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CENTRAL ELECTRICITY AUTHORITY

NOTIFICATION

New Delhi, the 20th September, 2010

No. CEI/1/59/CEA/EI.—In exercise of the powers conferred by section 177 of the Electricity Act, 2003 (36 of 2003), the Central Electricity Authority hereby makes the following regulations for Measures relating to Safety and Electric Supply, namely:-

Chapter I

1. **Short title and Commencement.-** (1) These regulations may be called the Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010.

(2) They shall come into force on the date of their final publication in the Official Gazette.

2. **Definitions.-** (1) In these regulations, unless the context otherwise requires,

(a) "Act" means the Electricity Act,2003;

(b) "accessible" means within physical reach without the use of any appliance or special effort;

(c) "ampere" means a unit of electric current and is a constant current which, flowing in two parallel straight conductors of infinite length of negligible cross section and placed at a distance of one meter apart in a vacuum will produce a force of $2x10^{-7}$ Newton per meter length between the conductors;

(d) "apparatus "means electrical apparatus and includes all machines, fittings, accessories and appliances in which conductors are used;

(e) "bare" means not covered with insulating materials;

(f) "cable" means 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;

(g) "circuit" means an arrangement of conductor or conductors for the purpose of conveying electricity and forming a system or a branch of a system;

(h) "circuit breaker" means 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;

(i) "concentric cable" means 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;

(j) "conductor" means any wire, cable, bar, tube, rail or plate used for conducting electricity and so arranged as to be electrically connected to a system;

(k) "conduit" means 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;

(l) "connected load" means the sum of the ratings of the electricity consuming apparatus connected to a consumer's installation;

(m) "covered with insulating material" means adequately covered with insulating material of such quality and thickness as to prevent danger;

(n) "cut out" means any appliance for automatically interrupting the transmission of electricity through the conductor when the current rises above a pre-determined amount, and shall also include fusible cut-out;

(o) "danger" means 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 electricity;

(p) "dead" means at or about earth potential and disconnected from any live system. It is used only with reference to current carrying parts when these parts are not live.

(q) "designated person" means a person designated under regulation 3;

(r) "earthed" or "connected with earth" means connected with the general mass of earth in such manner as to ensure at all times an immediate discharge of electricity without danger;

(s) "earthing system" means an electrical system in which all the conductors and appliances are earthed;

(t) "enclosed sub-station" means 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 electricity to or from a voltage at or exceeding 650 V (other than transforming or converting solely for the operation of switch gear or instruments) with or without any other apparatus for switching, controlling or otherwise regulating the electricity, and includes the apparatus therein;

(u) "enclosed switch-station" means 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 switching, controlling or otherwise regulating electricity at or exceeding 650 V but not for transforming or converting electricity(other than for transforming or converting solely for the operation of switchgear or instruments)and includes the apparatus therein,

(v) "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 enclosure;

(w) "flexible cable" means 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 insulating material being such as to afford flexibility.

(x) "guarded" means covered, shielded, fenced or otherwise protected by means of suitable casings, barrier, rails or metal screens to remove the possibility of dangerous contact or approach by persons or objects to a point of danger;

(y) "hand-held portable apparatus" means 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;

(z) "High Voltage Direct Current (HVDC)" means Direct Current (DC) voltage above 100000 Volts used for transmission of power.

(za) "inspector of mines" means an Inspector appointed under the Mines Act,1952 (35 of 1952);

(zb) "installation" means any composite electrical unit used for the purpose of generating, transforming, transmitting, converting, distributing or utilizing electricity;

(zc) "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;

(zd) "increased safety type 'e' " means 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;

(ze) "lightning arrestor" means 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 flow current if present and restoring itself thereafter to its original operating conditions;

(zf) "linked switch" means a switch with all the poles mechanically linked so as to operate simultaneously;

(zg) "live" means electrically charged;

(zh) "metallic covering" means mechanically strong metal covering surrounding one or more conductors;

(zi) "meter" means a device suitable for measuring, indicating and recording consumption of electricity or any other quantity related with electrical system and shall include, wherever applicable, other equipment such as Current Transformer (CT), Voltage Transformer (VT) or Capacitor Voltage Transformer (CVT) with necessary wiring and accessories;

(zj) "mine" has the same meaning as defined in the Mines Act, 1952 (35 of 1952);

(zk) "neutral conductor" means that conductor of a 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;

(zl) "occupier" means the owner or person in occupation of the premises where electricity is used or proposed to be used;

(zm) "ohm" means a unit of electrical resistance and is the electrical resistance between two points of a conductor when a constant potential difference of one volt, applied to these points produces a current of one ampere in the conductor, provided no electromotive force is generated in the conductor;

(zn) "open sparking" means 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;

(zo) "overhead line" means any electric supply line which is placed above ground and in the open air but excluding live rails of a traction system;

(zp) "owner" means the company or body corporate or association or body of individuals, whether incorporated or not or artificial juridical person which owns or operates or maintains Electric Plants and Lines;

(zq) "owner", "agent" and "manager" of a mine have the same meanings as are assigned to them in the Mines Act,1952(35 of 1952);

(zr) "poles" means the phase terminals of a Switch.

(zs) "portable apparatus" means an apparatus which is so designed as to be capable of being moved while in operation;

(zt) "portable hand lamp" means a portable light-fitting provided with suitable handle, guard and flexible cord connected to a plug;

(zu) "Schedule" means a schedule to these regulations.

(zw) "section" means a Section of the Act;

(zv) "span" means the horizontal distance between two adjacent supporting points of an overhead conductor;

(zw) "street box" means a totally enclosed structure, either above or below ground containing apparatus for transforming, switching, controlling or otherwise regulating electricity;

(zx) "supplier" means any generating company or licensee from whose system electricity flows into the system of another generating company or licensee or consumer;

(zy) "switch" means a manually operated device for opening and closing or for changing the connection of a circuit;

(zz) "switchboard" means an assembly including the switchgear for the control of electrical circuits, electric connections and the supporting frame;

(zza) "switchgear" shall denote switches, circuit breakers, cut-outs and other apparatus used for the operation, regulation and control of circuits;

(zzb) "system" means an electrical system in which all the conductors and apparatus are electrically connected to a common source of electric supply;

(zzc) "transportable apparatus" means 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;

(zzd) "volt" means a unit of potential difference of electro-motive force and is the difference of electric potential which exists between two points of a conductor carrying a constant current of one ampere, when the power dissipated between these points is one watt;

(zze) "voltage" means 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 voltmeter meeting Indian Standards;

(zzf) "watt" is a unit of active power and "MW" means megawatt and is equal to 10^6 watts.

(2) Words and expressions used and not defined in these regulations but defined in the Act shall have the meanings respectively assigned to them in the Act.

Chapter II

3. **Designating person(s) to operate and carry out the work on electrical lines and apparatus.-** (1) A supplier or a consumer, or the owner, agent or manager of a mine, or the agent of any company operating in an oil-field or the owner of a drilled well in an oil field or a contractor who has entered into a contract with a supplier or a consumer to carry out duties incidental to the generation, transformation, transmission, conversion, distribution or use of electricity shall designate persons for the purpose to operate and carry out the work on electrical lines and apparatus.

(2) The supplier or consumer, or the owner, agent or manager of a mine, or the agent of any company operating in an oil-field or the owner of a drilled well in an oil field or a contractor referred to on sub-regulation (1) shall maintain a register wherein the names of the designated persons and the purpose for which they are engaged, shall be entered.

(3) No person shall be designated under sub-regulation (1) unless,-

(i) he possesses a certificate of competency or electrical work permit, issued by the Appropriate Government.

(ii) his name is entered in the register referred to in sub-relgulation (2).

4. **Inspection of designated officers and other safety measures.-** (1) The register maintained under sub-regulation (2) of regulation 3 shall be produced before the Electrical Inspector when required by him.

(2) If on inspection, the Electrical Inspector finds that the designated person does not fulfill the required qualification, he shall recommend the removal of the name of such persons from the register.

5. **Electrical Safety Officer.-** (1) All suppliers of electricity including generating companies, transmission companies and distribution companies shall designate an Electrical Safety Officer for ensuring observance of safety measures specified under these regulations in their organisation for construction, operation and maintenance of power stations, sub-stations, transmission and distribution lines.

(2) The Electrical Safety Officer shall be an Electrical Engineering degree holder with at least ten years of experience in operation and maintenance of electricity plants or an Electrical Engineering Diploma holder with at least fifteen years of experience in operation and maintenance of electric plant.

(3) The Electrical Safety Officer designated under sub-regulation (1), shall ensure periodic inspection of such installations, get them tested and keep a record thereof and such records shall be made available to the Electrical Inspector if and when required.

(4) For every factory registered under Factory Act, 1948, where more than 250 kW of electrical load is connected, the management of the factory shall designate a person having qualification specified in sub-regulation (2), for ensuring the

observance of the safety provisions laid under the Act and the regulations made thereunder, who shall periodically inspect such installation, get them tested and keep a record thereof and such records shall be made available to the Electrical Inspector if and when required.

6. **Safety measures for operation and maintenance of electric plants.**- (1) Engineers and supervisors appointed to operate or undertake maintenance of any part or whole of a thermal power generating station and a hydro power plant together with the associated sub-station shall hold diploma in Engineering from a recognized institute, or a degree in Engineering from a university.

(2) The Technicians to assist engineers or supervisors shall possess a certificate in appropriate trade, preferably with a two years course from a Industrial Training Institute recognized by the Central Government or the State Government.

(3) Engineers, supervisors and Technicians engaged for operation and maintenance of electric plants should have successfully undergone the type of training as specified in Schedule-I.

Provided that the existing employees shall have to undergo the training mentioned in sub-regulation (3) within three years from the date of coming into force of these regulations.

(4) The owner of every thermal power generating station and hydro power plant together with their associated sub-station shall arrange for training of personnel engaged in the operation and maintenance of his generating station along with associated sub-station in his own institute or any other institute recognized by the Central Government or the State Government.

Provided that separate training shall be given to the persons engaged in operation and maintenance of thermal power stations and hydro power stations including associated sub-stations.

7. **Safety measures for operation and maintenance of transmission, distribution systems.**- (1) Engineers or supervisors engaged in operation and maintenance of transmission and distribution systems shall hold diploma in electrical, mechanical, electronics and instrumentation Engineering from a recognized institute or university.

(2) The Technicians to assist engineers or supervisors shall possess a certificate in appropriate trade, preferably with a two years course from a Industrial Training Institute recognized by the Central Government or State Government.

(3) Engineers, supervisors and Technicians engaged for operation and maintenance of transmission and distribution systems electric plants should have successfully undergone the type of training as specified in Schedule-II.

Provided that the existing employees shall have to undergo the training mentioned in sub-regulation (3) within three years from the date of coming into force of these regulations.

(4) Owner of every transmission or distribution system shall arrange for training of their personnel engaged in the operation and maintenance of transmission and distribution system in his own institute or any other institute recognized by the Central Government or State Government.

8. **Keeping of records and inspection thereof.-** (1) The generating company or licensee shall maintain records of the maps, plans and sections relating to supply or transmission of electricity and submit the same to the Electrical Inspector for inspection as and when required by him.

(2) The Electrical Inspector shall supply a copy of the report of inspection referred to in sub-regulation (1), to the generating company or licensee, as the case may be.

9. **Deposit of maps.** – When a license has been granted, two sets of maps showing, as regards such licensee, the particulars specified in application for license shall be signed and dated to correspond with the date of notification of the grant of the license by an officer designated by the Appropriate Commission in this behalf, one set of such maps shall be retained by the said officer and the other one shall be furnished to the licensee.

10. **Deposit of printed copies.-** (1) Every person who is granted a license, shall, within thirty days of the grant thereof, have copies of the license and maps, showing the area of supply as specified in the license to Exhibit I same for public inspection at all reasonable times at his head office, his local offices, if any, and at the office of every local authority within the area of supply.

(2) Every such licensee shall, within the aforesaid period of thirty days, supply free of charge one copy of the license along with the relevant maps to every local authority within the area of supply and shall also make necessary arrangement for the sale of printed copies of the license and maps to all persons applying for the same, at a price to be notified by the Appropriate Government from time to time.

11. **Plan for area of supply to be made and kept open for inspection.-** (1) The licensee shall, after commencing to supply electricity, forthwith cause a plan, to be made in electronic form, of the area of supply, and shall cause to be marked thereon the alignment and in the case of underground works, the approximate depth below the surface of all the existing electric supply lines, street distributing boxes and other works, and shall once in every year cause that plan to be duly corrected so as to show the electric supply lines, street distributing boxes and other works for the time being in position and shall also, if so required by an Electrical Inspector, cause to be made sections showing the approximate level of all his existing underground works other than service lines.

(2) Every plan shall be drawn to such horizontal and vertical scale as the Appropriate Commission may require.

Provided that no scale shall be required unless maps of the locality on that scale are for the time being available to the public.

(3) Every plan and section so made or corrected, or a copy thereof, marked with the date when it was made or corrected, shall be kept by the licensee at his

principal office or place of business within the area of supply, and shall at all reasonable times be open to the inspection of all applicants, and copies thereof shall be supplied.

Provided that existing and old plans and sections and underground distribution network shall be converted to electronic form within three years from the date of commencement of these regulations.

(4) Global Positioning System (GPS) mapping or mapping through any other latest technology, of existing and old plans and sections shall be completed within five years from the date of commencement of these regulations and new plans and sections shall be compatible to the Global Positioning System mapping or mapping through any other latest technology.

(5) The licensee shall, if required by an Electrical Inspector, and, where the licensee is not a local authority, by the local authority, if any, concerned, supply free of charge to such Electrical Inspector or local authority a duplicate copy of every such plan or section or a part of the same duly corrected.

(6) The copies of plans and sections under this regulation shall be supplied by the licensee to every applicant on the payment of such fee as the Appropriate Commission may, by regulation, specify.

Chapter III

General safety requirements

12. **General safety requirements pertaining to construction, installation, protection, operation and maintenance of electric supply lines and apparatus.-** (1) All electric supply lines and apparatus shall be of sufficient rating for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty cycle which they may be required to perform under the environmental conditions of installation, and shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human beings, animals and property.

(2) Save as otherwise provided in these regulations, the relevant code of practice of the Bureau of Indian Standards or National Electrical Code, if any, may be followed to carry out the purposes of this regulation and in the event of any inconsistency, the provisions of these regulaions shall prevail.

(3) The material and apparatus used shall conform to the relevant specifications of the Bureau of Indian Standards or International Elelctro-Technical Commission where such specifications have already been laid down.

(4) All electrical equipment shall be installed above the Mean Sea Level (MSL) as declared by local Municiple Authorities and where such equipment is to be installed in the basement, consumer shall ensure that the design of the basement

should be such that there is no seapage or leakage or logging of water in the basement.

13. **Service lines and apparatus on consumer's premises.-** (1) The supplier shall ensure that all electric supply lines, wires, fittings and apparatus belonging to him or under his control, which are on a consumer's premises, are in a safe-condition and in all respects fit for supplying electricity and the supplier shall take precautions to avoid danger arising on such premises from such supply lines, wires, fittings and apparatus.

(2) Service lines placed by the supplier on the premises of a consumer which are underground or which are accessible shall be so insulated and protected by the supplier as to be secured under all ordinary conditions against electrical, mechanical, chemical or other injury to the insulation.

(3) The consumer shall, as far as circumstances permit, take precautions for the safe custody of the equipment on his premises belonging to the supplier.

(4) The consumer shall also ensure that the installation under his control is maintained in a safe condition.

14. **Switchgear on consumer's premises.-** (1) The supplier shall provide a suitable switchgear in each conductor of every service line other than an earthed or earthed neutral conductor or the earthed external conductor of a concentric cable within a consumer's premises, in an accessible position and such switchgear shall be contained within an adequately enclosed fireproof receptacle:

Provided that where more than one consumer is supplied through a common service line, each such consumer shall be provided with an independent switchgear at the point of rigid junction to the common service.

(2) Every electric supply line other than the earthed or earthed neutral conductor of any system or the earthed external conductor of a concentric cable shall be protected by a suitable switchgear by its owner.

15. **Identification of earthed and earthed neutral conductors and position of switches and switchgear therein.-** Where the conductors include an earthed conductor of a two-wire system or an earthed neutral conductor of a multi-wire system or a conductor which is to be connected thereto, the following conditions shall be complied with:-

(i) an indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor, or the conductor which is to be connected thereto, to enable such conductor to be distinguished from any live conductor and such indication shall be provided-

(a) where the earthed or earthed neutral conductor is the property of the supplier, at or near the point of commencement of supply;

(b) where a conductor forming part of a consumer's system is to be connected to the supplier's earthed or earthed neutral conductor, at the point where such connection is to be made;

(c) in all other cases, at a point corresponding to the point of commencement of supply or at such other points as may be approved by an Electrical Inspector.

(ii) no cut-out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted or remain inserted in any earthed or earthed neutral conductor of a two wire-system or in any earthed or earthed neutral conductor of a multi-wire system or in any conductor connected thereto.

Provided that the above requirement shall not apply in case of-

(a) a link for testing purposes, or

(b) a switch for use in controlling a generator or transformer.

16. Earthed terminal on consumer's premises.- (1) The supplier shall provide and maintain on the consumer's premises for the consumer's use, a suitable earthed terminal in an accessible position at or near the point of commencement of supply.

Provided that in the case of installation of voltage exceeding 250 V the consumer shall, in addition to the aforementioned earthing arrangement, provide his own earthing system with an independent electrode.

Provided further that the supplier may not provide any earthed terminal in the case of installations already connected to his system on or before the date to be specified by the State Government in this behalf if he is satisfied that the consumer's earthing arrangement is efficient.

(2) The consumer shall take all reasonable precautions to prevent mechanical damage to the earthed terminal and its lead belonging to the supplier.

(3) The supplier may recover from the consumer the cost of installation on the basis of schedule of charges published by him in advance and where such schedule of charges is not published, the procedure laid down, in regulation 63 shall apply.

Explanation.- For the purposes of sub-regulation (1), the expression "point of commencement of supply of electricity" shall mean the point at the incoming terminal of the switchgear installed by the consumer.

17. Accessibility of bare conductors.- Where bare conductors are used in a building, the owner of such conductors shall,-

(a) ensure that they are inaccessible;

(b) provide in readily accessible position switches for rendering them dead whenever necessary; and

(c) take such other safety measures as are specified in the relevant Indian Standards.

18. Danger Notices.- The owner of every installation of voltage exceeding 250 V shall affix permanently in a conspicious position a danger notice in Hindi or English and the local language of the District, with a sign of skull and bones of a design as per IS -2551 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 overhead lines of voltage exceeding 650 V which can be easily climbed upon without the aid of ladder or special appliances;

(c) luminous tube sign requiring supply, X-ray and similar high frequency installations of voltage exceeding 650 V but not exceeding 33 kV:

Provided that where it is not possible to affix such notices on any generator, motor, transformer or other apparatus, they shall be affixed as near as possible thereto, or the word 'danger' and the voltage of the apparatus concerned shall be permanently painted on it:

Provided further that where the generator, motor, transformer or other apparatus is within an enclosure one notice affixed to the said enclosure shall be sufficient for the purposes of this regulation.

Explanation- For the purpose of clause (b) rails, tubular poles, wooden supports, reinforced cement concrete poles without steps, I-sections and channels, shall be deemed as supports which cannot be easily climbed upon

19. Handling of electric supply lines and apparatus.- (1) Before any conductor or apparatus is handled, adequate precautions shall be taken, by earthing or other suitable means, to discharge electrically such conductor or apparatus, and any adjacent conductor or apparatus if there is danger therefrom, and to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

(2) Every person who is working on an electric supply line or apparatus or both shall be provided with tools and devices such as gloves, rubber shoes, safety belts, ladders, earthing devices, helmets, line testers, hand lines and the like for protecting him from mechanical and electrical injury and such tools and devices shall always be maintained in sound and efficient working condition.

(3) No person shall work on any live electric supply line or apparatus and no person shall assist such person on such work, unless he is designated in that behalf, and takes the safety precautions given in Schedule-III.

(4) Every telecommunication line on supports carrying a line of voltage exceeding 650 V but not exceeding 33 kV shall, for the purpose of working thereon, be deemed to be a line of voltage exceeding 650 V.

(5) All non-current carrying metal parts of switchgear and control panels shall be properly earthed and insulating floors or mat conforming to IS-15652: 2006, of appropriate voltage level shall be provided in front of the panels for the safety of operating personnel.

(6) All panels shall be painted with the description of its identification at front and at the rear.

20. **Supply to vehicles and cranes.**- Every person owning a vehicle, travelling crane, or the like to which electricity is supplied from an external source shall ensure that it is efficiently controlled by a suitable switch enabling all voltage to be cut off in one operation and, where such vehicle, travelling crane or the like runs on metal rails, the owner shall ensure that the rails are electrically continuous and earthed.

21. **Cables for portable or transportable apparatus.**- (1) Flexible cables shall not be used for portable or transportable motors, generators, transformers, rectifiers, electric drills, electric sprayers, welding sets or any other portable or transportable apparatus unless they are heavily insulated and adequately protected from mechanical injury.

(2) Where the protection is by means of metallic covering, the covering shall be in metallic connection with the frame of any such apparatus and earthed.

(3) The cables shall be three core type and four core type for portable and transportable apparatus working on single phase and three phase supply respectively and the wire meant to be used for ground connection shall be easily identifiable.

22. **Cables protected by bituminous materials.**- (1) Where the supplier or the owner has brought into use an electric supply line, other than an overhead line, which is not completely enclosed in a continuous metallic covering connected with earth and is insulated or protected *in situ* by composition or material of a bituminous character,-

(i) any pipe, conduit, or the like into which such electric supply line may have been drawn or placed shall, unless other arrangements are approved by the Electrical Inspector in any particular case, be effectively sealed at its point of entry into any street box so as to prevent any flow of gas to or from the street box, and;

(ii) such electric supply line shall be periodically inspected and tested where accessible, and the result of each such inspection and test shall be duly recorded by the supplier or the owner.

(2) The supplier or the owner after the coming into force of these regulations, shall not bring into use any further electric supply line as aforesaid which is insulated or

protected *in situ* by any composition or material known to be liable to produce noxious or explosive gases on excessive heating.

23. **Street boxes.**- (1) Street boxes shall not contain gas pipes, and precautions shall be taken to prevent, as far as reasonably possible, any influx of water or gas.

(2) Where electric supply lines forming part of different systems pass through the same street box, they shall be readily distinguishable from one another and all electric supply lines of voltage exceeding 650 V at or in street boxes shall be adequately supported and protected so as to prevent risk of damage to or danger from adjacent electric supply lines.

(3) All street boxes shall be regularly inspected for the purpose of detecting the presence of gas and if any influx or accumulation is discovered, the owner shall give immediate notice to any authority or company who have gas mains in the neighbourhood of the street box and in cases where a street box is large enough to admit the entrance of a person after the electric supply lines or apparatus therein have been placed in position, ample provision shall be made-

(i) to ensure that any gas which may by accident have obtained access to the box shall escape before a person is allowed to enter; and

(ii) for the prevention of danger from sparking.

(4) The owners of all street boxes or pillars containing circuits or apparatus shall ensure that their covers and doors are kept closed and locked and are so provided that they can be opened only by means of a key or a special appliance.

24. **Distinction of different circuits.**- The owner of every generating station, sub-station, junction-box or pillar in which there are any circuits or apparatus, whether intended for operation at different voltages or at the same voltage, shall ensure by means of indication of a permanent nature that the respective circuits are readily distinguishable from one another.

25. **Distinction of the installations having more than one feed.**- The owner of every installation including sub-station, double pole structure, four pole structure or any other structure having more than one feed, shall ensure by means of indication of a permanent nature, that the installation is readily distinguishable from other installations

26. **Accidental charging.**- (1) The owners of all circuits and apparatus shall so arrange them that there shall be no danger of any part thereof becoming accidentally charged to any voltage beyond the limits of voltage for which they are intended.

(2) Where alternating current and direct current circuits are installed on the same box or support, they shall be so arranged and protected that they shall not come into contact with each other when live.

27. **Provisions applicable to protective equipment.**- (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 fires, shall be conspicuously marked

and kept in all generating stations, enclosed sub-stations and switching-stations in convenient location.

(2) The fire extinguishers shall be tested for satisfactory operation as per relevant Indian Standard at least once a year and record of such tests shall be maintained.

(3) First-aid boxes or cupboards conspicuously marked and equipped with such contents as the State Government may specify, shall be provided and maintained in every generating station, enclosed sub-station, enclosed switching station and in vehicles used for maintenance of lines so as to be readily accessible during all working hours and all such boxes and cupboards shall, except in the case of unattended sub-stations and switching stations, be kept in charge of responsible persons who are trained in first-aid treatment and one of such persons shall be available during working hours.

(4) Two or more gas masks shall be provided conspicuously and installed and maintained at accessible places in every generating station with capacity of 5 MW and above and enclosed sub-station with transformation capacity of 5 MVA and above for use in the event of fire or smoke:

Provided that where more than one generator with capacity of 5 MW and above is installed in a power station, each generator shall be provided with at least two separate gas masks in an accessible and conspicuous place:

Provided further that adequate number of gas masks shall be provided by the owner at every generating station and enlosed sub-station with capacity less than 5 MW and 5 MVA respectively.

28. Display of instructions for resuscitation of persons suffering from electric shock.- (1) Instructions, in English or Hindi and the local language of the District and where Hindi is the local language, in English and Hindi for the resuscitation of persons suffering from electric shock, shall be affixed by the owner in a conspicuous place in every generating station, enclosed sub-station, enclosed switching station, mines and in every factory as defined in clause (m) of section 2 of the Factory Act,1948 (63 of 1948) in which electricity is used and in such other premises where electricity is used as the Electrical Inspector may, by notice in writing served on the owner, direct.

(2) The owner of every generating station, enclosed sub-station, enclosed switching station and every factory or other premises to which these regulations apply, shall ensure that all designated persons employed by him are acquainted with and are competent to apply the instructions referred to in sub-regulation (1).

(3) In every manned generating station, sub-station or switching station of voltage exceeding 650 V, an artificial respirator shall be provided and kept in good working condition.

29. Precautions to be adopted by consumers, owners, occupiers, electrical contractors, electrical workmen and suppliers.- (1) No electrical installation work, including additions, alterations, repairs and adjustments to existing installations, except such replacement of lamps, fans, fuses, switches, domestic

appliances of voltage not exceeding 250V and fittings as in no way alters its capacity or character, shall be carried out upon the premises of or on behalf of any consumer, supplier, owner or occupier for the purpose of supply to such consumer, supplier, owner or occupier except by an electrical contractor licensed in this behalf by the State Government and under the direct supervision of a person holding a certificate of competency and by a person holding a permit issued or recognised by the State Government.

Provided that in the case of works executed for or on behalf of the Central Government and in the case of installations in mines, oil fields and railways, the Central Government and in other cases the State Government, may, by notification in the Official Gazette, exempt on such conditions as it may impose, any such work described therein either generally or in the case of any specified class of consumers, suppliers, owners or occupiers.

(2) No electrical installation work which has been carried out in contravention of sub-regulation (1) shall either be energised or connected to the works of any supplier.

30. **Periodical inspection and testing of installations.-** (1) Where an installation is already connected to the supply system of the supplier or trader, every such installation shall be periodically inspected and tested at intervals not exceeding five years either by the Electrical Inspector or by the supplier as may be directed by the State Government in this behalf or in the case of installations belonging to, or under the control of the Central Government, and in the case of installation in mines, oilfields and railways, by the Central Government.

(2) The periodical inspection and testing of installations of voltage above 650 V belonging to the supplier, shall also be carried out at intervals not exceeding five years by the Electrical Inspector;

(3) Where the supplier is directed by the Central or the State Government, as the case may be, to inspect and test the installation, he shall report on the condition of the installation to the consumer concerned in the Forms I, II and III as specified in Schedule-IV and shall submit a copy of such report to the Electrical Inspector;

(4) The Electrical Inspector may, on receipt of such report, accept the report submitted by the supplier or record variations as the circumstances of each case may require and may recommend that the defects may be ractified as per report;

(5) In the event of the failure of the owner of any installation to rectify the defects in his installation pointed out by the Electrical Inspector in his report and within the time indicated therein, such installation shall be liable to be disconnected under the directions of the Electrical Inspector after serving the owner of such installation with a notice for not less than forty eight hours.

Provided that the installation shall not be disconnected in case an appeal is made under sub-rule (1) of rule (8) of "Qualifications, Powers and Functions of Chief Electrical Inspector and Electrical Inspectors issued by Central Government vide GSR 481 (E) dated 17.08.2006 and the appellate authority has stayed the orders of disconnection.

31. **Testing of consumer's installation.-** (1) Upon receipt of an application for a new or additional supply of electricity and before connecting the supply or reconnecting the same after a period of six months, the supplier shall either test the installation himself or accept the test results submitted by the consumer when the same has been duly signed by the licensed Electrical Contractor.

(2) The supplier shall maintain a record of test results obtained at each supply point to a consumer, in a Schedule-V.

(3) If as a result of such inspection and test, the supplier is satisfied that the installation is likely to be dangerous, he shall serve on the applicant a notice in writing requiring him to make such modifications as are necessary to render the installation safe and may refuse to connect or reconnect the supply until the required modifications have been completed.

32. **Installation and testing of generating units.-** Capacity above which generating units will be required to be inspected by the Electrical Inspector before commissioning shall be as per the notification to be issued by the Appropriate Government, under clause (x) sub-section (2) of section 176 and sub-section (1) of section 162 of the Act.

Chapter IV

General conditions relating to supply and use of electricity

33. **Precautions against leakage before connection.-** (1) The supplier shall not connect with his works the installation or apparatus on the premises of any applicant for supply unless he is reasonably satisfied that the connection will not at the time of making the connection cause a leakage from that installation or apparatus of a magnitude detrimental to safety which shall be checked by measuring the installation resistance as under,-

(i) all equipments shall have the insulation resistance (IR) value as stipulated in the relevant Indian Standards;

(ii) on application of 500 V DC between each live conductor and earth for a period of one minute the insulation resistance of installation and equipment of voltage not exceeding 650 V shall be at least 1 MEGA OHM or as specified in the relevant Indian Standard;

(iii) on application of 2.5 kV·DC between each live conductor and earth for a period of one minute, the insulation resistance of installation and equipment of voltage exceeding 650 V but not exceeding 33 kVshall be at least 5 MEGA OHM or as specified in the relevant Indian Standard.

(2) If the supplier declines to make a connection under the provisions of sub-regulation (1) he shall convey to the applicant the reasons in writing for so declining.

34. Leakage on consumer's premises.- (1) If the Electrical Inspector or the supplier has reasons to believe that there is leakage in the system of a consumer which is likely to affect injuriously the use of electricity by the supplier or by other persons, or which is likely to cause danger, he may give the consumer notice in writing that he desires to inspect and test the consumer's installation.

(2) If on such notice being given the consumer does not give all reasonable facilities for inspection and testing of his installation, or when an insulation resistance of the consumer's installation is so low as to prevent safe use of electricity, the supplier may, and if directed so to do by the Electrical Inspector shall discontinue the supply of electricity to the installation but only after giving to the consumer forty eight hours notice in writing of disconnection of supply and shall not recommence the supply until he or the Electrical Inspector is satisfied that the cause of the leakage has been removed.

35. Supply and use of electricity.- (1) The electricity shall not be supplied, transformed, converted, inverted or used or continued to be supplied, transformed, converted, inverted or used unless the conditions contained in sub-regulations (2) to (8) are complied with.

(2) The following controls of requisite capacity to carry and break the current shall be placed as near as possible after the point of commencement of supply so as to be readily accessible and capable of being easily operated to completely isolate the supply to the installation, such equipment being in addition to any equipment installed for controlling individual circuits or apparatus, namely:-

(i) a linked switch with fuse or a circuit breaker by consumers of voltage which does not exceed 650 V;

(ii) a linked switch with fuse or a circuit breaker by a consumer of voltage exceeding 650V but not exceeding 33 kV having aggregate installed transformer or apparatus capacity up to 1000 KVA to be supplied at voltage upto 11 kV and 2500 KVA at higher voltages (above 11 kV and not exceeding 33 kV);

(iii) a circuit breaker by consumers at voltage exceeding 650 V but not exceeding 33 kV having an aggregate installed transformer and apparatus capacity above 1000 KVA and supplied at voltage upto 11 kV and above 2500 KVA at higher voltages (above 11 kV and not exceeding 33 kV);

(iv) a circuit breaker by a consumer of voltage exceeding 33 kV.

Provided that where the point of commencement of supply and the consumer apparatus are near each other, one linked switch with fuse or circuit breaker near the point of commencement of supply shall be considered sufficient.

(3) In case of every transformer the following shall be provided; namely:-

(i) on primary side for transformers a linked switch with fuse or circuit breaker of adequate capacity:

Provided that the linked switch on the primary side of the transformer may be of such capacity as to carry the full load current and to break only the magnetising current of the transformer:

Provided further that for all transformers:

(a) having a capacity of 5000 KVA and above installed before the year 2000; and

(b) having a capacity 1000 KVA and above installed in or after the year 2000, a circuit breaker shall be provided:

Provided also that the linked switch on the primary side of the transformer shall not required for the unit auxiliary transformer and generator transformer;

(ii) in respect of all transformers installed in or after the year 2000, on the secondary side of all transformers a circuit breaker of adequate rating shall be installed:

Provided that for suppliers' transformers of capacity below 1000 KVA, a linked switch with fuse or circuit breaker of adequate rating shall be installed on secondary side.

(4) Except in the case of composite control gear designed as a unit each distinct circuit is to be protected against excess energy by means of suitable cut-out or a circuit breaker of adequate breaking capacity suitably located and so constructed as to prevent danger from overheating, arcing or scattering of hot metal when it comes into operation and to permit for ready renewal of the fusible metal of the cut-out without danger.

(5) The supply of electricity to each motor or a group of motors or other apparatus meant for operating one particular machine shall be controlled by a suitable linked switch or a circuit breaker or an emergency tripping device with manual reset of requisite capacity placed in such a position as to be adjacent to the motor or a group of motors or other apparatus readily accessible to and easily operated by the person incharge and so connected in the circuit that by its means all supply of electricity can be cut off from the motor or group of motors or apparatus from any regulating switch, resistance of other device associated therewith.

(6) All insulating materials shall be chosen with special regard to the circumstances of their proposed use and their mechanical strength shall be

sufficient for their purpose and so far as is practicable of such a character or so protected as to maintain adequately their insulating property under all working conditions in respect of temperature and moisture; and

(7) Adequate precautions shall be taken to ensure that no live parts are so exposed as to cause danger.

(8) Every consumer shall use all reasonable means to ensure that where electricity is supplied by a supplier no person other than the supplier shall interfere with service lines and apparatus placed by the supplier on the premises of the consumer.

36. Provisions for supply and use of electricity in multi-storeyed building more than 15 metres in height.- (1) The connected load and voltage of supply above which inspection is to be carried out by an Electrical Inspector for a multi-storeyed bulding of more than fifteen meters height shall be notified by the Appropriate Government.

(2) Before making an application for commencement of supply or recommencement of supply after an installation has been disconnected for a period of six months or more, the owner or ocupier of a multi-storeyed building shall give not less than thirty days notice in writing to the Electrical Inspector specify therein the particulars of installation and the supply of electricity shall not be commenced or recommenced within this period, without the approval in writing of the Electrical Inspector.

(3) The supplier or owner of the installation shall provide at the point of commencement of supply a suitable isolating device with cut-out or breaker to operate on all phases except neutral in the 3-phase, 4-wire circuit and fixed in a conspicuous position at not more than 1.70 metres above the ground so as to completely isolate the supply to the building in case of emergency.

(4) The owner or occupier of a multi-storeyed building shall ensure that electrical installations and works inside the building are carried out and maintained in such a manner as to prevent danger due to shock and fire hazards, and the installation is carried out in accordance with the relevant codes of practice.

(5) No other service pipes and cables shall be taken along the ducts provided for laying power cables and all ducts provided for power cables and other services shall be provided with fire barrier at each floor crossing.

37. Conditions applicable to installations of voltage exceeding 250 Volts.- The following conditions shall be complied with where electricity of voltage above 250 V is supplied, converted, transformed or used; namely:-

(i) all conductors, other than those of overhead lines, shall be completely enclosed in mechanically strong metal casing or metallic covering which is electrically and mechanically continuous and adequately protected against mechanical damage unless the said conductors are accessible only to an designated person or are installed and protected so as to prevent danger:

Provided that non-metallic conduits conforming to the relevant Indian Standard Specifications may be used for installations of voltage not exceeding 650 V;

(ii) all metal works, enclosing, supporting or associated with the installation, other than that designed to serve as a conductor shall be connected with an earthing system as per standards laid down in the Indian Standards in this regard and the provisions of regulation 41.

(iii) Every switchboard shall comply with the following,-

(a) a clear space of not less than one metre in width shall be provided in front of the switchboard;

(b) if there are any attachments or bare connections at the back of the switchboard, the space, if any, behind the switchboard shall be either less than twenty centimetres or more than sevety five centimetres in width, measured from the farthest protruding part of any attachment or conductor;

(c) if the space behind the switchboard exceeds sevety five centimetres in width, there shall be a passage way from either end of the switchboard, clear to a height of 1.8 metres.

(iv) In case of installations provided in premises where inflammable materials including gases and chemicals are produced, handled or stored, the electrical installations, equipment and apparatus shall comply with the requirements of flame proof, dust tight, totally enclosed or any other suitable type of electrical fittings depending upon the hazardous zones as per the relevant Indian Standard Specifications.

(v) Where an application has been made to a supplier for supply of electricity to any installation, he shall not commence the supply or where the supply has been discontinued for a period of six months and above, recommence the supply unless the consumer has complied with, in all respects the conditions of supply set out in these regulations.

(vi) Where a supplier proposes to supply or use electricity at or to recommence supply of voltage exceeding 250 V but not exceeding 650 V after it has been discontinued for a period of six months, he shall, before connecting or reconnecting the supply, give notice in writing of such intention to the Electrical Inspector.

