

12. Action taken regarding first-aid, medical attendance etc. immediately after the occurrence of the accident (give details).
13. Whether the District Magistrate and Police Station concerned have been notified of the accident (if so, give details).
14. Steps taken to preserve the evidence in connection with the accident to extent possible.
15. Name and designation(s) of the person(s) assisting, supervising the person(s) killed or injured.
16. What safety equipments were given to and used by the person(s) who met with this accident (e.g. rubber gloves, rubber mats, safety belts and ladders etc.) ?
17. Whether isolating switches and other sectionalising devices were employed to deaden the sections for working on the same ? Whether working section was earthed at the site of work?
18. Whether the work on the live lines was undertaken by authorised person(s) ? If so, the name and the designation of such person(s) may be given.
19. Whether artificial resuscitation treatment was given to the person(s) who met with the electric accident ? If yes, how long was it continued before its abandonment ?
20. Names and designations of persons present at and witnessed the accident.
21. Any other information remarks.

Place:

Time:

Date:

Signature

Name

Designation

Address of the person reporting

¹[ANNEXURE XIV]

(See Rule 3(2A))

GUIDELINES FOR PROVIDING TRAINING AS REQUIRED UNDER RULE 3(2A)

1. The owner of every generating station of capacity of 100MW and above shall arrange for training of personnel engaged in the operation and maintenance of his generating station, in the manner specified below:-
 - (1) (a) The training may be arranged in his own institute or any other institute established for this purpose.
(b) Any institute where such training is arranged shall have been recognised by the Central Electricity Authority.
 - (2) There shall be separate training courses for the persons to be engaged in operation and maintenance of thermal power stations and hydro power stations together with associated sub-stations. In respect of thermal stations, separate course may be arranged for the operating and supervisory staff and other skilled persons who are to assist them.
 - (3) Refresher courses shall be arranged periodically for the persons who have already undergone training under para (2) above and those who have already sufficient experience in the operation and maintenance of a generating station and are engaged in its operation and maintenance under clause (b) of sub-rule 2(A) of rule 3 to familiarise with modern practices of operation and maintenance.
2. Duration and content of training shall be as specified below:-
 - (1) **Thermal Power Stations.**- The duration of the training courses for the operating supervisory staff (both electrical and mechanical) shall not be less than 12 months. This shall include 186 hours of lectures as specified in Appendix I to this Annexure followed by specialised lectures as specified in Appendix II to this Annexure for the mechanical and electrical fields. The lectures may be arranged during the half day and the other half day shall be spent on observation by the trainees in the power stations to get familiarised with different sections of the power station. After the lecture course is completed the trainees should be taken on visits to a few modern power stations and factories manufacturing turbines, generators, switchgear, instrumentation and auxiliary equipments. 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 familiarising the trainees with the operation of power stations, through simulator facilities.
 - (2) The duration of the training course for the skilled person to assist the operators and supervisory staff in a thermal power stations shall not be less than nine months. This shall include 82 hours of lectures as specified in Appendix III to this Annexure followed by specialised lectures as specified in Appendix IV. The lectures may be arranged during the half day and the other half day being spent on observation by the trainees in the power stations so that they get familiarised with different sections of the power station. After the later course is completed; the trainee shall be taken on visits to study a few modern power stations and factories manufacturing turbines, generators, switch gear, instrumentation and auxiliary equipments. The remaining period will be spent on in-plant training under close supervision.
 - (3) The duration of the training course for the operation and supervisory staff to work in hydro power stations shall not be less than nine months. This shall include 124 hours of lectures as specified in Appendix V to this Annexure. The procedure for familiarisation visits and in-plant training shall be similar to that which has been specified in respect of thermal power stations.
 - (4) Those who are expected to be engaged in the operation and maintenance of the sub-station associated with the generating station shall be given a training of duration of not less than six months as specified in Appendix VI to this Annexure. This shall be followed by visits and in-plant training.

1. Ins. vide G.S.R. 461, dated 9th May, 1981.

- (5) The duration and contents of the refresher course shall be determined jointly by the owner of the generating station and the training institute.

2. Qualifications:

The minimum qualification for the operating and supervisory staff shall preferably be a high second class diploma in mechanical or electrical engineering or a degree from a recognised institute or university. The minimum qualifications for the persons to assist the operating and supervisory staff shall be certificate from a recognised Industrial Training Institute in appropriate trade.

