water jet system to be provided on platforms where trains stop for longer duration during the morning period.

k) Provision of Foot Over Bridges (FOB) at crossing stations, during doubling or gauge conversion upto 'D' category station, wherever no FOB is available.

l) AC VIP Lounge/Executive Lounge to be provided at 'A1' category stations under desirable amenities.

m) Coin Operated Ticket Vending Machines to be provided at 'A1, 'A', 'B' and 'C' category stations under desirable amenities.

n) Passenger operated Touch Screen Enquiry terminals extended to 'B' category stations also under desirable amenities.

o) N-Max i.e. maximum number of passengers dealt at stations during peak hours has been defined clearly.

p) Strategic measures to ensure cleanliness at stations have been introduced.

4. The scheme of Adarsh stations was introduced in the year 2009. It is considered that there is an urgent need to shift the focus of Adarsh stations from beautification to utility, comfort and cleanliness and also to facilitate cleanliness and upkeep of the station. Accordingly, revised instructions on Adarsh stations in supersession of Board's letter No. 2009/TG-IV/10/PA/Adarsh Stations dated 17/09/2009 are being issued separately.

5. Railways are requested to disseminate the contents of the revised Circular (which supersedes the earlier circular issued under Board's letter No. 94/LMB/2/175 dated 17.1.2007 & 15.2.07) widely in the field and take necessary action for its early implementation.

This issues in consultation with the Finance Directorate of the Ministry of Railways.

Please acknowledge receipt.

(DESH RATAN GUPTA)
Exec. Director(Land &Amenities)-III
Railway Board

(A. MADHUKUMAR REDDY)
Exec. Director (Passenger Marketing)
Railway Board

DA: 20 pages

No. 2012/LM (PA)/3/5

New Delhi, dt.11.09.2012

Copy forwarded for information to the FA&CAOs, all Indian Railways

For Financial Commissioner / Railways

Copy to: (i) ED/EEM, ED (T&C), ED/Works, Railway Board

(ii) F(X) I, F(X) II, TG-III, TG-IV, Electrical (G) Branches, Railway Board

(iii) MD/IRCON, MD/RVNL, MD/RITES

Enclosure to Letter No. 2012/LM (PA) /3/5 Dated 11.09.2012

COMPREHENSIVE INSTRUCTIONS ON PROVISION OF PASSENGER AMENITIES

1. GENERAL:

1.1 Indian Railways carry the highest volume of passengers. Considering the large volume of passenger traffic, Indian Railways need to create infrastructure to meet the growing aspirations of rail users.

1.2 Comprehensive instructions issued in Jan' 2007 on provision of passenger amenities at railway stations, have been reviewed in view of technological advances and to fulfill the increased expectations of our passengers for enhanced amenities/facilities at railway stations.

1.3 While planning for provision/augmentation of amenities, due consideration needs to be given to the importance of the station from the point of view of passenger traffic.

2. CATEGORISATION OF STATIONS:

2.1 Stations have been categorized in seven categories, i.e. A1, A, B, C, D, E & F depending upon the earning which is the indicator of passenger traffic. Criteria for categorization of stations are enclosed as **Annexure-I**.

2.2 The categorization of stations shall be reviewed every five years. The last review was done in 2007-08 based on the earnings of 2006-07. Categorization based on the earnings of 2011-12 shall be reviewed in 2012-13. Zonal Railways are advised to review the station categorization in accordance with the earnings for the year 2011-12 as the revised categorization shall remain unchanged for the next 5 years. The number of stations falling under various categories shall remain unchanged till next review is done.

2.3 For the purpose of categorization of stations, the basic parameter is the passenger earnings of each station, from both reserved and unreserved passengers. The earnings are to be calculated on the basis of the number of passengers boarding at a particular station (both reserved and unreserved), irrespective of the location from where the ticket has been issued. The data of passenger earning should be collected from PRS, UTS, SPTM and JTBS etc.