(vii)If at any time after connecting the supply, the supplier is satisfied that any provision of these regulations are not being observed he shall give notice of the same in writing to the consumer and the Electrical Inspector, specifying how the provisions have not been observed and to rectify such defects in a reasonable time and if the consumer fails to rectify such defects pointed out, he may discontinue the supply after giving the consumer a reasonable opportunity

of being heard and recording reasons in writing and the supply shall be discontinued only on written orders of an officer duly notified by the supplier in this behalf and shall be restored with all possible speed after such defects are rectified by the consumer to the satisfaction of the supplier.

38. **Appeal to Electrical Inspector in regard to defects.-** (1) If any applicant for a supply or a consumer is dissatisfied with the action of the supplier in declining to commence, to continue or to recommence the supply of electricity to his premises on the grounds that the installation is defective or is likely to be dangerous, he may appeal to the Electrical Inspector to test the installation and the supplier shall not, if the Electrical Inspector intimates that the installation is free from the defect or danger complained of, refuse supply to the consumer on the grounds aforesaid, and shall, within twenty four hours after the receipt of such intimation from the Electrical Inspector, commence, continue or recommence the supply of electricity.

(2) Any test for which application has been made under sub regulation (1), shall be carried out within seven days after the receipt of such application.

39. **Precautions against failure of supply and notice of failures.-** (1) The layout of the electric supply lines of the supplier for the supply of electricity throughout his area of supply shall under normal working conditions be sectionalised and so arranged, and provided with switchgear or circuit-breakers, so located, as to restrict within reasonable limits the extent of the portion of the system affected by any failure of supply.

(2) The supplier shall take all reasonable precautions to avoid any accidental interruptions of supply, and also to avoid danger to the public or to any employee or designated person when engaged on any operation during and in connection with the installation, extension, replacement, repair and maintenance of any works.

(3) The supplier shall send to the Electrical Inspector a notice of failure of supply of such kind as the Electrical Inspector may from time to time require to be notifed to him, and such notice shall be sent by the earliest mode of communication after the failure occurs or after the failure becomes known to the supplier and shall be in the Form given in Schedule-VI.

(4) For the purpose of testing or for any other purpose connected with the efficient working of the supplier's installations, the supply of electricity may be discontinued by the supplier for such period as may be necessary, subject to not less than twenty four hours notice being given by the supplier to all consumers likely to be affected by such discontinuance:

Provided that no such notioe shall be given in cases of emergency.

Chapter V

Safety provisions for electrical installations and apparatus of voltage not exceeding 650 volts :

40. Test for resistance of insulation.- (1) Where any electric supply line for use at voltages not exceeding 650 V has been disconnected from a system for the purpose of addition, alteration or repair, such electric supply line shall not be reconnected to the system until the supplier or the owner has applied the test prescribed under regulation 33.

(2) The provision under sub-regulation (1) shall not apply to overhead lines except overhead insulated cables, unless the Electrical Inspector otherwise directs in any particular case.

41. Connection with earth.- The following conditions shall apply to the connection with earth of systems at voltage normally exceeding 125 V but not exceeding 650 V, namely:-

(i) neutral conductor of a 3-phase, 4-wire system and the middle conductor of a 2-phase, 3-wire system shall be earthed by not less than two separate and distinct connections with a minimum of two different earth electrodes or such large number as may be necessary to bring the earth resistance to a satisfactory value both at the generating station and at the sub-station.

(ii) the earth electrodes so provided, shall be inter-connected to reduce earth resistance.

(iii) neutral conductor shall also be earthed at one or more points along the distribution system or service line in addition to any connection with earth which may be at the consumer's premises.

(iv) in the case of a system comprising electric supply lines having concentric cables, the external conductor of such cables shall be earthed by two separate and distinct connections with earth.

(v) the connection with earth may include a link by means of which the connection may be temporarily interrupted for the purpose of testing or for locating a fault.

(vi) in a direct current three wire system, the middle conductor shall be earthed at the generating station only, and the current from the middle conductor to earth shall be continuously recorded by means of a recording ammeter, and if at any time the current exceeds one-thousandth part of the maximum supply current, immediate steps shall be taken to improve the insulation of the system.

(vii) where the middle conductor is earthed by means of a circuit breaker with a resistance connected in parallel, the resistance shall not exceed ten ohms and on the opening of the circuit breaker, immediate steps shall be

taken to improve the insulation of the system, and the circuit breaker shall be reclosed as soon as possible.

(viii) the resistance shall be used only as a protection for the ammeter in case of earths on the system and until such earths are removed and immediate steps shall be taken to locate and remove the earth.

(ix) in the case of an alternating current system, there shall not be inserted in the connection with earth any impedance, other than that required solely for the operation of switchgear or instruments, cut-out or circuit breaker, and the result of any test made to ascertain whether the current, if any, passing through the connection with earth is normal, shall be duly recorded by the supplier.

(x) no person shall make connection with earth by the aid of, nor shall he keep it in contact with, any water mains not belonging to him except with the consent of the owner thereof and of the Electrical Inspector.

(xi) alternating current systems which are connected with earth as aforesaid shall be electrically interconnected:

Provided that each connection with earth is bonded to the metal sheathing and metallic armouring, if any, of the electric supply lines concerned.

(xii) the frame of every generator, stationary motor, portable motor, and the metallic parts, not intended as conductors, of all transformers and any other apparatus used for regulating or controlling electricity, and all electricity consuming apparatus, of voltage exceeding 250 V but not exceeding 650 V shall be earthed by the owner by two separate and distinct connections with earth.

(xiii) neutral point of every generator and transformer shall be earthed by connecting it to the earthing system by not less than two sepearte and distinct connections.

(xiv) all metal casing or metallic coverings containing or protecting any electric supply line or apparatus 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 conditions mentioned in this regulation shall not apply, where the supply voltage does not exceed 250 V and the apparatus consists of wall tubes or brackets, electroliers, switches, ceiling fans or other fittings, other than portable hand lamps and portable and transportable apparatus, unless provided with earth terminal and to class-II apparatus and appliances:

Provided further that where the supply voltage is not exceeding 250 V and where the installations are either new or renovated, all plug

sockets shall be of the three pin type, and the third pin shall be permanently and efficiently earthed.

(xv) All earthing systems shall, -

(a) consist of equipotential bonding conductors capable of carrying the prospective earth fault current and a group of pipes, rods and plate electrodes for dissipating the current to the general mass of earth without exceeding the allowable temperature limits as per relevant Indian Standards in order to maintain all non-current carrying metal works reasonably at earth potential and to avoid dangerous contact potentials being developed on such metal works;

(b) limit earth resistance sufficiently low to permit adequate fault current for the operation of protective devices in time and to reduce neutral shifting;

(c) be mechanically strong, withstand corrosion and retain electrical continuity during the life of the installation and all earthing systems shall be tested to ensure efficient earthing, before the electric supply lines or apparatus are energised.

(xvi) all earthing systems belonging to the supplier shall in addition, be tested for resistance on dry day during the dry season not less than once every two years.

(xvii) a record of every earth test made and the result thereof shall be kept by the supplier for a period of not less than two years after the day of testing and shall be available to the Electrical Inspector when required.

Explanation:- The expression "Class-II apparatus and appliance" shall have the same meaning as is assigned to it in the relevant Indian Standards.

42. Earth leakage protective device. – The supply of electricity to every electrical installation other than voltage not exceeding 250 V below 5 kW and those installations of voltage not exceeding 250 V which do not attract provisions of section 54 of the Act, shall be controlled by an earth leakage protective device so as to disconnect the supply instantly on the occurance of earth fault or leakage of current:

Provided that such earth leakage protective device shall not be required for overhead supply lines having protective devices which are effectively bonded to the neutral of supply transformers and conforming to regulation 73.

Chapter VI

Safety provisions for electrical installations and apparatus of voltage exceeding 650 volts

43. **Approval by Electrical Inspector.** – (1) Voltage above which electrical installations will be required to be inspected by the Electrical Inspector before commencement of supply or recommencement after shutdown for six months and above shall be as per the notification to be issued by the Appropriate Government, under clause (x) of sub-section (2) of section 176 and sub-section (1) of section 162 of the Act.

(2) Before making an application to the Electrical Inspector for permission to commence or recommence supply after an installation has been disconnected for six months and above at voltage exceeding 650 V to any person, the supplier shall ensure that electric supply lines or apparatus of voltage exceeding 650 V belonging to him are placed in position, properly joined and duly completed and examined and the supply of electricity shall not be commenced by the supplier for installations of voltage needing inspection under these regulations unless the provisions of regulations 12 to 29, 33 to 35, 44 to 51 and 55 to 77 have been complied with and the approval in writing of the Electrical Inspector has been obtained by him:

Provided that the supplier may energise the aforesaid electric supply lines or apparatus for the purpose of tests specified in regulation 46.

(3) The owner of any installation of voltage exceeding 650 V shall, before making application to the Electrical Inspector for approval of his installation or additions thereto, test every circuit of voltage exceeding 650 V or additions thereto, other than an overhead line, and satisfy himself that they withstand the application of the testing voltage set out in sub-regulation (1) of regulation 46 and shall duly record the results of such tests and forward them to the Electrical Inspector:

Provided that an Electrical Inspector may direct such owner to carry out such tests as he deems necessary or accept the manufacturer's certified tests in respect of any particular apparatus in place of the tests required by this regulation

(4) The owner of any installation of voltage exceeding 650 V who makes any addition or alteration to his installation shall not connect to the supply his apparatus or electric supply lines, comprising the said alterations or additions unless and until such alteration or addition has been approved in writing by the Electrical Inspector.

44. **Use of electricity at voltage exceeding 650 Volts.** - (1) The Electrical Inspector shall not authorise the supplier to commence supply or where the supply has been discontinued for a period of six months and above, to recommence the supply at voltage exceeding 650 V to any consumer unless-

(i) all conductors and apparatus situated on the premises of the consumer are so placed as to be inaccessible except to a designated person

and all operations in connection with the said conductors and apparatus are carried out by a designated person;

(ii) the consumer has provided and agrees to maintain a separate building or a locked weather proof and fire proof enclosure of agreed design and location, to which the supplier at all times shall have access for the purpose of housing his apparatus and metering equipment, or where the provision for a separate building or enclosure is impracticable, the consumer has segregated the aforesaid apparatus of the supplier from any other part of his own apparatus:

Provided that such segregation shall be by the provision of fire proof walls, if the Electrical Inspector considers it to be necessary:

Provided further that in the case of an outdoor installation the consumer shall suitably segregate the aforesaid apparatus belonging to the supplier from his own;

(iii) all pole type sub-stations are constructed and maintained in accordance with regulation 50.

(2) The owner shall observe the following conditions, where electricity at voltage exceeding 650 V is supplied, converted, transformed or used,-

(i) he shall maintain safety clearances for electrical apparatus as per Bureau of Indian Standard specification so that sufficient space is available for easy operation and maintenance without any hazard to the operating and maintenance personnel working near the equipment and for ensuring adequate ventilation;

(ii) he shall not allow any encroachment below such installation:

Provided that where the Electrical Inspector comes across any such encroachment, he shall direct the owner to remove such encroachments;

(iii) the minimum safety working clearances specified in Schedule-VII shall be maintained for the bare conductors or live parts of any apparatus in outdoor sub-stations excluding overhead lines of installations of voltage exceeding 650 V;

(iv) he shall ensure that the windings of motors or other apparatus within reach from any position in which a person may require to be, are suitably protected so as to prevent danger;

(v) he shall ensure that where a transformer or transformers are used, suitable provision shall be made, either by connecting with earth, a point of the circuit at the lower voltage or otherwise, to guard against danger by reason of the said circuit becoming accidentally charged above its normal voltage by leakage from or contact with the circuit at the higher voltage;

(vi) a sub-station or a switching station with apparatus having more than 2000 litres of oil shall not be located in the basement where proper oil draining arrangement cannot be provided;

(vii) where a sub-station or a switching station with apparatus having more than 2000 litres of oil is installed, whether indoor or outdoors, he shall take the following measures, namely:-

(a) the baffle walls of four hours fire rating shall be provided between the apparatus,-

(i) where there is a single phase transformer banks in the switch-yards of generating stations and sub-stations;

(ii) on the consumer premises;

(iii) where adequate clearance between the units is not available.

(b) provisions shall be made for suitable oil soakpit and where use of more than 9000 litres of oil in any one oil tank, receptacle or chamber is involved, provision shall be made for the draining away or removal of any oil which may leak or escape from the tank, receptacle or chamber containing the same, and special precautions shall be taken to prevent the spread of any fire resulting from the ignition of the oil from any cause and adequate provision shall be made for extinguishing any fire which may occur;

(c) spare oil shall not be stored in the vicinity of any oil filled equipment in any such sub-station or switching station;

(d) all the transformers and switchgears shall be maintained in accordance with the maintenance schedules prepared in accordance with the relevant codes of practice of Bureau of Indian Standards;

(e) dry type of transformers only shall be used for installations inside the residential and commercial buildings;

(viii) without prejudice to the above measures, he shall take adequate fire protection arrangement for quenching the fire in the apparatus;

(ix) he shall ensure that the transformers of 10 MVA and above rating or in case of oil filled transformers with oil capacity of more than 2000 liters are provided with fire fighting system as per IS - 3034: 1993 or with Nitrogen Injection Fire Protection system;

(x) where it is necessary to locate the sub-station, or switching station in the basement, he shall take the following measures, namely:-

(a) the room shall necessarily be in the first basement at the periphery of the basement;

(b) the entrances to the room shall be provided with fire resisting doors of 2 hour fire rating and the door shall always be kept closed and a notice of this effect shall be affixed on outer side of the door;

(c) a curb (sill) of a suitable height shall be provided at the entrance in order to prevent the flow of oil from a ruptured transformer into other parts of the basement;

(d) direct access to the transformer room shall be provided from outside and the surrounding walls shall be lined with fire bricks;

(e) the cables to primary side and secondary side shall have sealing at all floors and wall opening of atleast two hours rating;

(f) fire Retardent Low Smoke (FRLS) cable of two hours rating shall be used.

(xi) he shall ensure that oil filled transformers installed indoors in other than residential or commercial buildings are placed at the ground floor or not below the first basement;

(xii) he shall ensure that cable trenches inside the sub-stations and switching stations containing cables are filled with sand, pebbles or similar non-inflammable materials or completely covered with non-inflammable slabs;

(xiii) he shall ensure that unless the conditions are such that all the conductors and apparatus may be made dead at the same time for the purpose of cleaning or for other work, the said conductors and apparatus shall be so arranged that these may be made dead in sections, and that work on any such section may be carried on by a designated person without danger;

(xiv) only persons designated under sub-regulation (1) of regulation 3, shall carry out the work on live lines and apparatus.

(3) All apparatus shall be protected against lightning and apparatus exceeding 220 kV shall also be protected against switching over voltages.

(4) The equipment used for protection and switching shall be adequately co-ordinated with the protected apparatus to ensure safe operation and to maintain the stability of the inter-connected units of the power system.

(5) The minimum clearances specified in Schedule-VIII shall be maintained for bare conductors or live parts of any apparatus in outdoor sub-stations, excluding overhead lines of High Voltage Direct Current installations.

(6) There shall not be tapping of another transmission line from the main line for 66 kV and above class of lines.

45. Inter-locks and protection for use of electricity at voltage exceeding 650 Volts.- (1) The owner shall ensure the following, namley:-

(i) isolators and the controlling circuit breakers shall be inter-locked so that the isolators cannot be operated unless the corresponding breaker is in open position;

(ii) isolators and the corresponding earthing switches shall be inter-locked so that no earthing switch can be closed unless and until the corresponding isolator is in open position;

(iii) where two or more supplies are not intended to be operated in parallel, the respective circuit breakers or linked switches controlling the supplies shall be inter-locked to prevent possibility of any inadvertent paralleling or feedback;

(iv) when two or more transformers are operated in parallel, the system shall be so arranged as to trip the secondary breaker of a transformer in case the primary breaker of that transformer trips;

(v) all gates or doors which give access to live parts of an installation shall be inter-locked in such a way that these cannot be opened unless the live parts are made dead and proper discharging and earthing of these parts should be ensured before any person comes in close proximity of such parts;

(vi) where two or more generators operate in parallel and neutral switching is adopted, inter-lock shall be provided to ensure that generator breaker cannot be closed unless one of the neutrals is connected to the earthing system.

(2) The following protection shall be provided in all systems and circuits to automatically disconnect the supply under abnormal conditions, namly:-

(i) over current protection to disconnect the supply automatically if the rated current of the equipment, cable or supply line is exceeded for a time which the equipment, cable or supply line is not designed to withstand;

(ii) earth fault or earth leakage protection to disconnect the supply automatically if the earth fault current exceeds the limit of current for keeping the contact potential within the reasonable values;

(iii) gas pressure type and winding and oil temperature protection to give alarm and tripping shall be provided on all transformers of ratings 1000 KVA and above;

(iv) transformers of capacity 10 MVA and above shall be protected against incipient faults by differential protection;

(v) all generators with rating of 100 KVA and above shall be protected against earth fault or leakage;

(vi) all generators of rating 1000 KVA and above shall be protected against faults within the generator winding using restricted earth fault protection or differential protection or by both;

(vii) high speed bus bar differential protection along with local breaker back up protection shall be commissioned and shall always be available at all 132 kV and above voltage sub-stations and switching stations and generating stations connected with the grid:

Provided that in respect of existing 132 kV sub-stations and switching stations having more than one incoming feeders, the high speed bus bar differential protection along with local breaker back up protection, shall be commissioned and shall always be available;

(viii) every generating station and sub-station connected to the grid at 220 kV and above shall be provided with disturbance recording and event logging facilities and all such equipment shall be provided with time synchronization facility for global common time reference but wherever numerical relays with provision of recording fault data are installed, disturbance recorder and event logger may not be installed;

(ix) distance protection and carrier communication protection shall be provided for all lines connecting to 400/220 kV substation.

46. Testing, Operation and Maintenance.- (1) Before approval is accorded by the Electrical Inspector under regulation 43 the manufacturer's test certificates shall, if required, be produced for all the routine tests as required under the relevant Indian Standards.

(2) No new apparatus, cable or supply line of voltage exceeding 650 Volts shall be commissioned unless such apparatus, cable or supply line are subjected to site tests as per relevant code of practice of the Bureau of Indian Standards.

(3) No apparatus, cable or supply line of voltage exceeding 650 V which has been kept disconnected, for a period of six months or more, from the system for alterations 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 Bureau of Indian Standards.

(4) Notwithstanding the provisions of this regulation, the Electrical Inspector may require certain tests to be carried out before or after charging the installations.

(5) All apparatus, cables and supply lines shall be maintained in healthy conditions and tests shall be carried out periodically as per the relevant code of practice of the Bureau of Indian Standards.

(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 the responsibility of the owner of all installations of voltage exceeding 650 V to maintain and operate the installations in a condition free from danger and as recommended by the manufacturer or by the relevant codes of practice of the Bureau of Indian Standards.

(8) Failures of transformers and reactors of 20 MVA or MVAR and higher capacity shall be reported by the consumer and the suppliers of electricity, within forty eight hours of the occurrence of the failure, to the Central Electricity Authority and the reasons for failure and measures to be taken to avoid recurrence of failure shall be sent to the Central Electricity Authority within one month of the occurrence in the format given in Schedule-IX.

47. **Precautions to be taken against excess leakage in case of metal sheathed electric supply lines.-** The following precautions shall be taken in case of electric supply lines other than overhead lines, for use at voltage exceeding 650 V; namely:-

(i) the conductors of the cable except the cable with thermoplastic insulation without any metallic screen or armour shall be enclosed in metal sheathing which shall be electrically continuous 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;

(ii) the resistance of the 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.

Explanation- For the purpose of this regulation;

(a) in the case of thermoplastic insulated and sheathed cables with metallic armour the metallic wire or tape armour, shall be considered as metal sheathing.

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

48. **Connection with earth for apparatus exceeding 650V.-** (1) All non-current carrying metal parts associated with an installation of voltage exceeding 650 V shall be effectively earthed to a grounding system or mat which shall,-

(i) limit the touch and step potential to tolerable values;

(ii) limit the ground potential rise to tolerable values so as to prevent danger due to transfer of potential through ground, earth wires, cable sheath, fences, pipe lines, etc.;

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

(2) In the case of star connected system with earthed neutrals or delta connected system with earthed artificial neutral point,-

(i) the neutral point of every generator and transformer shall be earthed by connecting it to the earthing system not by less than two separate and distinct connections:

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

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

(ii) the generator or transformer neutral shall be earthed through a suitable impedance where an appreciable harmonic current flowing in the neutral connection causes interference, with communication circuits;

(iii) in case of the 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.

(3) In case of generating stations, sub-stations and industrial installations of voltage exceeding 33 kV, 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 the step and touch potential to exceed its permissible values.

(4) Single phase systems of voltage exceeding 650 V shall be effectively earthed.

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

(6) Where a supplier proposes to connect with earth an existing system for use at voltage exceeding 650 V which has not hitherto been so connected with earth, he shall give not less than fourteen days notice in writing together with particulars of the proposed connection with earth to the telegraph-authority established under the Indian Telegraph Act, 1885 (13 of 1885).

(7) Where the earthing lead and earth connection are used only in connection with earthing guards erected under overhead lines of voltage exceeding 650 V where they cross a telecommunication line or a railway line, and where such lines are equipped with earth leakage, the earth resistance shall not exceed twenty five

ohms and the project authorities shall obtain No Objection Certificate (NOC) from Railway Authorities and Power and Telecommunication Co-ordination Committee before energisation of the facilities.

(8) Every earthing 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 and records of such tests shall be maintained and produced, if so required, before the Electrical Inspector.

49. General conditions as to transformation and control of electricity.- (1) Where electricity of voltage exceeding 650 V is transformed, converted, regulated or otherwise controlled in sub-stations or switching stations including outdoor sub-stations and outdoor switching stations to be transformed or in street boxes constructed underground, the following provisions shall be observed, namely:-

(i) sub-stations and switching stations shall preferably be erected above ground, but where necessarily constructed underground due provisions for ventilation and drainage shall be made and any space housing switchgear shall not be used for storage of any materials especially inflammable and combustible materials or refuse;

(ii) outdoor sub-stations except pole type sub-stations and outdoor switching 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 metres in height or other means so as to prevent access to the electric supply lines and apparatus therein by an undesignated person and the fencing of such area shall be earthed efficiently;

(iii) 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 receptacle above ground wherever practicable.

(2) Where electricity is transformed, suitable connection shall be made by connecting with earth a point of the system at the lower voltage and also 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.

50. Pole type sub-stations.- 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 the case of pole type sub-station on wooden supports and wooden platform the metal hand-rail shall not be connected with earth.

51. Condensers.- Suitable arrangement shall be made for immediate and automatic or manual discharge of every static condenser on disconnection of supply.

52. Supply to luminous tube sign installations of voltage exceeding 650 Volts but not exceeding 33 kV.- (1) Any person who proposes to use or who is using electricity for the purpose of operating a luminous tube sign installation, or who proposes to transform or is transforming electricity to a voltage exceeding 650 V but not exceeding 33 kV for any such purpose shall comply with the following conditions, namely:-.

(i) all live parts of the installation, including all apparatus and live conductors in the secondary circuit, but excluding the tubes except in the neighbourhood of their terminals, shall be inaccessible to undesignated persons and such parts shall be effectively screened;

(ii) irrespective of the method of obtaining the voltage of the circuit which feeds the luminous discharge tube sign, no part of any conductor of such circuit shall be in metallic connection, except in respect of its connection with earth, with any conductor of the supply system or with the primary winding of the transformer;

(iii) all live parts of an exterior installation shall be so disposed as to protect them against the effects of the weather and such installation shall be so arranged and separated from the surroundings as to limit, as far as possible, the spreading of fire;

(iv) the secondary circuit shall be permanently earthed at the transformer and the core of every transformer shall be earthed;

(v) where the conductors of the primary circuit are not in metallic connection with the supply conductors, one phase of such primary circuit shall be permanently earthed at the motor generator or convertor, or at the transformer and an earth leakage circuit breaker of sufficient rating shall be provided on the side of voltage not exceeding 250 V to detect the leakage in such luminous tube sign installations;

(vi) a sub-circuit which forms the primary circuit of a fixed luminous discharge tube sign installation shall be reserved solely for such purpose;

(vii) a separate primary final sub-circuit shall be provided for each transformer or each group of transformers having an aggregate input not exceeding 1,000 volt-amperes, of a fixed luminous discharge tube sign installation;

(viii) an interior installation shall be provided with suitable adjacent means for disconnecting all phases of the supply except the "neutral" in a 3-phase, 4-wire circuit;

(ix) for installations on the exterior of a building a suitable emergency fire-proof linked switch to operate on all phases except the neutral in a 3-phase, 4-wire circuit shall be provided and fixed in a conspicuous position at not more than 1.70 metres above the ground;

(x) a special "caution" notice shall be affixed in a conspicuous place on the door of every enclosure of voltage exceeding 650 V but not exceeding 33 kV to the effect that the supply must be cut off before the enclosure is opened;

(xi) where static condensers are used, they shall be installed on the load side of the fuses and the primary side of the transformers where the voltage does not exceed 250 V;

(xii) where static condensers are used on primary side, provision shall be made for automatic or manual discharging of the condensers when the supply is cut off;

(xiii) before using the static condensers or any interrupting device on the voltage exceeding 650 V, the executing agencies shall test and ensure that automatic discharging device is functional thereon.

(2) The owner or user of any luminous tube sign or similar installation of voltage exceeding 650 V but not exceeding 33 kV shall not bring the same into use without giving to the Electrical Inspector not less than fourteen days notice in writing of his intention so to do.

53. **Supply to electrode boilers of voltage exceeding 650 Volt but not exceeding 33 kV.-** (1) Where a system having a point connected with earth is used for supply of electricity to an electrode boiler of voltage exceeding 650 V which is also connected with earth, the owner or user of electrode boiler shall comply with the following conditions, namely:-

(i) the metal work of the electrode boiler shall be efficiently connected to the metal sheathing and metallic armouring, if any, of the electric supply line of voltage exceeding 650 V but not exceeding 33 kV whereby electricity is suppied to the electrode boiler;

(ii) the supply of electricity at voltage exceeding 650 V to the electrode boiler shall be controlled by a suitable circuit-breaker so set as to operate in the event of the phase currents becoming unbalanced to the extent of ten per cent of the rated current consumption of the electrode boiler under normal conditions of operation:

Provided that if in any case a higher setting is essential to ensure stability of operation of the electrode boiler, the setting may be increased so as not to exceed fifteen per cent of the rated current consumption of the electrode boiler under normal conditions of operation;

(iii) an inverse time element device may be used in conjuction with the aforesaid circuit breaker to prevent the operation thereof unnecessarily on the occurrence of unbalanced phase currents of momentary or short duration;

(iv) the supplier or owner shall serve a notice in writing on the telegraph-authority at least seven days prior to the date on which such supply of electricity is to be afforded specifying the location of every point, including

the earth connection of the electrode boiler, at which the system is connected with earth.

(2) The owner or user of any electrode boiler of voltage exceeding 650 V shall not bring the same into use without giving the Electrical Inspector not less than fourteen days notice in writing of his intention so to do.

54. **Supply to X-ray and high frequency installations.**- (1) Any person, who proposes to use or who is using electricity for the purpose of operating an X-ray or similar high-frequency installation, other than portable units or shock-proof self contained and stationary units shall comply the following conditions, namely:-

(i) mechanical barriers shall be provided to prevent too close an approach to any parts of the X-ray apparatus of voltage exceeding 650 V but not exceeding 33 kV, except the X-ray tube and its leads, unless such parts of voltage exceeding 650 V but not exceeding 33 kV have been rendered shock proof by being shielded by earthed metal or adequate insulating material;

(ii) where generators operating at 300 kV peak or more are used, such generators shall be installed in rooms separate from those containing the other equipment and any step-up transformer employed shall be so installed and protected as to prevent danger;

(iii) a suitable switch shall be provided to control the circuit supplying a generator, and shall be so arranged as to be open except while the door of the room housing the generator is locked from the outside;

(iv) X-ray tubes used in therapy shall be mounted in an earthed metal enclosure;

(v) every X-ray machine shall be provided with a milliammeter or other suitable measuring instrument, readily visible from the control position and connected, if practicable, in the earthed lead, but guarded if connected in the lead of voltage exceeding 650 V but not exceeding 33 kV:

Provided that earth leakage circuit breaker of sufficient rating shall be provided on the side wherein voltage does not exceed 250 V to detect the leakage in such X-ray installations.

Explanation:- For the purpose of this regulation "shock proof", as applied to X-ray and high-frequency equipment, shall mean that such equipment is guarded with earthed metal so that no person may come into contact with any live part.

(2) (i) in the case of nonshock proof equipment, overhead conductors of voltage exceeding 650 V but not exceeding 33 kV, unless suitably guarded against personal contact, shall be adequately spaced and high voltage leads on tilting tables and fluroscopes shall be adequately insulated or so surrounded by barriers as to prevent inadvertent contact;

(ii) the circuit of voltage not exceeding 250 V of the step up transformer shall contain a manually operated control device having overload protection, in addition to the over current device for circuit protection, and these devices shall have no exposed live parts and for diagnostic work there shall be an additional switch in the said circuit, which shall be of one of the following types:-

(a) a switch with a spring or other mechanism that will open automatically except while held close by the operator, or;

(b) a time switch which will open automatically after a definite period of time for which it has been set;

(iii) if more than one piece of apparatus be operated from the same source of voltage exceeding 650 V, each shall be provided with a switch of voltage exceeding 650 V to give independent control;

(iv) low frequency current-carrying parts of a machine of the quenched-gap or open gap type shall be so insulated or guarded that they cannot be touched during operation but the high frequency circuit-proper which delivers high-frequency current normally for the therapeutic purposes shall be exempt from such insulation;

(v) all X-ray generators having capacitors shall have suitable means for discharging the capacitors manually;

(vi) except in the case of self-contained units, all 200 kV peak or higher X-ray generators shall have a sphere gap installed in the system of voltage exceeding 650 V but not exceeding 33 kV adjusted so that it will break down on over voltage surges.

(3) (i) all non-current carrying metal parts of tube stands, fluroscopes and other apparatus shall be properly earthed and insulating floors, mats or platforms shall be provided for operators in proximity to parts of voltage exceeding 650V unless such parts have been rendered shock proof;

(ii) where short wave therapy machines are used, the treatment tables and examining chairs shall be wholly non-metallic.

(4) The owner of any X-ray installation or similar high frequency apparatus shall not bring the same into use without giving to the Electrical Inspector not less than fourteen days notice in writing of his intention to do so:

Provided that the aforesaid notice shall not be necessary in the case of shock-proof portable X-ray and high-frequency equipment which have been inspected before the commencement of their use and periodically thereafter.

Chapter VII

Safety requirements for overhead lines, underground cables and generating stations

55. Material and strength.- (1) All conductors of overhead lines other than those specified in regulation 68 shall have a breaking strength of not less than 350 kg.

(2) Where the voltage does not exceed 250 V and the span is of less than fifteen metres and is drawn through the owner's or consumer's premises, a conductor having an actual breaking strength of not less than 150 kg may be used.

56. Joints.- (1) No conductor of an overhead line shall have more than one joint in a span and joints between conductors of overhead lines shall be mechanically and electrically secure under the conditions of operation.

(2) The ultimate strength and the electrical conductivity of the joint shall be as per relevant Indian Standards.

57. Maximum stresses and factors of safety.- (1) The load and permissible stresses on the structural members, conductors and ground wire of self supporting steel lattice towers for overhead transmission lines shall be in accordance with the specifications laid down, from time to time, by the Bureau of Indian Standards.

(2) Overhead lines not covered in sub-regulation (1) shall have the following minimum factors of safety, namely:-

(i)	for metal supports	-	1.5
(ii)	for mechanically processed concrete supports	-	2.0
(iii)	for hand-moulded concrete supports	-	2.5
(iv)	for wood supports	-	3.0

(3) The minimum factors of safety shall be based on such load as may cause failure of the support to perform its function, assuming that the foundation and other components of the structure are intact.

(4) The load shall be equivalent to the yield point stress or the modulus of rupture, as the case may be, for supports subject to bending and vertical loads and the crippling load for supports used as strut.

(5) The strength of the supports of the overhead lines in the direction of the line shall not be less than one-fourth of the strength required in the direction transverse to the line.

(6) The minimum factor of safety for stay-wires, guard-wires or bearer-wires shall be 2.5 based on the ultimate tensile strength of the wire.

(7) The minimum factor of safety for conductors shall be two, based on their ultimate tensile strength, in addition, the conductor's tension at 32^0 C, without external load, shall not exceed the following percentages of the ultimate tensile strength of the conductor:-

(i)	Initial unloaded tension	.....	35 per cent
(ii)	Final unloaded tension	.....	25 per cent

Provided that for the conductors having a cross section of a generally triangular shape, such as conductors composed of 3-wires, the final unloaded tension at 32^0 C shall not exceed thirty per cent of the ultimate tensile strength of such conductor.

(8) For the purpose of calculating the factors of safety in sub-regulation (2), the following conditions shall be observed, namely:-

(i) the maximum wind pressure shall be as specified in the relevant Indian Standards;

(ii) for cylindrical bodies the effective area shall be taken as full projected area exposed to wind pressure; and

(iii) the maximum and minimum temperatures shall be such as specified in the relevant Indian Standards.

(9) Notwithstanding anything contained in sub-regulation (2) to (8) in localities where overhead lines are liable to accumulations of ice or snow, the load and permissible stresses on the structural members, conductors and ground wire of self supporting steel lattice towers for overhead transmission lines shall be in accordance with the specifications laid down, from time to time, by the Bureau of Indian Standards or as specified by Appropriate Government, by order in writing.

58. Clearance above ground of the lowest conductor of overhead lines.- (1) No conductor of an overhead line, including service lines, erected across a street shall at any part thereof be at a height of less than-

(i)	for lines of voltage not exceeding 650 Volts	-	5.8 metres
(ii)	for lines of voltage exceeding 650 Volts but not exceeding 33 kV	-	6.1 metres

(2) No conductor of an overhead line, including service lines, erected along any street shall at any part thereof be at a height less than-

(i)	for lines of voltage not exceeding 650 Volts	-	5.5 metres
(ii)	for lines of voltage exceeding 650 Volts but not exceeding 33 kV	-	5.8 metres

(3) No conductor of an overhead line including service lines, erected elsewhere than along or across any street shall be at a height less than -

(i)	for lines of voltage upto and including 11,000 Volts,if bare	-	4.6 metres
(ii)	for lines of voltage upto and including 11,000 Volts, if insulated	-	4.0 metres
(iii)	for lines of voltage exceeding 11,000 Volts but not exceeding 33 kV	-	5.2 metres

(4) For lines of voltage exceeding 33 kV the clearance above ground shall not be less than 5.2 metres plus 0.3 metre for every 33,000 Volts or part thereof by which the voltage of the line exceeds 33,000 Volts;

Provided that the minimum clearance along or across any street shall not be less than 6.1 metres.

(5) For High Voltage Direct Current (HVDC) lines, the clearance above ground shall not be less than:-

Sl.No.	DC Voltage(kV)	Ground Clearance (mtrs.)
1.	100 kV	6.1
2.	200 kV	7.3
3.	300 kV	8.5
4.	400 kV	9.4
5.	500 kV	10.6
6.	600 kV	11.8
7.	800 kV	13.9

(6) Ground clearances shall be as specified in schedule-X.

59. **Clearance between conductors and trolley wires.-** (1) No conductor of an overhead line crossing a tramway or trolley bus route using trolley wires shall have less than the following clearances above any trolley wire-

(i) lines of voltage not exceeding 650 Volts - 1.2 metres

Provided that where an insulated conductor suspended from a bearer wire crosses over a trolley wire the minimum clearance for such insulated conductor shall be 0.6 metre.

(ii) lines of voltage exceeding 650 Volts up to and including 11,000 Volts - 1.8 metres

(iii) lines of voltage exceeding 11,000 Volts but not exceeding33,000 Volts - 2.5 metres

(iv) lines of voltage exceeding 33 kV - 3.0 metres

(2) In any case of a crossing specified in sub-regulation (1), whoever lays his line later in time, shall provide the clearance between his own line and the line which will be crossed in accordance with the provisions of the said sub-regulation:

Provided that if the later entrant is the owner of the lower line and is not able to provide adequate clearance, he shall bear the cost for modification of the upper line so as to comply with this sub-regulation.

60. Clearance from buildings of lines of voltage and service lines not exceeding 650 Volts.- (1) An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line.

(2) Where an overhead line of voltage not exceeding 650 V passes above or adjacent to or terminates on any building, the following minimum clearances from any accessible point, on the basis of maximum sag, shall be observed, namely:-

(i) for any flat roof, open balcony, varandah roof and lean-to-roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres from the highest point, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres from the nearest point, and

(ii) for pitched roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres immediately under the line, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres.

(3) Any conductor so situated as to have a clearance less than that specified above shall be adequately insulated and shall be attached at suitable intervals to a bare earthed bearer wire having a breaking strength of not less than 350 kg.

(4) The horizontal clearance shall be measured when the line is at a maximum deflection from the vertical due to wind pressure.

(5) Vertical and horizontal clearances shall be as specified in schedule-X.

Explanation:- For the purpose of this regulation, the expression "building" shall be deemed to include any structure, whether permanent or temporary.

61. Clearances from buildings of lines of voltage exceeding 650 V.- (1) An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line.

(2) Where an overhead line of voltage exceeding 650 V passes above or adjacent to any building or part of a building it shall have on the basis of maximum sag a vertical clearance above the highest part of the building immediately under such line, of not less than-

(i) for lines of voltages exceeding 650 Volts upto and including 33,000 Volts	- 3.7 metres
(ii)for lines of voltages exceeding 33 kV	- 3.7 metres plus 0.30 metre for every additional 33,000 Volts or part thereof.