3. Creation of the Institute:

- (1) Every training institute shall be established adjacent to a power station so as to facilitate familiarisation and provide in-plant training.
- (2) The training institute shall preferably be of residential type and shall have a full time Principal and adequate number of teaching staff. The training institute shall have facilities for demonstrations by models, simulators and for exhibition of slides and movies.
- (3) The institute shall have a systematised scheme of evaluation and assessment of the performance of the candidates by conducting oral and written tests at adequate intervals. The assessment forms shall be as specified in Appendix VII to this Annexure.
- (4) The number of trainees in any one batch shall not normally exceed 25 so as to maintain a good teacher-trainees relationship.
- (5) 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 specialised training course in the art of imparting training.

¹[Annexure XV
{See rule 65(8)}

Form for failure report in respect of Transformers/Reactors of 20 MVA and above

1. Type of Equipment (Transformer/Reactor)
2. Capacity (MVA)
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
Installation Manager/Executive
Engineer of the installation)]

APPENDIX I
**SYLLABUS FOR THE OPERATING AND SUPERVISORY STAFF ENGAGED IN THE
 OPERATION AND MAINTENANCE OF THE THERMAL POWER STATIONS**
 (General course for Electrical and Mechanical)

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Concept of modern Thermal Station: 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	4
II	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
III	Plant lay out in large central station including machine arrangements, equipment layout and auxiliary arrangements.	3
IV	Constructional details of large pulverised fuel boilers and auxiliaries (i) Water and steam drums, heaters and tubes. (ii) Types of furnace and firing arrangements, burner details. (iii) Economisers, primary, secondary, superheaters, re-heaters and attemperators.	16

1.	2.	3.
	(iv) Forced draught, Induced draught, Primary Air exhaustor and gas recirculation fans, compressors.	
	(v) Types of coal mills (balls/recess, balltube, bowl roller) stoker, coal feeders.	
	(vi) Air preheaters, Lunstorm, tubes, steam.	
	(vii) Dust extraction plant – electrostatic, mechanical.	
	(viii) Soot blowers: steam/compressed air operated.	
	(ix) Station compressed air system – reciprocating and rotary compressors.	
	(x) Oil handling and firing equipment.	
	(xi) Boiler mountings, gauge glasses, safety valves, stop valves, start-up devices, stamping, chemical dosing, continuous blow down.	
	(xii) Refractories and laggings as used in modern power stations.	
V	Turbine and auxiliaries, constructional details	9
	(i) Principle of operation, heat conversion cycles, types of turbines.	
	(ii) Casing, steam chests, wheel blading, nozzles, diaphragms, glands, flanges and bolt heating, bearings.	
	(iii) Condenser and vacuum extraction plant, ejectors.	
	(iv) Lubrication system, pumps, coolers, filters, shaft turbines and lifting gear.	
	(v) Feed water Booster and extraction and cooling water pump.	
	(vi) Low pressure and high pressure feed water heaters, deaerators and evaporators.	
	(vii) High and low power by pass systems.	
	(viii) Oil purifications unit.	
VI	Alternators and excitation systems	6
	(i) Constructional details of alternators, methods of cooling (Hydrogen/air cooling).	
	(ii) Main and pilot exciters, voltage regulators, types and characteristics, amplidyne and magnetic amplifier.	
	(iii) Methods of grounding.	
VII	Coal handling plant: Tipplers, hoppers, vibratory feeders and conveyors, crushers, magnetic separators and pulleys.	6
VIII	Ash and slag handling plant: Electrostatic precipitators, Methods of conveying pneumatic, vacuumatic, hydraulic; bucket elevators, conveyors, screw extractors	2
IX	Water sources, treatment: Raw water pumping station, domestic, circulating and boiler make up water treatment, River salinity, local water conditions, their variations in different seasons and effects on power station operation.	7
X	(i) Fuels: 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.	6