3. MINIMUM ESSENTIAL AMENITIES (MEA):

3.1 When a station is constructed, certain minimum amenities are required to be provided at each category of station (on the basis of projected traffic/earnings). These are called **Minimum Essential Amenities (MEA).**

3.2 Keeping in view of need for enhanced amenities at stations, norms of some MEAs have been revised. Norms for provision of Minimum Essential Amenities required to be provided in each category of stations are enclosed as **Annexure –II** and quantum for provision of Minimum Essential Amenities required to be provided are enclosed as **Annexure-III**. Availability of these amenities will have to be ensured. Railways will immediately undertake a survey to confirm availability of the minimum amenities as per the prescribed scale, at all the stations on the basis of earnings of the station and provide minimum essential amenities as per the prescribed scale. Minimum Essential Amenities as per revised scale prescribed in this circular, based on categorization of stations as per passenger earnings for 2011-12, are required to be provided by 31st March, 2016.Subsequently, quinquenial review is to be conducted with respect to availability of minimum essential amenities vis-a-vis category of stations at that time.

4. RECOMMENDED AMENITIES: Provision of Amenities as per recommended scale:

4.1 The availability of amenities at station as per norms of "Minimum Essential Amenities" (vide Annexure-III) may not be commensurate with the actual passenger traffic dealt at the station. Hence, the requirement of actual amenities based on traffic as per the norms laid down in **Annexure IV** should be worked out and any augmentation based on this, will be known as Recommended Amenities.

4.2 **Powers of GM of the Railway to review –**
In case quantum of amenities as worked out on the basis of norms for Recommended Amenities in Annexure IV is less than quantum prescribed for Minimum Essential Amenities in Annexure 'III', the actual quantum of Minimum Essential Amenities to be provided could be reduced, with the approval of GM and Board should be intimated of the same. No further delegation is permitted for such approval.

4.3 Provision of recommended level of amenities at stations, which is a parameter of adequacy of the scale of amenities provided as per actual passenger volume, has not received adequate attention. Railways should review the existing facilities vis-à-vis requirements for recommended amenities and a time-bound action plan be made for augmenting shortfalls, as a thrust area.

5. DESIRABLE AMENITIES:

5.1 Desirable amenities are those amenities which are considered desirable to improve customer satisfaction and interface process at the station. The quantum of these amenities would depend upon the category of the station. Norms for Desirable level of amenities at various categories of stations are given at **Annexure-V**.

5.2 Various amenities out of the list given in Annexure 'V' should be provided based on the need and relative importance of the station.

5.3 Calculation of passenger volume:

5.3.1 The method of calculation of number of passengers per day and maximum passengers at any time per day should be uniform. Zonal Railways should ensure that the number of passengers per day (originating passengers) is calculated as an average number of passengers (reserved and unreserved category) booked by PRS and UTS/other system over a period of one year (excluding the month pertaining to the period of Mela traffic.). Normally, the number of passengers handled at stations is double of reserved/booked passengers to account for the inward passengers. However, the criteria for provision of facilities at stations would continue to be based on earnings.

5.3.2 For the purpose of calculating N Max(the maximum number of passengers), Zonal Railways should consider maximum number of trains dealt with in any interval of half an hour at the station and multiply the same by the average number of passengers dealt per train at that station. The average number of passengers per train at a station shall be the average number of daily passengers dealt with at the station divided by the number of trains stopping at the station during 24 hours.

6. DISPLAY OF AVAILABLE AMENITIES:

At each station, a list shall be displayed in Station Manager/Master's room showing the quantum of Minimum Essential Amenities required to be provided for that category of station, as per these guidelines, vis-a-vis the amenities actually available. The details of other amenities available at the station should also be displayed.

7. PREPARATION OF MASTER PLANS AND PLANNING FOR PASSENGER AMENITY WORKS:

7.1 The Zonal Railways shall carry out a survey of available amenities at stations in relation to those listed in the Annexures.

7.2 Drawing from the results of this survey, a list of the Minimum Essential Amenities, Recommended and Desirable Amenities to be provided, should then be separately drawn up station-wise for each route. The Master Plan for each station should show the amenities required.

7.3 These lists shall continue to form the basis for drawing up the Divisional Action plans. Action Plans so formulated should then be amalgamated into one General Action Plan and inter-se priorities for different works assigned.

7.4 Minimum Essential Amenities should be provided first as per the scale at all categories of stations. Thereafter, priority should be given for augmenting amenities to recommended level at A1, A, B & C category stations.

7.5 Keeping the normal allocation of funds, under the Plan Heads "Passenger Amenities" in view, a time –frame be allocated to each phase of the General Action Plan. Low cost amenities items for which funds can easily be earmarked be taken up earlier than those requiring heavy outlay even if the latter are higher in the priority. Remaining works should be prioritized in a manner such that, gaps in minimum essential amenities, recommended amenities and desirable amenities are filled up, generally in that order.