(3) The horizontal clearance between the nearest conductor and any part of such building shall, on the basis of maximum deflection due to wind pressure, be not less than-

(i)	for lines of voltages exceeding 650 V upto and including 11,000 Volts	- 1.2 metres
(ii)	for lines of voltages exceeding 11,000 V and up to and including 33,000 V	- 2.0 metres
(iii)	for lines of voltages exceeding 33 kV	- 2.0 metres plus 0.3 metre fore every additional 33kV or part thereof.

(4) For High Voltage Direct Current (HVDC) systems, vertical clearance and horizontal clearance, on the basis of maximum deflection due to wind pressure, from buildings shall be maintained as below:

Sl.No	DC Voltage (kV)	Vertical Clearance (mtrs.)	Horizontal Clearance (mtrs.)
1.	100 kV	4.6	2.9
2.	200 kV	5.8	4.1
3.	300 kV	7.0	5.3
4.	400 kV	7.9	6.2
5.	500 kV	9.1	7.4
6.	600 kV	10.3	8.6
7.	800 kV	12.4	10.7

(5) Vertical and horizontal clearances shall be as specified in schedule-X.

Explanation:- For the purpose of this regulation the expresssion "building" shall be deemed to include any structure, whether permanent or temporary.

62. **Conductors at different voltages on same supports.-** Where conductors forming parts of systems at different voltages are erected on the same supports, the owner shall make adequate provision 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 the higher voltage system and the methods of construction and the applicable minimum clearances between the conductors of the two systems shall be as specified in regulation 69 for lines crossing each other.

63. Erection or alteration of buildings, structures, flood banks and elevation of roads.- (1) If at any time subsequent to the erection of an overhead line, whether covered with insulating material or not, any person proposes to erect a new building or structure or flood bank or to raise any road level or to carry out any other type of work whether permanent or temporary or to make in or upon any building, or structure or flood bank or road, any permanent or temporary addition or alteration, he and the contractor whom he employs to carry out the erection, addition or alteration, shall, give intimation in writing of his intention to do so, to the supplier or owner and to the Electrical Inspector and shall furnish therewith a scale drawing showing the proposed building, structure, flood bank, road or any addition or alteration and scaffolding thereof required during the construction.

(2) On receipt of such intimation, the supplier or owner shall examine,-

(i) whether the line under reference was laid in acordance with the provisions of these regulations and any other law;

(ii) whether it is technically feasible;

(iii) whether it meets the requirement of Right of Way (ROW);

(iv) whether such person was liable to pay the cost of alteration of the overhead line and if so, send a notice without undue delay, to such person together with an estimate of the cost of the expenditure likely to be incurred to so alter the overhead line and require him to deposit, within thirty days of the receipt of the notice, with the supplier or owner, the amount of the estimated cost.

(3) If such person disputes the cost of alteration of the overhead line estimated by the supplier or owner or even the responsibility to pay such cost, the dispute may be referred to the Electrical Inspector whose decision thereof shall be final.

(4) The Electrical Inspector shall estimate the cost of alteration of overhead line on the following basis, namely:-

(i) the cost of material used on the alteration after crediting the depreciated cost of the material which shall be available from the existing line;

(ii) the wages of labour employed in affecting the alteration;

(iii) supervision charges to the extent of fifteen per cent of the wages mentioned in sub clause (ii); and charges incurred by the supplier or owner in complying with the provisions of section 67 of the Act, in respect of such alterations.

(5) Any addition or alteration to the building or structure shall be allowed only after the deposite of such estimated cost to the supplier or owner.

(6) No work upon such building, structure, flood bank, road and addition or alteration thereto shall be commenced or continued until the Electrical Inspector

has certified that the provisions of regulation 58, 60 and 61 should not be contravened either during or after the aforesaid construction:

Provided that the Electrical Inspector may, if he is satisfied that the overhead line has been so guarded as to secure the protection of persons or property from injury, certify that the work may be executed prior to the alteration of the overhead line or in the case of temporary addition or alteration, without alteration of the overhead line.

(7) The supplier or owner shall, on receipt of such deposit, alter the overhead line in such a way that it does not contravene the provisions regulation 58, 60 and 61 either during or after such construction within two months from the date of such deposit or within such longer period as the Electrical Inspector may allow.

64. **Transporting and storing of material near overhead lines.-** (1) No rods, pipes or similar materials shall be taken below, or in the vicinity of, any bare overhead conductors or lines if these contravene the provisions of regulations 60 and 61 unless such materials are transported under the direct supervision of a person designated in this behalf by the owner of such overhead conductors or lines.

(2) No rods, pipes or other similar materials shall be brought within the flash over distance of bare live conductors or lines.

(3) No material or earth work or agricultural produce shall be dumped or stored, no trees grown below or in the vicinity of, bare overhead conductors, or lines to contravene the provision of regulations 60 and 61.

(4) No flammable material shall be stored under the electric supply line.

(5) No fire shall be allowed above underground cables.

(6) Firing of any material below electric lines shall be prohibited.

65. **General clearances.-** (1) For the purpose of computing the vertical clearance of an overhead line, the maximum sag of any conductor shall be calculated on the basis of the maximum sag in still air and the maximum temperature as specified under regulations 57 and computing any horizontal clearance of an overhead line the maximum deflection of any conductor shall be calculated on the basis of the wind pressure specified under regulations 57.

(2) No blasting for any purpose shall be done within 300 metres from the boundary of a sub-station or from the electric supply lines of voltage exceeding 650 V or tower structure thereof without the written permission of the owner of such sub-station or electric supply lines or tower structures and in case of mining lease hold area, without the written permission of the Inspector of Mines.

(3) No cutting of soil within ten meters from the tower structure of 132 kV and above voltage level shall be permitted without the written permission of the owner of tower structure.

(4) No person shall construct brick kiln or other polluting units near the installations or transmission lines of 220 kV and above within a distance of 500 metres.

66. **Routes proximity to aerodromes.-** Overhead lines shall not be erected in the vicinity of aerodromes unless the Airport Authorities have approved in writing the route of the proposed lines as per relevant Indian Standards.

67. **Maximum interval between supports.-** All conductors shall be attached to supports at intervals not exceeding the safe limits based on the ultimate tensile strength of the conductor and the factor of safety specified under regulations 57.

Provided that in the case of overhead lines carrying conductors of voltage not exceeding 650 V when erected in, over, along or across any street, the interval shall not, without the consent in writing of the Electrical Inspector, exceed 65 metres.

68. **Conditions to apply where telecommunication lines and power lines are carried on same supports.-** (1) Every overhead telecommunication line erected on supports carrying a power line shall consist of conductors each having a breaking strength of not less than 270 kg.

(2) Every telephone used on a telecommunication line erected on supports carrying a power line shall be suitably guarded against lightning and shall be protected by cut-outs.

(3) Where a telecommunication line is erected on supports carrying a power line of voltage exceeding 650 V, arrangement shall be made to safeguard any person against injury resulting from contact, leakage or induction between such power and telecommunication lines.

69. **Lines crossing or approaching each other and lines crossing street and road.-** Where an overhead line crosses or is in proximity to any telecommunication line, the owner of either the overhead line or the telecommunication line, whoever lays his line later, shall arrange to provide for protective devices or guarding arrangement and shall observe the following provisions, namely:-

(i) when it is intended to erect a telecommunication line or an overhead line which will cross or be in proximity to an overhead line or a telecommunication line, as the case may be, the person proposing to erect such line shall give one month's notice of his intention so to do along with the relevant details of protection and drawings to the owner of the existing line;

(ii) guarding shall be provided where lines of voltage not exceeding 33 kV cross a road or street;

(iii) where an overhead line crosses or is in proximity to another overhead line, guarding arrangements shall be provided so to guard against the possibility of their coming into contact with each other;

(iv) where an overhead line crosses another overhead line, clearances shall be as under:-

(Minimum clearances in metres between lines crossing each other)

Sl. No	Nominal System Voltage	11-66 kV	110-132 kV	220 kV	400 kV	800 kV
1.	Low and Medium	2.44	3.05	4.58	5.49	7.94
2.	11-66 kV	2.44	3.05	4.58	5.49	7.94
3.	110-132 kV	3.05	3.05	4.58	5.49	7.94
4.	220 kV	4.58	4.58	4.58	5.49	7.94
5.	400 kV	5.49	5.49	5.49	5.49	7.94
6.	800 kV	7.94	7.94	7.94	7.94	7.94

Provided that no guardings are required when line of voltage exceeding 33 kV crosses over another line of 250 V and above voltage or a road or a tram subject to the condition that adequate clearances are provided between the lowest conductor of the line of voltage exceeding 33 kV and the top most conductor of the overhead line crossing underneath the line of voltage exceeding 33 kV and the clearances as stipulated in regulation 58 from the topmost surface of the road maintained;

(v) where an overhead direct current (DC) line crosses another overhead line, clearances shall be as under:-

(Minimum clearances in metres between AC and DC lines crossing each other)

Sl. No.	Sysytem Voltage AC/DC	100 kV DC	200 kV DC	300 kV DC	400 kV DC	500 kV DC	600 kV DC
1.	Low and Medium AC	3.05	4.71	5.32	6.04	6.79	7.54
2.	11-66 kV AC	3.05	4.71	5.32	6.04	6.79	7.54
3.	110-132 kV AC	3.05	4.71	5.32	6.04	6.79	7.54
4.	220 kV AC	4.58	4.71	5.32	6.04	6.79	7.54
5.	200 kV DC	4.71	4.71	5.32	6.04	6.79	7.54

6.	300 kV AC	5.32	5.32	5.32	6.04	6.79	7.54
7.	400 kV AC	5.49	5.49	5.49	6.04	6.79	7.54
8.	400 kV DC	6.04	6.04	6.04	6.04	6.79	7.54
9.	500 kV DC	6.79	6.79	6.79	6.79	6.79	7.54
10.	600 kV DC	7.54	7.54	7.54	7.54	7.54	7.54
11.	800 kV DC	7.94	7.94	7.94	7.94	7.94	7.94

(vi) a person erecting or proposing to erect a line which may cross or be in proximity with an existing line, shall provide arrangements on his own line or require the owner of the other overhead line to provide guarding arrangements as referred to in clause (iii) and (iv);

(vii) in all cases referred to in this regulation the expenses of providing the guarding arrangements or protective devices shall be borne by the person whose line was last erected;

(viii) where two lines cross, the crossing shall be made as nearly at right angles as the nature of the case admits and as near the support of the line as practicable, and the support of the lower line shall not be erected below the upper line;

(ix) the guarding arrangements shall ordinarily be carried out by the owner of the supports on which it is made and he shall be responsible for its efficient maintenace.

70. **Guarding.-** (1) Where guarding is required under these regulations the following shall be observed , namely:-

(i) every guard-wire shall be connected with earth at each point at which its electrical continuity is broken;

(ii) every guard-wire shall have an actual breaking strength of not less than 635 kg and if made of iron or steel , shall be galvanised;

(iii) every guard-wire or cross-connected systems of guard-wires shall have sufficient current-carrying capacity to ensure them rendering dead, without risk of fusing of the guard-wire or wires, till the contact of any live wire has been removed.

(2) In the case of a line crossing over a trolley-wire the guarding shall be subjected to the following conditions, namely:-.

(i) where there is only one trolley-wire, two guard-wires shall be erected as in DIAGRAM-A;

(ii) where there are two trolley –wires and the distance between them does not exceed 40 cms, two guard-wires shall be erected as in DIAGRAM-B;

(iii) where there are two trolley wires and the distance between them exceeds 40 cms but does not exceed 1.2 metres, three guard-wires shall be erected as in DIAGRAM-C;

(iv) where there are two trolley-wires and the distance between them exceeds 1.2 metres, each trolley-wire shall be separately guarded as in DIAGRAM-D;

(v) the rise of trolley boom shall be so limited that when the trolley leaves the trolley-wire, it shall not foul the guard-wires; and

(vi) where a telegraph-line is liable to fall or be blown down upon an arm, stay-wire or span-wire and so slide-down upon a trolley-wire, guard hooks shall be provided to prevent such sliding.

DIAGRAM-A

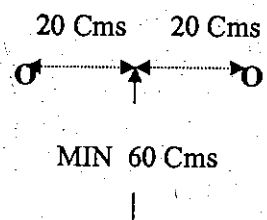


DIAGRAM-B **DIAGRAM-C**

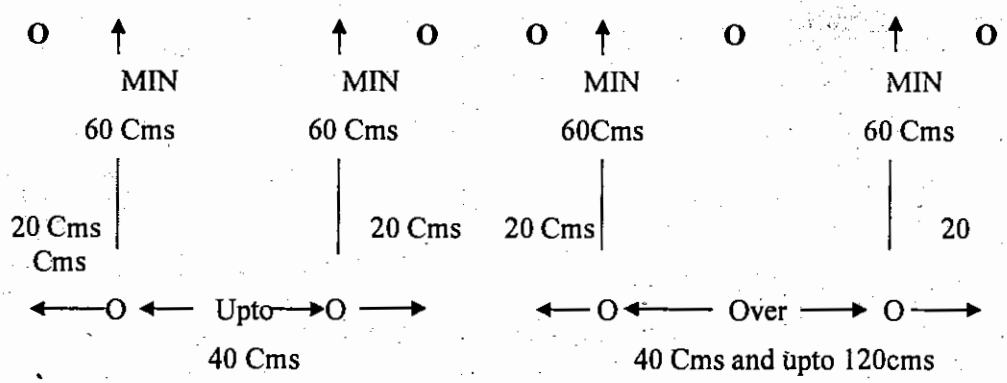
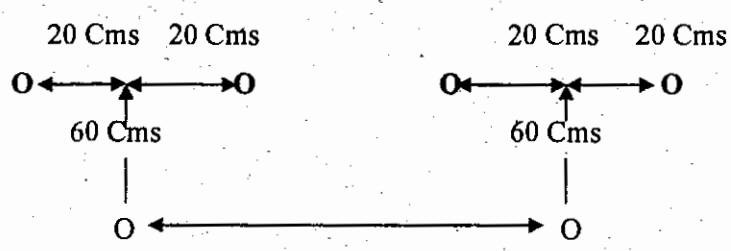


DIAGRAM-D



OVER 120cms.

71. Service lines from overhead lines.- No service-line or tapping shall be taken off an overhead line except at a point of support:

Provided that the number of tappings per conductor shall not be more than four in case of connections at voltage not exceeding 650 V.

72. Earthing.- (1) All metal supports and all reinforced and prestressed cement concrete supports of overhead lines and metallic fittings attached thereto, shall be either permanently and efficiently earthed by providing a continuous earth wire and securely fastening to each pole and connecting with earth ordinarily at three points in every km. with the spacing between the points being as nearly equidistant as possible or each support and the metallic fitting attached thereto shall be efficiently earthed.

(2) Metallic bearer wire used for supporting insulated wire of overhead service lines of voltage not exceeding 650 V shall be efficiently earthed or insulated.

(3) Each stay-wire shall be similarly earthed unless insulator has been placed in it at a height not less than 3.0 metres from the ground.

73. Safety and protective devices.- (1) Every overhead line which is not being suspended from a dead bearer wire, not being covered with insulating material and not being a trolley-wire, is erected over any part of a street or other public place

or in any factory or mine or on any consumer's premises shall be protected with earth gaurding for rendering the line electrically harmless in case it breaks.

(2) An Electrical Inspector may, by notice in writing, require the owner of any such overhead line, wherever it may be erected, to protect it in the manner specified in sub-regulation (1).

(3) The owner of every overhead line of voltage exceeding 650 V shall make adequate arrangements as per relevant Indian Standards to prevent undesignated persons from ascending any of the supports of such overhead lines which can be easily climbed upon without the help of a ladder or special appliances.

Explanation.- For the purpose of this relgulation, rails, reinforced cement concrete poles and pre-stressed cement concrete poles without steps, tubular poles, wooden supports without steps, I-sections and channels' shall be deemed as supports which cannot be easily climbed upon.

74. **Protection against lightning.-** (1) The owner of every overhead line, sub-station or generating station which is exposed to lightning shall adopt efficient means for diverting to earth any electrical surges due to lightning which may result into injuries.

(2) The earthing lead for any lightning arrestor shall not pass through any iron or steel pipe, but shall be taken as directly as possible from the lightning arrestor without touching any metal part to a separate vertical ground electrode or junction of the earth mat already provided for the sub-station of voltage exceeding 650 V subject to the avoidance of bends wherever practicable.

75. **Unused overhead lines.-** Where an overhead line ceases to be used as an electric supply line:

(i) the owner shall maintain it in a safe mechanical condition in accordance with regulation 57 or remove it.

(ii) the Electrical Inspector shall, by a notice in writing served on the owner, require him to maintain it in a safe mechanical condition or to remove it within thirty days of the receipt of the notice.

76. **Laying of cables.-** (1) No underground power cable of voltage exceeding 33 kV shall be laid without a minimum underground depth of 1.2 meters.

(2) No underground telecommunication cable shall be laid without a minimum separation distance of 0.6 meters to the underground power cable of voltage exceeding 33 kV.

77. **Protection against electromagnetic interference.-** The owner of every overhead power line of voltage level 11 kV or higher shall submit proposal for obtaining Power Telecommunication Co-ordination Committee clearance to ensure safety of the personnel and telecom equipment.

Chapter VIII

Safety requirements for Electric Traction

78. Application of chapter.- (1) The regulations in this chapter shall apply only where electricity is used for the purposes of traction:

Provided that nothing in this chapter shall apply to electricity used for the public carriage of passengers, animals or goods on, or for the lighting or ventilation of the rolling stock of any railway or tramway subject to the provisions of the Railways Act, 1989 (24 of 1989).

(2) In this chapter the conductor used for transmitting electricity to a vehicle is referred to as the "line" and the other conductor as the "return".

(3) The owner of the line, return, rails or trolley wire, as the case may be, shall be responsible for the observance of regulations 79 to 92.

(4) Before an application is made by the owner of an installation of voltage exceeding 650 V to the Electrical Inspector for permission to commence or recommence supply after such installation has been disconnected for six months and above, the supplier shall ensure that the electric supply lines or apparatus at voltage exceeding 650 V belonging to him are placed in position, properly connected and duly completed.

(5) The supply of electricity shall not be commenced by the supplier unless and until the Electrical Inspector is satisfied that the provisions of regulations 44 to 50 and regulation 79 to 92 have been complied with and the approval in writing of the Electrical Inspector has been obtained by him.

79. Voltage of supply to vehicle.- No person shall supply electricity to any trolley wire or other conductor at voltage exceeding 650 V used in direct electrical and mechanical connection with any vehicle, except with the written approval of the Central Government or the State Government, as the case may be, and subject to such conditions as the State Government may think reasonable to impose.

80. Insulation of lines.- Every line shall be insulated throughout and a line may consist of either bare conductors supported on structures through insulators or insulated cable.

81. Insulation of returns.- (1) Where any rails on which cars run, or any conductors laid between or within 0.9 metre of such rails, form any part of a return, such part may be un-insulated and all other returns or parts of a return, shall be insulated, unless they are of such conductivity as to secure the conditions required by sub-regulations (2) and (3) of regulation 82.

(2) Where any part of a return is un-insulated, it shall be connected with the negative or neutral of the system.

82. Proximity to metallic pipes.- (1) Where an un-insulated return is in proximity to any metallic pipe, structure or substance not belonging to the owner of the return,

the owner of un-insulated return shall, if so required by the owner of such pipe, structure or substance, connect his return therewith at his own expense.

(2) Where the return is partly or entirely un-insulated, the owner shall, in the construction and maintenance of his system, adopt such means for reducing the difference produced by the current between the potential of the un-insulated return at any one point and the potential of the un-insulated return at any other point as to ensure that the difference of potential between the un-insulated return and any metallic pipe, structure or substance in the vicinity shall not exceed four volts where the return is relatively positive, or one and one-third volts where the return is relatively negative.

(3) The owner of any such pipe, structure or substance in respect of it require the owner of the un-insulated return at reasonable times and intervals to ascertain by test in his presence or in the presence of his representative, whether the condition specified in sub-regulation (2) is fulfilled, and, if such condition is found to be fulfilled, all reasonable expenses of, and incidental to, carrying out of the test shall be borne by the owner of the pipe, structure or substance.

(4) The potential of un-insulated return with respect to earth at any point shall not exceed fifty volt under normal conditions.

(5) The petroleum sidings installation earth shall be connected to the un-insulated return to make it equi-potential and pipelines in the vicinity of the track should be properly earthed.

83. Difference of potential on return.- Where the return is partly or entirely un-insulated, the owner shall keep a continuous record of the difference of potential, during the working of his system, between every junction of an insulated return with an un-insulated return and the point on the route most distant from that junction, and the difference of potential shall not, under normal running conditions, exceed a mean value of seven volts between the highest momentary peak and the average for the hour of maximum load.

84. Leakage on conduit system.- Where both the line and the return are placed within a conduit, the following conditions shall be fulfilled in the construction and maintenance of the system, namely:-

(i) where the rails are used to form any part of the return, they shall be electrically connected at distances not exceeding 30 metres apart, with the conduit by means of copper strips having a cross-sectional area of at least 0.40 sq. cm. or by other means of equal conductivity and where the return is wholly insulated and contained within the conduit, the latter shall be connected with earth at the generating station or sub-station through an instrument suitable for the indication of any contact or partial contact of either the line or the return with the conduit; and

(ii) the leakage-current shall be ascertained daily, before or after the hours of running, when the line is fully charged and if at any time it is found to exceed 0.6 ampere per km. of single tramway track, the

transmission and use of electricity shall be suspended unless the leakage is stopped within twenty four hours.

85. **Leakage on system other than conduit system.-** Where both the line and the return are not placed within a conduit, the leakage current shall be ascertained daily before or after the hours of running, when the line is fully charged and if at any time it is found to exceed 0.3 ampere per km. of single tramway track, the transmission and use of electricity shall be suspended unless the leakage is stopped within twenty four hours.

86. **Passengers not to have access to electric circuit.-** Precautions to the satisfaction of an Electrical Inspector shall be taken by the owner of every vehicle to prevent,-

(i) the access of passengers to any portion of the electric circuit where there is danger from electric shock;

(ii) any metal, hand-rail or other metallic substance liable to be handled by passengers, becoming charged.

87. **Isolation of sections.-** Every trolley wire shall be constructed in sections not exceeding 1.6 km. in length, and means shall be provided for isolating each section.

88. **Minimum size and strength of trolley wire.-** No trolley-wire shall be of less cross-sectional area than 0.5 sq. cm. or shall have an actual breaking load of less than 2000 kg.

89. **Height of trolley wire and length of span.-** A trolley wire or a traction feeder on the same supports as a trolley wire shall, at no place be, at a height from the surface of the street of less than 5.2 metres except, where it passes under a bridge or other fixed structure, or through or along a tunnel or mineshaft or the like in which case it shall be suspended to the satisfaction of an Electrical Inspector.

90. **Earthing of guard wires.-** Every guard wire shall be connected with earth at each point at which its electrical continuity is broken and shall also be connected with the rails at intervals of not more than five spans.

91. **Proximity to magnetic observatories and laboratories.-** Traction works shall not be carried out in the vicinity of geomagnetic observatories and laboratories without the concurrence of the Central Government or of any officer authorised by it in this behalf.

92. **Records.-** (1) The owner shall keep the following records, namely : -

(i) daily records showing –

(a) the maximum working current from the source of supply;

(b) the maximum working voltage at the source of supply;

(c) the difference of potential, as required under regulation 83; and

(d) the leakage current, if any, as required under regulation 84 and 85.

(ii) occasional records showing –

(a) every test made under sub-regulation (2) and (3) of regulation 82

(b) every stoppage of leakage, together with the time occupied; and

(c) particulars of any abnormal occurrence affecting the electrical working of the system.

(2) The records so kept under sub-regulation (1) shall be open to examination by Electrical Inspector.

Chapter IX

Safety requirements for mines and oil fields

93. Application of chapter.- The regulation in this chapter shall apply only where electricity is used in mines as defined in the Mines Act, 1952 (35 of 1952) and oil fields.

94. Responsibility for observance.- (1) It shall be the duty of every person in charge of and responsible to the mine including the owner, agent, manager and Engineer of mine and oil field to comply with and enforce the regulations in this chapter and it shall be the duty of all persons employed to conduct their work in accordance with these regulations.

(2) In every mine or oil-field while electricity is being used such number of designated supervisors and electricians shall be on duty as the owner may decide.

Explanation – For the purposes of this regulation, the word "Engineer" shall

(i) in the case of a coal mine, have the same meaning as assigned to it in the Coal Mines Regulations, 1957;

(ii) in the case of a metalliferous mine, have the same meaning as assigned to it in the Metalliferous Mines Regulations, 1961; and

(iii) in the case of an oil mine, mean the 'Installation Manager' under the Oil Mines Regulations, 1984.

95. Notices.- (1) On or before the first day of February in every year, in respect of every mine or oil-field, returns giving the size and type of apparatus, together with such particulars in regard to circumstances of its use which may be required by the Inspector, shall be sent to the inspector of mines by the persons specified in

regulation 94 in the form set out in Schedule-XI or Schedule-XII whichever is applicable.

(2) The persons specified in regulation 94, shall also give to the inspector of mines not less than seven days notice in writing of the intention to bring into use any new installation in a mine or oil-field giving details of apparatus installed and its location:

Provided that in case of any additions or alterations to an existing installation of voltage not exceeding 650 V, immediate notice in writing shall be sent to the inspector of mines before such additions or alterations are brought into use.

Provided further that this regulation shall not apply to telecommunication or signaling apparatus.

96. **Plans.-** (1) A correct plan, on the same scale as the plan kept at the mine in fulfillment of the requirements of the Mines Act, 1952 (35 of 1952), shall be available in the office at the mine showing the position of all fixed apparatus and conductors therein, other than lights, telecommunication or signaling apparatus, or cables for the same.

(2) A similar plan on the scale not less than 25 cm. to a km. (1:4000) shall be kept by the manager or owner of one or more wells in any oil-field.

(3) A similar plan on such scale as the Central Government may direct, showing the position of all electric supply lines, shall be kept in the office of any licensee or other person transmitting or distributing electricity in a mine or oil-field.

(4) The plans specified under this regulation shall be examined and corrected as often as necessary to keep them up-to-date and the dates of such examinations shall be entered thereon by the manager or owner of the mine or wells and such plans shall be available to the Inspector, or inspector of mines, at any time.

97. **Lighting, overhead lines, communication and fire precautions.-** (1) In a mine illuminated by electricity, one or more flame safety lamps, or other lights approved by the inspector of mines, shall be maintained in a state of continuous illumination in all places where failure of the electric light at any time shall be prejudicial to safety.

(2) Efficient means of communication shall be provided in every mine between the point where the switchgear under sub-regulation (1) regulation 105 is erected, the shaft bottom and other distributing centres in the mines.

(3) Fire extinguishing appliances of adequate capacity and of an approved type shall be installed and properly maintained in every place in a mine containing apparatus, other than cables, telecommunication and signaling apparatus.

(4) In case of mines, minimum clearance above ground of the lowest conductor of over head lines or over head cables where dumpers or trackless vehicles are being operated, shall not be less than twelve meters in height from the ground across the road where dumpers or trackless vehicles cross.

98. **Isolation and fixing of transformer and switchgear.**- (1) Transformers and switchgear shall be placed in a separate room, compartment or box where necessary to prevent danger of mechanical damage.

(2) Unless the apparatus is so constructed, protected and worked as to obviate the risk of fire, no inflammable material shall be used in the construction of any room, compartment or box containing apparatus, or in the construction of any of the fittings therein and each such room, compartment or box shall be substantially constructed and shall be kept dry and illuminated and efficient ventilation shall be provided for all apparatus installed therein.

(3) All apparatus that has to be worked or attended to and all handles intended to be operated shall be placed at a spacious working place which is accessible, clear of obstruction and free from danger, so far as circumstances permit.

99. **Method of earthing.**- Where earthing is necessary in a mine it shall be carried out by connection to an earthing system at the surface of the mine and in a manner approved by the inspector of mines.

100. **Protective equipment.**- (1) In the interest of safety, appropriate equipment shall be suitably placed in the mines for automatically disconnecting supply to any part of the system, where a fault, including an earth fault, occurs and fault current shall not be more than 750 milliampere in installations of voltage exceeding 250 V and upto1100 V for below ground mines and oil fields and 50 ampere in installations of voltage exceeding 1100 V and upto 11 kV in open cast mines and the magnitude of the earth fault current shall be limited to these specified values by employing suitably designed, restricted neutral system of power supply.

(2) The operation of the switchgear and the relays shall be recorded daily at the generating station, sub-station or switch station in a register kept for the purpose.

(3) The effectiveness of the switchgear and the protective system shall always be kept and maintained in working order, shall be checked once every three months and the result thereof shall be recorded in a separate register kept for the purpose.

101. **Earthing metal.**- (1) All metallic sheaths, coverings, handles, joint boxes, switchgear frames, instrument covers, switch and fuse covers of boxes, all lamp holders, unless efficiently protected by an insulated covering made of fire resisting material, and the frames and bedplates of generators, transformers and motors, including portable motors, shall be earthed by connection to an earthing system in the manner specified in regulation 99.

(2) Where cables are provided with a metallic covering constructed and installed in accordance with clause (d) of regulation 106, such metallic covering may be used as a means of connection to the earthing system.

(3) All conductors of an earthing system shall have conductivity, at all parts and all joints, at least equal to fifty per cent of that of the largest conductor used solely to supply the apparatus, a part of which desired to be earthed:

Provided that no conductor of an earthing system shall have a cross-sectional area less than 0.15 sq. cm. except in the case of the earth conductor of a flexible cable used with portable apparatus where the voltage does not exceed 125 Volts, and the cross-sectional area and conductance of the earthcore is not less than that of the largest of the live conductors in the cable.

(4) All joints in earth conductors and all joints in the metallic covering of cables shall be properly soldered or otherwise efficiently made.

(5) No switch, fuse or circuit-breaker shall be inserted in any earth conductor.

(6) This regulation shall not apply, except in the case of portable apparatus, to any system in a mine in which the voltage does not exceed 30 V.

102. Voltage limits.- Electricity shall not be transmitted into a mine at a voltage exceeding 11000 Volts and shall not be used therein at a voltage exceeding 6600 Volts:

Provided that-

(i) where hand-held portable apparatus is used, the voltage shall not exceed 125 V;

(ii) where electric lighting is used,-

(a) in underground mines, the lighting system shall have a mid or neutral point connected with earth and the voltage shall not exceed 125 V between phases;

(b) on the surface of a mine or in an open cast mine, the voltage may be raised to 250 V, if the neutral or the mid point of the system is connected with earth and the voltage between the phases does not exceed 250 V;

(iii) where portable hand-lamps are used in underground working of mine, the voltage shall not exceed 30 V;

(iv) where any circuit is used for the remote control or electric inter-locking of apparatus, the circuit voltage shall not exceed 30 V:

Provided further that in fixed plants, the said voltage may be permitted upto 650 V, if the bolted type plug is used.

103. Transformers.- Where electricity is transformed, suitable provision shall be made to guard against danger by reason of the lower voltage apparatus becoming accidentally charged above its normal voltage by leakage from or contact with the higher voltage apparatus.

104. Switchgear and terminals.- Switchgear and all terminals, cable-ends, cable-joints and connections to apparatus shall be totally enclosed and shall be constructed, installed and maintained as to comply with the following requirements, namely:-

(i) all parts shall be of mechanical strength sufficient to resist rough usage;

(ii) all conductors and contact areas shall be of adequate current-carrying capacity and all joints in conductors shall be properly soldered or otherwise efficiently made;

(iii) the lodgement of any matter likely to diminish the insulation or affect the working of any switchgear shall be prevented;

(iv) all live parts shall be so protected or enclosed as to prevent persons accidentally coming into contact with them and to prevent danger from arcs, short-circuits, fire, water, gas or oil;

(v) where there may be risk of igniting gas, coal-dust, oil or other inflammable material, all parts shall be so protected as to prevent open sparking; and

(vi) every switch or circuit-breaker shall be so constructed as to be capable of opening the circuit it controls and dealing with any short-circuit without danger.

105. Disconnection of supply.- (1) Properly constructed switchgear for disconnecting the supply of electricity to a mine or oil-field shall be provided at a point approved by the inspector of mines.

(2) At any time, when any cable or overhead line supplying electricity to the mine from the aforesaid switchgear is live, a person designated to operate the said switchgears shall be available within easy reach thereof:

Provided that in the case of gassy coal seam of second degree and third degree gassiness, the main mechanical ventilator operated by electricity shall be interlocked with the switchgear so as to automatically disconnect the power supply in the event of stoppage of main mechanical ventilator.

(3) When necessary in the interest of safety, any apparatus suitably placed, shall be provided for disconnecting the supply from every part of a system.

(4) If the inspector of mines in the interest of safety considered it necessary, he may direct that the apparatus specified in sub-regulation (3) shall be so arranged as to disconnect automatically, from the supply, any section of the system subjected to a fault.

(5) Every motor shall be controlled by switchgear which shall be so arranged as to disconnect the supply from the motor and from all apparatus connected thereto and such switchgear shall be so placed as to be easily operated by the person designated to operate the motor.

(6) Whenever required by the inspector of mines the motor shall be controlled by a switchgear to disconnect automatically the supply in the event of conditions of over-current, over-voltage and single phasing.

(7) Auxiliary fan shall be interlocked with the switchgear controlling power supply to the in-bye face equipment of below ground coal mine for automatic disconnection of power supply in the event of the stoppage of the auxiliary fan.

106. Cables.- All cables, other than flexible cables for portable or transportable apparatus, shall fulfill the following requirements, namely:-

(i) all such cables, other than the outer conductor of a concentric cable, shall be covered with insulating material and shall be efficiently protected from mechanical damage and supported at sufficiently frequent intervals and in such a manner as to prevent damage to such cables;

(ii) (a) except as provided in clause (iii) no cables other than concentric cables or single core or two core or multi core cables protected by a metallic covering and which contain all the conductors of a circuit shall be used where the voltage exceeds 125 V or when an Inspector considers that there is risk of igniting gas or coal dust or other inflammable material, and so directs;

(b) the sheath of metal-sheathed cables and the metallic armouring of armoured cables shall be of a thickness not less than that recommended from time to time in the relevant standard of the Bureau of Indian Standards;

(iii) where a voltage exceeding 250 V but not exceeding 650 V direct current system is used, two single core cables may be used for any circuit provided that their metallic coverings are bonded together by earth conductors so placed that the distance between any two conseeutive bonds is not greater than thirty metres measured along either cable;

(iv) The metallic covering of every cable shall be -

(a) electrically and mechanically continuous throughout;

(b) earthed, if it is required by sub-regulation (3) of regulation 101 to be earthed by a connection to the earthing system of conductivity specified therein;

(c) efficiently protected against corrosion where necessary;

(d) of a conductivity at all parts and at all joints at least equal to fifty per cent of the conductivity of the largest conductor enclosed by the said metallic covering; and

(e) where there may be risk of igniting gas, coal-dust, or other inflammable material, so constructed as to prevent, as far as practicable, the occurrence of open sparking as the result of any fault or leakage from live conductors.

(v) cables and conductors where connected to motors, transformers, switchgear and other apparatus, shall be installed so that,-

(a) they are mechanically protected by securely attaching the metallic covering to the apparatus; and

(b) the insulating material at each cable end is efficiently sealed so as to prevent the diminution of its insulating properties;

(vi) where necessary to prevent abrasion or to secure gas-tightness, properly constructed glands or bushes shall be provided;

(vii) unarmored cables or conductors shall be conveyed either in metallic pipes or metal casings or suspended from efficient insulators by means of non-conducting materials which will not cut the covering and which will prevent contact with any timbering or metal work and if separate insulated conductors are used, they shall be installed at least 3.75 cm. apart and shall not be brought together except at lamps, switches and fittings.

107.Flexible cables.- (1) Flexible cables for portable or transportable apparatus shall be two core or multi core, unless required for electric welding, and shall be covered with insulating material which shall be efficiently protected from mechanical injury.

(2) If flexible metallic covering is used either as the outer conductor of a concentric cable or as a means of protection from mechanical injury, it shall not be used by itself to form an earth conductor for such apparatus, but it may be used for that purpose in conjunction with an earthing core.

(3) Every flexible cable intended for use with portable or transportable apparatus shall be connected to the system and to such apparatus by properly constructed connectors:

Provided that for machines of voltage exceeding 650 V but not exceeding 33 kV a bolted type connector shall be used and the trailing cable shall be suitably anchored at the machine end.

Provided further that where there are space limitations for multiple on-board motors and equipment for transportable or portable machines, direct entry flexible cable with elastomeric sealing rings, compression gland, packing gland or sealing box which does not alter the flame proof property may be permitted and if a cable entry can accept any sealing ring with same outside diameter but different internal dimension, the ring shall have a minimum uncompressed axial height of twenty millimeter for circular cables of diameter not greater than twenty millimeter and twenty five millimeter for circular cables of diameter greater than twenty millimeter.

(4) At every point where flexible cables are joined to main cables, a circuit breaker shall be provided which is capable of automatically disconnecting the supply from such flexible cables.

(5) Every flexible cable attached to a portable or transportable machine shall be examined periodically by the person designated to operate the machine, and if such cable is used underground, it shall be examined at least once in each shift by

such person and if such cable is found to be damaged or defective, it shall forthwith be replaced by a cable in good condition.

(6) If the voltage of the circuit exceeds 250 V, all flexible cables attached to any transportable apparatus shall be provided with flexible metallic screening or pliable armouring and cables of portable apparatus shall be provided with flexible metallic screening on all the power and pilot cores.

Provided that the provision of this regulation shall not apply to flexible cables attached to any transportable or portable apparatus used in open cast mines or below ground mines where reeling and unreeling of such cables is necessary as per design features of the equipment.

(7) All flexible metallic screening or armouring specified in sub-regulation (6) shall fulfill the requirement specified in clause (iv) of regulation 106 .