1.	2.	3.
XI	Basic flow diagrams in power station practice	8
	(i) Coal and fuel oil cycle	
	(ii) Air and gas cycle	
	(iii) Fly ash and slag handling arrangements	
	(iv) Condensate and feed heating cycle (from condenser hotwell upto economiser)	
	(v) Steam and water cycle (from economiser to turbine inlet)	
	(vi) Circulating water cycle.	
	(vii) Hydrogen filling in generator and hydrogen gland sealing of generator.	
	(viii) Bearing cooling system.	
XII	Direct and closed cooling circuits, cooling towers, types and characteristics.	2
XIII	D.C. & A.C. power supply for auxiliaries arrangements of units and station boards, station lighting and automatic changeover.	4
XIV	Transformers: main transformers, interconnecting transformer, station/unit transformers, voltage grounding transformers, types of connections, paralleling, tapchanger gear.	5
XV	Out-door switchyard single line diagrams, busbars, circuit breakers, isolators, current transformers, potential transformers, lightning arrestors, grounding.	5
XVI	Indoor and outdoor switchgear : types: bulk oil, minimum oil, air blast, air break – constructional details	3
XVII	Instrumentation and measurements: constructional details of measuring instruments for pressure, flow, temperature, level, draught, vibration eccentricity, conductivity, PH value, differential expansion, oxygen analyser, current, power, reactive power, frequency, energy, winding temperature. Auto-controllers, hydrogen purity meter. Axial shift indicator and recorder, fuel gas analysers, Megger – its use for primary detection of faults.	16
XVIII	Operation, control and supervision	15
	(i) General boiler start-up procedure	
	(ii) Operation of boilers under different loading conditions, soot blowing.	
	(iii) Banking and preservation of boilers.	
	(iv) Demonstration wherever possible through simulators of various operating conditions.	
	(v) Handling of boiler under emergency conditions, such as tripping of turbo-alternator set, high/low drum levels, flame failure, failure of supply to auxiliaries.	
	(vi) General start-up procedure for high pressure multicylinder reheat type turbines from cold, warm and hot conditions.	
	(vii) Handling of turbine, generator and auxiliary plant under emergency 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.	
	(viii) Alternator – synchronising, loading, parallel operations, MW & MVAR sharing.	
XIX	Controls and Protection – sequential operation and interlocks:	

1.	2.	3.
	(i) Boiler and auxiliaries	2
	(ii) Turbines and auxiliaries.	2
	(iii) Combustion control – pressure, fuel, air and feed heating cycle.	2
	(iv) Analysis of feed and Boiler water, fuel gas at station laboratory.	4
	(v) Feed water and feed heating cycle controls.	2
	(vi) Turbine governing, speed setting, speed drop setting and control circuits.	3
	(vii) Generator protection, under-voltage, over-voltage, differential, reverse power, under excitation, negative phase sequence, earth fault with types of the relays used.	4
	(viii) Importance of sequential inter-locks	2
	(ix) Transformer protection – differential, overload earth faults, high temperature, buchholz with types of the relays used.	4
	(x) Types of motors and variable speed-drive and speed controls	4
	(xi) Various types of pumps and their starting and control	3
	(xii) Steam temperature control	
	(xiii) Furnace purging	
XX	Fire fighting and multisifier type protection	3
XXI	General safety precautions, treatment of electrical or acid alkali burn, permit to work, first aid.	2
XXII	Indian Boiler Rules, Factory Act, Indian Electricity Act, 1910, Electricity (Supply) Act, 1948, Indian Electricity Rules, 1956 and other statutory regulation concerning Power Stations (General outline)	4
XXIII	General plant maintenance procedure, PERT/CPM Methods, Power Station records and calculation of efficiency	10
XXIV	Various type of valves, traps, their constructional details and application	2
XXV	Cranes, hoists, characteristics and control	3
XXVI	Personnel management, duties and responsibilities, Labour Laws and Labour Welfare	6
XXVII	Broad principles of material management and inventory control	4
		186

APPENDIX II

1. SPECIALISED MECHANICAL COURSE FOR OPERATING & SUPERVISORY STAFF WHO WILL BE ENGAGED ON THE MECHANICAL SIDE OF THE POWER PLANT.