7.6 Minimum Essential Amenities as prescribed in Annexure 'III' shall be provided as part of the concerned Plan Head at the time of construction of new stations. Elimination of shortfall in Minimum Essential Amenities at existing stations and augmentation of any facility at a station shall, however, be charged under Plan Head "Passenger Amenities".

8. OTHER IMPORTANT ASPECTS:

8.1 **Definition of Platform**: Island platform should be treated as single platform for provision of Minimum Essential Amenities. (Circular No. 2000/LMB/2/212 dated 23.06.2000)

8.2 **Foot Over Bridges:** New FOBs should be at least 6 m wide at 'A-1', 'A' and 'C' category stations, wherever feasible. New FOBs at 'A1' & 'A' category stations should be compatible for installation of escalators. Foot over-bridges shall be provided at all crossing stations during doubling/gauge conversion upto 'D' category stations, wherever the same are not available.

8.3 **Toilets:** All toilets should be gradually converted to Pay & Use toilets as per guidelines issued under Board's letter No. 05/TGIV/10/SAN/32/Pay& Use Policy Dt 7.6.06.

At Suburban stations:

(a) Only urinals should be provided at the end of the suburban island platforms as the major requirement of suburban passengers is a urinal. Wash basins should invariably be provided near the urinals.

(b) The power to dispense with provision of toilets/urinals at the platforms is delegated to the General Managers.

(c) Toilets should be provided only in concourse/circulating areas of suburban stations. 'Pay & Use' toilets should be provided in the concourse/circulating area of all stations. However, at stations where the provision of 'Pay & Use' toilets is not feasible, departmentally operated toilets can be provided with the approval of Divisional Railway Manager.

At Non-suburban stations:

(a) The power of provision of urinals instead of full toilets at the platforms of A1, A & B category stations is delegated to the General Managers.

(b) Only urinals should be provided on island platforms at other than A1, A & B category stations. Wash basins should invariably be provided near the urinals

8.4 **Signage:** All the signage at the station should be standardized in terms of Railway Board's circular No. 97/TGII/39/11/signage dt. 11.3.99. For location of signage, a plan should be made for each station.

8.5 **Stalls & Trolleys:** The number of trolleys and catering stalls under the platform shelter should be reduced to a minimum and Automatic vending machines should be encouraged to replace existing vending stalls. The norms circulated by Tourism and Catering Directorate in this regard should be adhered to.

8.6 **Circulating Area:** In the circulating area, proper traffic movement flow plan should be made. Proper landscaping in the circulating area should also be developed. Wherever circulation areas are redesigned, altered, or whenever stations are congested, possibility of providing FOB landings directly into circulating area should be examined as it decongests main platforms. There should be proper segregation of incoming and outgoing passengers, wherever considered necessary (Detailed guidelines have been issued under Board's letter No. 2005/LMB/02/267 Dt 7.12.05).

8.7 **Entry & Exit:** Proper planning is essential to facilitate easy movement of passengers at stations. In order to decongest the entrance, separate entry/exit gates to be provided at stations, wherever feasible. All unauthorized entry points into the stations irrespective of their class should be closed excepting the specified exit and entry.

8.8 **Illumination & Energy saving**: The illumination at the stations should be improved. The enquiry and Booking Offices should be specially brightened up at all the stations.LED based station name boards on the station building shall be provided at A-1, A & B category stations as per RDSO specifications. Platform name-boards should be suitably illuminated so that the station name is visible at night to the passengers travelling by trains.

For ensuring energy conservation:

(a) Platform lighting circuit shall be segregated such that during "No train" period about 30% lights are 'ON' and before train arrival all the lights are switched 'ON'. In this regard, necessary changes in electrical circuits at stations may be planned in a phased manner.

(b) All the electrical fittings and power supply equipments with at least BEE's 3 star rating shall be used.

(c) All important stations of historical and archeological value may be suitably illuminated.

8.9 **Mobile & Laptop Chargers:**5 pin, 5 amp, 230v (Railway approved) sockets for mobile and laptop charging shall be provided in adequate numbers at refreshment rooms and Waiting Rooms.

8.10 **Air Cooling System:** At A-1, A & B category stations where natural ventilation is not adequate, air cooling system should be installed subject to feasibility.