Provided that in the case of separately screened flexible cables the conductance of each such screen shall not be less than twenty five per cent of that of the power conductor and the combined conductance of all such screens shall in no case be less than that of 0.15 sq. cm. copper conductor.

(8) Flexible cable exceeding hundred metres in length shall not be used with any portable or transportable apparatus:

Provided that such flexible cable when used with coal cutting machines or cutter or loader or armoured face conveyor for long wall operation, or with shuttle cars or load haul dumper or cutter loader or all alike equipment for development and de-pillaring operation shall not exceed two hundred fifty metres in length:

Provided further that the aforesaid cable in case of an open cast mine when used with electrically operated heavy earth moving machinery shall not exceed three hundred metres in length and for bucked wheel excavator at 11 kV shall not exceed one thousand metres in length.

(9) Flexible cable, when installed in a mine, shall be efficiently supported and protected from mechanical injury.

(10) Flexible cables shall not be used with apparatus other than portable or transportable apparatus.

(11) Where flexible cables are used they shall be detached or otherwise isolated from the source of supply when not in use, and arrangements shall be made to prevent the energising of such cables by undesignated persons.

108. Portable and transportable machines.- The person designated to operate an electrically driven coal-cutter, or other portable or transportable machine, shall not leave the machine while it is in operation and shall, before leaving the area in which such machine is operating, ensure that the supply is disconnected from the flexible cable which supplies electricity to the machine and when any such machine is in operation, steps shall be taken to ensure that the flexible cable is not dragged along by the machine:

Provided that all portable and transportable machines used in underground mines shall operate on remote control from the concerned switchgear with pilot core protection.

109.Sundry precautions.- (1) All apparatus shall be maintained reasonably free from dust, dirt and moisture, and shall be kept clear of obstruction.

(2) All apparatus other than portable and transportable apparatus shall be housed in a room, compartment or box so constructed as to protect the contents from damage occasioned by falling material or passing traffic.

(3) Inflammable or explosive material shall not be stored in any room, compartment or box containing apparatus, or in the vicinity of any apparatus.

(4) In case of a fault in any circuit, the part affected shall be made dead without delay and shall remain so until the fault has been remedied.

(5) While lamps are being changed the supply shall be disconnected.

(6) No lampholder shall have metallic connection with the guard or other metal work of a portable hand lamp.

(7) The following notices in Hindi and local language of the district, so designed and protected as to be easily legible at all times, shall be exhibited at the following places, namely:-

(i) where electrical apparatus is in use, a notice forbidding undesignated persons to operate or otherwise interfere with such apparatus;

(ii) in the interior or at the surface of the mine where a telephone or other means of communication is provided, a notice giving full instructions to person, at the surface of the mine, designated to effect the disconnection of the supply of electricity to the mine.

(8) All apparatus, including portable and transportable apparatus, shall be operated only by those persons who are designated for the purpose.

(9) Where a plug-and-socket-coupling other than of bolted type is used with flexible cables, an electrical inter-lock or other approved device shall be provided to prevent the opening of the coupling while the conductors are live.

110.Precautions where gas exists. – (1) In any part of a coal-seam of the first degree gassiness –

(i) all cables shall be constructed, installed, protected, operated and maintained in such a manner as to prevent risk of open sparking;

(ii) all signaling, telecommunication, remote control and insulation tester circuits shall be so constructed, installed, protected, operated and maintained as to be intrinsically safe;

(iii) all apparatus including portable and transportable apparatus including lighting fittings used at any place which lies in-bye of the last ventilation connection shall be flame-proof:

Provided that electrically operated or battery operated portable or transportable apparatus such as shuttle car, men or material transporting equipment of increased safety type "e" shall be permitted at any place with suitable monitoring devices for detection of gases, if any;

(iv) all electric lamps at any place which lie in-bye of the last ventilation connection and return airways shall be in flame proof enclosure and at other places these shall be in increased safety enclosure type 'e'.

(2) At any place which lies in any part of a coal-seam of second and third degree gassiness –

(i) all signaling, telecommunication, remote control and insulation tester circuits shall be so constructed, installed, protected, operated and maintained as to be intrinsically safe;

(ii) all cables shall be constructed, installed, protected, operated and maintained in such a manner as to prevent risk of open sparking;

(iii) all apparatus, including portable and transportable apparatus used at any place within ninety metres of any working face or goaf in case of a second degree gassy mine and within two hundred seventy metres of any working face or goaf in case of third degree gassy mine or at any place which lies in-bye of the last ventilation connection or in any return airways shall be flame-proof;

(iv) all electric lamps shall be enclosed in flame-proof enclosures.

(3) In any oil mine or oil-field, at any place within the zone-2 hazardous areas-

(i) all signaling and telecommunication, remote control and insulation tester circuits shall be so constructed, installed, operated, protected and maintained as to be intrinsically safe;

(ii) all cables shall be so constructed, installed, operated and maintained as to prevent risk of open sparking;

(iii) all apparatus including portable and transportable apparatus shall have the following types of enclosures conforming to the relevant Indian Standards, namely:-

(a) flame-proof enclosure type 'd' or
(b) pressurized enclosure type 'p' or
(c) sand filled apparatus type 'q' or
(d) increased safety enclosure type 'e', 'n' and 'o'

(iv) all electric lamps shall be enclosed in increased safety enclosure type 'e'.

(4) In any oil mine or oil-field, at any place within the zone-1 hazardous areas-

(i) all signaling and telecommunication, remote control and insulation tester circuits shall be so constructed, installed, operated, protected and maintained as to be intrinsically safe;

(ii) all cables shall be so constructed, installed, operated and maintained as to prevent risk of open sparking;

(iii) all apparatus including portable and transportable apparatus shall have the following types of enclosures conforming to the relevant Indian Standards, namely:-

(a) flame-proof enclosure type 'd' or
(b) pressurized enclosure type 'p' or
(c) sand filled apparatus type 'q'

(iv) all electric lamps shall be enclosed in flame-proof enclosures.

(5) In any oil mine at any place within zone-0 hazardous area no electrical equipment shall be used and where it is not practicable, intrinsically safe apparatus are only to be used with the prior approval of the Inspector.

(6) In any coal-seam of degree second and degree third gassiness or the hazardous area of oil-mine the supply shall be discontinued;

(i) immediately, if open sparking occurs;

(ii) during the period required for examination or adjustment of the apparatus, which shall necessitate the exposing of any part liable to open sparking;

(iii) the supply shall not be reconnected until the apparatus has been examined by the electrical supervisor or one of his duly appointed assistants and until the defect, if any, has been remedied or the necessary adjustment made; and

(iv) a flame safety lamp shall be provided and maintained in a state of continuous illumination near an apparatus, including portable or transportable apparatus, which remains energised and where the appearance of the flame of such safety lamps indicates the presence of inflammable gas, the supply to all apparatus in the vicinity shall be immediately disconnected and the incident reported forthwith to an official of the mine and such apparatus shall be interlocked with the controlling switch in such a manner as to disconnect power supply automatically in the event of percentage of inflammable gas exceeding one and one quarter in that particular district:

Provided that where apparatus for automatic detection of the percentage of inflammable gas or vapor are employed in addition to the flame safety lamps, such apparatus shall be approved by the inspector of mines and maintained in perfect order.

(7) In any part of a coal-seam of any degree of gassiness or in any hazardous area of an oil-mine, if the presence of inflammable gas in the general body of air is found at any time to exceed one and one quarter per cent, the supply of energy shall be immediately disconnected from all cables and apparatus in the area and the supply shall not be reconnected so long as the percentage of inflammable gas remains in excess of one and one quarter per cent.

(8) In an oil mine where concentration of inflammable gas exceeds twenty percent of its lowest explosive limit, the supply of electricity shall be cut-off immediately from all cables and apparatus lying within thirty metres of the installation and all sources of ignition shall also be removed from the said area and normal work shall not be resumed unless the area is made gas-free:

Provided that such disconnection shall not apply to intrinsically safe environmental monitoring scientific instruments.

(9) Any such disconnection or reconnection of the supply shall be noted in the log sheet which shall be maintained in the form set out in Schedule-XIII and shall be reported to the inspector of mines.

(10) The provisions of this regulation shall apply to any metalliferrous mine which may be notified by the inspector of mines if inflammable gas occurs or if the inspector of mines is of the opinion that inflammable gas is likely to occur in such mine.

Explanation – For the purpose of this regulation;
(1) the expression 'coal-seam of first degree gassiness', 'coal-seam of second degree gassiness', 'coal-seam of third degree gassiness' and 'flame-proof apparatus' shall have the meanings respectively assigned to them in the Coal Mines Regulations, 1957.

(2) The following areas in an oil-mine or oil-field shall be known as hazardous areas, namely:-

(i) an area of not less than ninety metres around an oil-well where a blow-out has occurred or is likely to occur, as may be designated by the Engineer-incharge or the seniormost official present at the site;

(ii) an area within ninety metres of an oil-well which is being tested by open flow;

(iii) an area within fifteen metres of :

(a) a producing well-head or any point of open discharge of the crude there from or other point where emission of hazardous atmosphere is normally likely to arise; or

(b) any wildcat or exploration well-head being drilled in an area where abnormal pressure conditions are known to exist; or

(c) any exploration or interspaced well-head being drilled in the area where abnormal pressure conditions are known to exist;

(iv) any area within four and one half meters of :

(a) any producing well-head where a closed system of production is employed such as to prevent the emission or accumulation in the area in normal circumstances of a hazardous atmosphere; or

(b) exploration or interspaced well-head being drilled in an area where the pressure conditions are normal and where the system of drilling employed includes adequate measures for the prevention in normal circumstances of emission or accumulation within the area of a hazardous atmosphere; or

(c) an oil-well which is being tested other than by open flow.

(3) "hazardous atmosphere" means an atmosphere containing any inflammable gases or vapours in a concentration capable of ignition.

(4) "Zone 0 hazardous area" means "an area in which hazardous atmosphere is continuously present."

(5) "Zone 1 hazardous area" means "an area in which hazardous atmosphere is likely to occur under normal operating conditions".

(6) "Zone 2 hazardous area" means "an area in which hazardous atmosphere is likely to occur under abnormal operating conditions".

111.Shot-firing. – (1) When shot-firing is in progress adequate precautions shall be taken to protect apparatus and conductors, other than those used for shot-firing, from injury.

(2) Current from lighting or power circuits shall not be used for firing shots.

(3) The provisions of regulation 107 shall apply in regard to the covering and protection of shot-firing cables, and adequate precautions shall be taken to prevent such cable touching other cables and apparatus.

112.Signaling. - Where electrical signaling is used,-

(i) adequate precautions shall be taken to prevent signal and telephone wires coming into contact with other cables and apparatus;

(ii) the voltage used in any one circuit shall not exceed 30 V;

(iii) contact-makers shall be so constructed as to prevent the accidental closing of the circuit; and

(iv) bare conductors, where used shall be installed in suitable insulators.

113.Haulage. - Haulage by electric locomotives on the overhead trolley-wire system, at voltage not exceeding 650 V and haulage by storage battery locomotives may

be used with the prior consent in writing of the Electrical Inspector, and subject to such conditions as he may impose in the interests of safety.

114. **Earthing of neutral points.** - Where the voltage of an alternating current system exceeds 30 Volts, the neutral or mid-point shall be earthed by connection to an earthing system in the manner specified in regulation 99.

Provided that when the system concerned is required for blasting and signaling purposes, the provisions of this regulation shall not apply.

Provided further that in case of unearthed neutral system adequate protection shall be provided with the approval of the Inspector

115. **Supervision.** - (1)(i) One or more electrical supervisors as directed by the Inspector shall be appointed in writing by the owner, agent or manager of a mine or by the agent or the owner, of one or more wells in an oil field to supervise the installation.

(ii) The electrical supervisor so appointed shall be the person holding a valid Electrical Supervisor's Certificate of Competency, covering mining installation issued under sub-regulation (1) of regulation 29.

(iii) One or more electricians as directed by the Inspector shall be appointed in writing by the owner, agent or manager of a mine or by the agent or the owner, of one or more wells in an oil field for compliance with the duties specified in this regulation.

(iv) The Electrician shall be a person holding license under sub-regulation (1) of regulation 29.

(v) For small open cast mines and below ground mines receiving supply at voltage not more than 650 V and not having portable or transportable apparatus, electrical supervisor and electrician shall be appointed for more than one mine by the Inspector.

(2) Every person appointed to operate, supervise, examine or adjust any apparatus shall be competent to undertake the work which he is required to carry out as directed by the Engineer.

(3) The electrical supervisor shall be responsible for the proper performance of the following duties, by himself or by an electrician appointed under sub-regulation (1).

(i) thorough examination of all apparatus, including the testing of earth conductors and metallic coverings for continuity, as often as may be necessary to prevent danger;

(ii) examination and testing of all new apparatus, and of all apparatus, re-erected in the mine before it is put into service in a new position.

(4) In the absence of any electrical supervisor, the owner, agent or manager of the mine and oil field shall appoint in writing a substitute electrical supervisor.

(5) (i) The electrical supervisor or the substitute electrical supervisor appointed under sub-regulation (4) to replace him shall be personally responsible for the maintenance at the mine or oil-field, of a log-book made up of the daily log sheets prepared in the form set out in Schedule- XIII.

(ii) The results of all tests carried out in accordance with the provisions of sub-regulation (3) shall be recorded in the log-sheets prepared in the form set out in Schedule- XIII.

Chapter X

Miscellaneous

116.Deviations.- (1) The Central Government or the State Government, as the case may be, by order in writing, allow deviations in respect of matters referred in these regulations except regulation 30.

(2)The Electrical Inspector or the inspector of mines may, by order in writing, allow deviations in respect of matters referred in regulations 12 to 17, 28, 35(2)(3) and (5), 36(3), 37(i) to (iv), 41(xii), 43, 44(2), 46, 52 to 54, 57 to 61, 65, 72, 74, 78 to 91, 102, 107(6), (8) and (10) and 114

Explanation- Every order allowing the deviations by the Electrical Inspector or the Inspector of Mines under sub-regulation (2) shall be placed before the Central or State Government which may disallow or revise such deviations.

AMARJEET SINGH, Secy.

[ADVT III/4/187G/2010/Exty.]

Schedule-I

Safety measures for operation and maintenance of electrical plants

[See sub-regulation (3) of regulation (6)]

Part I

(1) Duration and content of training shall be as specified below:-

(a) Thermal Power Stations.- (i) The minimum duration of the training courses for the operating engineers and supervisors (mechanical, electrical and instrumentation) shall be as specified in Table I for coal based, diesel engine based and gas turbine based thermal power plants. The contents of training courses and on job training, along with respective duration, shall be as specified in Part II, III, IV, V, VI, VII, VIII and IX of this Schedule, appropriate to the specialized course in mechanical or electrical or instrumentation Engineering. Trainees should spend time on observing different functions of Thermal Power Plant along with its operation. After the lecture course is completed the trainees should be taken on visits to a few modern power stations and factories manufacturing turbines, generators, switch gear, instrumentation and auxiliary equipment. The remaining period will be spent on in-plant training where the candidates will be given an opportunity to operate or maintain the machinery by themselves under close supervision of the regular operating staff as well as the training supervisors. Arrangements shall be made for familiarizing the trainees with the operation of power stations through simulator facilities.

TABLE I

Course Duration for Engineers and Supervisors – Thermal Power Plants

S. No.	Training Course	Coal Based Plant	Diesel Engine Based Plant	Gas Turbine Based Plant
1.	Common Mechanical, Electrical and Instrumentation Course	5 Weeks	4 Weeks	4 ½ Weeks
2.	Common On Job and Simulator Training for Mechanical, Electrical and Instrumentation	12 Weeks	4 Weeks	8 Weeks
3.	Specialized Course for Engineers and Supervisors			
	(a) Mechanical	6 Weeks	2 Weeks	2½ Weeks
	(b) Electrical	4 Weeks	4 Weeks	4 Weeks
	(c) Instrumentation	2 Weeks	2 Weeks	2 Weeks
4.	Specialized On Job Training for			
	(a) Mechanical	4 Weeks	Nil	4 Weeks
	(b) Electrical	4 Weeks	Nil	4 Weeks
	(c) Instrumentation	4 Weeks	Nil	4 Weeks
5.	Plant visits and evaluation	3 Weeks	3 Weeks	3 Weeks

(ii) The minimum duration of the training courses for the Technicians (mechanical, electrical and instrumentation trades) to assist the operating engineers and supervisors shall be as specified in Table II for coal based, diesel engine based and gas turbine based thermal power plants. The contents of training courses and on job training, along with respective duration, shall be as specified in Part X, XI, XII, XIII, XIV, XV and XVI of this Schedule, appropriate to the specialized trade of mechanical or electrical or instrumentation Engineering. The lectures may be arranged and trainees may spend time on observation in the power stations so that they get familiarized with different sections of the power station. After the lecture course is completed the trainees shall be taken on visits to study a few modern power stations and factories manufacturing turbines, generators, switch gear, instrumentation and auxiliary equipment. The remaining period will be spent on in-plant training under close supervision.

TABLE II

Course Duration for Technicians– Thermal Power Plants

Sl. No	Training Course	Coal Based Plant	Diesel Engine Based Plant	Gas Turbine Based Plant
1.	Common Mechanical, Electrical and Instrumentation Course for Technicians.	4 Weeks	5 Weeks	4 Weeks
2.	Specialised Course for Technicians			
	(a) Mechanical	2 ½ Weeks	2 Weeks	2 ½ Weeks
	(b) Electrical	2 ½ Weeks	2 ½ Weeks	2 ½ Weeks
	(c) Instrumentation	2 ½ Weeks	2 ½ Weeks	2 ½ Weeks
3.	Specialised On Job Training for Technicians			
	(a) Mechanical	16 Weeks	8 Weeks	16 Weeks
	(b) Electrical	16 Weeks	8 Weeks	16 Weeks
	(c) Instrumentation	16 Weeks	8 Weeks	16 Weeks
4.	Plant visits and evaluation	2 Weeks	2 Weeks	2 Weeks

(b) Hydro Electric Power Stations.- (i) The minimum duration of the training courses for the operating engineers and supervisors (Mechanical, Electrical and Instrumentation) shall be as specified in Table III for hydro electric power stations. The contents of training courses and on job training, along with respective duration, shall be as specified in Part XVII, XVIII, XIX and XX of this Schedule, appropriate to the specialized course in mechanical or electrical or instrumentation Engineering. The procedure for familiarization visits and in-plant training shall be similar to that which has been specified in respect of thermal power stations. Arrangement may be made for familiarizing the trainees with operation of Hydro Power Stations through Simulator facilities.

TABLE III

Course duration for Engineers and Supervisors – hydro power plants

S. No	Training Course	Duration
1.	Common Mechanical, Electrical and Instrumentation Course for Engineers and Supervisors.	6 Weeks
2.	Common On Job and Simulator Training for Mechanical, Electrical and Instrumentation Engineers and Supervisors.	7 Weeks
3.	Specialised Course for Engineers and Supervisors	
	(a) Mechanical	2 ½ Weeks
	(b) Electrical	4 Weeks
	(c) Instrumentation	2 Weeks

4.	Specialised On Job Training for Engineers and Supervisors		
	(a)	Mechanical	3 Weeks
	(b)	Electrical	4 Weeks
	(c)	Instrumentation	4 Weeks
5.	Plant visits and evaluation		2 Weeks

(ii) The minimum duration of the training courses for the technicians (mechanical, electrical and instrumentation) to assist the operating engineers and supervisors shall be as specified in Table IV for hydro power stations. The contents of training courses and on job training, along with respective duration, shall be as specified in Part XXI, XXII, XXIII and XXIV of this Schedule, appropriate to the specialized trade in mechanical or electrical or instrumentation Engineering. The procedure for familiarization visits and in-plant training shall be similar to that which has been specified in respect of thermal power stations.

TABLE IV

Course Duration for Technicians – Hydro Power Plants

S.No	Training Course	Duration
1.	Common Mechanical, Electrical and Instrumentation Course for Technicians	3 Weeks
2.	Common On Job Training for Mechanical, Electrical and Instrumentation for Technicians	4 Weeks
3.	Specialised Course for Technicians	
	(a) Mechanical	1 ½ Weeks
	(b) Electrical	2 Weeks
	(c) Instrumentation	1 ½ Weeks
4.	Specialised On Job Training for Technicians	
	(a) Mechanical	4 Weeks
	(b) Electrical	4 Weeks
	(c) Instrumentation	4 Weeks
5.	Plant visits and evaluation	2 Weeks

(d) **Sub-stations and switchyards of generating stations.-** Those who are expected to be engaged in the operation and maintenance of substation associated with the generating station, shall be given a training of duration of not less than 2½ months for engineers and supervisors (mechanical, electrical and instrumentation) and 1½ months for technicians (mechanical, electrical and instrumentation trades). The minimum duration of the training courses for the operating engineers and supervisors shall be as specified in Table V for substations associated with generating stations. The minimum duration of the training courses for the technicians shall be as specified in Table VI. The contents of the training course and on job training, along with respective duration shall be as specified in Part XXV for engineers and supervisors and as specified in Part XXVI of this Schedule for technicians to the extent of practical job requirement in sub-station associated with the generating station. This shall be followed by visits and in plant training. Arrangement for Simulator training may also be made.

TABLE V

Course duration for Engineers and Supervisors – sub-stations associated with generating stations

S.No.	Training Course	Duration
1.	Common Mechanical, Electrical and Instrumentation Course for Engineers and Supervisors.	6 Weeks
2.	Common On Job and Simulator Training for Mechanical, Electrical and Instrumentation Engineers and Supervisors.	4 Weeks
3.	Plant visits and evaluation	2 Weeks

TABLE VI

Course Duration for Technicians – Substations Associated with Generating Stations

S.No.	Training Course	Duration
1.	Common Mechanical, Electrical and Instrumentation Course for Technicians.	2½ Weeks
2.	Common On Job Training, Industrial visits and evaluation	3 Weeks

(2) Facilities for creation of training institutes.- (a) The Training Institute shall have a regular building, residential and recreation facilities.

(b) The Training Institute shall have a full time Principal and adequate number of teaching staff.

(c) The Training Institute shall have adequate number of classrooms, seminar and conference hall and auditorium, library, computer centre, workshops (mechanical, electrical and basic workshops), laboratories (control and instrumentation, water chemistry and relevant testing and research facilities). The Training Institute shall have facilities for demonstration by static and working models, simulators, training resource unit supported with Appropriate reprographic facilities, Audio-visual training aides, Computer Based Training (CBT) packages, Liquid Crystal Diode (LCD), Slide and Overhead projectors.

(d) The Training Institute shall have a regular tie-up with the Power Stations, Sub-stations, Load Dispatch Centres, transmission and distribution utilities including hot line training centres so as to provide training in the respective fields.

(e) The Institute shall have facilities to arrange refresher courses for those personnel who have already experience in the operation and maintenance of a generating station. The staff of the Training Institute shall be properly qualified and preferably undergone a specialized training course in the art of imparting training.

(f) The Institute shall have networking of training facilities with the reputed educational or professional institutes.

(g) Assessment forms for Engineers and Supervisors and for Technicians to assist the engineers and supervisors are given at Part XXVII of this Schedule.

Part II

SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE COAL BASED THERMAL POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation/Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring	3
II	Concept of modern thermal station : Power generation from coal, Central Station and utility systems, base load and peaking stations, concept of unit system, typical thermal cycles, parameters, heat rates, fuel rates, steam rates, typical heat balance of boiler, turbine and generator.	3
III	Choice of location of large thermal station : Site availability, water requirements, fuel, load centres, transport facilities, air pollution, topography, choice of size of generating units.	3
IV	Plant layout in large central station including machine arrangements, equipments layout, switchyard and auxiliary arrangements.	2
V	Constructional details and basic principles of large pulverized fuel boiler and auxiliaries (i) Water and steam drums, heaters and tubes. (ii) Types of furnace and firing arrangement and firing system– Primary, secondary air arrangement, burner arrangement and furnace safeguard supervisory system, burner details. (iii) Economizers, primary, secondary, super heaters, pre heaters and temperatures. (iv) Forced draught, Induced draught, Primary Air exhauster, scanner and igniter air fans, and gas re-circulation fans, compressors, seal air fan. (v) Types of coal mills, (ball/races, ball tube, bowl roller) stoker, coal feeders, Gravimetric feeders (Raw coal feeders)	15

	(vi) Air preheaters, rotary, tubular and steam air heater (vii) Dust extraction plant- electrostatic, mechanical and bottom ash system (viii) Soot blowers (ix) Station instrument and service compressed air reciprocating and rotary compressors. (x) Feed regulating station (xi) Boiler mountings, drum level indicators , safety valves, stop valves, start-up devices, sampling, chemical dosing, continuous blow down, air vents and drain system, critical piping supports and hangers (xii) Refractories and laggings as used in modern power stations. (xiii) Ash disposal system – Dry bottom, wet bottom-scrapper feeders and clinker grinders.	
VI	Construction and working principles of Turbine and auxiliaries, (i) Principle of operation, heat conversion cycles, types of turbines. (ii) Casing steam chests, wheel blading, nozzles, diaphragms, control valves, glands, flanges and HT bolt heating, bearings, governing system. (iii) Condenser, vacuum pump, steam ejectors, circulating water pumps (iv) Lubrication system pumps, centrifuging machines, coolers, filters, shaft turbine and lifting gear, Main oil pump, Jacking oil pump, Starting oil pump, AC-DC oil pump, Emergency oil pump. (v) Boiler feed pump, fill pump and auxiliary cooling water system, auxiliary steam system. (vi) Low pressure and high pressure feed water heaters, de-aerators and evaporators, gland steam coolers, drip, air venting and drain system (vii) High pressure and low-pressure by-pass systems. (viii) Automatic turbine run-up system	3
VII	Various types of valves, traps, their constructional details and application. Cranes, hoists- characteristics and controls	3
VIII	Construction and working principles of alternators and excitation systems : (i) Alternators, cooling arrangements (Hydrogen/air cooling), stator water cooling, Hydrogen sealing system (ii) Main and pilot exciters, voltage regulators, types and characteristic, amplifier and magnetic amplifier, static excitation system, Automatic Voltage Regulation (AVR). (iii) Method of grounding.	2
IX	Construction and working principles of fuel handling plant equipments :	10

(i) Coal Handling Plant :- Wagon Tippler, hoppers, vibratory feeders , screen and conveyor system crushers, magnetic separators and pulleys, dust suppressors, dust extractors, stacker re-claimer, rotary breakers, Merry-Go-Round system,
(ii) Fuel oil handling plant – Oil storage tanks, unloading station oil pumps and heating arrangement
(iii) Coal transportation by ship- Coal transportation by different types of ships such as gearless ship, geared ship, self unloading ships, ship loading and unloading equipment such as grab type and continuous ship loaders / un-loaders.
(iv) Coal washing and blending

X Construction and working principles of Ash and slag handling equipments: 1
Electrostatic precipitators, methods of conveying, pneumatic, vacuumatic, hydraulic, bucket elevators, conveyors, screw extractors, ash slurry pumps, High pressure and low pressure pumps, dry ash collection. Power Environment Interface, Environmental Management System

XI Water Sources and treatment : 3
(i) Raw water pumping station, domestic, circulating and boiler makeup water treatment, River salinity, local water conditions, water recovery system, their variations in different seasons and effects on power station operations.
(ii) Hydrogen generating plant

XII Fuels : 3
(i) Solid, liquid and gaseous fuels analysis.
(ii) Coal-types and suitability for different kinds of boilers-alterations in firing methods due to change of coal composition.

XIII General understanding of Basic flow diagrams in power stations practice : 3
(i) Coal cycle.
(ii) Fuel oil cycle.
(iii) Air and gas cycle.
(iv) Fly ash and bottom ash/ slag handling arrangements.
(v) Condensate and feed heating cycle (from condenser hot well up to economizer).
(vi) Water and steam cycle (from economizer to turbine inlet).
(vii) Chemical dosing circuit
(viii) Circulating water cycle.
(ix) Governing oil, turbine oil, generator, Seal oil circuit.
(x) Hydrogen filling in generator and hydrogen gland sealing of generator. Bearing cooling system.
(xi) Stator water cooling cycle

XIV	Direct and closed cooling water circuits, cooling towers - types and characteristics.	3
XV	D.C. and A.C. power supply for auxiliaries, arrangements of unit and station boards, station lighting and automatic changeover.	3
XVI	Transformers: Main transformers, interconnecting transformers, station/unit transformers, voltage grounding transformers, type of connections, paralleling, tap changing gear.	4
XVII	Outdoor switchyard single line diagrams bus bars, circuit breakers, isolators, current transformers, potential transformers, lightning arresters, grounding.	4
XVIII	Indoor and outdoor switchgear: Types - bulk oil, minimum oil, air blast, vacuum air breaker, gas breaker constructional and functional details.	4
XIX	Working principle basics of Instrumentation and measurements: Details of measuring instruments for pressure, flow, temperature, level, draught, vibration, eccentricity, conductivity, pH value, differential expansion, oxygen analyser, voltage, current, active power, reactive power, frequency, energy, winding temperature. Auto-controllers, hydrogen purity meter, axial shift indicator and recorder, flue gas analysers, megger - its use for primary detection of faults, data acquisition system, digital distributed control, UPS, Unit co-ordinated master control. Pre-commissioning/ commissioning activities-Boiler Hydraulic test, alkali boil out, acid cleaning, TG: Alkali flushing of regenerative system, acid cleaning of oil pipe lines. TG on barring gear. Others: Steam blower, rotor valve blasting, steam roller synchronizing	12
XX	Operation, control and supervision (i) General boiler start-up procedure. (ii) Operation of boilers under different loading conditions, soot blowing. (iii) Analysis of feed and boiler water, fuel, flue gas at station laboratory, Power plant chemistry-chemical operating regime and control, steam purity (iv) Banking and preservation of oilers. (v) Demonstration wherever possible through simulators of various operating conditions. (vi) Handling of boiler under failure conditions, (such as tripping of turbo-alternator set, high/ low drum levels, flame failure, failure of supply to auxiliaries) and under emergency conditions such as grid	12

	failures, tube failures, fire out and furnace explosion (vii) General start up procedure for high-pressure multi-cylinder reheat type turbines from cold, warm and hot conditions. (viii) Handling of turbine, generator and auxiliary plant under failure conditions, such as vacuum failure, low feed water, condenser levels, excitation failure, circulating water failure, feed water heater high levels, excessive vibration, water or oil ingress in generator, failure of lubricating, sealing oil circuits and emergency conditions such as grid failure, black starting. (ix) Alternator-synchronising, loading, parallel operations, MW and MVAR sharing. (x) Operation of vents and drains in boiler and turbine	
XXI	Controls and Protection - Sequential operation and interlocks: (i) Unit protection and interlocks. (ii) Boiler and auxiliaries. (iii) Turbine and auxiliaries. (iv) Combustion control-pressure, fuel, air and feed heating cycle. (v) Feed water and fuel heating cycle controls. (vi) Turbine governing, speed setting, speed droop setting and control circuits. (vii) Generator protection - under-voltage, over-voltage, differential reverse power, under-excitation, negative phase sequence, earth fault with types of the relays used, Back up impedance, frequency relay, pole slipping and over current relays (viii) Importance of sequential interlocks. (ix) Transformer protection - differential, overload, earth faults, high temperature, buchholz with types of the relays used. (x) LT/HT motor electrical protection- Types of motors and variable speed drive and speed controls. (xi) Various types of pumps and their starting and control. (xii) Steam pressure and temperature control. (xiii) Furnace purging.	21
XXII	(i) Various types of valves, maps, their constructional details and application (ii) Fire-fighting and emulsifier type protection.	1
XXIII	General safety precautions, treatment of electrical or acid or alkali burn, permit to work, first aid, protective clothing, safety in movement and storage of materials, switchyard safety.	1 ½
XXIV	Indian Boiler Rules, Factory Act, Electricity Act, 2003, Central Electricity Authority (Measures relating to Safety	4

	and Electric Supply) Regulations, 2010 and other statutory Regulations concerning Power Stations (General outline), Environmental Pollution Act/Regulations.	
XXV	General plant maintenance procedure, PERT/CPM methods, Power station records, maintenance planning.	6
XXVI	Efficiency and environment, plant performance, generation cost, efficiency monitoring and optimization, stack emission monitoring and ambient air quality. Availability Based tariff, CERC notification on Tariff.	12
XXVII	Personnel management, duties and responsibilities, labour laws and labour welfare.	2
XXVIII	Broad Principles of material management and inventory control	2
	Total	145 ½ Hours ≅ **5 Weeks**
XXIX	On Job Training: (1) Control room desk operations : (i) Pre-start checks, (ii) Protection interlocks, (iii) Light up procedures and routine checks, (iv) Stopping and emergency operations of Boiler, Turbine, Generator and their auxiliaries (v) Electrical operation location and off-site plant location	**10 Weeks**
	2. Simulator training/Computer applications in operation and maintenance of the plant	**2 Weeks**

Part III

SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE DIESEL ENGINE BASED POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation/Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring	3
II	Concept of modern Diesel Power Station, Power Generation from Heavy Fuels, Central Station and Utility systems, base load and peaking stations, concept of unit systems, heat rates, heat balance of engines and general principles of Thermodynamics, enthalpy, entropy, etc.	3
III	Choice of location of large Diesel Station, Site availability, water requirement, fuel, load centers, transport facilities, air pollution, topography, choice of size of generating units.	2
IV	Plant layout in large Diesel Station including machine arrangements, equipment layout, and switch yard and auxiliary arrangements.	2
V	(i) IC Engines, classification, based on 2 Stroke, 4 Stroke, SI, CI, comparisons, difference between CI and SI, classification by cylinder arrangements, engine parts and materials used, indicated thermal efficiency%, mechanical efficiency %, specific fuel consumption, air fuel ratio, cal. value of fuel, etc. (ii) Air standard cycles, thermodynamic relations, parameters, Carnot cycle, Stirling cycle, Ericsson cycle, Lenoir cycle, Auto cycle, Dual cycle, Diesel cycle, Atkinson cycle, Brayton cycle, fuel air cycles, various losses, effect of variables such as compression ratio, fuel ratio, etc., difference between real cycle and fuel air cycle, etc. (iii) Petroleum fuels, introduction and structures, refining processes and products, Diesel fuels, octane number, cetane number, calorific value, viscosity, flash point, pour point, sulphur content, ash content, asphaltens, water and	18

sediment content, catalytic fines, problems caused by heavy fuels.

(iv) Combustion: - in IC engines, air fuel ratio – delay period and factors affecting it – Diesel knock , theory and methods of control, observations of burning of gases – cold starting of IC engines and aids.

(v) Super charging objects – cycles – methods – effects of supercharging on performance of the engine – superchargers – turbo charging and methods

(vi) Dual fuel and multifuel engines – combustion and factors affecting combustion – characteristics of multi fuel engines – suitability of various engines as multi fuel unit – performance of multiple engines.

(vii) Engine – friction and lubrication – lubrication principles – bearing lubrication – functions of lubricating system – properties of lube oil – additives – classification of lube oils, filters – crank case ventilation.

(viii) Engine cooling – areas of heat flow – heat transfer - piston and cylinder temperature – quantity of water required – cooling systems – air cooling, water cooling and comparison, re – cooling of water, radiators , cooling fans, thermostatic control, etc.

(ix) Constructional features of engine – crank case - crank shaft – main and connecting rod bearings – connecting rod – piston, crown and rings, cylinder liners, cylinder head – exhaust and inlet valves – fuel injection pump – injectors – cam shaft push rods – tappets – rocker arm etc.

(x) Performance and Testing of Engines – basic measurements – speed – specific lube oil consumption – air consumption – exhaust smoke – emissions – BHP – FHP and IHP measurements, de-rating of engines.etc.

(xi) Air pollution – pollutants – Diesel emissions – smoke and control – Diesel odour control – comparison of Diesel and other fuel emissions.

VI Construction and working principles of D.G. plant auxiliaries : 18

(i) Heavy fuel oil handling system: – railway siding, package boiler – transfer pumps – storage tanks, dip measurements, temperature and density corrections, shrinkage - heat tracing and controls – measurements of fuel parameters such as viscosity, density, flash point, sulphur content, ash, water content, acidity, calorific value, carbon residue, pour point, fire fighting arrangements in the HFO storage area.

(ii) HFO Purifiers: - function of HFO centrifuge – purification – clarification – principles of centrifugal pump – component parts of separator and separator plant – layout diagram of separator plant – sectional view of separator – operating cycle of separator plant – recommended separator temperatures – sludge removal , sludge transfer pump.

(iii) Common Heavy fuel oil System: - functions of settling tanks, service tanks – heavy fuel transfer pump – heat tracing of settling and service tanks and temperature control.

(iv) Diesel Handling system: - transportation modes – measurements – storage – fire fighting arrangements etc., common diesel oil systems – transfer pump etc.

(v) Common Lube Oil System: - transportation - measurements – storage measurement of lube oil characteristics such as flash point kinematic viscosity – viscosity index, TBN value, insolubles in Hexane and Toluene.

(vi) Cooling water Treatment :– Choice of water as refrigerant – classification of water – matter present in water – analysis of water for acids, bases and salts – pH value – disadvantages such as incrustation, sediments – galvanic corrosion – battery effect – influence of chlorides and sulphites – cavitation, protection methods – plant cooling water system and boiler water treatment methods and systems.

(vii) Engine cooling water system and injector cooling water system. Detailed analysis of single line P&I diagram.

(viii) Air Intake System: - oil bath filters – silencer – over speed butter fly and pressure relief valves - air temperature control methods. Detailed analysis of single line P&I diagram.

(ix) Exhaust Gas System: - general flow diagram – recovery boiler – exhaust gas regulating valves – silencer – expansion joint, etc.

(x) Compressed Air:- classification of compressors – operation of single and multistage compressors – maintenance problems – detailed analysis of P&I diagram of plant common air and unit control air compressor systems.

(xi) Governor: – governor components – basics of hydraulic and mechanical governor – speed droop, governor oil, and introduction to electronic governing – comparison with mechanical governor – over speed shut down.

(xii) Effluent Treatment Plant: - collection pit – decantation pit – sludge pit – buffer pit – decanter unit – deoiler unit – fuel recovery – coalescent filter.

(xiii) Fuel and lube oil system:-detailed analysis of P&I diagram of unit fuel oil system and lube oil system – viscosity regulators.

(xiv) Properties of Steam: – formation of steam, definitions connected with steam – steam tables – Mollier diagrams – classifications of boiler – waste heat recovery – detailed analysis of P&I diagrams of common and unit steam systems.

VII Various types of valves, traps, their constructional details and application, cranes hoist characteristics and controls. 4

VIII	Construction and working principles of alternator and excitation systems: (i) Alternator, Cooling Arrangements. (ii) Static Excitation System, Automatic voltage regulator. (iii) Method of Grounding.	4
IX	D.C and A.C power supply for auxiliaries, arrangement of unit and station switch cubicles, station lighting and automatic change over.	2
X	Transformers – Main transformers, interconnecting transformers, station/unit transformers, and neutral grounding transformers, parallel operation of transformers, on load and off load tap changing gears.	3
XI	Outdoor switch yard :- Single line diagrams, bus bars, circuit breakers, isolators, current and potential transformers, lightning arrestors, , importance of earth mat grounding..	3
XII	Indoor and Outdoor switch gear - Types - bulk oil, minimum oil, air blast, SF_6, and vacuum circuit breakers, construction and functional details	3
XIII	Working principles and basics of instrumentation and measurements : Details of measuring instruments for pressure, flow, temperature, level, vibration, eccentricity, conductivity, pH values, differential expansion, current, voltage, frequency, active and reactive power, energy, megger - its use, multimeter, data acquisition system, digital distributed control, UPS, programmable logic controller.	6
XIV	Operation, control and supervision : (i) General startup procedure, manual and automatic starting, change over to heavy fuel (ii) Operation of engine under different loading conditions. (iii) Engine safety :- Crank case pressure, mist concentration monitor, lube oil , ultra low pressure and high temperature, jacket water high temperature, over speed tripping, common electrical faults, turbo charger, lube oil outlet high temperature, fuel oil low pressure, jacket water low pressure, engine inlet air high temperature, etc. (iv) Starting and running – in, of the engine after overhaul – precautions. (v) Load reduction, normal stopping, and emergency stopping, rinsing operations. (vi) Operation and supervision of running DG sets, rinsing. (vii) Operating anomalies – causes and remedies. (viii) Precautions to be taken for restarting engine after long period of immobilization. (ix) Alternator , synchronizing, loading , parallel operation, MW and MVAR	9

XV	Controls and Protection :– Sequential operation and inter locks – detailed study of logical diagrams of PLC, transformer protection – differential, over load, earth fault, oil and winding high temperature, Buchholz relay, etc., LT and HT motor electrical protection, types of motors, variable speed drives and controls, generator protection – under and over voltage, differential, reverse power, under excitation, negative phase sequence, earth fault, etc., various types of pumps, their starting and controls, neutral shift relay, etc.	6
XVI	Fire Fighting and emulsifier type of protection.	1
XVII	General Safety precautions, treatment of electrical or acid or alkali burns, work permits, first aid, protective clothing, safety in movement and storage of materials, switch yard safety.	2
XVIII	Indian Boiler Rules, Factory Act, Electricity Act, 2003, Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 and other statutory Regulations concerning power stations, Environmental Pollution Act/ Regulations.	4
XIX	General Plant Maintenance procedure, PERT/CPM methods, power station records, maintenance planning.	3
XX	Efficiency and environment, plant performance, generation cost, efficiency monitoring and optimization, stack emission monitoring and ambient air quality, fuel and lube oil conservation and minimization of auxiliary losses. Availability based tariff, CERC notification on tariff.	9
XXI	Personnel management, duties and responsibilities, labour laws and labour welfare.	3
XXII	Broad Principles of material management and inventory control	2
	Total	110 Hours **≅ 4 Weeks**
XXIII	On Job Training: (1) Control Room Desk Operations: (i) Prestart Checks. (ii) Protection and starting inter locks. (iii) Routine checks such as leakages, pressure, temperatures, levels, operation of air, fuel, lube oil filters, checks for lube oil flow in the engine and turbocharger, oil seal pressure, checks for no water, no oil or fuel leaking from decompression cocks, checks for abnormal noise, mist concentration, crank case pressure, starting air pressure, cylinder temperature after running, bearing temperatures,	**2 Weeks**

starting firing sequence.

(iv) Stopping under emergency conditions of engine, generator and auxiliaries, rinsing operations

(v) On site Electrical operation location and off site plant locations.

(vi) Simulator Training/Computer applications in operation and maintenance of the plant.

2. To be associated with field maintenance Engineers in the area **2 Weeks**

(i) Fuel handling and purifier

(ii) Compressor and ETP

(iii) JW, LO Seal Pumps and drive, chemical dosing system

(iv) JW, IW level controllers viscosity Regulations

(v) Charge air Regulations, cyl. temp.monitor

(vi) Engine air modular protection including calibration of inputs and setting of thresholds

(vii) Starting air control equipment and firing sequence.

(viii) Steam system level controllers, calibration, press controllers, boiler circulating water pumps, condensate transfer pumps, etc.

(ix) NDT and Welding

Part IV

SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE COMBINED CYCLE GAS TURBINE BASED POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation/Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring	3
II	Concept of Gas Turbine: power generation from petroleum fuels such as naphtha , gas, modular NGL Central Station and utility systems, base load and peaking stations, concept of system, typical Open and Combined cycles, parameters, heat rates, fuel rates, steam rates, typical heat balance of gas turbine, waste heat recovery boiler and turbo generator.	3
III	Choice of location of large Gas Power Station: Site availability, water requirements, fuel supply centers, air pollution, topography.	3
IV	Plant layout in large central station including machine arrangements, equipment layout, switchyard and auxiliary arrangements.	2

V	Constructional details and basic principles of gas turbines. (i) Air filters (ii) Compressors (iii) Furnace chamber (iv) Gas turbine	12
VI	Gas Turbine Air Intake inlet air filtration, Exhaust system and Compressor System, Gas turbine auxiliaries and governing system, Air compressor and Air drawing system	6
VII	Construction and functional features of steam turbine and auxiliaries, governing system, oil system, control valves	6
VIII	Construction and working principles of Alternators and excitation systems: (i) Alternators, cooling arrangements (hydrogen/air cooling), stator water cooling, hydrogen sealing system. (ii) Characteristic amplifier and magnetic amplifier, static excitation system, Automatic Voltage Regulation (AVR). (iii) Method of grounding.	6
IX	Fuel handling, storage and supply, fuel characteristic	3
X	General understanding of Basic flow diagrams in power station practice : (i) Fuel cycle (ii) Air Cycle	6
XI	Direct and closed cooling water circuits, cooling towers, types and characteristics.	1
XII	D.C. and A.C. power supply for auxiliaries, arrangements of unit and station boards, station lighting and automatic changeover.	2
XIII	Transformers: Main transformers, interconnecting transformers, station/unit transformers, voltage grounding transformers, type of connections, paralleling, tap changing gear.	3
XIV	Outdoor switchyard, single line diagrams, busbars, circuit breakers, isolators, current transformers, potential transformers, lightning arresters, grounding.	3
XV	Indoor and outdoor switch gear: Types - bulk oil, minimum oil, air blast, SF_6, and vacuum circuit breakers, construction and functional details.	3
XVI	Working principle and basics of Instrumentation and measurements: Details of measuring instruments for pressure, flow, temperature, level, draught, vibration, eccentricity, conductivity, pH value, differential expansion, oxygen analyzer, current, voltage, active power, reactive power, frequency, energy, winding temperature. Auto-controllers, axial shift indicator and recorder, flue gas	8

	analyzers, Megger – its use for primary detection of faults, data acquisition system, digital distributed control, UPS, Unit co-ordinated master control.	
XVII	Precommissioning/ Commissioning Activities	4
XVIII	Operation, control and supervision (i) General gas turbine start-up procedure. (ii) Operation of gas turbine under different loading conditions. (iii) Analysis of water, fuel, at station laboratory. (iv) Demonstration wherever possible through simulators of various operating conditions. (v) Handling of gas/steam turbine under failure conditions (such as tripping of turbo-alternator set, failure of supply to auxiliaries) and under emergency conditions such as grid failures, tube failures, fire out, etc. (vi) General start up procedure for high-pressure turbines from cold warm and hot conditions. (vii) Handling of turbine, generator and auxiliary plant under failure conditions, and emergency conditions such as grid failure. (viii) Alternator-synchronizing, loading, parallel operations, MW and MVAR sharing. (ix) Water Treatment and water chemistry, R O System and mesied bed, Boiler meter internal treatment	22
XIX	Controls and Protection – Sequential operation and interlocks: (i) Unit protection and interlocks. (ii) Gas turbine and auxiliaries. (iii) Steam Turbine and auxiliaries. (iv) Combustion control-pressure, fuel, air cycle. (v) Turbine governing, speed setting, speed droop setting and control circuits. (vi) Generator protection, under-voltage, over-voltage, differential, reverse power, under-excitation, negative phase sequence, earth fault and types of relays used. (vii) Importance of sequential inters locks. (viii) Transformer protection - differential, overload,, earth faults, high temperature, Buchholz and types of relays used. (ix) LT/HT motor electrical protection (x) Types of motors and variable speed drive and speed controls. (xi) Various types of pumps and their starting and control. (xii) Steam pressure and temperature control including automatic detection and alarm system for naphtha fuel handling / storage. (xiii) Furnace purging.	18
XX	Fire-fighting equipment and permanent fire fighting appliances including automatic detection.	1

XXI	General safety precautions, treatment of electrical or acid/ alkali burn, permit to work, first aid, protective clothing, safety in movement and storage of materials, switchyard safety, safe handling of naphtha fuel in transport, storage and in gas turbines.	2
XXII	Indian Boiler Rules, Factory Act, Electricity Act, 2003, Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 and other statutory Regulations concerning Power Stations (General outline), Environmental Pollution Act/Regulations.	4
XXIII	General plant maintenance procedure, PERT/CPM methods, power station records, maintenance planning.	6
XXIV	Efficiency and environment, plant performance, generation cost, efficiency monitoring and optimization, stack emission monitoring and ambient air quality. Availability Based Tariff, CERC notification on Tariff, Gas Turbine Emission guidelines and control methods, Non emission target levels, Power output allowance, Heat recovery allowance, emission levels for other contaminants	9
XXV	Personnel management, duties and responsibilities, labour laws and labour welfare.	2
XXVI	Broad Principles of material management and inventory control	2
	Total	140 Hours ≅ **4½ Weeks**
XXVII	On Job Training: (1) Control room desk operations: (i) Pre- start checks, (ii) Protection interlocks , (iii) Light up procedures and routine checks , (iv) Stopping and emergency operation of Boiler , Turbine , (v) Generators and their auxiliaries (vi) On site Electrical operation location and off-site plant location	**7 Weeks**
	2. Simulator training/Computer application in operation and maintenance of the plant	**1 Week**

Part V

SPECIALISED SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED ON THE MECHANICAL SIDE OF THE COAL BASED THERMAL POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Boiler: Corrosion of boiler and auxiliaries, condenser and feed water heating plant, Scale formation in boiler in relation to water conditions.	4
II	Acid cleaning and preservation of boiler, mechanical removal of deposits, scaffolding methods, quick-erect scaffolding in furnace, ultra-sonic thickness survey. High pressure water jet equipment.	6
III	Annual boiler and auxiliaries overhaul- hydraulic test, floating of safety valves, preventive and breakdown maintenance of boiler auxiliaries, cutting of tubes and welding, ultrasonic testing and stress relieving.	12
IV	Efficient operation of boilers- interpretation of gas analysis for proper combustion controls and methods of reducing other losses.	8
V	Constructional details of hydraulic and other types of couplings, torque converters, servo motor.	3
VI	Constructional details of various types of pumps, their drives and automatic starting, air-conditioning. Constructional details of various types of draught fans, their drives and automatic starting. Types of wear on fans and pumps and their effects, detection of unbalance in fans and pumps, instruments for measuring vibrations, vibration analysis and dynamic balancing procedures, noise measurements and control.	9
VII	Coal handling plant : (i) Sequential Operation. (ii) Conveyor and conveyor drives. (iii) Tensioning arrangements. (iv) Maintenance of guide rollers / idlers. (v) Sway switches/slip switches. (vi) Beetle charger for wagon marshalling. (vii) Wagon tipplers and coal crushers, weighing of coal, different types of weighing bridges and meters, coal storage problems and prevention of spontaneous combustion. Sampling of coal/British Standards Specification/Indian Standards Specification, procedure and proximate analysis. (viii) Belt jointing methods–vulcanising, mechanical clamping, etc.	12

	(ix) Stacker re-claimer. (x) Vibrating feeders, vibrating screens. (xi) Magnetic separators. (xii) Coal crushers.	
VIII	(i) Working principle and construction of water treatment plant. (ii) Water treatment-hardness, pH value, clarifiers, treatment, phosphate and hydrazine dosing, base exchangers. (iii) DG sets and compressors	6
IX	Annual overhaul and inspection of turbine and auxiliary plant, condenser tube cleaning, maintenance of pumps, lubrication system, recycling of lubricating oil and selection of lubricant, condenser tube materials- wear and tear and effect of local water conditions, types of failure, detection, preventive maintenance and re-tubing of condensers, Maintenance of LP / HP heaters and de-aerators.	9
X	(i) Maintenance practice – Rigging and slinging, valve grinding methods, high pressure welding heat insulation methods, pipe work, alignments, bearing, scraping and matching practice, radiography and stress relieving methods. Anti-friction bearings and their installation and lubrication. Non destructive testing and principles, procedures and application. Welding techniques and equipment. (ii) Lubrication principles and their characteristic.	12
XI	Indian Boiler Regulations and other statutory Regulations.	2
XII	Workshop, types and use of hand tools and tackles, fabrication of spares, repairs and maintenance of mechanical equipments such as vehicles, tractors, dozers, shunters, cranes and hoists, welding – modern techniques and their applications in maintenance of boilers, turbine and associated plant	10
XIII	Composition, properties and behavior of Engineering materials used in power stations.	6
XIV	Residual life assessment and extension methods	6
XV	Mechanical safety rules and policies	4
XVI	Maintenance planning and spares inventory, productivity, cost control.	6
XVII	Simulator Training	60
	Total	175 Hours ≅6 **Weeks**
XVIII	On Job Training: To be associated with field maintenance Engineers in the area of : (i) Pressure parts maintenance (ii) Rotary equipment maintenance (iii) Pumps and drive maintenance (iv) NDT and welding (v) Turbine and auxiliaries maintenance	**4 weeks**

Part VI

SPECIALISED SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED ON THE MECHANICAL SIDE OF DIESEL ENGINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Constructional details of hydraulic and other types of couplings, torque converters - servo motor.	2
II.	Constructional details of various types of pumps, their drives and automatic starting, air conditioning. Constructional details of various types of ventilation fans, and automatic starting, types of wear on fans and pumps and their effects, detection of unbalance in fans and pumps. Instruments for measuring vibrations, vibration analysis and dynamic balancing procedures, noise measurements and control.	5
III.	Fuel handling plant: Detailed operation and maintenance of fuel stock yard, fuel purifiers, heat tracing, transfer pumps, settling and service tank, etc.,	2
IV.	(i) Water Treatment – quality of water, dozing of chemicals for cooling water and boiler water. Study and effects of water quality parameters. (ii) Compressors.	3
V.	Scheduled Overhaul and inspection of engine and auxiliaries of the Plant: (i) Scheduled engine maintenance works required at 1500 hours, 3000 hours, 6000 hours, 12000 hours and 24000 hours; maintenance procedures of lubricating oil pumps, jacket water pump, etc., recycling of lubricating oil and monitoring of lube oil parameters. (ii) Types of failures in the engine, break down maintenance, carrying out hydraulic tests on cylinder heads, exhaust valves etc., calibration of injectors and fuel oil pumps (iii) Maintenance of Turbocharger, dismantling, checking the bearings, Compressor wheel, turbine shaft and blades, cleaning, measurement of clearances on the compressor as well as on the turbine side, before and after dismantling. Turbo charger washing methods. (iv) Routine checking of oil pressure, water pressure, inlet and outlet temperature, operating condition monitoring, types of failures and detection, scheduled maintenance works	15

	such as bowl cleaning, replacement of clutch shoes, vertical and horizontal bearing, de-sludging operation, starting and stopping of separators.	
VI		9
	Maintenance practice, valve grinding, lapping, high pressure welding, heat insulation methods, pipe work and alignments. Motor and pump coupling alignments, bearing, scraping and matching practice, radiography and stress relieving methods, antifriction bearings and their installation and lubrication. Non destructive testing and principles, procedures and application. Welding techniques and equipments. Replacing of oil seals and bearings, reconditioning of inlet valves, exhaust valve, fuel pumps, etc., maintenance of boiler circulating and condensate transfer pumps, recovery, boiler backwash, etc.	
VII.		2
	Workshop, types and use of hand tools and tackles, fabrication of spares, repairs and maintenance of mechanical equipment such as fork lifts, cranes, hoists, welding – modern techniques and their applications.	
VIII.		5
	Composition, properties and behavior of Engineering materials used in power stations.	
IX		6
	Residual life assessment and extension methods.	
X		4
	Mechanical safety rules and policies.	
XI		8
	Maintenance planning and spares inventory, productivity, cost control.	
		61 Hours
	Total	≅ **2 Weeks**

Part VII

SPECIALIZED SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED ON THE MECHANICAL SIDE OF THE COMBINED CYCLE GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Waste heat recovery boiler: Corrosion of boiler and feed water heating plant, scale formation in boiler in relation to water conditions.	6
II	Acid cleaning and preservation of boiler, mechanical removal of deposits, auxiliary cooling water system, by pass stack and its features.	3
III	Constructional details of hydraulic and other types of couplings, torque converters, servo motor.	6
IV	Constructional details of various types of pumps, their drives and automatic starting, air-conditioning, various types of draught fans, their drives and automatic starting.	3
V	Types of wear on fans and pumps and their effects, detection of unbalance in fans and pumps, instruments for measuring vibrations, vibration analysis and dynamic balancing procedures, noise measurements and control.	5
VI	(i) Water treatment- hardness, pH value, clarifiers, treatment, phosphate and hydrazine dosing, base exchangers. (ii) DG sets and compressors.	6
VII	Power cycle, piping, fittings, valves and thermal insulation, Gas turbine overhaul procedures.	6
VIII	Annual overhaul and inspection of turbine and auxiliary plant, condenser tube cleaning, maintenance of pumps lubrication system, recycling of lubricating oil and selection of lubricant, condenser tube materials- wear and tear and effect of local water conditions, types of failure, detection, preventive maintenance and re-tubing of condensers.	12
IX	Maintenance practice – Rigging and slinging, valve grinding methods, high pressure welding, heat insulation methods, pipe work, alignments, bearing, scraping and matching practice, radiography and stress relieving methods. Anti-friction bearings and their installation and lubrication. Non destructive testing and principles, procedures and application. Welding techniques. Alignment methods.	10

X	Indian Boiler Regulations and other statutory Regulations.	2
XI	Workshop, types and use of hand tools and tackles, fabrication of spares, repairs and maintenance of mechanical equipments such as vehicles, tractors, dozers, shunters, cranes and hoists, welding – modern techniques and their applications in maintenance of boilers, turbines and associated plant.	6
XII	Composition, properties and behavior of Engineering materials used in power stations.	2
XIII	Residual life assessment and extension methods/Mechanical safety rules and policies	3
XIV	Maintenance planning and spares inventory, productivity, cost control.	6
	Total	76 Hours ≅ **2 ½ Weeks**
XV	On Job Training: To be associated with field maintenance Engineers in the area of : (i) Pressure parts maintenance (ii) Rotary equipment maintenance (iii) Pumps and drive maintenance (iv) NDT and welding (v) Turbine and auxiliaries maintenance. (vi) Steam and Gas turbine maintenance: Inspection of combustion chamber, replacement of liners, air filters, acid and alkaline cleaning of water coolers, NDT, governor bearing inspections, exhaust area inspection, replacement of guide vanes, cleaning of blade cooling passage, maintenance of bleed valves, compressor cleaning.	**4 weeks**

Part VIII

SPECIALISED SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED ON THE ELECTRICAL SIDE OF COAL, DIESEL ENGINE AND GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Maintenance and commissioning of generators, excitation system, generator seals, Generator protection- earth fault in rotor and stator, negative phase sequence, loss of excitation, differential protection, back up protection, reverse power protection, under-voltage protection, overload protection, constructional details of the relays used, method of setting and their testing, and over heating of rotors.	12
II	Motor maintenance	4
III	Transformer protection - Buchholz relay, over current, differential and earth fault protection, types of relays used, their construction, testing and settings.	3
IV	Transformer commissioning, di-electric strength of oil, insulation resistance, tap changers, filtration of oil, pre-commissioning testing. Tan-Delta resistivity of oil and preventive maintenance of transformers, dissolved gas analysis.	3
V	Circuit breakers, commissioning and maintenance, isolators, disconnectors, bus bar arrangements, charging, synchronising with the grid, disconnecting for repairs, maintenance of switchgear contactors.	4
VI	Maintenance of equipments in the outdoor switchyard, current transformers, potential transformers and lightning arrestors, operation and maintenance. Bus differential protection.	4
VII	Thermography monitoring	2
VIII	Line protection, fault analysis, bus-bar and local breaker back-up protection (LBB).	4
IX	Cables – control cables, layouts of equipments at voltage exceeding 650V, testing and maintenance.	4
X	Principle of electronic controls and transistorised circuits.	5
XI	Pneumatic and di-electric transmitters and receivers, servo-motors.	6

XII	Interlocking, sequential control circuits, details of components used.	7
XIII	Calibration and testing of various types of instruments – indicating instruments, measuring instruments, recorders, and analysers.	8
XIV	Statutory Electricity Acts and Rules and permit procedure	4
XV	Starting and control equipments of various types of motors, station battery-care and maintenance, trickle charging and extended charging, operation and maintenance of rectifiers and battery chargers, UPS, emergency power supply.	10
XVI	Economic load dispatch, power system control and operation, MVAR-control, voltage Regulation and frequency control, capacitors and reactors, islanding schemes, carrier current equipments, telephones, telemetering.	8
XVII	Station Emergency lighting arrangements.	1
XVIII	Simulator Training	30
	Total	119 Hours ≅ **4 Weeks**
XIX		**4 weeks**

On Job Training (Applicable only for Engineers and Supervisors engaged on Coal and Gas Turbine based plants):

To be associated with field electrical maintenance in the area of:

(i) HT/LT motors
(ii) Transformer maintenance
(iii) AC/DC supply systems, station batteries and DG sets
(iv) Generator/ excitation systems
(v) Switchyard / switchgear equipment maintenance

Part IX

SPECIALISED SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED ON THE INSTRUMENTATION SIDE OF COAL, DIESEL ENGINE AND GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Working principles, calibration, control methods and maintenance aspects of temperature measurement devices: (i) Resistance thermometers, thermocouples (ii) Recorders, indicators (iii) Transmitters.	4
II.	Working principles, calibration, control methods and maintenance aspects of pressure measurement devices: (i) Diaphragm gauges, Bourdon gauges (ii) Recorders, indicators (iii) Transmitters.	4
III	Working principles, calibration, control methods and maintenance aspects of flow measurement devices: (i) Positive, semi-positive, rate and differential pressure flow meters (ii) Recorders and indicators (iii) Transmitters.	4
IV.	Working principles, calibration, control methods and maintenance aspects of level measurement devices: (i) Dip-sticks, sight glass, pressure gauge bellows / diaphragm, float, buoyancy, gas purge, differential pressure and capacitance type level measurement system (ii) Recorders and indicators (iii) Transmitters.	4
V.	Telemetering and signal conditioning – pneumatic systems, electrical systems, electronic systems and maintenance aspects.	3
VI.	Basic electronics – Component familiarisation and various types of circuits, microprocessors	2
VII.	Turbovisory instruments – their basic principles, application and calibration: (i) Eccentricity and vibration, its interpretation and measurements, different pick-ups, their location, etc. (ii) Use of vibration instruments and analysis, differential expansion, measurement and interpretation, different pick-ups, their location, etc., overall thermal expansion	6

	measurements, axial shift position measurements, valve position and servo motor position indicators, differential metal temperature measurements, turbine stress evaluators	
VIII.	Actuators: Operating principles of pneumatic, hydraulic and electrical actuators and their control mechanisms, maintenance, inspection and testing aspects.	2
IX	Analytical instruments: Theory and working principles- steam/ water analysers, like conductivity, pH, Na, NH_3, Hydrazine etc., theory and working principles of combustion monitoring instruments such as CO_2, O_2, etc., interpretation of the above parameters to the operating regimes of the plant.	4
X	HP/LP bypass and PRDS system: Piping schematic with details of various valves and transmitters, Equipment details – mechanical and electrical, Control philosophy, Pre-commissioning checks and commissioning procedures.	6
XI.	Instrument air system: Air Supplier, piping and piping layout, air purification and conditioning, basic theory and working principles of pneumatic transmitters and secondary instruments, theory and working principles of E/P converters and valve positioners	2
XII.	Control and Instrumentation scheme tracing: Instrumentation and control scheme of fuel, air, flue gas, feed water and steam systems including their measurements	9
XIII.	(i) Furnace Safeguard Supervisory System (FSSS), plant equipment protection and interlock system. (not applicable for DG Plant and Gas Turbine based Plant) (ii) Automatic turbine run-up system (ATRS), analog and digital controllers. (not applicable for DG Plant)	9
XIV.	Data acquisition system/digital distributed control (DDC), UPS, control room layout	6
	Total	65 Hours ≅ **2 Weeks**
XV	**On Job Training:** **(Applicable only for Engineers/Supervisors engaged on Coal and Gas Turbine based plants)** (i) Control system – basic principles, constructional features, calibration, preventive maintenance and	**3 weeks**

	trouble shooting of analog control systems, level, flow, pressure and temperature control systems, component / cards used in control systems, static and dynamic timing, control valves and dampers	
(ii)	Data acquisition system or distributed digital control system – basic principles, constructional features, calibration, preventive maintenance and trouble shooting of digital and analog inputs to DAS and their conditioning, I/O and interface, functioning of alarms, monitoring formats and logs, sequence of events	**1 week**

Part X

SYLLABUS FOR TECHNICIANS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE COAL BASED THERMAL POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Numbers of Hours
1	2	3
I.	Power plant familiarisation	6
II	Fundamental units and their conversion (mechanical, electrical, thermo-dynamic).	2
III	Engineering drawing and practice.	6
IV.	Fuels and combustion, types of fuels – their properties and testing, requirement of efficient combustion	4
V.	Boiler and boiler house plant and auxiliaries : (i) General description (ii) Arrangement of boilers (iii) Boiler auxiliaries (iv) Boiler instrumentation (v) Fabrication and assembly of different parts of boiler and its accessories (vi) High pressure welding in boilers (vii) Arrangement of pulverised fuel boiler in a modern thermal power station (viii) Operation appreciation (start-up, running and shutdown)	16
VI.	Water conditioning, pre-treatment and demineralisation, water chemistry.	4
VII.	Ash handling- electrostatic precipitation and mechanical dust collector- functions and description of two types.	2
VIII.	Turbine and turbine house auxiliaries. (i) Fundamental principle of steam turbine (ii) Theory and operation of steam turbine (iii) Governing and protection of turbine (iv) Operation appreciation (start-up, running and shutdown)	12

IX.	Handling of turbines and boilers under emergency conditions.	4
X.	Condenser and vacuum extraction plant : (i) Purpose and function (ii) Construction of surface condenser and vacuum pumps	3
XI.	Regenerative feed water heating, constructional details of low pressure and high pressure feed water heaters, de-aerators and evaporators.	2
XII.	Cooling water systems and cooling towers.	1
XIII.	Flow diagrams of basic cycles and scheme tracing : (i) Coal handling. (ii) Steam and condensate (iii) Ash and slag handling (iv) Station services - domestic water, air conditioning, ventilation, lifts (v) Air services, air compressors, switchgear (vi) Bearing cooling, and general service water system (vii) Circulating water system (viii) Feed water and reheating plant (ix) Fuel oil system (x) Station batteries and battery charging equipment (xi) Station lighting, power supply and distribution boards.	16
XIV.	Mechanical appreciation – correct use of machines, tools and tackles, gauges, fits and clearances, tolerances, brazing, soldering and welding, bearings, gears and thread, fasteners	6
XV.	Bearings types, installation and removal procedures and maintenance of clearances and tolerances, oil seals types, their applications and clearances.	2
XVI.	Lubrication and cooling principles.	2
XVII.	Station instrumentation and controls.	8
XVIII.	Fire-fighting installations in thermal power station.	3
XIX.	Electric shocks, first aid, acid burn, alkali wounds, chlorine gas poisoning and their treatment.	3
XX.	Duties and responsibilities of operators and plant attendants, carrying out instructions, reporting to supervisors, recording and reading unusual occurrences, expected behavior, discipline, sincerity, cleanliness and love for machines.	2
XXI	Personnel safety equipment, cleanliness, caution and care in power station working.	1
XXII.	How electricity is generated, transmitted and distributed i.e. generator to Consumer service board.	2

XXIII	Principle and working of alternating current and direct current generators and their parallel operation.	2
XXIV	Principle and working of transformers and their parallel operation	1
XXV.	Principle and working of alternating current and direct current motors, their speed characteristics, controls.	2
XXVI.	Storage battery- principle, construction and charging.	1
XXVII	Alternator cooling - different systems of cooling, advantages of hydrogen cooling over others, hydrogen plant.	2
	Total	115 Hours ≅ 4 Weeks

Part XI

SYLLABUS FOR TECHNICIANS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE DIESEL ENGINE BASED POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	Power plant familiarization.	8
II.	Fundamental units and their conversion and measurement (mechanical, electrical, thermodynamic)	4
III.	Engineering drawing and practice	6
IV	Fuels and combustion, types of fuels – their properties and testing, requirements of efficient combustion.	8
V.	Diesel Engine and Auxiliaries : (i) General description (ii) Arrangement of engine (iii) Engine auxiliaries (iv) Assembly of different parts of engine and its accessories (v) Engine instrumentation (vi) Operation appreciation (start up, running and shut down).	24
VI	Water conditioning, pre treatment and demineralization.	6
VII	Effluent treatment, plant functions and description, importance of treatment plant.	4
VIII	Turbochargers: (i) Fundamental principles of turbocharger (ii) Theory and operation of turbocharger (iii) Monitoring and protection of turbocharger	6

IX	Handling of Engine under Emergency conditions.	6
X	Fuel oil and lube oil separators: (i) Purpose and function (ii) Operation and maintenance of separators	6
XI	Cooling water system and radiators.	2
XII	Flow Diagrams of basic cycles and scheme tracing. (i) Fuel handling. (ii) Fuel oil system (HFO and Diesel oil) (iii) Jacket water cooling system (iv) Lube oil system (v) Air intake system (vi) Engine cooling water system (vii) Exhaust gas system (viii) Station services, domestic water, air conditioning, ventilation, lifts, etc. (ix) Air services, air compressor (x) Steam system and heat tracing of fuel pipes (xi) Station batteries and battery charging equipments (xii) Station lighting, power supply and distribution boards, switch gear.	24
XIII	Mechanical application – correct use of machines, tools and tackles, gauges, fits and clearances, tolerances, brazing, soldering and welding bearings, gears and thread, fasteners.	6
XIV	Station instrumentation and controls.	8
XV	Fire fighting installation in D.G. power station.	2
XVI	Electric shocks, first aid, acid burns, alkali wounds/chlorine gas poisoning and their treatment.	3
XVII	Duties and responsibilities of operators and plant attendants in carrying out instructions, reporting to supervisors, recording, reading unusual occurrences, expected behaviour, discipline, sincerity, cleanliness and love for machines.	3
XVIII	Safety equipment and personal cleanliness, cautions and cares in power station working.	3
XIX	How electricity is generated, transmitted and distributed i.e. generator to Consumer service board.	2
XX	Principle and working of alternating current and direct current generators and their parallel operation	2
XXI	Principle and working of transformers and their parallel operation	2
XXII	Principle and working of alternating current and direct current motors, their speed characteristics and control.	2

XXIII	Storage battery- principle, construction, boost charging, float charging and importance of DC in DG power plant	3
		140 Hours
	Total	≅ 5 Weeks

Part XII

SYLLABUS FOR TECHNICIANS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE COMBINED CYCLE GAS TURBINE BASED POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I.	Gas Power plant familiarization	8
II.	Fundamental units and their conversion (Mechanical, electrical, thermo-dynamic).	2
III.	Engineering drawing and practice.	6
IV.	Fuels and combustion types of fuels – their properties and testing, requirement of efficient combustion	4
V.	Gas turbine and WHRB (i) General description. (ii) Arrangement of Gas turbines (iii) WHRB (Waste Heat Recovery Boiler) (iv) Instrumentation and Control system (v) Fabrication and assembly of different parts of gas turbine and its accessories. (vi) High pressure welding . (vii) Fuel storage and transport arrangement. (viii) Operation appreciation (start-up, running and shutdown)	20
VI.	Water conditioning, pre-treatment and demineralisation.	4
VII.	Steam turbine and turbine house auxiliaries. (i) Fundamental principle of steam turbine. (ii) Theory and operation of steam turbine (iii) Arrangement of steam turbine. (iv) Governing and protection of turbine. (v) Operation appreciation (start-up, running and shutdown)	12
VIII.	Handling of gas turbine, steam turbine and WHRB	4
IX.	Condenser and vacuum extraction plant : (i) Purpose and function. (ii) Construction of surface condenser and vacuum pumps	3

X.	Cooling water systems and cooling towers.	1
XI.	Flow diagrams of basic cycles and scheme tracing : (i) Steam and condensate (ii) Station services, domestic water, air conditioning, ventilation, lifts (iii) Air services, air compressors, switchgear. (iv) Bearing cooling and general service water system. (v) Circulating water system. (vi) Feed water system (vii) Fuel oil system (viii) Station batteries and battery charging equipment (ix) Station lighting, power supply and distribution boards	18
XII.	Mechanical appreciation – correct use of machines, tools and tackles, gauges, fits and clearances, tolerances, brazing, soldering and welding, bearings, gears and thread, fasteners	6
XIII.	Station instrumentation and controls.	8
XIV.	Fire-fighting installations in thermal power station.	2
XV.	Electric shocks, first aid, acid burn, alkali wounds, chlorine gas poisoning and their treatment.	3
XVI.	Duties and responsibilities of operators and plant attendants, carrying out instructions, reporting to supervisors, recording reading unusual occurrences, expected behavior, discipline, sincerity, cleanliness and love for machines.	3
XVII.	Safety of personnel and equipment, cleanliness, caution and care in power station working.	3
XVIII.	How electricity is generated, transmitted and distributed i.e. generator to Consumer service board.	2
XIX.	Fundamental units, conversion and measurement of electrical quantities.	1
XX.	Principle and working of alternating current and direct current generators and their parallel operation.	2
XXI.	Principle and working of transformers and their parallel operation	2
XXII.	Principle and working of alternating current and direct current motors, their speed characteristics, controls.	2
XXIII.	Storage battery- principle, construction and charging.	1
XXIV.	Alternator cooling, different systems of cooling, advantages of hydrogen cooling over others, hydrogen plant.	2
	Total	119 Hours ≅ **4 Weeks**

Part XIII

SPECIALISED SYLLABUS FOR TECHNICIANS ENGAGED ON MECHANICAL SIDE OF THE COAL AND GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Types of bearings, oil seals and their uses.	4
II.	Types of valves, safety valve, suction valve, delivery valve, non-return valve, bypass valve, drain valve, air release valve, control valve, float operated valve, solenoid operated and pneumatically operated valve and their applications.	15
III.	Efficiency loss in boiler / turbine cycle	4
IV.	Interpretation of instrument reading and accurate logging	2
V.	Marking and measuring, workshop practice, welding and gas cutting, pipe fitting methods	5
VI.	Pump maintenance	5
VII.	Shaft alignment methods	4
VIII.	Drives maintenance, keys	4
IX.	Insulation types and applications	2
X.	Mechanical safety	4
XI.	Vulcanizing	2
XII.	Couplings – different types- rigid, flexible, magnetic and fluid couplings.	3
XIII.	Clutches - different types and uses.	2
XIV.	Maintenance of pneumatic measuring instruments, servomotors, power cylinders and other thermostats, Monistats.	4
XV.	Maintenance of instruments, recorders, clocks.	4
XVI.	Vibrations – general knowledge of their causes, effects, remedies, measurement and balancing.	8
	Total	72 Hours ≅ **2 ½ Weeks**
XVII.	On Job Training in above areas with hands on practicals	**16 Weeks**

Part XIV

SPECIALISED SYLLABUS FOR TECHNICIANS ENGAGED ON MECHANICAL SIDE OF THE DIESEL ENGINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Types of bearings and their uses.	3
II	Types of valves, safety valve, suction valve, delivery valve, non return valve, bypass valve, drain valve, air release valve, control valve, float operated valve, solenoid operated and pneumatically operated valve and their applications.	5
III	Efficiency computation in Diesel Engine.	4
IV	Interpreting instrument reading and accurate logging.	2
V	Marking and measuring, workshop practice, welding and gas cutting, pipe fitting methods.	4
VI	Pumps maintenance.	4
VII	Shaft alignment methods.	4
VIII	Drives maintenance keys	4
IX	Insulation types and applications.	2
X	Mechanical safety	4
XI	Vulcanizing	2
XII	Coupling- different types, rigid, flexible, magnetic and fluid couplings.	2
XIII	Clutches- different types and uses	2
XIV	Maintenance of pneumatic measuring instruments, servomotors, power cylinders and other thermostats, monostats.	4
XV	Maintenance of instruments, recorders, clocks	4
XVI	Vibration – general knowledge of their causes, effects, remedies, measurement and balancing.	8
	Total	58 Hours ≅ **2 Weeks**
XVII	On job Training in above areas with hands on practicals	**8 Weeks**