8.11 **Floorings:** Flooring standards for platform, concourse and FOB/waiting room, etc., as per instructions issued by RDSO (accepted by Board) may be followed in new works, renovation or replacement works. (RDSO letter No.WKS/WS/05/FS dated 22.09.09).

8.12 **Booking counters:** Booking counters upto 'E' category stations shall be provided with UTS system.

8.13 **Dustbins:** Adequate number of uniformly designed standard dustbins should be provided at all categories of stations. At A-1, A, B, and D categories of stations, dustbins should be provided at regular spacing of 50 meters on each platform. At C and E category stations, adequate number of dustbins as required should be provided. It must be ensured that provision of dustbins does not impede the free flow of passengers.

9. AMENITIES FOR PERSONS WITH DISABILITY (PwD):

9.1. As per extant instructions, Short-term facilities, consisting of following 7 items are to be provided at all stations:

(i) Provision of standard ramp with railing for barrier free entry.
(ii) Earmarking at least two parking lots for vehicles used by disabled persons.
(iii) Provision of a non-slippery walkway from parking lot to building
(iv) Provision of signage of appropriate visibility.
(v) Provision of at least one drinking water tap suitable for use by a disabled person.
(vi) Provision of at least one toilet on the ground floor.
(vii) "May I help You" booth.

(Detailed drawings/guidelines for the above were laid down in RDSO's report ofNov.1998, circulated under Board's letter No. 96/LM(B)/2/404 Dt 30.12.1998)

9.2 Above facilities have already been provided at all A1 &A category Stations, and are now being extended to all B category stations. Above facilities should be provided at the remaining 'B' category stations at the earliest. These facilities should also be extended to all other category of stations.

9.3 As per extant instructions, Long-terms facility, comprising of following 2 items are to be provided:

(i) Provision of facility for inter-platform transfer.
(ii) Engraving on edges of platforms.
Above facilities are to be provided at A1, A & B category stations.

9.4 Regarding inter-platform transfer, provision of 1 in 12 ramps/lifts to existing FOBs/Subways may not be feasible as a general solution. This facility has to be mainly provided through pathways at the end of platforms for disabled passengers, on wheelchairs (to be provided free of cost), duly escorted by coolies (on payment), as per present practice. Accordingly, pathways at platform ends, wherever not existing presently, should be provided in a time bound manner, beginning with A1 and A & B category stations. Moreover, these should be properly provided with precast CC/paver blocks at track crossings etc and laid to accurate level, to ensure a smooth ride for handicapped persons on wheel chairs, without need for lifting at any stage. The other long-term facility, viz., engravings on platform edges may also be taken up progressively beginning with A1, A and 'B' category stations.

10. MAINTENANCE OF PASSENGER AMENITIES:

10.1 It is important to maintain the amenities provided at all the stations in good working order at all times. Maintenance staff shall carry out repairs needed to restore the amenity to functional order, immediately after receipt of information from the Station Master/Station Manager. Hygiene and cleanliness should be an important activity for day to day monitoring.

10.2 General Manager shall arrange to provide adequate imprest with Station masters of stations where Railways maintenance staff are not headquartered, to enable them organize expeditious repairs to small items of passenger amenities such as hand pumps/taps, water trolleys, clock, light/fans, urinal/latrines and furniture at the station.

11. WEB BASED PASSENGER AMENITY MANAGEMENT SYSTEM:

Additions/Modifications to the passenger amenities available at the stations should be incorporated in the data base & Passenger Amenities Management System on web based IRPSM module. For this purpose, window shall be opened periodically to update data and Railways shall be required to complete updation of passenger amenities' data by the notified date.

12. MEASURES FOR IMPROVING CLEANLINESS AND HYGINE:

Passengers coming to Railway Station should be educated through Public announcements, posters, TV/Radio Commercial spots to keep the Station clean. Punitive measures should also be put in place to penalize people found littering, spitting, defecating at inappropriate places in Railway Premises.

****

ANNEXURE-I

CATEGORIES OF STATIONS FOR PROVISION OF PASSENGER AMENITIES

S No	Category	Criteria
1.	A1	Non-Suburban stations with an annual passenger earning of more than Rs. 60 crores.
2.	A	Non-suburban stations with an annual passenger earnings of Rs. 8 crores and upto Rs 60 crores.
3.	B	I. Non suburban stations with annual passenger earnings between Rs. 4 crores to Rs. 8 crores. II. Stations of tourist importance or an important junction station (to be decided by G.M.).
4.	C	All suburban stations*.
5.	D	Non suburban stations with passenger earnings between Rs. 60 lakhs and Rs. 4 crores.
6.	E	Non suburban stations with passenger earnings less than Rs. 60 lakhs.
7.	F	Halts

*For station dealing with both suburban / non-suburban traffic, the Railway may take a view regarding up-gradation of classification depending upon station earnings, quantum of non-suburban traffic, etc.