Part XV

SPECIALISED SYLLABUS FOR TECHNICIANS ENGAGED ON ELECTRICAL SIDE OF THE COAL, DIESEL ENGINE AND GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Alarm systems – visual and audible.	2
II.	Isolators, circuit breakers and contactors.	3
III.	Earthing and neutral grounding, necessity of, methods for, safety rules while handling electrical equipments. Reading electrical circuit diagrams	4
IV	Motor winding and repairs.	4
V	Maintenance of internal telephones and public address systems.	3
VI	Meggering and testing of wiring and cable faults.	3
VII	Maintenance of electrical motors.	3
VIII	Maintenance of electrical switchgears.	8
IX	Fuses- re-wireable type, cartridges type, high rupturing capacity fuse, constructional features of fuse and fuse sockets, knife type high rupturing capacity fuses, use of pullers for insertion and removal, colour code for fuse ratings.	8
X	Motor starters and their applications – direct-on-line, star –delta, rotor resistance, contactors and relays	5
XI	Meggers, avometers, voltmeters, ammeters, watt meters, energy meters- general information about their use.	6
XII	Maintenance of batteries and rectifiers	3
XIII.	Maintenance of transformers and tap changers.	6
XIV.	Laying and jointing of cables of voltage up to 250 V and exceeding 250 V but not exceeding 650 V.	4
XV.	Panel wiring methods, connections, earthing principles of operation of small distribution transformers.	2
XVI	Current and potential transformers, purpose, connection and use.	2
XVII	Various types of drives.	2

XVIII	Elementary knowledge of Engineering materials and their properties.	2
XIX	Lubrication and cooling system	4
	Total	74 Hours ≅ 2 ½ Weeks
XX	On Job Training in above areas with hands on practicals:	
	(i) Technicians engaged on coal and gas based Power Plants.	**16 Weeks**
	(ii) Technicians engaged on Diesel engine based Power Plants.	**8 Weeks**

Part XVI

SPECIALISED SYLLABUS TECHNICIANS ENGAGED ON INSTRUMENTATION SIDE OF THE COAL, DIESEL ENGINE AND GAS TURBINE BASED POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Pressure gauges – Bourdon type gauge, manometer, vacuum - gauge, barometer, principles of operation, absolute pressure, gauge and vacuum pressure and their inter-relationship, calibration.	5
II	Temperature indicators, mercury thermometers, resistance thermometers, thermocouples, pyrometers, gas thermometers temperature alarm, calibration.	4
III	Level gauges - different types - level alarm, calibration.	3
IV	Flow meters - steam and water, general principles, calibration. Instrument workshop practice – multi meters, megger	3
V	Electronic circuit diagram study, drilling, soldering, use of resistance bridge and workshop potentiometer.	6
VI	Electronics – components, oscilloscope, power supply, signal generator applications, logics and timers.	8
VII	Telemetering and signal conditioning, transducers, thresholds, transmitters and their calibration.	12
VIII	Instrument air control systems	2
IX	Actuator maintenance.	4
X	Analytical instruments.	3
XI	Furnace safeguard supervisory instruments, turbovisory instruments. (Not applicable in case of Diesel engine based power plants and gas turbine based power plants.)	6

XII	Instrument fault finding	2
XIII	Familiarisation of data acquisition system / distributed digital control.	3
XIV	Power supplies and alarm system	6
XV	Safety precautions	1
	Total	68 Hours ≅ 2 ½ Weeks
XVI	On Job Training in above areas with hands on practicals	
	(i) Technicians engaged on coal and gas based Power Plants.	**16 Weeks**
	(ii) Technicians engaged on Diesel engine based Power Plants.	**8 Weeks**

Part XVII

SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE HYDRO ELECTRIC POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation / Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring	5
II	Concept of modern hydro station: Types of stations, their role in the power systems, base load, and peaking load, run-off-the river, storage type and pumped storage power plants, concept of unit, typical surface and underground hydro power stations.	3
III	Choice of location of large hydro station: water availability land availability, selection of installed capacity, selection of type of turbine, choice of size of generating units.	3
IV	Hydraulic system, reservoir, storage capacity, operation of reservoirs, dams and barrages, intake, surge tank, power tunnels/channel, fore bay and penstocks, pressure shaft, tail race and tail race tunnel/channel, protection against water hammer and negative pressure in penstocks and suction head. Dewatering of water conductor systems.	3
V	Plant lay out in hydro stations above 25MW capacity including machine arrangement, equipment, switchyard and auxiliary arrangements.	3

VI	Constructional details and working principles of valves - butterfly, spherical, needle etc. (i) Requirements and principle of operation (ii) Type and selection criteria of valves and their operation and control.	3
VII	Constructional details and working principles of hydro mechanical equipments. (i) Requirements and principle of operation. (ii) Type and selection criteria of hydro mechanical equipments and their operation and control.	3
VIII	Constructional details and working principles of turbines and auxiliaries. (i) Principle of operation, types and characteristics of turbines (ii) Choice, rating and specifications of turbines (iii) Components of turbines and their design (iv) Type of governors - hydraulic and electronic (v) Guide bearing and shaft seal arrangements	12
IX	Working principles, characteristics and operation of auxiliary systems. (1) Unit Auxiliaries (i) Oil pressure units (ii) HP lubrication system (iii) Braking and jacking system (iv) Central grease lubrication system (v) Carbon dust collection system for slip rings, exciters and brake pads. (vi) Cooling water system. (2) Common Auxiliaries (i) EOT cranes and hoists (ii) Ventilation system (iii) Air conditioning system (iv) Compressed air system (v) Drinking water system (vi) Sewerage system (vii) Elevator/lifts (viii) Dewatering and drainage system (ix) Communication systems	9
X	Constructional details and working principles of alternators and excitation systems. (i) Alternators, characteristics and rating, types of winding, bearing arrangements, cooling arrangements (ii) Main and pilot exciters, voltage regulators, types and characteristics, amplifier and magnetic amplifier, static excitation system, Automatic Voltage Regulation (AVR) (iii) Methods of grounding (iv) Generator - transformer connections	12
XI	DC and AC power supply for auxiliaries, arrangement of unit auxiliary and station service boards, station lighting and automatic changeover. Station batteries and charging methods. Standby and emergency power and lighting systems.	5

XII	Transformers: Main transformers, station/unit transformers, grounding transformers, type of connections, tap changer gear, cooling arrangements, size selection of main transformers, parallel operation and Regulation.	5
XIII	Out door switchyard, bus bar arrangements, single line diagram, circuit breakers, isolators, current transformers, potential transformers, lightning arrestors, wave traps, coupling capacitor, LMU and three element protection devices, grounding arrangements.	3
XIV	Indoor and out door switch gear: Types: MCB, bulk oil, minimum oil, air blast, vacuum, SF_6 breakers, constructional-functional details and characteristics.	12
XV	SF_6 gas filled EHV switchgear	4
XVI	(i) Working principle and basis of instrumentation and measurements: Detail of measuring instruments for pressure, flow, temperature, level, vibration, alignment and current, voltage, power, reactive power, frequency, energy, winding temperature, auto controllers, recorder, Megger- its use for primary detection of faults, data acquisition system, digital distributed control, UPS, unit co-ordinate master control. (ii) Testing of electrical and mechanical testing equipments	14
XVII	Control and protection – sequential operation and interlocks (i) Unit protection and interlocks (ii) Turbine and auxiliaries and vibration monitoring (iii) Turbine governing, speed setting, speed droop setting and control circuits (iv) Generator protection, under voltage, over voltage, differential, reverse power, under excitation, negative phase sequence, earth fault, etc. (v) Different types of protection relays (vi) Importance of sequential interlocks (vii) Transformer protection- differential, over load, over fluxing, restricted earth fault, high temperature, buchholz protection (viii) Types of motors and variable speed drive and control (ix) Various types of pumps and their starting control (x) Annunciation systems (xi) On line monitoring devices	15
XVIII	Operation control and supervision (i) General machine start and stop procedure and sequence (ii) Handling of turbine and generator and auxiliaries under failure condition. such as, mechanical and electrical auxiliary and governor failure, grid failure and other failure conditions. (iii) Alternator- synchronizing, loading, parallel operation, active and reactive power sharing and frequency control.	12

XIX	(i) Fire safety procedure (ii) Fire protection of generator (iii) Fire fighting and emulsifier type protection	5
XX	General safety precautions, treatment of electrical or acid/alkali burns, permit to work, first aid, protective gear/ clothing, safety in movement and storage of materials, safety aspects of switchyard.	4
XXI	Factory Act, Electricity Act, 2003, Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, and other statutory Regulations concerning power stations (broad outline).	10
XXII	Erection, testing and commissioning of turbine, generator, control and instrumentation, switchyard and auxiliary systems, maintenance procedures, PERT/CPM method, power station records, maintenance planning.	12
XXIII	Plant performance, generation cost, machine availability and other commercial aspects.	6
XXIV	Personnel management, duties and responsibilities, labour laws and labour welfare.	4
XXV	Broad principles of material management, procurement procedure and inventory control.	6
	Total	173 Hours ≅ **6 Weeks**
XXVI	On job training: (1) Control room desk operation: (i) Pre-start checks (ii) Protection interlocks (iii) Startup procedure and routine checks (iv) Stopping and emergency operation of turbine, generator and their auxiliaries (v) Operation of generating unit in abnormal circumstances (vi) Simulator training/computer application for plants	**7 Weeks** *(6 Weeks)*
	2. Fire fighting and fire safety procedures during emergency.	*(1 week)*

Part XVIII

SPECIALISED SYLLABUS FOR OPERATION AND MAINTENANCE ENGINEERS AND SUPERVISORS ENGAGED ON THE MECHANICAL SIDE OF HYDRO ELECTRIC POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Predictive, preventive and emergent maintenance, types of failure and detection: (i) Periodical maintenance and inspection of turbine and auxiliaries (ii) Maintenance of pumps, valves and pipe work (iii) Lubrication principles and their characteristics (iv) Purification of lubricating oil and selection (v) Mechanical alignment (vi) Static and dynamic balancing of machines (vii) Maintenance planning (viii) Modern techniques and their applications in maintenance of turbine and associated auxiliaries. (ix) Cavitation and erosion of under water components due to higher abrasive silt laden water.	12
II	1. Pre-commissioning and commissioning tests of hydro mechanical gates and inlet valves – dry and wet 2. Predictive, preventive and emergent maintenance of : (i) Inlet valves (ii) Hydro mechanical gates (iii) EOT cranes	12
III	Predictive, preventive and emergent maintenance of: (i) Ventilation and air conditioning system (ii) Central grease lubricating unit (iii) Air compressors (iv) Lifts (v) DG sets (vi) Fire fighting equipments	10
IV	Maintenance practices - rigging and slinging, bearing, scraping and matching, radiography and stress relieving methods, anti-friction bearings and their installation and lubrication, non destructive testing and principles, procedure and application. Welding techniques and equipment.	10
V	Workshop: Types and use of hydraulic, pneumatic and hand tools and tackles. Fabrication of spares. Repairs and maintenance of mechanical equipments such as vehicles, dozers, cranes.	8
VI	Composition, properties and behavior of Engineering materials used in power stations	8

VII	Residual life assessment and life extension methods	6
VIII	Mechanical safety rules and practice	4
IX	Spares inventory, productivity, cost control.	4
	Total	74 Hours ≅ **2 ½ Weeks**
X	On Job Training: To be associated with field maintenance of : (i) Turbine and auxiliaries like governor, shaft seal, inlet valve, etc. (ii) Common auxiliaries such as cooling water system, compressed air, ventilation and air conditioning, fire fighting, EOT cranes etc. (iii) Welding and non destructive testing (iv) Work shop procedures	**3 weeks**

Part XIX

SPECIALISED SYLLABUS FOR OPERATION AND MAINTENANCE ENGINEERS AND SUPERVISORS ENGAGED ON THE ELECTRICAL SIDE OF THE HYDRO ELECTRIC POWER PLANT

Item No.	Particulars	Number of Hours
1	2	3
I.	Predictive, preventive and emergent maintenance and inspection of generators, excitation system, generator bearing. Principles of electronic controls and transistorized circuits. Generator protection- earth fault in rotor and stator, negative phase sequence, loss of excitation, differential protection, back up protection, reverse power protection, under/over voltage protection, over load protection, dry out of generators. Constructional details of the different types of relays and other sensing equipments, method of setting and their testing. Wiring details of control panels. Insulating materials and their use.	15
II.	Predictive, preventive and emergent maintenance of motors.	4
III.	Transformer: preventive maintenance of transformers, dielectric strength of oil, insulation resistance, tap changers, filtration of oil. Tan-Delta resistivity of oil, dissolved gas analysis and other testing of oil	8
IV	Transformer: Protection- Buchholz relay protection, over current protection, differential protection and earth fault protection, types of relays used, their construction, testing and setting. Commissioning tests.	8
V	Circuit breakers' maintenance, isolators, disconnectors, bus bar arrangements, charging, synchronizing with the grid, disconnecting for repairs, maintenance of switchgear contactors.	8

VI	Maintenance of equipments in the outdoor and indoor switchyard. Operation and maintenance of current transformers, potential transformers and lighting arrestors. Bus differential protection, etc. LV, HV and EHV cables and their jointing and testing.	8
VII	Maintenance of SF_6 gas filled insulated switch gear.	6
VIII	Station auxiliary supply, station battery-care and maintenance, trickle charging and extended charging, operation and maintenance of rectifiers and battery chargers, UPS, emergency power supply, station grounding arrangements.	10
IX	Line protection and fault analysis.	4
X	PLCC equipments, telemetering, and other latest communication systems like fiber optics, microwave, etc.	8
XI	Computerized on-line monitoring of power plant(DRs, Event Logger and SCADA)	4
XII	Interlocking sequential control circuits, details of components used.	7
XIII	Calibration and testing of various types of instruments, indicating/ measuring instruments, recorders and analyzers, including transducers and RTUs (Remote Transmitting Units)	10
XIV	Statutory Electricity Acts and Rules, permit procedure and site safety rules.	4
XV	Economic load dispatch, power system control and operation , MVAR-control, voltage Regulation and frequency control, islanding schemes, function of RLDC/SLDC	10
XVI	Station emergency lighting arrangements.	2
XVII	R&M and residual life assessments and life extension of equipments	4
	Total	120 Hours **≅ 4 Weeks**
XVIII	On Job Training: To be associated with field electrical maintenance of : (i) Generator and auxiliaries (ii) Common auxiliary systems (iii) Transformer (iv) LT/HT switch gear in power plant and indoor and out door switch yard (v) Control room operation.	**4 weeks**

Part XX

SPECIALISED SYLLABUS FOR OPERATION AND MAINTENANCE ENGINEERS AND SUPERVISORS ENGAGED ON THE INSTRUMENTATION SIDE OF THE HYDRO ELECTRIC POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Working principles, calibration, control methods and maintenance aspects of temperature measurement devices. (i) Resistance thermometers, thermocouples (ii) Recorders, indicators (iii) Transmitters (iv) Transducers and RTUs.	5
II.	Working principles, calibration, control methods and maintenance aspects of pressure measurement devices (i) Diaphragm gauge, Bourdon gauge (ii) Recorders, indicators (iii) Transmitters	4
III.	Working principles, calibration, control methods and maintenance aspects of flow measurement devices: (i) Positive, semi-positive, rate and differential pressure flow meters. (ii) Recorders and indicators (iii) Transmitters.	4
IV.	Working principles, calibration, control methods and maintenance aspects of level measurement devices : (i) Pressure gauge bellows/diaphragm, float, buoyancy, gas purge, differential pressure and capacitance type level measurement systems (ii) Recorders and indicators (iii) Transmitters	4
V.	Telemetering and signal conditioning - pneumatic systems, electrical systems, electronic systems and maintenance aspects.	4
VI	Basic electronics – Component familiarization and various types of circuits, microprocessors	8
VII	Turbovisory instruments- their basic principles, application and calibration : alignment and vibration, its interpretation and measurements, different types of pick-ups, their location, etc., use of vibration instruments and analysis, different pickups, their location, etc., axial shift position measurements, valve position and servo motor position indicators, differential metal temperature measurements.	12

VIII	Actuators: Operating principles of pneumatic, hydraulic and electrical actuators and their control mechanisms, maintenance, inspection and testing aspects.	6
IX	Instrument air system: Air Supplier, piping and piping layout.	4
X.	Data acquisition systems. Microprocessor based control system for generating units including governors and excitation systems. Digital distributed control (DDC), UPS, control room layout	11
	Total	62 Hours ≅ **2 Weeks**
XI.	On Job training: (1) Control system – basic principles, construction features, calibration, preventive maintenance and trouble shooting. Analog control systems, level, flow, pressure and temperature control systems, component/cards used in control systems, static and dynamic timing, control valves and dampers.	**2 weeks**
	(2) Data Acquisition System (DAS) or distributed digital control system – basic principles, construction features, calibration, preventive maintenance and trouble shooting of digital and analog inputs to DAS and their conditioning, I/O and interface, functioning of alarms, monitoring formats and logs, sequence of events.	**2 weeks**

Part XXI

SYLLABUS FOR TECHNICIANS ENGAGED IN THE OPERATION AND MAINTENANCE OF THE HYDRO ELECTRIC POWER PLANTS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	Fundamental units, conversion of and measuring electrical quantities.	2
II	How electricity is generated, transmitted and distributed i.e. generator to Consumer service board.	2
III	Principle and working of alternating current and direct current generators, motors, their speed characteristics, controls.	2
IV	Principle and working of transformers and their parallel operation	2
V	Power plant familiarization	6
VI	Turbine and auxiliaries: (i) Fundamental principle of turbines and inlet valves (ii) Theory and operation of turbines and inlet valves	8

	(iii) Governing and protection of turbine (iv) Operating procedures (start-up, running and shutdown) (v) Various types of faults in generators, turbines and auxiliaries -analysis thereof.	
VII	Generator and auxiliaries: (i) Fundamental principle and working of generators (ii) Excitation system (iii) Automatic voltage regulator (iv) HV, EHV, LT and control cables (v) Generator transformer connection (vi) Protection of generators (vii) Operating procedures (start up, running and shut down)	8
VIII	Engineering drawing and practice	6
IX.	Handling of turbines under emergency conditions	4
X.	Power station mechanical auxiliary system- general aspects and basic flow diagrams, etc. (i) EOT cranes (ii) Hydro mechanical gates (iii) OPU (iv) Central grease lubricating unit (v) HP lubrication system (vi) Carbon dust collection system (vii) Cooling water systems, bearing cooling, generator cooling and transformer cooling (viii) Braking and jacking system (ix) Drainage and dewatering system (x) Drinking water, air conditioning and ventilation system (xi) Air services, air compressors (xii) Lifts	8
XI.	Mechanical appreciation – correct use of machines, tools and tackles, gauges, fits and clearances, tolerances, brazing, soldering and welding, bearings, gears and threads, fasteners.	6
XII	Electrical appreciation- correct and Appropriate use of electrical tools like Megger, tong testers, multi-meters, insulation testing equipment, earthing and its importance.	6
XIII	Bearings- types, installation and removal procedures and maintenance, clearance and tolerances, oil seals- types, applications with clearances.	2
XIV	Lubrication and cooling principles.	2
XV	Station instrumentation and controls.	4
XVI	Power station electrical auxiliary system - general aspects and basic flow diagrams, etc. (i) Station lighting, power supply and distribution boards (ii) Station batteries and battery charging system	8

	(iii) Unit and station transformers (iv) DG sets and their maintenance	
XVII	Electric shocks, first aid, acid burn, alkali wounds, Chlorine gas poisoning and their treatment.	3
XVIII	Fire fighting installations in hydro power station	2
XIX	Personnel safety equipment, cleanliness, caution and care in power station working. Importance of earthing.	2
XX	Duties and responsibilities of operators and plant attendants, carrying out instructions, reporting to supervisors, recording reading, visual occurrence, expected behavior, discipline, sincerity, cleanliness and love for machines	3
	Total	86 Hours ≅ 3 Weeks
XXI	On job Training in above areas with hands on practicals	4 weeks

Part XXII

SPECIALISED SYLLABUS FOR TECHNICIANS TO BE ENGAGED ON THE MECHANICAL SIDE OF THE HYDRO ELECTRIC POWER PLANTS

Item No.	Particulars.	Number of Hours
1	2	3
I	Operation and general aspects of annual maintenance of turbine and auxiliaries (i) Turbine (ii) Inlet valve (iii) Governing system (iv) Shaft seal	6
II	Operation and general maintenance of common mechanical auxiliaries: (i) Pumps and associated pipe work such as cooling water system, fire fighting system, drainage system, dewatering system (ii) Air conditioning and ventilation system (iii) Air compressors (iv) EOT cranes (v) Hydro mechanical gates (vi) Turbine and generator bearing (vii) Lifts (viii) Fire fighting system for power house complex and specifically for equipments like transformers and generators with knowledge of different fire fighting systems.	6

III	Types of valves- safety valve, suction valve, delivery valve, non-return valve, bypass valve, drain valve, air release valve, control valve, float operated valve, solenoid operated and pneumatically operated valves and their applications.	4
IV	Interpretation of instrument reading and accurate logging	2
V	Workshop practice, making of spare parts, welding and gas cutting, pipe fitting methods, introduction to various tools, tackles and practice.	4
VI	Shaft alignment methods.	4
VII	Rubber components, their uses and handling.	2
VIII	Maintenance of measuring instruments such as dial gauges, micrometers, vernier calipers etc.	4
IX	Couplings-different types, rigid and flexible coupling.	2
X	Vibration-general knowledge of the causes, effects, remedies, measurement and balancing.	4
XI	Standard storage practices for spares and materials.	2
XII	Mechanical safety.	2
	Total	42 Hours ≅ 1 ½ Weeks
XIII	On Job Training in above areas with hands on practical.	**4 weeks**

Part XXIII

SPECIALISED SYLLABUS FOR TECHNICIANS TO BE ENGAGED ON THE ELECTRICAL SIDE OF THE HYDRO ELECTRIC POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I	Operation and general aspects of annual maintenance of generators and auxiliaries (i) Generator and its dry out (ii) Excitation system (iii) AVR	8
II	Operation and general maintenance of common electrical auxiliaries (i) Station supply (ii) Batteries and chargers, DC distribution boards and emergency lighting system (iii) Motor winding and repairs (iv) Understanding of electrical panel wiring (v) PLCC system (vi) EOT crane	8

III	Operation and maintenance of transformers including oil filtration	6
IV	Out door switch yard equipment such as isolators, circuit breakers and contactors, earthing switches, CT, CVT, LA	3
V	Indoor switch gear system	4
VI	Alarm systems - visual and audible	2
VII	Earthing and neutral grounding: necessity of methods for safety while handling electrical equipments. Reading electrical circuit diagrams	4
VIII	Maintenance of internal telephones and public address system	3
IX	Meggering and testing of electrical equipment, wiring and cables	3
X	Maintenance of electrical switchgears	6
XI	Fuses-rewirable types, cartridges type, high rupturing capacity fuse, constructional features of fuse and fuse sockets, knife type high rupturing capacity fuses, use of pullers for insertion and removal, colour code for fuse ratings.	6
XII	Motor starters and their applications- direct-on-line, star delta, rotor resistance, contactors and relays	5
XIII	Voltmeters, ammeters, watt meters, energy meters, meggers, multimeters, tong testers and general information about their use	6
XIV	Laying and jointing of cables of voltage upto 250 V and exceeding 250 V but not exceeding 650 V.	4
XV	Panel wiring methods, connections, earthing, and principles of operation of small distribution transformers.	2
XVI	Protection relays, current and potential transformers, purposes, connections and use.	2
XVII	Elementary knowledge of electrical Engineering materials and their properties.	2
XVIII	Basic knowledge of computers and on line monitoring system	2
XIX	Familiarization with supervisory control and data acquisition system.	4
	Total	80 Hours ≅ **3 Weeks**
XX	On job Training in above areas with hands on practicals.	**4 weeks**

Part XXIV

SPECIALISED SYLLABUS FOR TECHNICIANS TO BE ENGAGED ON THE INSTRUMENTATION SIDE OF THE HYDRO ELECTRIC POWER PLANTS

Item No.	Particulars	Number of Hours
1	2	3
I.	Familiarization with Supervisory control and data acquisition system	4
II.	Power supplies and alarm system	4
III.	Power station instruments, their maintenance and testing (i) Event sequence recorder (ii) Disturbance fault recorders (iii) Sequence controllers (iv) Digital relays	4
IV	Water flow meters and their application and maintenance	2
V	Pressure gauge: Bourdon type gauge, barometer principles of operation, absolute pressure, vacuum pressure, maintenance of pressure gauges.	3
VI	Level gauges: Different types of level gauges and their application in power house and calibration	3
VII	Temperature indicators: mercury thermometers, resistance thermometers, thermocouples, their use in power house and calibration	3
VIII	Instrument workshop practice: electronic circuit diagram study, multi-meters, Megger, drilling, soldering, use of resistance bridge and workshop potentiometer	6
IX	Electronic components, oscilloscope, power supply, signal generator applications, logics and timers	8
X	Telemetering and signal conditioning, transducers, thresholds, transmitters and their calibration	8
XI	Instrument fault finding	2
XII	Safety precautions	1
	Total	48 Hours ≅ **1 ½ Weeks**
XIII	On job Training in above areas with hands on practicals.	**4 Weeks**

Part XXV

SYLLABUS FOR ENGINEERS AND SUPERVISORS ENGAGED IN OPERATION AND MAINTENANCE OF SUB-STATIONS ASSOCIATED WITH THE GENERATING STATIONS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation/Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring (viii) Energy conservation	5
II	Layout and location of 66 kV and higher voltage sub-stations.	4
III	Main equipments used together with their specifications including gas insulated switching systems	6
IV	Concept of High Voltage DC Transmission	3
V	Construction of high voltage lines, types of towers, types of insulators and their electrical and mechanical characteristics.	3
VI	High tension feeders, their load carrying capacities.	3
VII	(i) Alternating and direct currents, relation between voltage, current, power, reactive power and common units in use. Power factor, Ohm's Law, resistance, reactance, impedance, percentage impedance. Three phase vectors, phase - displacement between current and voltage (ii) Basic principles of transformation, magnetisation, hysteresis, reluctance, retentivity, electromagnets. Flux density, ampereturns equation for transformation, reactors, etc. (iii) Two winding, three winding and auto transformers. Grounding transformers, salient features of shell type and core type transformers, hot rolled and cold rolled steel cores, stampings and their assembly. Different vector groups and terminal connection (iv) Transformer fixtures, e.g., Buchholz relay, on-load and off-load tap changer, breathers, conservators, bushings	29

	of different types, thermometers, indicators, alarms (v) Cooling of transformer and oil, different methods of cooling, importance of oil filtering and drying-out of transformers, di-electric strength of oil, different varieties of filters and their comparison, types of radiators (vi) Transformer tests – failure and causes, maintenance and repairs (vii) Parallel operation, Regulation, voltage control, tap change, commissioning tests	
VIII	Breakers: (i) Functions of breakers, their action. (ii) Different types of outdoor and indoor breakers, e.g. bulk oil, minimum oil and air blast, SF_6- principles and their applications (iii) Operating mechanism, manual, spring, hydraulic pneumatic, motor (iv) Breaker maintenance, failures and their causes, Commissioning procedure	8
IX	Bus bars: (i) Indoor bus bars, their capacity, forces on them during short circuit, bus bar mountings and their clearances (ii) Strung and tubular type bus bars, their current ratings, supports, jumpers, clearances. (iii) Busbar fittings and connectors (iv) Cables of voltage exceeding 650 V, types, their maintenance and testing	6
X	Current and potential transformers: (i) Types of current and potential transformers, their working principles, ratings, accuracies. (ii) Functions of current and potential transformers. (iii) Failure of current and potential transformers, their causes.	5
XI	Isolators: (i) Tilting and rotating isolators, with and without arcing horns, horizontal center break type, tandem isolators, earthing blades, current rating, breaking a circuit by isolator, interlocking with circuit breaker (ii) Maintenance of isolators	5
XII	Lightning protection: (i) Simple description of lightning phenomena, surges and their protection (ii) Construction of lightning arrestors and the principles of their working (iii) Different types of lightning arrestors and ratings (iv) Earthing and location of lightning arrestors.	3

	(v) Codes and Practices for lightning protection	
XIII	Capacitors	3
XIV	Control Room: (i) Necessity and function of a control board, types of boards, instruments of the board. (ii) Functions of the various relays and indicators, mimic diagram indicators, annunciator and alarm, characteristics of relay testing and setting of relays (iii) Remote control of breakers, isolators, tap changers, indicators on the control board. (iv) Control and power cables (v) Metering, concept of tariff, event loggers, disturbance recorders	10
XV	Auxiliary supply: (i) Current and ampere-hour ratings of batteries, battery charging equipment, checking of specific gravity of electrolyte, maintenance of batteries (ii) Importance of direct current supply and its functions. (iii) Auxiliary direct current supply (iv) AC distribution board	5
XVI	Clearances and Compliance of CEA (Measures relating to Safety and Electricity Supply) Regulations 2010 (i) Minimum clearance between phases and phase to ground for different voltages (ii) CEA(Measures relating to Safety and Electric Supply) Regulations, 2010 pertaining to sub-stations.	5
XVII	Earthing: (i) Safety earthing and system earthing, the method of earthing e.g., solid earthing, resistance earthing, peterson coil earthing, earthing of lightning arrestor, importance and advantages of each type (ii) Different types of earth electrodes, earthing mats, recommended values of earth resistance, measurement of earth resistance	3
XVIII	Maintenance: Maintenance of log sheet and other records. The importance of maintenance of good records.	3
XIX	Safety: (i) Safety procedures and procedures for giving line clear and taking it back. Maintenance of records of line clear. (ii) First-aid, artificial respiration and shock treatment.	10
XX	(i) Interlocking and sequential operation of different equipments. (ii) Protections :- Transformers, lines, reactors, bus bar.	8

XXI	Synchronising, charging and discharging of lines of voltage exceeding 650 V but not exceeding 33 kV. Live line testing.	3
XXII	Calibration and testing of various types of equipment, indicating and measuring equipments, recorders, analysers.	4
XXIII	Handling emergency conditions.	3
XXIV	Diagnosing troubles in the plant from instruments and annunciation.	3
XXV	Thermography monitoring.	4
XXVI	Study of carrier system, PLCC	2
XXVII	Auxiliary equipments such as compressors, station lighting, etc.	2
XXVIII	Fire-fighting equipment – their operations, maintenance and refilling, emulsifier, fire wall protections	3
XXIX	Personnel management, duties and responsibilities, labour welfare and labour laws	4
XXX	Power and telecommunication co-ordination committee (PTCC) guidelines.	2
XXXI	Broad principles of material management and inventory control	3
XXXII	Simulator Training	30
	Total	190 Hours ≅ 6 Weeks
XXXIII	On Job Training related to above areas	4 Weeks
XXXIV	Industrial visits and evaluation	2 Weeks

Part XXVI

SYLLABUS FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS IN OPERATION AND MAINTENANCE OF SUB-STATIONS ASSOCIATED WITH THE GENERATING STATIONS

Common course for Electrical, Mechanical and Instrumentation

Item No.	Particulars	Number of Hours
1	2	3
I	General Introduction: (i) Functions of State Electricity Board/Utility (ii) Introduction to Electricity Act 2003, CEA (Measures relating to Safety and Electric Supply) Regulations, 2010. (iii) Substation: (a) Sub-stations, Selection of site, clearances and control room (b) Sub-stations - 33 kV to 765 kV (c) Selection of voltage level for Sub-station and layouts	6
II	Equipments: (i) Control/Relay panels and meters (ii) Switch gear, Breakers (iii) Isolators (iv) Cables- types, construction and jointing (v) Power Capacitors (vi) Lightning arrestors (vii) CT, PT and carrier communication.	12
III	Transformers (Power and Distribution): (i) Types of transformers and parallel operations (ii) Cooling and drying out of transformers (iii) Testing of transformers (iv) Maintenance of transformers (v) Protection of transformers (vi) Failures of transformers	12
IV	Circuit Breakers, Isolators and Relays: (i) Principle and construction (ii) Types of circuit breakers (iii) Maintenance of circuit breakers (iv) Relays - various types and functions (v) Maintenance of isolators	12
V	Storage Batteries: Need, Functions, Commissioning and Maintenance	6
VI	Cable Jointing: Cables-types, selection, cable trenches, cable routing and laying, cable clamping, jointing and termination of HT, power and control cables and junction box, etc.	3

	Earthing:	
VII	Sub-station earthing, equipment earthing and Consumer earthing and procedure for improving quality of earth resistance	3
	Safety and fire fighting	
VIII	(1) Safety (i) Basic principle of safety, importance of safety rules and their observation (ii) List of Safety equipment, their use and maintenance thereof (iii) Permit procedure (iv) Self permit, Permit on phone and Procedures to be observed (v) Electric shock and safety. (vi) Causes of Accident, Precautions to be taken to avoid accidents while working. (2) Fire fighting: (i) Principle and causes of fire, class of fire i.e., A, B, C. Precautions to be taken to avoid fire (ii) Fire fighting equipments, their type and use, their periodical maintenance	6
	Duties of staff:	
IX	Duties of staff assisting supervisory and operating staff and maintenance of records	6
	Human Resource Development:	
X	(i) Personal development and motivation (ii) Communication skill and its importance (iii) Attitudinal training	9
	Total	75 Hours ≅ **2 ½ Weeks**
XI	On job training, industrial visits and evaluation: (1) Study Visits - after introduction: (i) 1st visit :11 kV and 33 kV sub-station (ii) 2nd visit : 66 kV and 132 kV sub-station (iii) 3rd visit : 220 kV and 400 kV sub-station 2. Study and practicals (i) Measurement of current, voltage, power, energy, frequency and power factor (ii) Testing and connection of over current and earth fault relays (iii) Study of Buchholz relays (iv) Measurement of earth resistivity (v) Meggering of installation and equipments (vi) Study and maintenance of breathers (vii) Study of "on load tap changer" for transformer (viii) Study of line construction materials and hardware (ix) Demonstration of conductor jointing (x) Demonstration of cable jointing.	**3 Weeks**

(xi) Study of various type of power fuses, control fuses, kitkat and horn gaps.
(xii) Use of safety equipments and practicals followed for permit on works
(xiii) First aid and fire fighting drills
(xiv) Energy conservation

Part XXVII

ASSESSMENT FORMS (TRAINING PERFORMANCE)

(I) ASSESSMENT FORM FOR ENGINEERS AND SUPERVISORS

Name of the Trainee .....

Period : From ..... to ..... (extended period).

Working in .....

Section .....

Department .....

Item No.	Particulars	Marks allotted	Marks given	Remarks
1	2	3	4	5
I	Punctuality and attendance	+(5)		
	(i) Is he reluctant to continue on overtime	-(1)		
	(ii) Is he in the habit of taking leaves at the eleventh hour	-(1)		
	(iii) Does he insist on compensatory off	-(1)		
II	Intelligence and grasp:			
	(i) Does he have full knowledge of the plant and equipment on which he is working and follows the instructions given to him and can execute them properly	+(10)		
	(ii) Is he industrious, hard working and painstaking			
	(iii) Has he shown any special skill of operation in saving plant and equipment in trouble or emergency	+(5)		
		+(10)		
III	Temperament and behaviour:			
	(i) Behaviour with superiors/colleagues and subordinates	+(5)		
	(ii) Capacity to take quick and correct decisions			
	(iii) Capacity to handle independent responsibility	+(5)		
		+(10)		
IV	Any special qualifications- capacity to execute a particular or difficult job economically, intelligently, resourcefully or with special skill	+(10)		

V	Judgment of the candidate by taking viva-voce test or by asking questions verbally	+(40)

Total marks +100

The marks may be given as below:-

Excellent	91-100%
Very good	71-90%
Good	61-70%
Average	51-60%
Below average	Below 51%

Section-in-charge

(Power Plant)

Special Remarks if any:-

Station Superintendent

(II) ASSESSMENT FORM FOR ENGINEERS/SUPERVISORS

(For use of the Training Department)

(1) Name of the Trainee

.....

(2) Date of birth/age

.....

(3) Training period : From .....(Months)

.....

(4) Technical qualification

.....

.....

.....

.....

(5) Specialisation if any

.....

(6) Practical experience

.....

(7) Marks secured in periodical tests (out of 100):

Test	No.	Date	Written	Viva	On job	Project

(8) Percentage of marks secured in all the tests:

(9) General Remarks and Recommendations:

Director of the Institute

(III) ASSESSMENT FORM FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS

Name of the Trainee .....

Period : From ..... to ..... (extended period).

Working in .....

Section .....

Department .....

Item No.	Particulars	Marks allotted	Marks given	Remarks
1	2	3	4	5
I	Punctuality and attendance:			
	(i) Does he attend the duty punctually and avoids absenting without prior intimation.	+(5)		
	(ii) Is he reluctant to continue on overtime	-(1)		
	(iii) Is he in the habit of taking leaves at the eleventh hour	-(1)		
	(iv) Is he even prepared to take leave without wages	-(4)		
	(v) Whether he availed medical leave often	-(1)		
II	Intelligence and grasp:			
	(i) Does he have full knowledge of the plant and equipment on which he is working and follows the instructions given to him and can execute them properly	+(10)		
	(ii) Is he industrious, hard working and painstaking	+(5)		
	(iii) (a) Has he shown any special skill of operation in saving plant and equipment in trouble or emergency . OR (b) Has he shown any special skill or innovation in any maintenance job.	+(10)		
III	Temperament and behaviour:			
	(i) Behaviour with superiors/colleagues	+(5)		
	(ii) Capacity to take quick and correct decisions by himself or to point out the discrepancies to superiors promptly while attending plant and equipment.	+(5)		
	(iii) Capacity to take independent charge as plant attendants (Name of the plant)	+(10)		

IV	Any special qualifications: (i) Is he suitable for any other plant other than the one mentioned above at III(iii) (ii) Can he record the readings correctly (iii) Is he suitable for any particular skilled maintenance job as an artisan. (iv) Has he specialised in any particular trade such as winder, high pressure welding, etc.	+(10)
V	Judgment of the candidate by taking viva-voce test or by asking questions verbally about power plant and equipment	+(40)
	Total marks	+100

The marks may be given as below:-

Excellent	91- 100%
Very good	71-90%
Good	61-70%
Average	51-60%
Below average	Below 51%

Section-in-charge
(Power Plant)

Special Remarks if any:-

Station Superintendent

(IV) ASSESSMENT FORM FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS

(For use of the Training Department)

(1) Name of the Trainee

.....

(2) Date of birth/age

.....

(3) Training period : From .....to .....(Months)

.....

(4) Highest technical qualification

.....

(5) Specialisation, if any

.....

(6) Practical experience

.....

(7) Marks secured in periodical tests (out of 100):

Test	No.	Date	Written	Viva	On job

(8) Percentage of marks secured in all the tests:

.....

(9) General remarks and recommendations:

Director of the Institute

Schedule-II

Safety measures for operation and maintenance of transmission and distribution system

[See sub-regulation (3) of regulation (7)]

Part I

(1). Duration and content of training shall be as specified below:

(i) Engineers and supervisors – The time allocation and various components of the training course for engineers and supervisors who would be engaged on operation and maintenance of transmission system shall be as given in Part II of this Schedule.

(ii) Technicians – The time allocation and various components of the training course for technicians who would assist the engineers and supervisors in operation and maintenance of transmission system shall be as given in Part III of this Schedule.

(iii) Engineers, Supervisors and Technicians – The time allocation and various components of the training course for engineers, supervisors and Technicians in operation and maintenance of sub-transmission and distribution system shall be as given in Part IV, V and VI of this Scedule.

(iv) Refresher course - The duration and contents of the refresher courses shall be determined jointly by the owner of the said system and training institute.

(v) Visits to factories- As part of practical training the trainees may be taken to factories manufacturing equipments used in transmission and distribution installations.

(vi) Performance of the trainee(s) – The training institutes shall group the syllabus in modules for organising the training. The pass percentage in each module for theory and for project work shall be 50% whereas for on job training and for viva voce it shall be 75%. The sponsor(s) of the trainees may consider the institution of incentives and awards for excellent performance during the training and also for suitable action for sub-standard performance.

(2). Creation of the Institute:

(i) The existing training institutes established for training of personnel engaged in operation and maintenance of generating stations and substations associated with generating stations can create additional facilities for training in transmission and distribution systems.

(ii) Guidelines for such institutes specified under Schedule-I (Item 2) under the heading "Facilities for Creation of training institute" shall also be applicable for institutes which would impart training in transmission and distribution systems.

(3). Assessment forms for engineers and supervisors and for Technicians to assist the engineers and supervisors are given at Part XXVII of Schedule I.

Part II

SYLLABUS FOR ENGINEERS AND SUPERVISORS FOR OPERATION AND MAINTENANCE OF TRANSMISSION SYSTEM

Item No.	Particulars	Number of Hours
1	2	3
I.	General Introduction: (i) World Power Scenario (ii) Growth of Power Industry in India (iii) Generation Scenario in India (iv) Transmission and Distribution Scenario in India (v) Role of Private Power Participants in India (vi) Organisation/Power Sector set up (vii) Introduction to Indian Standard specifications for Electrical wiring (viii) Energy Conversation	6
II.	Power Generation: (i) Types of generation: conventional and non-conventional; Thermal Power Plant: components/ equipments and their brief details and uses, features and characteristics of boiler, turbine, generator, excitation, etc. Brief operational aspects, captive power plants (ii) Hydro Power Plant: components/ equipments and their brief details; features and characteristics of turbine generator, excitation, etc. Brief operational aspects (iii) Gas Power Plant: concept of open cycle and combined cycle; components, characteristics of gas turbines, brief operational aspects, captive power plants (iv) Nuclear Power Plant: salient features (v) Non-Conventional Energy : various sources, working principle, electricity generation (vi) Co-generation, optimal mix of different types of generation, base load and peak load operation	18
III.	Power Transmission: (1) HVAC and HVDC Transmission System (i) Brief history of EHV transmission system in India (ii) Tower types A, B, C, D and special towers (iii) Conductors/Earthwire and their accessories, types, configuration, transposition, selection criteria (iv) Insulators and hardware fittings: types, strength, details (v) Right of way, CEA (Measures relating to Safety and Electric Supply) Regulations, 2010 and Acts, statutory clearances from other agencies, compensation, etc. (vi) Surveying, route alignment, profiling, tower spotting (vii) Benching and soil classification, soil investigation and soil resistivity measurement. (viii) Tower design and testing, quality checks	30

(ix) Tower erection hardware and accessories, fitting procedures, stringing, clearances, commissioning

(x) Operation and Maintenance of Transmission Line : line patrolling, routine checks, filling log books, T & P, thermovision scanning, fault failure analysis, hot line maintenance, case studies

(xi) Development of HVDC technology, economics, comparison with HVAC systems, principles of HVDC conversion, HVDC lines, HVDC sub-stations - converters, reactive power considerations, HVDC system, operation and control, maintenance, AC and DC harmonics and filtering, protection system, insulation, coordination, emergencies and case studies.

(xii) FACTS (Flexible AC Transmission System)

(2) Sub - Stations (765kV/400 kV/220kV/132kV) 75

(i) Types : generation sub-station, grid sub-station, mobile sub-station, gas insulated sub-station, HVDC sub-station, indoor/outdoor, etc., general comparison

(ii) General arrangement and layout of switchyard, switching schemes, single line diagram

(iii) Power Transformers and Reactors

(a) Types : major components, constructional details, functions

(b) Design and selection, specification and rating

(c) Bushings, On Load Tap Changers (OLTC), Buchholz relay, conservator, breather, thermo syphon filter, indicators, etc.

(d) Cooling arrangements - methods of cooling, pumps, fans, radiators, etc.

(e) Transformer tests

(f) Introduction to relevant Indian Standards

(iv) Switchgears and Introduction to relevant Indian Standard

(a) Circuit Breaker: types (MOCB, ABCB, VCB, SF_6), constructional details, layout arrangement, connection to bus, design, selection parameters, ratings/ specifications, interlocks and introduction to relevant Indian Standard

(b) Isolator: types (Vertical, Horizontal, Pantography Breaks, constructional details, Earth switch, interlocks, design/selection, ratings/specifications

(c) Bus bar types, construction, supports, insulators, connectors, jumpers, safety clearances, design/selection, ratings/specifications

(d) CT/CVT/Lightning Arrestor/Lightning Mast: Types, constructional details, use, location, selection/design, ratings/specifications

(e) Power Line Carrier Communication (PLCC): principle, purpose, types of coupling and choice of components, use and operation of PLCC system, modules of PLCC panels, ratings/specifications

(f) Meters, Indicators, and Recorders: types and functional description of all types of meters, indicators and recorders-Voltmeter, Ammeter, Frequency Meter, Wattmeter, Energy meter, Event logger (EL), Disturbance Recorder (DR), Fault Locator (FL), indicators and knowledge of relevant Indian Standard

(g) Relays: types, functions, constructional details, selection, ratings/ specifications, testing and setting of relays and knowledge of relevant Indian Standard

(h) Protection System Philosophy: types, design, protection schemes, tripping schemes, protection of transformers/reactors, motors, feeders, generator bus, etc.

(v) Grounding: types of grounding, earth testing and treatment, earth mat design, step potential, touch potentials, transfer potentials, neutral grounding factor.

(vi) Auxiliary facilities

(a) DG set

(b) Fire fighting system - types of fire, extinguisher, Emulsifier system, deluge system, fire fighting system for transformer/reactor, oil storage system, control room, office building, etc.

(c) Station Battery System

(d) LT supply

(e) Air Conditioning System

(f) Compressed Air System (service air system, instrument air system)

(vii) Control Room: layout, arrangement of equipments/panels, false ceiling and flooring, fire safety measures, Air-conditioning, Uninterrupted Power Supply (UPS), computer and its peripherals, lighting /emergency lighting

(viii) Cables: types, control cables, power cables, layout, trench/gallery arrangement, cable ratings, selection, and cable termination and jointing.

(ix) Compensating devices: shunt reactor/capacitor, series reactor/ capacitor, static var compensators (SVC)

(x) Sub-station operation: operational aspects of all equipments/systems, salient features and parameters, limiting values, control room operation, local/remote operation, operational guidelines/procedures, and synchronisation, grid operation, communication with RLDC/ SLDC, etc., permit to work, line clear procedure, maintenance of log books, records , tripping reports, shift procedures, monitoring, duties /responsibilities of sub-station staff, interlocks and sequential operation, operational problems, operation under emergency, case studies.

(xi) Sub-station Maintenance:

(a) Need, philosophy, types- routine, preventive, planned, predictive, break-down, emergency maintenance, comparisons, life expectancy curves

(bathtub curves), tools and tackles, testing instruments, safety devices, sampling equipments, test kits, visual checks, condition monitoring techniques, on-line maintenance, daily/weekly/ monthly/quarterly/half yearly/annual maintenance of different equipments, planning the maintenance activities, preparation of maintenance estimates, budgeting for control, maintenance records, history

(b) spare parts management

(c) Transformer and Reactor Maintenance-factors affecting the life of transformer/reactor, types of faults that can occur, reasons for breakdown, visual checks/ inspection/ preliminary testing of various components- oil sampling and testing, oil filtration, Dissolved Gas Analysis (DGA), maintenance Schedule, fault rectification, need for major overhaul and methods

(d) Switchgear and Protection Maintenance : maintenance of CB, isolator, earthswitch, support insulators, CT/CVT, LA. Lightning Mast (LM), meters/ recorders, PLCC, protective relay maintenance, protection system maintenance

(e) Maintenance of auxiliaries and other systems- battery and charging system, DG set, air conditioning plant, compressed air system, fire fighting system, switchyard – lighting, control room, earth resistance testing, cables, compensating devices.

(xii) Erection and commissioning of sub-station, Project Evaluation and Review Technique (PERT), Critical Path Method (CPM), charts, project monitoring, erection, pre-commissioning checks/tests, commissioning, synchronisation.

(xiii) Civil works – surveying, site selection, soil investigation, general layout and architectural drawing, switchyard foundation, cable trench design, oil pit, control room building, DG set building, Fire fighting system and AC system- design, design and construction of roads, drains, water supply pipe lines, fencing/compound wall.

3. Load Dispatch and Communication 18

(i) Load Dispatch Centres- functions, SLDC/RLDC, NLDC, pre-dispatch, during-dispatch, post dispatch functions

(ii) Supervisory Control and Data Acquisition (SCADA) System, RTU, front end computers, main computers, visual display units, mimic boards

(iii) Energy Management System- functions

(iv) Load forecasting, generation scheduling, load management, load shedding

(v) Hydro - thermal scheduling

(vi) Voltage/frequency control

(vii) Reactive Power Management

(viii) Grid Management - problems/solutions
(ix) Operational co-operation, import/export of energy, role of tariff in system operation
(x) Maintenance, on-line maintenance
(xi) Grid disturbances- case studies
(xii) Software tools

Communication System: types- PLCC, microwave, leased lines, fibre optics, satellite, V-SAT Communication, comparison, characteristics, modules, planning criteria, selection criteria , RTUs, modems, baud rate, communication protocols, data exchange, system noise and interference, integrated communication system, O&M of communication system, protocol details, telemetry, tele-control and tele-protection.

IV. Commercial Aspects And Contracts 24

(1) Commercial Aspects

(i) Introduction to commercial aspects of power system/distribution system
(ii) Tariff Structure, types, components, methods of working out, revenue realization
(iii) Energy accounting, Availability Based Tariff (ABT), inter-utility tariff, commercial disputes and solutions
(iv) Inventory planning and control, bill of materials, purchase procedures, standardization and codification of stores
(v) Resource mobilisation through bonds/ debentures/shares.
(vi) Cost Engineering, costing and control, estimation, estimates for providing service (LT/HT) connections, street lighting.
(vii) Electricity Rules and Regulations, Enactment
(viii) Budget types, budgeting procedure, appropriation, budget control.
(ix) Accounting, auditing.

(2) Contracts 12

(i) Contract basics, terminology
(ii) Qualification- requirement, pre-qualification, bids, evaluation
(iii) Notice Inviting Tender (NIT), Notice Inviting Quotation
(iv) Preparation of bid documents, tendering/ bidding
(v) Bid opening, bid evaluation, award of contract, monitoring of contract.
(vi) Contractual obligations/liquidation, guarantee /warranty
(vii) Vendor - qualification, development
(viii) Contractual problems and solutions
(ix) Revised cost estimation, justification for cost/time over-run, substitute items
(x) Handing/taking over procedures, closing of contract
(xi) Legal issues of contracts, arbitration

V. Management: 12

(i) Principles of management, leadership, effective

	communication, motivation, decision making, strategic management (ii) Management Information System (iii) Project Management (iv) Finance Management (v) Construction Management (vi) Materials Management (vii) Total Quality Management	
VI.	System Planning and New Technologies: (1) System Planning (i) Introduction to power system planning requirements and methods (ii) Load forecasting and techniques (iii) Load flow studies for planning (iv) Preparation of feasibility report (FR), Detailed Project Report (DPR) (v) Approval/clearance of projects	6
	(2) New Technologies: (i) Latest development in transmission system design, material, component, system, tariff, operation, maintenance (ii) Latest developments in distribution system design, components, meters, system, tariff, operation, maintenance (iii) Latest developments in power system, communication, application of computers to power system.	6
	Total	207 Hours ≅ **7 Weeks**
VII.	On Job Training: (1) System Operation (On job) (A) Sub-Station (Generating/Grid/Distribution) (i) Layout, equipment familiarisation (ii) Details, functioning, specification and different parameters of switchyard, control room, auxiliary system equipments (iii) Shift handing/taking over, logging of parameters, routine checks on equipments/ systems (iv) Operational aspects of equipments /systems, synchronization, grid operation, charging procedure (v) Line/feeder connections, protection schemes, loading aspects, etc. (vi) Salient features and operational aspects of HVDC sub-station.	**3 Weeks**
	(B) Load Dispatch and Communication (i) Load Dispatch Centre (NLDC/RLDC/SLDC): set up, functioning (ii) Supervisory Control and Data Acquisition (SCADA) and Energy Management System (EMS) functioning (iii) Load forecasting	

(iv) Generation scheduling
(v) Voltage and frequency control activities
(vi) Communication system operation
(vii) System Software
(viii) Shift operation

(2) System Maintenance (On job) **3 Weeks**

(A) Sub-Station Maintenance
(i) Visual checks, routine, preventive, planned, break-down maintenance of equipments/system
(ii) Transformer, reactor, switchgear, relays, protection system and auxiliary facilities.
(iii) Maintenance schedules
(iv) Referring log books/history records for maintenance.
(v) Testing Lab facilities, testing and commissioning.
(vi) Procedure for permit to work/line clear.
(vii) Safety devices and practices.

(B) T&D Line/Cable Maintenance
(i) Line patrolling, thermovision scanning, hot spots, hardware replacement procedure, T&P.
(ii) Emergency Restoration System (ERS)
(iii) Hot Line Maintenance.
(iv) Industrial visits and evaluation

Part III

SYLLABUS FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS IN OPERATION AND MAINTENANCE OF TRANSMISSION SYSTEM

Item No.	Particulars	Number of Hours
1	2	3
I	General introduction: (i) Functions of State Electricity Board/Utility (ii) Introduction to Electricity Act, 2003, and CEA (Measures relating to Safety and Electric Supply) Regulations, 2010.	6
II	Substation and Equipments: (i) Substations (a) Sub-stations, selection of site, clearances and control room (b) Sub-stations 33 kV to 765 kV (c) Selection of voltage level for sub-station and layouts (ii) Equipments: (a) Control/relay panels and meters (b) Switch gear, breakers (c) Isolators (d) Cables-types, construction and jointing (e) Power capacitors (f) Lightning arrestors (g) CT, PT and carrier communication.	12

III	Transformers (Power and Distribution) (i) Types of transformers and parallel operations (ii) Cooling and drying out of transformers (iii) Testing of transformers (iv) Maintenance of transformers (v) Protection of transformers (vi) Failures of transformers	12
IV	Circuit Breakers, Isolators and Relays (i) Principle and construction (ii) Types of circuit breakers (iii) Maintenance of circuit breakers (iv) Relays - various types and functions (v) Maintenance of isolators	12
V	Storage Batteries: Need, Functions, commissioning and maintenance	6
VI	Earthing: Sub-station earthing, equipment earthing and Consumer earthing and procedure for improving quality of earth resistance	3
VII	Safety and fire fighting (1) Safety (i) Basic principle of safety, importance of safety rules and their observation (ii) List of safety equipment, their use and maintenance thereof (iii) Permit procedure (iv) Self permit, permit on phone and procedures to be observed (v) Electric shock and safety. (vi) Causes of accident, precautions to be taken to avoid accidents while working. (2) Fire fighting: (i) Principle and causes of fire, class of fires, ie., A, B, C. Precautions to be taken to avoid fire (ii) Fire fighting equipments, their type and use, their periodical maintenance	6
VIII	Transmission and Distribution (Line-Construction and Maintenance) (1) Construction (i) Survey of HT, LT Lines and service lines and cables, crossing such as road, railway, river, etc. (ii) Selection of materials and poles for lines and handling of materials (iii) Pole erection, size of pit, concreting, pole alignment, etc.	18

	(iv) Types of stays, their marking, grouting, stay insulator binding, etc. (v) Types of conductors and their parameters such as current carrying capacity, etc., cables-types and joints. (vi) Type of guarding and clearances, anticlimbing devices, danger board, etc. (vii) Erection of transformer DP structure (viii) Patrolling, line meggering and commissioning of power lines	
	(2) Line Maintenance (i) Fuse grading necessity and its benefits (ii) Patrolling, tree cutting and safe clearances (iii) Guarding of lines, clearances and maintenance, attending to breakdowns. (iv) Importance and maintenance of air-break switch, dropout fuse set, dist. box etc. (v) Pre-monsoon maintenance - necessity and procedure thereof (vi) Balancing of load using tong tester	
	(3) Service Connection, theft of energy (i) Types of service connections (overhead, underground, High Tension/ Low Tension, Single phase, Three phase) (ii) Point of supply, testing of Consumers' wiring and earthing terminals (iii) Materials required for service connection, fuse grading, underground cable connections (feeder pillar, mini pillar, junction box.) (iv) Theft of energy, preventive measures, unauthorized extensions (v) Consumer relations and dealing with Consumer problems	
IX	Duties of staff Duties of staff, assisting supervisory an operating staff and maintenance of records	6
X	Human Resource Development (i) Personal development and motivation (ii) Communication skill and its importance (iii) Attitudinal training	9
	Total	90 Hours ≅ **3 Weeks**
XI	On Job Training, industrial visits and evaluation: (1) Study Visits - after introduction (i) 1st visit :11 kV and 33 kV sub-station (ii) 2nd visit : 66 kV and 132 kV sub-station (iii) 3rd visit : 220 kV and 400 kV sub-station	**3 Weeks**

(2) Study and practicals

(i) Measurement of current, voltage, power, energy, frequency and power factor
(ii) Testing and connection of relays
(iii) Study of Buchholz relays
(iv) Measurement of earth resistivity
(v) Meggering of installation and equipments
(vi) Study and maintenance of breathers
(vii) Study of "on load tap changer" for transformer
(viii) Study of line construction materials and hardware
(ix) Demonstration of conductor jointing
(x) Demonstration of cable jointing.
(xi) Study of various type of power fuses, control fuses, kitkat and horn gaps.
(xii) Use of safety equipments and practicals followed for permit on works
(xiii) First aid and fire fighting drills

Part IV

SYLLABUS FOR ENGINEERS ENGAGED IN THE OPERATION AND MAINTENANCE OF SUB-TRANSMISSION AND DISTRIBUTION SYSTEM

Item No.	Particulars	Number of Hours
1	2	3
I	Overview of Power Sector Scenario: (i) Growth of Power Industry in India (ii) Organisation/ Power Sector set-up in India (iii) Electricity Distribution in India (iv) Private Participation in Distribution (v) Distribution Reforms in India.	3
II	Regulatory Environment – Rules and Regulations: (i) Electricity Act,2003 – Provisions relating to electricity distribution (ii) Role of Regulatory Commissions (iii) CEA(Measures relating to Safety and Electric Supply) Regulations, 2010 – Relating to electricity distribution. (iv) Energy Conservation Act	3
III	Distribution planning and optimization: (i) Philosophy of distribution planning. (ii) Acquaintance with software for distribution planning and optimisation. (iii) Operation of software. (iv) Data entry formats and report generation. (v) Case study.	30
IV	Sub-transmission and Distribution Lines: (i) Supports-towers/ poles: (a) Types and selection criteria (b) Surveying and erection	15

(ii) Line conductor/ cables:
(a) Classification
(b) Selection criteria
(c) Conductor stringing, jointing/ binding, sagging and tensioning, clipping and jumpering
(d) Earthing arrangements
(iii) Cable – types, selection, cable trenches, cable routing and laying, cable jointing and junction box
(iv) Earth wire/ neutral wire, guarding, etc.
(v) Selection and fixing of control devices, viz. Gang Operating Switches, fuses, isolators and earthing switches, lightning arrestors, and distribution box, etc.
(vi) Installation of service lines.
(vii) Street Lighting – design and layout methods.
(viii) Statutory clearances, viz. Environment and forest, local bodies, railway and telegraph crossings, river crossings, clearances under CEA (Measures relating to Safety and Electric Supply) Regulations, 2010, Acts.
(ix) Line/ cable maintenance including hot line maintenance – line patrolling, inspection, periodicity, work permit, line clear and authorisation, erection of temporary earth and restoration of supply, maintenance T&P and safety devices, thermo vision scanning, hot spots, etc.

V Electric Sub-Stations (33 kV and below): 15
(i) Type, site selection , layout and civil Engineering requirements.
(ii) Bus bar arrangement, sub-station equipment, viz. transformers, circuit breakers, etc.
(iii) Auxiliary systems, viz. DG set, battery system and fire fighting system, etc.
(iv) Control panel, meters, indicators and recorders and relays, etc.
(v) Erection, testing and commissioning of equipments/systems
(vi) Earthing of sub-stations equipments and soil testing
(vii) Transformer oil and its testing
(viii) Operation and maintenance of all equipments, protective relays and auxiliaries.

VI Metering Requirements: 6
(i) Type of metering, viz. DT metering, feeder metering and Consumer metering.
(ii) Regulations on installation of meters and technical standards
(iii) Meter types, their settings and operation, testing and sealing.
(iv) Selection of meter and metering equipment
(v) Familiarity with hardware (CMRI) and software for meter data download, analysis and detection of meter tampering
(vi) Role of advanced metering system in controlling commercial losses

VII	Concept of Losses and Loss Reduction Measures: (i) Concept of AT& C losses (ii) Segregation of losses. (iii) Technical loss reduction measures. (iv) Reactive power management. (v) Detection of thefts, tampering, unauthorized loads (vi) Anti-theft measures and case studies (vii) Commercial loss reduction measures. (viii) Penalties under the Act for theft and misuse of power. (ix) Energy audit and accounting. (x) Demand side management.	9
VIII	Reliability Issues, Quality of Power Supply, Customer Awareness and Satisfaction: (i) Reliability and quality of power supply and reliability indices. (ii) Causes and cures for breakdowns, tripping and voltage and frequency fluctuation. (iii) Creating customer awareness (iv) Prompt attendance to faults. (v) Overview of the Electricity Supply Codes of Regulatory Commissions.	6
IX	IT Intervention: (i) Familiarisation with distribution software packages and latest software tools and use thereof for billing and revenue realisation, GIS mapping and Consumer indexing, inventory control, keeping track of equipments failure rate, quick fault location, attendance, staff salary, energy accountability and MIS etc. (ii) SCADA – RTU, communication and distribution automation. (iii) Customer care and call centres.	12
X	Rural Electrification: (i) Outsourcing of distribution activities, appointment of franchisees and self load management by villagers and Gram Panchayats (ii) Maintenance of complaint centres and fault removal, etc., by village Panchayats etc. (iii) Separation of rural and urban supply system (iv) Fixation of responsibility for energy receipt and supply balance. (v) Rajiv Gandhi Grameen Vidyutikaran Yojana. (vi) Distributed generation.	9
XI	Project Management: Contracts: (i) Contract basics and terminology (ii) Qualification – requirement, pre-qualification (iii) Bids – Technical and Commercial	9

	(iv) Vendors – qualification, development	
	(v) Notice Inviting Tenders(NIT)/ Notice Inviting Quotations(NIQ)	
	(vi) Preparation of Bid Documents, tendering/ bidding	
	(vii) Bid opening and evaluation, Award of contracts, monitoring of contracts	
	(viii) Contractual obligations/ liquidation, guarantee/ warranty	
	(ix) Contractual problems and solutions	
	(x) Revision of cost estimates, justification of cost/ time overrun and substitute items	
	(xi) Handling/taking over procedures, closing of contracts	
	(xii) Legal issues of contracts and arbitration	
	(xiii) CVC Guidelines.	
XII	Disaster Management:	3
	(i) Institutional set-up for disaster Management	
	(ii) Impact of different types of disasters	
	(iii)Trigger mechanism and warning system	
	(iv)Check list and preparedness to address disasters.	
	(v) First aid techniques.	
XIII	Electrical Safety Aspects:	9
	(i) Basic principles of safety, importance of safety rules and their observance.	
	(ii) List of safety equipment, their use and maintenance thereof.	
	(iii) Permit procedure - self permit, permit on phone and procedures to be observed.	
	(iv) Electric shock, safety and procedure for recovery/ resuscitation.	
	(v) Causes of accidents, safe working procedures to avoid accidents.	
	(vi) Principle and causes of fire, and precautions to be taken to avoid fires.	
XIV	Field Visits and on-job training:	66
	(i) Familiarisation with layout of sub-stations and equipments	
	(ii) Operational aspects of equipments/ systems and synchronization	
	(iii) Line/ feeder connections, protection schemes, loading aspects, balancing of loads	
	(iv) Planning shift operations.	
	(v) Maintenance schedules	
	(vi) Procedures for permit to work/ line clear	
	(vii) Testing lab facilities, testing and commissioning	
	(viii) Maintenance of Log Books/ history records and adherence to the timely recording.	
	(ix) Familiarisation with IT tools.	
	Total	195 Hours ≅ **6 ½ Weeks**

Part V

SYLLABUS FOR SUPERVISORS ENGAGED IN THE OPERATION AND MAINTENANCE OF SUB-TRANSMISSION AND DISTRIBUTION SYSTEM

Item No.	Particulars	Number of Hours
1	2	3
I	Overview of Power Sector Scenario (i) Growth of Power Industry in India. (ii) Organisation/ Power Sector set-up in India. (iii) Electricity Distribution in India (iv) Private Participation in Distribution. (v) Distribution Reforms in India.	3
II	Distribution Planning and Optimisation: (i) Philosophy of distribution planning. (ii) Acquaintance with software for distribution planning and optimisation. (iii) Operation of software. (iv) Data entry formats and report generation. (v) Case study.	6
III	Sub-transmission and Distribution Lines: (i) Supports-towers/ poles (a) Types and selection criteria (b) Surveying and erection (ii) Line Conductor/ Cables – (a) Classification (b) Selection criteria (c) Conductor stringing, jointing/ binding, sagging and tensioning, clipping and jumpering (d) Earthing arrangements (iii) Cables – types, selection, cable trenches, cable routing and laying, cable jointing and junction box (iv) Earth wire/ neutral wire, guarding, etc. (v) Selection and fixing of control devices, viz. Gang Operating switches, fuses, isolators and earthing switches, lightning arrestors, and distribution box, etc. (vi) Installation of service lines. (vii) Street Lighting – design and layout methods. (viii) Statutory clearances, viz. environment and forest , local bodies, railway and telegraph crossings, river crossings, clearances under Safety and Electric Supply Regulations/Acts. (ix) Line/ cable maintenance including hot line maintenance – line patrolling, inspection, periodicity, work permit, line clear and authorisation, erection of temporary earth and restoration of supply, maintenance T&P and safety devices, Thermo vision scanning, hot spots, etc.	9

IV	Electric Sub-Stations (33 kV and below): (i) Type, site selection , layout and civil Engineering requirements. (ii) Bus bar arrangement, sub-station equipment, viz. transformers, circuit breakers, etc. (iii) Auxiliary systems, viz. DG set, battery system and fire fighting system, etc. (iv) Control panel, meters, indicators and recorders and relays, etc. (v) Erection, testing and commissioning of equipments/systems (vi) Earthing of sub-stations equipments and soil testing (vii) Transformer oil and its testing (viii) Operation and maintenance of all equipments, protective relays and auxiliaries.	9
V	Metering Requirements: (i) Type of metering, viz. DT metering, feeder metering and Consumer metering. (ii) Regulations on installation of meters and technical standards (iii) Meter types, their settings and operation, testing and sealing.	3
VI	Concept of Losses and Loss Reduction Measures: (i) Concept of AT&C losses (ii) Segregation of losses. (iii) Technical loss reduction measures. (iv) Reactive power management. (v) Detection of thefts, tampering, unauthorized loads (vi) Anti-theft measures and case studies (vii) Commercial loss reduction measures. (viii) Penalties under the Act for theft and misuse of power. (ix) Energy audit and accounting. (x) Demand side management.	6
VII	Reliability Issues, Quality of Power Supply, Customer Awareness and Satisfaction: (i) Reliability quality of power supply and reliability indices. (ii) Causes and cures for breakdowns, tripping and voltage and frequency fluctuation. (iii) Creating customer awareness (iv) Prompt attendance to faults. (v) Overview of the Electricity Supply codes of Regulatory Commissions.	3
VIII	IT Intervention: (i) Familiarisation with distribution software packages and latest software tools and use thereof for billing and	6

revenue realisation, GIS mapping and Consumer indexing, Inventory control, keeping track of equipments failure rate, quick fault location, attendance, staff salary, Energy accountability and MIS, etc.

(ii) SCADA – RTU, communication and distribution automation.

(iii) Customer care and call centres.

(iv) Enterprise resource planning-
(a) Maintenance Management
(b) Asset Management
(c) Training Management
(d) Financial Accounting
(e) Material Management
(f) Outage Management
(g) Time Management

IX Rural Electrification: 3

(i) Outsourcing of distribution activities, appointment of franchisees and self load management by villagers and Gram Panchayats.

(ii) Maintenance of complaint centres and fault removal, etc., by Village Panchayats, etc.

(iii) Separation of rural and urban supply system

(iv) Fixation of responsibility for energy receipt and supply balance.

(v) Rajiv Gandhi Grameen Vidyutikaran Yojana.

(vi) Distributed generation.

X Project Management: Contracts: 3

(i) Contract basics and terminology

(ii) Qualification – requirement, pre-qualification

(iii) Bids – technical and commercial

(iv) Vendors – qualification, development

(v) Notice Inviting Tenders(NIT)/ Notice Inviting Quotations(NIQ)

(vi) Preparation of bid documents, tendering/ bidding

(vii) Bid opening and evaluation, award of contracts, monitoring of contracts

(viii) Contractual obligations/ liquidation, guarantee/ warranty

(ix) Contractual problems and solutions

(x) Revision of cost estimates, justification of cost/ time overrun and substitute items

(xi) Handling/taking over procedures, closing of contracts

(xii) Legal issues of contracts and arbitration

(xiii) CVC Guidelines.

XI Disaster Management: 3

(i) Institutional set-up for disaster management

(ii) Impact of different types of disasters

(iii) Trigger mechanism and warning system
(iv) Check list and preparedness to address disasters.
(v) First aid techniques.

XII	Electrical Safety Aspects: (i) Basic principles of safety, importance of safety rules and their observance. (ii) List of safety equipment, their use and maintenance thereof. (iii) Permit procedure- self permit, permit on phone and procedures to be observed. (iv) Electric shock, safety and procedure for recovery/ resuscitation. (v) Causes of accidents, safe working procedures to avoid accidents. (vi) Principle and causes of fire, and precautions to be taken to avoid fires.	6
XIII	Field Visits and On-Job Training: (i) Familiarisation with layout of sub-stations and equipments (ii) Operational aspects of equipments/ systems and synchronization (iii) Line/ feeder connections, protection schemes, loading aspects, balancing of loads (iv) Planning shift operations. (v) Maintenance schedules (vi) Procedures for permit to work/ line clear (vii) Testing lab facilities, testing and commissioning. (viii) Maintenance of Log Books/ history records and adherence to the timely recording. (ix) Familiarization with IT tools.	60
	Total	120 Hours ≅ 4 **Weeks**

Part VI

SYLLABUS FOR TECHNICIANS ENGAGED IN THE OPERATION AND MAINTENANCE OF SUB-TRANSMISSION AND DISTRIBUTION SYSTEM

Item No.	Particulars	Number of Hours
1	2	3
I	Overview of Power Sector Scenario: (i) Growth of Power Industry in India. (ii) Organisation/ Power Sector set-up in India. (iii) Electricity Distribution in India (iv) Private Participation in Distribution. (v) Distribution Reforms in India.	3
II	Sub-transmission and Distribution Lines: (i) Survey for lines at voltage upto 250 V, lines at voltage above 650 Volts but less than 33kV and for service lines and cables and crossings such as road, railway, river and other power and telecom lines. (ii) Selection of line materials and towers/ poles and safe handling of the same. (iii) Erection of towers/ poles – size of pit, concreting and pole/tower alignment, etc. (iv) Line Conductors – types, selection criteria, conductor stringing, jointing/ binding, sagging and tensioning, clipping and jumpering and earthing arrangements. (v) Types of stays, its marking, grouting, stay insulator, binding, etc. (vi) Cable – types, selection, cable trenches, cable routing and laying, cable jointing and junction box, etc. (vii) Types of guarding and clearances, earth wire/ neutral wire, anti-climbing devices and danger boards and their erection. (viii) Selection and fixing of control devices, viz. Gang Operating Switches, fuses, Isolators and earthing switches, lightning arrestors, and distribution box, etc. (ix) Installation of service lines. (x) Street lighting – layout methods. (xi) Line meggering and commissioning of distribution lines. (xii) Line patrolling, inspection, periodicity, work permit, line clear and authorisation, tree cutting and safe clearances, erection of temporary earth, attending to breakdowns and restoration of supply. (xiii) Maintenance T&P and safety devices, Thermo vision scanning, hot spots, etc. (xiv) Hot line maintenance.	9
III	Electric Sub-Stations (33 kV and below): (i) Type, site selection, layout and civil Engineering requirements.	9

(ii) Bus bar arrangement, sub-station equipment, viz. transformers, circuit breakers, isolator, lightning arrestors, CTs, PTs and power capacitors, etc.,
(iii) Types of transformers, their erection and parallel operation, testing, maintenance, protection and failure.
(iv) Auxiliary systems, viz. DG set, battery system and fire fighting system, etc. – need, functions, commissioning and maintenance.
(v) Control panels, meters, indicators, recorders and relays, etc. – operation, maintenance and recording readings, etc.
(vi) Control and power cables – types, laying of and jointing.
(vii) Installation , operation and maintenance of all equipments.
(viii) Cooling and drying out of transformers, transformer oil and its testing.
(ix) Erection of DP structure for transformer.
(x) High Voltage Distribution System (HVDS) – erection and connecting the Consumers.
(xi) Sub-station earthing, equipment earthing and Consumer's earthing, and use of Megger and procedure and materials for improving quality of earth resistance.
(xii) Fire fighting equipment, their type, use and periodical maintenance, indicators and recorders and relays, etc.

IV Metering Requirements: 3
(i) Type of metering, viz. DT metering, feeder metering and Consumer metering.
(ii) Regulations on installation of meters and technical standards
(iii) Meter types, their settings and operation, testing and sealing.
(iv) Computerised billing.

V Concept of Losses and Loss Reduction Measures: 3
(i) Concept of AT&C losses.
(ii) Detection of thefts, tampering, unauthorized loads.
(iii) Anti-theft measures and case studies.

VI Reliability issues, Quality of Power Supply, Customer Awareness and Satisfaction: 3
(i) Introduction to reliability and quality of power supply.
(ii) Causes and cures for breakdowns, tripping and voltage and frequency fluctuation.
(iii) Prompt attention to faults and customer care.

VII Electrical Safety Aspects: 12
(i) Basic principles of safety, importance of safety rules and their observance.

	(ii) List of safety equipment, their use and maintenance thereof.	
	(iii) Permit procedure- self permit, permit on phone and procedures to be observed.	
	(iv) Electric shock, safety and procedure for recovery/ resuscitation.	
	(v) Causes of accidents, safe working procedures to avoid accidents.	
	(vi) Principle and causes of fire, and precautions to be taken to avoid fires.	
VIII	Rural Electrification:	3
	(i) Separation of rural and urban supply systems.	
	(ii) Rajiv Gandhi Grameen Vidyutikaran Yojana.	
IX	Disaster Management:	3
	(i) Impact of different types of disasters.	
	(ii) Check list and preparedness to address disasters.	
	(iii) First aid techniques.	
X	Field Visits and On Job Training:	60
	(i) Familiarisation with layout of sub-stations and equipments.	
	(ii) Operational aspects of equipments/ systems and synchronization.	
	(iii) Line/ feeder connections, protection schemes, loading aspects, balancing of loads.	
	(iv) Adherence to shift system.	
	(v) Maintenance schedules.	
	(vi) Procedures for permit to work/ line clear.	
	(vii) Testing lab facilities, testing and commissioning.	
	(viii) Safety aspects and safety drill.	
	(ix) Hot line maintenance.	
	(x) Maintenance of Log Books/ history records and adherence to the timely recording.	
	(xi) Familiarisation with Tools and Plants (T&P).	
	(xii) Familiarisation with IT tools.	
	Total	108 Hours ≅ **4 Weeks**

Schedule-III

Handling of electric supply lines and apparatus

[See sub-regulation (3) of regulation (19)]

Precautions to be observed

(1) Hotline Maintenance trained personnel only are designated to do work on line.
(2) Work permit will be taken from the terminal substations at each end of the line.
(3) Work shall be performed with proper planning and prior understanding and clarity.