Note: Annual Passenger Earnings at the station for the purpose of the amenities shall be worked out as per para 2.3 of the instructions.

***

ANNEXURE - II

MINIMUM ESSENTIAL AMENITIES AT VARIOUS CATEGORIES OF STATIONS

Sl. No	Amenities	STATION CATEGORY						
		A1	A	B	C	D	E	F
1.	Booking Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.	Drinking water Piped/Hand Pump	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3.	Waiting hall	Yes	Yes	Yes	-	Yes	Yes	Yes
4.	Seating arrangement	Yes	Yes	Yes	Yes	Yes	Yes	-
5.	Platform shelter Shady trees	Yes -	Yes -	Yes -	Yes -	Yes -	Yes -	- Yes
6.	Urinals	Yes	Yes	Yes	Yes	Yes	Yes	-
7.	Latrines	Yes	Yes	Yes	Yes	Yes	Yes	-
8.	Platforms - High level- Medium level- Rail level-	 Yes - -	 Yes - -	 - Yes -	 Yes - -	 - Yes -	 - - Yes	 - - Yes
9.	Lighting #	Yes	Yes	Yes	Yes	Yes	Yes	Yes@
10.	Fans	Yes	Yes	Yes	Yes	Yes	Yes	-
11.	Foot over bridge	Yes*	Yes*	Yes	Yes	©	-	-
12.	Time Table Display	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13.	Clock	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14.	Water cooler	Yes	Yes	Yes	Yes	Yes	-	-
15	Public Address system/Compu-ter based announcement	Yes	Yes	Yes	-	-	-	-
16	Parking-cum-circulatory area, with lights	Yes	Yes	-	-	-	-	-
17	Electronic Train indicator board	Yes **	Yes	-	-	-	-	-
18	Public phone booth	Yes	Yes	-	-	-	-	-
19	Signage (standardised)	Yes	Yes	Yes	-	-	-	-

* With cover.

** At station entrance/concourse, on Foot-over bridges(at landing locations) and on platforms located appropriately to guide passengers at every stage.

Stations may be electrified as per provisions of Board's circular No. 95/Elec(G)/109/1 dt. 1.2.95.

@ Where train stops at night.

© Foot over-bridges shall be provided at all crossing stations during doubling/gauge conversion upto 'D' category stations, wherever the same are not available.

***

ANNEXURE -III

NORMS OF MINIMUM ESSENTIAL AMENITIES AT VARIOUS CATEGORIES OF STATIONS

S.N.	Amenity	STATION CATEGORY						
		A1	A	B	C	D	E	F
1	**Booking Facility %** **(No. of counters)**	15	10	6	4	4	2	1
2	**UTS as per norms**	Yes	Yes	Yes	Yes	Yes	Yes	-
3	**Drinking water ^** **(No. of taps/PF) $ ^^**	20	20	20	6	8	2*	Appropriate drinking water facility **
4	**Waiting hall @ Sq m**	250	125	75	0	30	15	10 sqm booking office cum Wtg.hall
5.	**Seating arrangeme-nt (No. of seats / PF)**	150	125	100	10	50	10	-
6	**Platform shelter** **(on each PF)#**	500 sqm	400 sqm	200 sqm	200 sqm	50 sqm +	50 sqm+	Shady trees
7	**Urinals##**	12	10	6	4	4	1	-
8	**Latrines##**	12	10	6	2	4	1	-
9	**Foot over bridge®**	1 with cover	1 with cover	1	1	®®		
10	**Water cooler £**	2 on each PF	2 on each PF	2 on each PF	2 on main PF	1 on main PF	-	-

11	**Signage (standardized)**	Yes	Yes	Yes	-	-	-	-
12	**Platforms *****	High Level	High Level	Medium Level	High Level	Medium Level	Rail Level	
13	**Lighting ++** (Lux level)	As per Annexure II of Board's letter No.2004/Elec(G)/109/1 dated 18.5.2007						
14	**Fans ©**	As given below						
15	**Time table Display**	As per extant instructions.						
16	**Clock**	To be decided by zonal railways.						
17	**Public Address system/Computer based announcement**	As per extant instructions						
18	**Parking-cum-circulatory area, with lights**	As per extant instructions						
19	**Electronic Train indicator board.**	As per extant instructions						
20	**Public phone booth**	As per extant instructions						

% At A1, A, B, C & D category of stations, the booking counters to operate round the clock except at stations where there is no night working.