(4) Favourable climatic condition for hotline operations is sunny weather. If the weather forecasts rain or thunderstorms work will not begin.
(5) Organisation of work shall be discussed among the members and responsibility of each team member fixed.
(6) Before going to the work site all equipment and tools shall be inspected and checked for correct operation.
(7) Auto re-closure shall be in 'OFF' position for the line at both ends.
(8) The work procedure shall be discussed with the team member at the tower location and the responsibility of each member shall be properly defined.
(9) The land in close vicinity to the tower shall be cleared to provide a site area for the required tools.
(10) All cleaned hot sticks, strain carrier and other assemblies shall be kept on the hotline tool rack to avoid ground contact.
(11) Wear helmet, safety shoes and safety belt shall compulsorily be used.
(12) All hot sticks and ladders shall be cleaned and checked for integrity by the hot sticks Tester.
(13) All linemen in the hotline team shall be equipped with personal protective equipment during the work.
(14) No live-line team members on the tower and conductor shall wear any metallic chain, wristwatch or ring to avoid any circulating current.
(15) The team linemen will wear conductive socks, boots, helmets and hand gloves. The 'hot-end' lineman shall wear complete bare hand suit.
(16) Tarpaulin sheet should be laid on the work area.
(17) A light vehicle shall be kept nearby during entire work period.

Tools normally required for hot line maintenance operation :

The following tools conforming to relevant Indian Standard or equivalent specifications shall be used in on-line working.

(1) Wire tongs
(2) Wire tongs saddle
(3) Tie sticks
(4) Strain link sticks
(5) Roller link sticks
(6) Suspension link sticks
(7) Auxiliary arms
(8) Strain carrier
(9) Gin poles
(10) Cum-a-along clamp
(11) Safety equipment like conductor guards, X-arm guards, insulator covers, hand gloves etc.
(12) Hot sticks

Safe Working Distance :

The following safe working distances shall be observed

Phase to Phase	Safe Clearance
kV	Meter
11	0.61
33	0.71
66	0.91
110	1.02
132	1.07
220	1.52
400	2.13

Schedule-IV

Forms of Inspection Report
[See sub-regulation (3) of regulation (30)]

FORM I
(Installations of voltage up to and including 250V)

Report No. _____ Date of Inspection _____

Date of Last inspection _____

1. Consumer No. _____
2. Voltage and system of supply:
   (i) Volts _____
   (ii) No. of Phases _____
   (iii) AC/DC _____
3. Type of wiring
4. Name of the consumer or owner _____
5. Address of the consumer or owner _____
6. Location of the premises _____
7. Particulars of the installations: _____

		Number	Connected Load in KW
(a)	(i) Light Points	_____	_____
	(ii) Fan Points	_____	_____
	(iii) Plug Points	_____	_____

State type of wiring whether casing capping, lead covered of teak wood batten, concealed conduit, Tough Rubber Sheathed and any other type.

(b) Other equipments (complete details to be furnished):
   (i) _____
   (ii) _____

Total connected load in KW _____

Maximum current demand in Amps _____

(on the basis of total connected load)

(c) Generators details i.e. Make, S. No, KVA rating and Voltage:

(i) _____
(ii) _____

General conditions of the installation:

Sl. No.	Regulation Nos.	Requirements	Report
8.	Regulation-12	(i) Is/Are there any visible sign(s) of overloading in respect of any apparatus wiring?	Yes/No
		(ii) Condition of flexible cords, sockets, switches, plug-pins, cut-outs and lamp holders and such other fittings.	Satisfactory/Not Satisfactory
		(iii) General condition of wiring.	Satisfactory/Not Satisfactory
		(iv) Whether any unauthorised temporary installation exist?	Yes/No
		(v) State if sockets are controlled by individual switches.	Yes/No
		(vi) Any other defect or condition which may be a source of danger. If yes give details.	Yes/No
9.	Regulation-13	Give report on condition of service lines, cables, wires, apparatus and such other fittings placed by the supplier or owner of the premises. If not satisfactory give details.	Satisfactory/Not Satisfactory
10.	Regulation-14	Whether suitable cut-outs provided by the supplier at the consumer's premises are within enclosed fire proof receptacle?	Yes/No
11.	Regulation-15	(i) State if switches are provided on live conductors.	Yes/No
		(ii) State if indication of a permanent nature is provided as per Regulation so as to distinguish neutral conductor from the live conductor.	Yes/No
		(iii) Whether a direct line is provided on the neutral in the case of single phase double pole iron clad switches instead of fuse ?	Yes/No
12.	Regulation-16	(i) State if earthed terminal is provided by the supplier.	Yes/No
		(ii) Have three pin plugs been provided for plug points ?	Yes/No
		(iii) General visible condition of the earthing arrangement.	Satisfactory/Not Satisfactory
13.	Regulation-17	Are the live parts in accessible position ?	Yes/No
14.	Regulation-34	Leakage on premises: State insulation resistance between conductors and earth in Mega Ohms.	----- M Ohms
15.	Regulation-35	(i) State if linked switches of requisite capacity are provided near the point of commencement of supply.	Yes/No
		(ii) State if the wiring is divided in suitable number of circuits and each such circuit is protected by suitable cut-out.	Yes/No

		(iii) State if supply to each motor or apparatus is controlled by suitable linked switch.	Yes/No
16.	Regulation-41	(i) Have the frames of every generator, stationary motor and so far as practicable portable motor and the metallic parts (not intended as conductors) of all other apparatus used for regulating* or controlling electricity been earthed by two separate and distinct connections with earth ?	Yes/No
		(ii) Is the earth wire free from mechanical damage ?	Yes/No
		(iii) In the case of conduit, or lead covered wiring, has the conduit or lead-cover been efficiently earthed ?	Yes/No
		(iv) If the consumer has his own earth-electrode, state if it is properly executed and has been tested. If yes give value of earth resistance.	Yes/No ------- Ohms.
17.	Overhead Lines	(i) State if the consumer has any overhead lines.	Yes/No
		(ii) Does the overhead line near the premises of consumer meets the requirement of regulation 58, 60 and 61? If not, give details.	Yes/No
		(iii) Is guarding provided for overhead lines at road crossings?	Yes/No
		(iv) Any other remarks.	

Date :

Signature of the Inspecting Officer/

Name _____

Designation _____

File No. _____

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* Not applicable to isolated wall tubes or to brackets, electroliers, switches, ceiling fans and such other fittings (other than portable hand lamps and transportable apparatus) unless provided with earth terminal.

FORM II

(Installations of voltage level more than 250V up to and including 650V)

Report No. _____ Date of Inspection _____

Date of last Inspection _____

1. Consumer No. _____
2. Voltage and system of supply:

(i) Volts _____(ii) No. of Phases _____ (iii) AC/DC _____

3. Name of the consumer or owner _____
4. Address of the consumer or owner _____
5. Location of the premises _____
6. Particulars of the installations

(a) Motors:

Make	No.	H.P.	Amps.	Voltage

(i)_____

(ii)_____

(b) Other equipment (complete details to be furnished):

(i)_____

(ii)_____

Total connected load h.p./KVA

_____

(c) Generators details i.e. Make, S. No, KVA rating and Voltage:

(i) _____

(ii) _____

General condition of the installation:

Sl. No.	Regulation Nos.	Requirements	Report
7.	Regulation-3	Is the register of designated persons properly made and kept up to date duly attested ?	Yes/No
8.	Regulation-12	(i) Is/Are there any visible sign(s) of overloading in respect of any apparatus wiring?	Yes/No
		(ii) Whether any unauthorised temporary installation exist?.	Yes/No
		(iii) Are the electric supply lines and apparatus so installed, protected, worked and maintained as to prevent danger ?	Yes/No
		(iv) Any other general remarks.	
9.	Regulation-13	Give report on condition of service lines, cables, wires, apparatus and such other fittings placed by the supplier or owner of the premises. If not satisfactory give details.	Sat S

10.	Regulation-14	Whether suitable cut-outs provided by the supplier at the consumer's premises are within enclosed fire proof receptacle?	Yes/No
11.	Regulation-15	(i) Whether switches are provided on live conductors?. (ii) Whether indication of a permanent nature is provided as per Regulation so as to distinguish neutral conductor from the live conductor?. (iii) Whether a direct line is provided on the neutral in the case of single phase double pole iron clad switches instead of fuse ?	Yes/No Yes/No Yes/No
12.	Regulation-16	(i) Whether earthed terminal is provided by the supplier?. (ii) General visible condition of the earthing arrangement.	Yes/No Satisfactory/Not Satisfactory
13.	Regulation-17	(i) Are bare conductors in building inaccessible? (ii) Whether readily accessible switches have been provided for rendering them dead ?	Yes/No Yes/No
14.	Regulation-18	Whether "Danger Notice" in Hindi and the local language of the district and of a design as per relevant Indian Standard is affixed permanently in conspicuous position?.	Yes/No
15.	Regulation-19	(i) Whether insulating floor or mats conforming to IS-15652:2006 have been provided? (ii) Whether identification of panel has been provided on the front and the rear of the panel?	Yes/No Yes/No
16.	Regulation-21	Whether flexible cables used for portable or transportable equipment covered under the Regulation, are heavily insulated and adequately protected from mechanical injury?.	Yes/No
17.	Regulation-22	State the condition of metallic coverings provided for various conductors.	Satisfactory/Not Satisfactory
18.	Regulation-24	Whether the circuits or apparatus intended for operating at different voltage(s) are distinguishable by means of indication(s) of permanent nature?.	Yes/No
19.	Regulation-26	Whether all circuits and apparatus are so arranged that there is no danger of any part(s) becoming accidentally charged to any voltage beyond the limits of voltage for which it/they is/are intended ?	Yes/No
20.	Regulation-27	(i) In the case of generating stations, whether fire-buckets filled with clean dry sand have been conspicuously marked and kept in convenient situations in addition to fire-extinguishers suitable for dealing with electric fires ?	Yes/No

		(ii) Whether First Aid Boxes or cupboards conspicuously marked and properly equipped are provided and maintained?. (iii) Is adequate staff trained in First Aid Treatment and fire fighting?	Yes/No Yes/No
21.	Regulation-28	(i) Whether instructions in English or Hindi and the local language of the district and where Hindi is the local language, in English and Hindi, for the resuscitation of persons suffering from electric shock have been affixed in a "conspicuous place" ?. (ii) Are the designated persons able to apply instructions for resuscitation of persons suffering from electric shock ?	Yes/No Yes/No
22.	Regulation-34	Leakage on premises: State insulation resistance between conductors and earth in Mega Ohms.	----- M Ohms
23.	Regulation-35	(i) Whether a suitable linked switch, or circuit breaker is placed near the point of commencement of supply so as to be readily accessible and capable of being easily operated to completely isolate the supply ? (ii) Whether every distinct circuit is protected against excess electricity by means of a suitable circuit breaker or cut-out ? (iii) Whether suitable linked switch or circuit breaker is provided near each motor or apparatus for controlling supply to the motor or apparatus?. (iv) Whether adequate precautions are taken to ensure that no live parts are so exposed as to cause danger?.	Yes/No Yes/No Yes/No
24.	Regulation-37	(i) Whether clear space of 100 cm is provided in front of the main switchboard?. (ii) Whether the space behind the switchboard exceeds 75 cm in width or is less than 20 cm?. (iii) In case the clear space behind the switchboard exceeds 75 cm. state whether a passage way from either end of the switchboard to a height of 1.80 metres is provided.	Yes/No Yes/No Yes/No
25.	Regulation-41	(i) Has the neutral point at the transformer and generator 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 the metallic parts (not intended as conductors) of all transformers and any other apparatus used for	Yes/No Yes/No

		regulating or controlling electricity and all apparatus consuming electricity at voltage exceeding 250V but not exceeding 650V been earthed by two separate and distinct connections with earth ?	
		(iii) Have the metal casings or metallic coverings 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?	Yes/No
		(iv) Whether the consumer's earth-electrode is properly executed and has been tested. If yes, give value of earth resistance?.	Yes/No ------- Ohms.
		(v) Is the earth wire free from any mechanical damage ?	Yes/No
26.	Regulation-45	Have the protections and interlocks for the generating units been provided. If not, give details?.	Yes/No
27..	Overhead Lines	(i) State if the consumer has any overhead lines.	Yes/No
		(ii) Does the overhead line near the premises of consumer meets the requirement of regulations 58, 60 and 61? If not, give details.	Yes/No
		(iii) Is guarding provided for overhead lines at road crossings?	Yes/No
		(iv) Any other remarks.	

Date :

Signature of the Inspecting Officer

Name _____

Designation _____

File No. _____

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FORM III

(Installations of voltage exceeding 650V)

Report No. _____ Date of Inspection _____ ,

Date of Last inspection _____

Sl. No.	Regulation Nos	Requirements	Report
1.	Regulation-3	Is the register of the designated persons properly made and kept up to date duly attested?	Yes/No
2.	Regulation-12	(i) Is/Are there any visible sign(s) of overloading in respect of any apparatus?	Yes/No
		(ii) Whether any unauthorised temporary installation exist?	Yes/No
		(iii) Whether the motors and controlling equipment are being over hauled periodically and record kept of the same in a register?	Yes/No
		(iv) Whether the transformer oil samples are being tested periodically and results recorded in a register?	Yes/No
		(v) Whether suitable lightning arrestors have been provided near the transformers for protection against lightning?	Yes/No
		(vi) Whether earth resistance is being measured periodically and results recorded in a register?	Yes/No
		(vii) Any other defect or condition which may be a source of danger. If Yes please explain?	Yes/No
		(viii) Whether operation and maintenance data has been clarified, categorized and computerized for prompt and easy retrieval?	Yes/No
		(ix) Whether predictive maintenance is being performed for installation of voltage exceeding 650V?	Yes/No
		(x) Whether residual life assessment and life extension programmes are being undertaken for installations or equipment of voltage exceeding 650V (applicable for installations or equipment more than 15 years old)?	Yes/No
		(xi) Whether all required type and routine tests at factory done for equipments. Deficiencies and Discrepancies in above test report and results, if any, shall be reported?	Yes/No
		(xii) Are there deficiencies in construction with	Yes/No

		reference to Indian Standard requirements. Please specify.	
3.	Regulation-13	Give report on condition of service lines, cables, wires, apparatus and such other fittings placed by the supplier or owner of the premises. If not satisfactory give details.	Satisfactory/Not Satisfactory
4.	Regulation-14	Whether suitable cut-outs provided by the supplier at the consumer's premises are within enclosed fire proof receptacle?	Yes/No
5.	Regulation-15	(i) Whether switches are provided on live conductors?. (ii) Whether indication of a permanent nature is provided as per Regulation so as to distinguish neutral conductor from the live conductor?. (iii) Whether a direct line is provided on the neutral in the case of single phase double pole iron clad switches instead of fuse ?	Yes/No Yes/No Yes/No
6.	Regulation-16	(i) Whether earthed terminal is provided by the supplier?. (ii) General visible condition of the earthing arrangement.	Yes/No Satisfactory/Not Satisfactory
7.	Regulation-17	(i) Are bare conductors in building inaccessible? (ii) Whether readily accessible switches have been provided for rendering them dead?	Yes/No Yes/No
8.	Regulation-18	Whether "Danger Notice" in Hindi and the local language of the district and of a design as per relevant Indian Standard is affixed permanently in conspicuous position?.	Yes/No
9.	Regulation-19	(i) Whether the practice of working on live lines and apparatus is adopted ? If so, have the safety measure been adopted as per Schedule-III ? (ii) Whether insulating floor or mats conforming to IS-15652:2006 have been provided? 14. (iii) Whether identification of panel has been provided on the front and the rear of the panel?	Yes/No Yes/No Yes/No
10.	Regulation-21	Whether flexible cables used for portable or transportable equipment covered under the Regulation, are heavily insulated and adequately protected from mechanical injury?..	Yes/No
11.	Regulation-22	State the condition of metallic coverings provided for various conductors.	Satisfactory/Not Satisfactory
12.	Regulation-24	Whether the circuits or apparatus intended for operating at different voltage(s) are distinguishable by means of indication(s) of permanent nature?.	Yes/No

13.	Regulation-26	Whether all circuits and apparatus are so arranged that there is no danger of any part(s) becoming accidentally charged to any voltage beyond the limits of voltage for which it/they is/are intended ?	Yes/No
14.	Regulation-27	(i) In the case of generating stations and enclosed sub stations, whether fire-buckets filled with clean dry sand have been conspicuously marked and kept in convenient situations in addition to fire-extinguishers suitable for dealing with electric fires ? (ii) Whether First Aid Boxes or cupboards conspicuously marked and properly equipped are provided and maintained?. (iii) Is adequate staff trained in First Aid Treatment and fire fighting?	Yes/No Yes/No Yes/No
15.	Regulation-28	(i) Whether instructions in English or Hindi and the local language of the district and where Hindi is the local language, in English and Hindi, for the resuscitation of persons suffering from electric shock have been affixed in a "conspicuous place" ?. (ii) Are the designated persons able to apply instructions for resuscitation of persons suffering from electric shock ?	Yes/No Yes/No
16.	Regulation-34	Leakage on premises: State insulation resistance between conductors and earth in Mega Ohms.	----- M Ohms
17.	Regulation-35	(i) Whether a suitable linked switch, or circuit breaker, or emergency tripping device is placed near the point of commencement of supply so as to be readily accessible and capable of being easily operated to completely isolate the supply? (ii) Whether suitable linked switch or a circuit breaker to carry and break the full load current on the secondary side of a transformer? (iii) Whether every distinct circuit is protected against excess electricity by means of a suitable circuit breaker or cut-out? (iv) Whether linked switch or circuit breaker or emergency tripping device is provided near the motor or other apparatus at voltage exceeding 650V but not exceeding 33kV for controlling supply to the motor or apparatus? (v) Whether adequate precautions are taken to ensure that no live parts are so exposed as to cause danger?	Yes/No Yes/No Yes/No Yes/No Yes/No

18.	Regulation-37	(i) Whether clear space of 100 cm is provided in front of the main switchboard?.	Yes/No
		(ii) Whether the space behind the switchboard exceeds 75 cm in width or is less than 20 cm?.	Yes/No
		(iii) In case the clear space behind the switchboard exceeds 75 cm. State whether a passage way from either end of the switchboard to a height of 1.80 meters is provided.	Yes/No
19.	Regulation-44	(i) Whether all conductors and apparatus including live parts thereof are inaccessible?	Yes/No
		(ii) Whether all windings of motors or other apparatus are suitably protected?	Yes/No
		(iii) State in case of transformers or reactors or switches or static condensers involving the use of more than 2,000 litres of oil in one chamber, if suitable oil soak pits are provided?	Yes/No
		(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)?	Yes/No
		(v) Whether trenches inside sub-station containing cables are filled with non-inflammable material or completely covered with non- inflammable slabs?	Yes/No
		(vi) Are conductors and apparatus so arranged that they may be made dead in sections for carrying out work thereon?	Yes/No
20.	Regulation-45	Whether protections and interlocks have been provided? If not, give details.	Yes/No
21.	Regulation-48	(i) Have the frames 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 electricity and all electricity consuming apparatus at voltage exceeding 650V but not exceeding 33kV been earthed by two separate and distinct connections with earth ?	Yes/No
		(ii) Is the earth wire free from any mechanical damage ?	Yes/Nc
		(iii) Has the neutral point at the transformer and generator been earthed by two separate and distinct connections with earth?	Yes/No
		(iv) Have the metal casings or metallic coverings containing or protecting any electric supply line or apparatus been	Yes/No

		properly earthed and so joined and connected across all junction boxes as to make good mechanical and electrical connections throughout their whole length? (v) Whether earthing has been properly executed and has been tested. If yes, give value of earth resistance.	Yes/No ------Ohms
22.	Regulation-49	Is the outdoor (except pole type) sub-station efficiently protected by fencing not less than 1.8 metres in height?	Yes/No
23	Regulation-50	(i) Where platform type construction is used for pole type sub-station, has sufficient space for a man to stand on the platform been provided? (ii) Has hand-rail been provided and connected with earth (if metallic and if sub-station has not been erected on wooden supports and wooden plateform)?	Yes/No Yes/No
24.	Regulation-51	Has suitable provision been made for immediate and automatic or manual discharge of every static condenser on disconnection of supply ?	Yes/No
25	Overhead Lines	(i) What is the minimum size of the conductors of overhead lines used ? State the type of conductors. (ii) Whether clearances above ground of the lowest conductor of overhead lines are as per regulation 58? (iii) On the basis of maximum sag, Whether vertical clearances where the line of voltage exceeding 650V passes above or adjacent to any building or part of a building are as per regulation 61? (iv) On the basis of maximum deflection due to wind pressure, whether horizontal clearances between the nearest conductor and any part of such building are as per regulation 61? (v) Where conductors forming parts of system at different voltages are erected on the same supports, whether adequate provision has been made as per regulation 62 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 the higher voltage system ? (vi) Where overhead lines cross or are in proximity to each other whether they have	Size of Conductor --- Yes/No Yes/No Yes/No Yes/No Yes/No

		been suitably protected to guard against possibility of their coming in contact with each other as per regulation 69?	
		(vii) Has every guard wire been properly earthed as per regulation 70 at each point at which its electrical continuity is broken?	Yes/No
		(viii)(a) Whether metal supports of overhead lines and metallic fittings attached thereto are permanently earthed as per regulation 72?	Yes/No
		(b) Has each stay-wire (except in case where an insulator has been placed in it at a height not less than 3 meters from the ground) been earthed as per regulation 72?	Yes/No
		(ix)(a) Whether overhead line is suitably protected with a device for rendering the line electrically harmless in case it breaks as per regulation 73?	Yes/No
		(b) Whether anti-climbing devices have been provided at each support as per regulation 73?	Yes/No
		(x) (a) Has the owner of overhead lines adopted efficient means for diverting to earth any electrical surges due to lightning in every overhead line which is so exposed as to be liable to injury from lightning as per regulation 74?	Yes/No
		(b) Whether earth lead from the lightning arrestors is connected to a separate earth electrode as per regulation 74?	Yes/No
		(xi) Whether unused overhead lines are maintained in a safe mechanical condition as per regulation 75?	Yes/No
		(xii) Whether statutory clearances from Authorities i.e. . Forest Department/Railways/ PTCC/Defence (AHQ)/Civil Aviation have been taken as per Indian standard. If yes, enclose copies of the same.	Yes/No
		(xii) Any other remarks.	

Date :

Signature of the Inspecting Officer/

Name _____

Designation _____

File No. _____

Copy forwarded to Chief Electrical Inspector for .....

Schedule-V

Form for obtaining results during inspection by supplier at each supply point to consumer

[See sub-regulation (2) of regulation (31)]

1. Name and address of the consumer
2. Details of installation
3. Short circuit fault level of the installation
4. Date of commissioning of installation (in case of additional supply or reconnection)
5. Results of tests conducted:

Sl No	Equipment	Test Conducted	Test Results	Remarks
1	Linked Switch with fuse(s)	(i) Mechanical operation (ii) Rating of fuse (iii) Contact of blades	Smooth/troublesome --------- Amp. Full/Partial	
1 a	Isolator	i) Mechanical operation ii) Remote operation iii) Local operation iv) Measurement of contact resistance v) Interlocking with earth switch vi) Interlocking with CB vii) IR Values Open condition Closed condition	OK/not OK OK/not OK OK/not OK ----------micro Ohm OK/not OK OK/not OK ----------M Ohm Ph-Ph Ph-E --- --- --- ---	
2	Circuit Breaker Sl.No. ------	(1) Rating of Circuit Breaker (a) Type (b) Voltage (c) Normal Current (d) Rupturing capacity (2) IR Values Open condition Close condition (3) Contact Resistance : (4) Mechanical operation: (5) Remote operation: (6) Local operation: (7) Interlocking with Isolator: (8) Interlocking with earth switch (9) Alarm and Trip for OTI/WTI/Buchholz/PRV (10) Earth Fault Relay : (11) Over current Relay :	 ---------- ---------- kV ---------- Amps ----------KA ----------M Ohm Ph-Ph Ph-E --- --- --- --- ----------micro ohm Instant smooth/time gap (Sec.) OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK	
	Circuit Breaker Control Circuits			

		(12) Under Voltage Relay: (13) SF6 pressure alarm and trip operation test	OK/not OK OK/not OK	
3	Transformer Sl. No. ----	(A) Insulation Resistance Values: 1. HT to LT : 2. HT to Earth: 3. LT to Earth: (B) Break down Voltage Test Oil Sample – I(Top) Oil Sample – II (Bottom) (C) Vector Group Test: (D) Polarity Tests: (E) Magnetizing Balance: (F) Tan Delta Test (as per capacity) (G) Oil level in conservator Tank: (H) Oil level in breather cup: (I) OTI/WTI settings : (J) OTI/WTI alarm and trip operation (K) Operation of Buchholz relay : (L) Operation of PRV (M) Oil leakage (N) Interlock of door switch for dry transformer (O) Clearances for Side clearance : Between two Transformers:(P) Body earth resistance Neutral earth resistance	 ----------M ohm ----------M ohm ----------M ohm ----------kV ----------kV OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK A/T---- ^{0}C A/T----^{0}C OK/not OK OK/not OK OK/not OK OK/not OK OK/not OK ---------Cms ----------Meters ---------- Ohm N_1---Ohm N_2---Ohm	
4	DG Set Sl. Nos. for 1. Alternator: 2. Engine :	(A) Interlocking with other Supply Sources: (B) Body earth resistance Neutral earth resistance	OK/not OK ---------- Ohm N_1---Ohm N_2---Ohm	
5	Cables Size: Sq. mm	(A) Insulation Resistance Values: 1. Ph - Ph : 2. Ph – Earth : 3. Ph – Earth + other Ph : (B) Bending Radius:	 --------- M Ohm ---------M Ohm ---------M Ohm OK/not OK	
6	Earthing :	A) Metal and Size of Earth Strips: B) Type of Earthings: (1) Plate Earthing: (2) Pipe Earthing: (3) Counter poise Earthing : (C) Values of Earth resistances of	Cu/Al/GI --- Sq. mm Yes/No Yes/No Yes/No N_1 ----ohm N_2 ----ohm	

		earth electrodes for (1) Reactor Neutral: (2) LAs : (3). Structure: (4) Frames/Bodies of Equipment: (5) Motors :	(R) ---ohm (Y) ---ohm (B) ----ohm --------ohm --------ohm --------ohm	
7	Potential Transformer	(i) Ratio test (ii) Polarity test (iii) BDV of oil (iv) IR test	OK/not OK OK/not OK ----------kV (R) P-E-------M Ohm (Y) P-E-------M Ohm (B) P-E-------M Ohm	
8.	Current Transformer	(i) Ratio test (ii) Polarity test (iii) BDV of oil (iv) IR test	OK/not OK OK/not OK ----------kV (R) P-E-------M Ohm (Y) P-E-------M Ohm (B) P-E-------M Ohm	
9.	Transmission line	(i) Physical condition of conductor/tower (ii) Check of tower accessories (iii) Tower footing resistance (iv) Conductor continuity test (v) Check of ground clearance (vi) Check of electrical clearance along the route	OK/not OK OK/not OK ----------Ohm OK/not OK OK/not OK OK/not OK	

General Observations :

Sl.No.	Item	Observations
1.	Check of required phase to phase, phase to ground and sectional clearance.	
2.	Check of equipment lay out and over all installation details.	
3.	Test of resistance of earth mat or earth electrodes as applicable.	
4.	Check of consumer's pre-commissioning test reports of individual equipment.	
5.	Check of manufacturer's routine/type test reports of individual equipment.	
6.	Whether Inspector's approval if applicable is obtained?	

7.	Whether owner's self certification about compliance with the Regulations is obtained?	
8.	General observation and views (specific deviation from the requirements of the Regulations shall be clearly brought out).	

Name, Signature and Seal of the Authority

Schedule-VI

Form for notice in respect of failure of supply

[See sub-regulation (3) of regulation (39)]

(1) Name and address of the supplier :
(2) Date and time of failure of supply :
(3) Areas affected due to failure :
(4) Causes of failure :
(5) Probable time for restoration of supply :
(6) Additional information, if any :

Date :

(Name, Signature, Designation and Seal of Authoity)

Place:

Time:

Schedule-VII

Minimum safety working clearances where electricity at voltage exceeding 650 V is supplied, converted, transformed or used

[See sub-regulation (2)(iii) of regulation (44)]

Highest System Voltage (kV)	Safety Working Clearance (Metres)
12	2.6
36	2.8
72.5	3.1
145	3.7
245	4.3
420	6.4
800	10.3

(1) The above values are valid for altitude not exceeding 1000 m. A correction factor of 1.25 per cent per 100 m is to be applied for increasing the clearance for altitude more than 1000 m and upto 3000 m;

(2) The above safety working clearances are based on an insulation height of 2.44 m which is the height of lowest point on the insulator, where it meets the earthed metal, from the ground;

(3) "Safety Working Clearance" is the minimum clearance to be maintained in air between the live part of the equipment on one hand and earth or another piece of equipment or conductor on which it is necessary to carry out the work, on the other;

(4) The "Highest System Voltage" is defined as the highest rms phase to phase voltage which occurs under normal operating conditions at any time and at any point of the system. It excludes voltage transients (such as those due to system switching) and temporary voltage variations due to abnormal system conditions (such as those due to fault conditions or the sudden disconnection of large loads).

Schedule-VIII

Minimum safety clearances to be maintained for bare conductors or live parts of any apparatus in out-door sub-stations, excluding overhead lines of HVDC istallations

[See sub-regulation (5) of regulation (44)]

S.No.	DC Voltage (kV)	Pole to Earth Clearance (Metres)	Ground Clearance (Metres)
1.	100 kV	1.17	4.55
2.	200 kV	1.80	5.65
3.	300 kV	2.45	6.75
4.	400 kV.	3.04	8.00
5.	500 kV	3.65	9.00
6.	600 kV	3.98	10.1
7.	800 kV	5.3	11.2

(1) The above ground clearances are not applicable to equipment that are housed within fence or a building and where access is prevented under energised condition through a suitable safety interlocking scheme;

(2) The above pole to earth clearances are for conductor-structure electrode configuration using gap factor k equal to 1.35.

(3) It is recognised that within a substation many different types of electrode configurations shall be there with different values of k, therefore, the above clearance shall be modified based upon the values of gap factor for a particular electrode configuration subjected to the minimum ground clearance.

(4) Clearance shall be provided for electrical apparatus so that sufficient space is available for easy operation and maintenance without any hazard to the operating and maintenance personnel working near the equipment and for ensuring adequate ventilation.

Schedule-IX

Form for reporting failure of Transformers or Reactors of rating 20 MVA/MVAR and above

[See sub-regulation (8) of regulation (46)]

(1) Type of Equipment (Transformer or Reactor)
(2) Capacity (MVA/MVAR)
(3) Location (Address)
(4) Owner and address of owner
(5) Date of failure
(6) Year of manufacture
(7) Date of Installation
(8) Make
(9) Reasons for failure
(10) Measures being taken to avoid recurrence of failure

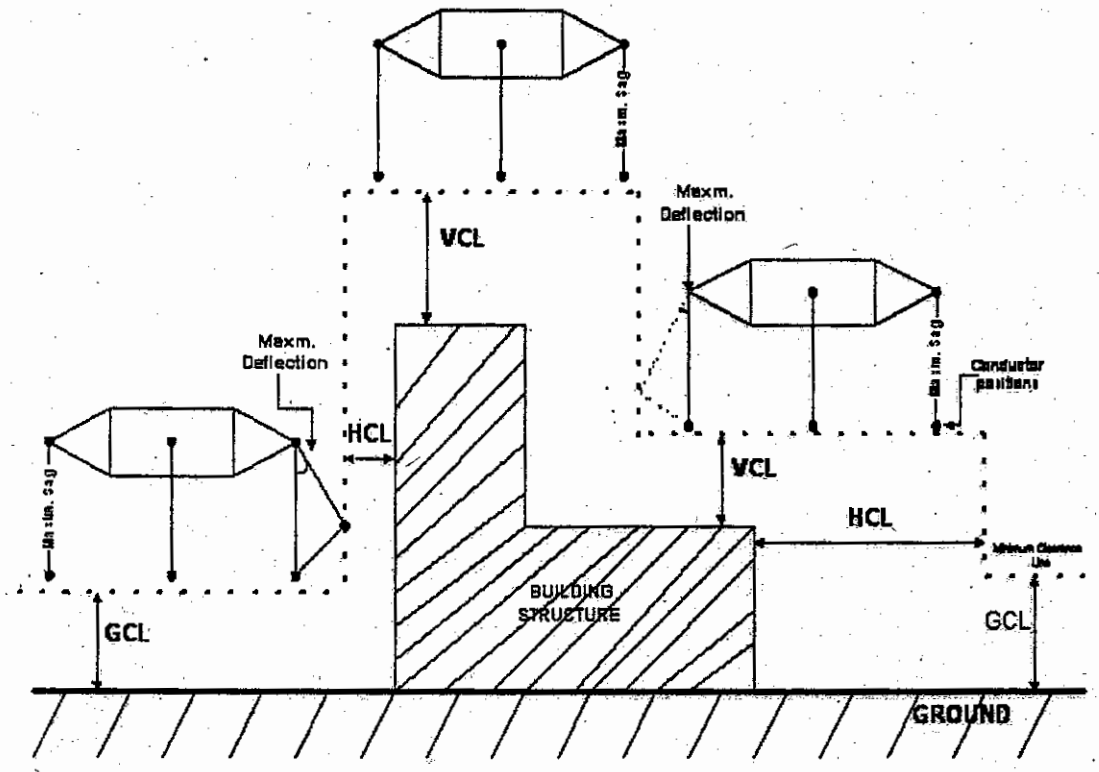
Date :

(Signature and name of Manager/Executive Engineer of the installation)

Schedule-X

Ground, Vertical and Horizontal clearances

[See sub-regulation (6) of regulation 58, sub-regulation (5) of regulation (60) and sub-regulation (5) of regulation 61]



GCL: Clearances as per Regulation 59
VCL: Clearances as per Regulation 60 & 61
HCL: Clearances as per Regulation 60 & 61

Schedule-XI

FORM OF ANNUAL RETURN FOR MINES

[See sub-regulation (1) of regulation (95)]

This form must be correctly filled up by the owner, agent, manager or engineer and sent to the Inspector not later than the first day of February every year.

Part A

Year ending 20

Name of Mine State
Situation of Mine District
Postal address of Mine
Name and address of owner
Name of agent
Name of manager
Name of engineer
Name of Electrical Supervisor

Part B

(1) System of supply (whether direct current or alternating current)
Voltage of supply
Periodicity (if alternating current)
Source of supply.

(2) Voltage at which electricity is used for :-
Lighting
Power

(3) Particulars of Motor etc.

POWER

(a) On Surface

Type of Motor (H.P./K.W.) / apparatus and voltage	Type of control gear	Location	Purpose for which used

(b) In Mine

Type of Motor (H.P./K.W.) / apparatus and voltage	Type of control gear	Location	Purpose for which used	Ventilation	Percentage of inflammable gas or vapour

LIGHTING

Type of light fitting	Wattage	Location	Percentage of inflammable gas or vapor

Schedule-XII

FORM OF ANNUAL RETURN FOR OIL-FIELDS

[See sub-regulation (1) of regulation (95)]

This form must be correctly filled up by the owner, agent, manager or engineer and sent to the Inspector not later than the first day of February every year.

Part A

Year ending 20

Situation of Oil-field State
Name of Oil-field District
Postal address of Oil-field
Name and address of owner
Name of agent
Name of manager
Name of engineer
Name of Electrical Supervisor

Part B

(1) System of supply (whether direct current or alternating current)
Voltage of supply
Periodicity (if alternating current)
Source of supply.

(2) Voltage at which electricity is used for :-
Lighting
Power

(3) Particulars of Motor etc. in use on the field :-

(a) On wells

No. or other identifying Mark of well	Drilling or pumping	Type and H.P of motor	No. of lamps and type	Other electrical appliances
1	2	3	4	5

(b) Not on wells

Type and H.P of motor	Purpose for which used	Identifying mark on map
1	2	3

(4) Other electrical appliances, not including in item3, in use on the field.

Appliances	Type and size in KW.	Purpose for which used	Identifying mark on map

Schedule-XIII

LOG SHEET FOR MINES AND OIL-FIELDS

[See sub-regulation (9) of regulation (110), clause (a) and (b) of sub-regulation (5) of regulation (115)]

Daily Log sheet for

(1) Name of Electrical Supervisor

(2) Report as to:-

(a) Condition of the insulation of the system.

(b) Specified defects of insulation (particulars of each failure of apparatus should be given).

(c) Accidents or dangerous occurrence (including any cases of electric shock and any cases of open sparking in apparatus in use in places where regulation 110 applies.

(d) Disconnection and reconnection of supply as required by sub-regulation (9) of regulation 110.

(e) Examination of earth fault detectors or recorders as provided by sub-regulation (3) of regulation 100.

(f) Examinations of apparatus as provided by Regulation 115.

(i) Routine examinations as required by clause (a) of sub-regulation (5) of regulation 115.

(ii) Special examination* as required by clause (b) of sub-regulation (5) of regulation 115.

(3) Remarks:-

Signed

Examined by

Electrical Supervisor:

Engineer:

Manager.

*State which apparatus has been examined or tested and result.

NOTE:- This log sheet should be filled in as completely as possible. If, for instance, there are no defects of insulation to report, the word 'none' should be written in the vacant space.

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