^ At stations falling in water scarcity zones or where water source dries up in summer, drinking water facility should be ensured at every platform by means of syntax tanks/CANS/*Matkas*/*Piaos* etc. as decided by GM of the Railways. At less important stations, particularly those falling under category E & F, one water supply source at a location convenient to passengers may be provided. Drinking water facility would include all necessary units whether donated by private parties or provided by the Railways themselves.

$ There should be one drinking water tap suitable for use by disabled persons on alternate water booths at every platform.

^^ Adequate number of water taps should be suitably located to serve passengers of GS coaches, i.e. at the end of platforms.

*At 'E' category stations, wherever piped water supply is not feasible due to local conditions, separate arrangement for potable water at each platform shall be made available with the approval of General Manager of the concerned Zonal Railway.

**drinking water arrangements should be made at halt stations by means of water taps/handpumps/tubewells/sintex tanks/piaos as decided by the General manager of the concerned Zonal Railway.

@ If the variation is marginally on the lower side (upto –5 sqm), then it can be taken to be adequately provided.

#Shelter should be suitably spaced ensuring natural light and ventilation and covering areas from where passengers aboard the General Coach.
+ Preferably light weight shelters.
##1. Number of latrines/urinals includes provision in waiting room/halls. 1/3rd of the toilet may be reserved for ladies. In case of 2 toilets existing, one each should be earmarked for ladies & gents.

2. Number of latrines/urinals can be reduced in water scarcity areas by the Railway with the approval of GM.

3. Includes pay and use toilets. The policy for setting up such toilets be referred in terms of Board's letter No. 05/TGIV/10/SAN/32/Pay& Use Policy Dt 7.6.06.

® New FOBs should be at least 6 m wide at 'A-1', 'A' and 'C' category stations wherever feasible. New FOBs at 'A1' & 'A' category stations should be compatible for installation of escalators.

®® Foot over-bridges shall be provided at all crossing stations during doubling/gauge conversion upto 'D' category stations, wherever the same are not available.

£ To be provided as per Board's letter No. 69/Elec(g)/730/8 Dt. 30.03.1971.

*** (a)On all New lines, Gauge Conversion & Doubling projects, minimum level of platforms shall be medium level(Board's letter No. 2003/LMB/14/29 Dt. 26.4.2005).Wherever medium level of platform is to be provided as per norms, the same shall be with the foundation for high level platform. (Board's letter No. 2012/LM(PA)/03/07/Policy dated 06.07.12). (b)Wherever platform height gets reduced on account of track works, the same should be restored (Board's letter No. 2003/LMB/14/29 Dt. 03.02.2005).(c) Platform should be high level, irrespective of category, wherever EMU trains are dealt with(Board's letter No. 2006/LMB/2/121 Dt. 11.8.2006).

++Solar energy based lighting needs to be introduced to provide emergency lighting at "D" and "E" Category stations, wherever feasible, in non-electric traction areas.

© For covered platforms having width of 6-9mts; one row of fans should be provided @one fan in the centre of supporting columns. For covered platforms with more than 9mts width, fans should be provided in 2 rows.

Note: (1) At stations where only one ASM is posted, only one booking window will be provided. In respect of 'E' category stations, where the earnings is less than Rs. 20 lakh per annum, the quantum of amenities to be provided could be decided by General Managers based on actual requirements.

(2) Scale of all the amenities prescribed above are the bare minimum to be provided at the appropriate category of stations. Amenities over and above the prescribed minimum scales will continue to be provided as per norms for provision of amenities at "Recommended Level".

***

ANNEXURE - IV

NORMS FOR RECOMMENDED LEVEL OF AMENITIES AT VARIOUS CATEGORIES OF STATIONS

Nmax= Maximum number of trains dealt with in any interval of half an hour at the station multiplied by the average number of passengers dealt per train at that station. The average number of passengers per train at a station shall be the average number of daily passengers dealt with at the station divided by the number of trains stopping at the station during 24 hours.

Ndb = Design figure for number of passenger for 'A'&'B' stations to be calculated as **Ndb = 0.3 (Nmax)**

Nds = Design figure for number of passenger for 'C', 'D'&'E' stations to be calculated as **Nds = 0.45 (Nmax)**

S.No.	Amenities	Recommended scale for provision	
		Cat. A1, A & B	**Other stations**
1.	**Booking Facility (No. of counters)**	1 window per 800 tickets per shift (shift with maximum number of tickets sold should be taken)	
2.	**Drinking water (No. of taps)**	No. of taps= Nmax/25. Taps should be distributed so that every alternate coach gets benefit of a tap	No. of taps= Nmax/25.
3.	**Waiting hall/Shed**	1.394 Ndb sqm	1.394 Nds sqm(Excluding C)
4.	**Seating arrangement (No. of seats)**	0.4 Ndb	0.4 Nds
5.	**Platform shelter* (on each PF)**	0.28 Nmax	0.28 Nmax
6.	**Urinals#**	Ndb/200	Nds/200
7.	**Latrines#**	Ndb/200	Nds/200
8.	**Platform level**	To be decided by the Zonal Railways	
9.	**Lighting ®**	As per Board's letter no. 95/Elec(G)/138/5 dated 19.3.96 Norms indicated in Note below.	
10.	**Fans ****	As per Board's letter no. 95/Elec(G)/138/5 dated 19.3.96.	

11.	**Foot over bridge**	To be decided by the Zonal Railways	
12.	**Time Table Display**	To be decided by the Zonal Railways	
13.	**Clock**	To be decided by the Zonal Railways	
14.	**Bathrooms$**	1/400 Ndb	1/400 Ndb at other junction & terminal stations only
15.	**Water Coolers**	To be provided if total number of passengers,inward and outward is more than 1000 per day (As per Bd's letter no. 69/Elec(g)/730/8 Dt 30.3.71. To be decided by the Zonal Railways	
16.	**IVRS**	A – 48 lines (calls 72000) B – 24 lines (calls 5000-20000)	A central IVRS with adequate lines should be provided to cover all suburban stations – Minimum 6 lines if IVRS is otherwise justified
17.	**Public Address system/Computer based announcement**	To be decided by the Zonal Railways	
18.	**Parking-cum-circulatory area, with lights**	To be decided by the Zonal Railways	
19.	**Electronic Train indicator board.**	To be decided by the Zonal Railways	
20.	**Public phone booth**	To be decided by the Zonal Railways	
21.	**Signage (standardized)**	To be decided by the Zonal Railways	

* At important A1, 'A' category and suburban stations, efforts should be to cover the entire PF.

1/3rd of urinals/latrines be reserved for ladies.

® (a) Emergency light: From Auxiliary Transformer (AT) connected to traction supply, 10 light points for A1 and A category stations on each platform. Emergency light from DG set/Solar supply on each platform at all stations where traction supply is not available, except E & F category stations. (b) Minimum One light in ASM room, Booking Window, Waiting Hall each, one light on each FOB at every 30 meter, 03 lights on each platform and one light in circulating area shall

be provided as emergency light with suitable back up power source such as Solar/wind etc.

** For covered platforms having width of 6-9 mts, one row of fans should be provided @one fan in the centre of supporting columns. For covered platforms with more than 9mts width, fans should be provided in 2 rows.

$ At suburban stations, bathrooms need not be provided.

Note: Norms for recommended level of illumination at various categories of stations are as follows (Ref Bd's Circular No 2005/Elec(G)/150/1 Dt 28.2.06)

S No.	Area	Proposed lux level for category I/ II/ III station
1.	Station circulating area	50/30/20
	Outdoor car parking	20/ 20/ 20
2.	Station concourse area	100/ 100/ 100
3.	Booking office, reservation office, enquiry office	200(localized above counter) & 100 in remaining areas for category I, II, III stations.
4.	Parcel & luggage office counter	150/ 150/150 150/150 /150
5.	Platform covered Open area	.50/30/20
6.	Waiting halls/rooms	100/100/ 100
7.	Retiring rooms	100/100 /100
8.	Restaurant & kitchen in general building area: i) restaurant area: ii) Kitchen: iii) Stores:	 150/150 /150 100/100/ 100 100/100/ 100
9.	Foot over bridge	50/30/20
10.	Other service buildings inside Railway station area	200 for SM's office for category I, II, III station

Category (I) –Stations on Zonal railway HQs/State capitals and all A1 &A category stations
Category (II) – Stations on Rlys. Divisional Hq./State Distt. HQs & all B Category stations
Category (III) – Stations in remaining Categories

***

ANNEXURE-V

NORMS OF DESIRABLE AMENITIES AT VARIOUS CATEGORIES OF STATIONS

S.No	Amenities	STATION CATEGORY						
		A-1	A	B	C	D	E	F
1.	Retiring room	Yes[1]	Yes	Yes	-	-	-	-
2.	Waiting room (with bathing facilities)							
	Upper Class	Yes[1]	Yes	-	-	-	-	-
	2nd class	Yes[1]	Yes	Yes	-	Yes	-	-
	Separate for ladies (combined upper and 2nd Class)	Yes[1]	Yes	-	-	-	-	-
3.	Cloak room	Yes	Yes	Yes	-	-	-	-
4.	Enquiry Counter	Yes	Yes	Yes	-	-	-	-
5.	NTES	Yes	Yes	-	-	-	-	-
6.	IVRS	Yes	Yes	Yes	-	-	-	-
7.	Public Address system /Computer based announcement	***Yes***	***Yes***	***Yes***	Yes	Yes	-	-
8.	Book stalls/other - stalls of essential goods	Yes[2]	Yes	Yes	Yes	Yes	-	-
9.	Refreshment room	Yes	Yes	Yes	-	-	-	-
10.	Parking/circulatory area with lights ***	***Yes***	***Yes***	Yes	Yes	Yes	-	-
11.	Washable apron with jet cleaning #	Yes	Yes	Yes	-	-	-	-
12.	Electronic Train indicator board	***Yes***	***Yes***	Yes	Yes	-	-	-
13.	Touch Screen Enquiry system	Yes	Yes	Yes	-	-	-	-
14.	Water vending machines	Yes	Yes**	Yes**	-	-	-	-
15.	Foot Over Bridges	***Yes***	***Yes***	***Yes***	***Yes***	Yes®		
16.	Escalators	Yes[3]	Yes[3]	-	Yes[3]	-	-	-

17.	**Travellator**	Yes[4]	Yes[4]	-	-	-	-	-
18.	**Signage (standardized)**	***Yes***	***Yes***	***Yes***	Yes	Yes	-	-
19.	**Modular Catering Stalls***	Yes	Yes	Yes	Yes	Yes	-	-
20.	**Automatic Vending Machines**	Yes	Yes**	Yes**	Yes**	-	-	-
21.	**Pay & Use Toilets on end platforms & circulating area.**	Yes	Yes	Yes	Yes	Yes	Yes	-
22.	**Provision of cyber cafes**	Yes[4]	-	-	-	-	-	-
23.	**Provision of ATMs (preferably with ticketing facility)**	Yes	Yes	Yes	Yes	Yes **	Yes **	-
24.	**Provision of at least one AC VIP/Executive Lounge**	Yes	-	-	-	-	-	-
25.	**Food Plaza**	Yes	-	-	-	-	-	-
26.	**Train coach indication system**	Yes	-	-	-	-	-	-
27.	**CCTV for announcement & security purpose**	Yes	-	-	-	-	-	-
28.	**Coin operated Ticket Vending Machines**	Yes	Yes	Yes	Yes	-	-	-
29.	**Pre-paid Taxi service**	Yes[5]	-	-	-	-	-	-
30.	**High Level Platform**	***Yes***	***Yes***	Yes	***Yes***	Yes[6]	-	-

Yes(in italics): Also prescribed as Minimum Essential Amenity under Annex. II.
*** Should include high mast lighting wherever feasible.
# Washable aprons with water hydrant/jet system should be provided at all platforms where morning train stops for longer duration to ensure cleanliness and better maintenance.
® On double line sections.
* In end platforms, all stalls should be preferably embedded in walls.
**Optional items vide Board's letter No.94/LMB/2/175 dated 16.1.05.

Numbered subscripts:

1: Up gradation to be taken up preferably under public-private partnership schemes. Retiring Rooms need not be provided at 'D' category stations.
2: Should provide for minimum essential medicines.
3: Escalators at 'A1', 'A' & 'C' category stations and stations of Tourist importance.
4: Subject to availability of space& feasibility.
5: Subject to availability/clearance from local authorities.
6: With the approval of General Manager.

***