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Corrosion of boiler and auxiliaries, condenser and feed water heating plant: Scale formation in boiler in relation to water conditions.	7
II	Acid cleaning and preservation of boilers. Mechanical removal of scale and deposits from boilers where acid cleaning is not advisable. High pressure water jet equipment.	14

1.	2.	3.
III	Annual boiler and auxiliaries overhaul hydraulic test, floating of safety valves, preventive and breakdown maintenance of boiler auxiliaries	10
IV	Efficient operation of boilers-interpretation of gas analysis for proper combustion controls and methods of reducing of other losses	8
V	Constructional details of hydraulic and other types of couplings, torque convertors, servo-motor	5
VI	Constructional details of various types of pumps, their drives and automatic starting, airconditioning. Constructional details of various types of drought 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, methods of primary balancing-balancing instruments and their use.	9
VII	Coal handling plant (i) Sequential operation, (ii) conveyor and conveyor drives, (iii) tensioning arrangements, (iv) maintenance of guide rollers, (v) sway switches/slip switches, (vi) beetle chargers for wagon marshalling, (vii) wagon tippers and coal crushers, weighing of coal, different types of weighing bridges and weight meters, storage problems and prevention of spontaneous combustion. Sampling of coal/British Standards Specification/Indian Standards Specification, procedure and proximate analysis.	8
VIII	Water treatment-hardness, pH value clarifiers, treatment, phosphate and hydrazine dosing, base exchangers.	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 retubing of condenser.	10
X	Maintenance practice-valve grinding methods, high pressure joints, heat insulation methods, pipework, alignments, beating, scraping & matching practice, radiography and stress relieving methods	6
XI	Indian Boiler Regulations and other statutory regulations.	4
XII	Workshop, 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 & associated plant.	10
XIII	Compositions, properties and behaviour of engineering materials used in power stations.	8
		105
	Common course for mechanical and electrical	186
	Supplementary course for mechanical	105
	Total Hours	291

2. SPECIALISED ELECTRICAL COURSE FOR OPERATING AND SUPERVISORY STAFF WHO WILL BE ENGAGED IN THE ELECTRICAL SIDE OF THE POWER PLANT.

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Generator protection – earth fault, rotor and stator, negative phase sequence, loss of excitation, differential protection, back up protection, reverse power-protection, under voltage protection, constructional details of the relays used, method of setting and their testing, overload protection and over heating of rotors.	15
II	Transformers protection, Buchholz relay, overcurrent, differential and earth fault protection, types of relays used, their construction, testing and settings.	6
III	Transformers, commissioning-dielectric strength of oil, insulation resistance, tap changers, filtration of oil, precommissioning testing. Tan δ resistivity of oil and preventive maintenance of transformers.	6
IV	Circuit breakers, commissioning and maintenance, isolators, disconnectors, busbar arrangements, charging, synchronising with the grid, disconnecting for repairs, maintenance of switchgear contactors.	8
V	Maintenance of equipments in the outdoor switchyard, current transformers, potential transformer and lightning arrestors, operation and maintenance Bus differential protection.	6
VI	Cables, control, high voltage and extra-high voltage types, layouts, testing and maintenance.	8
VII	Principle of electronic controls and transistorised circuits	5
VIII	Pneumatic and di-electric transmitters and receivers, servomotors.	6
IX	Interlocking sequential control circuits, details of components used.	7
X	Calibration and testing of various types of instruments, indicating, measuring instruments, recorders and analyser.	8
XI	Statutory Electricity Acts and rules, permit procedure	4
XII	Starting and control equipments of various types of motors, Station Battery-care & maintenance, trickle charging and extended charging, operation and maintenance of rectifiers and battery charges.	8
XIII	Economic load despatch, power system control and operation, MVAR-control, voltage regulation and frequency control, carrier current equipments, telephones, telemetering	5
XIV	Station emergency lighting arrangements	1
		<hr/> 93
	Common course for electrical and mechanical	186
	Supplementary course for electrical	93
	Total Hours	<hr/> 279 <hr/>

APPENDIX III

**SYLLABUS FOR SKILLED PERSONS FOR ASSISTING THE OPERATION AND
MAINTENANCE OF THE THERMAL POWER STATIONS**

(General course for Electrical and Mechanical)

Item No.	Particulars	Number of Hours
1.	2.	3.
I	General description of thermal power stations and outline of power station operation	5
II	Fundamental units and their conversion (mechanical, electrical, thermo-dynamics)	2
III	Fuels and combustion types of fuels – their properties and testing.	1
IV	Boiler and boiler house plant and auxiliaries 1. General description. 2. Arrangement of boilers. 3. Boiler auxiliaries. 4. Boiler instrumentation. 5. Fabrication and assembly of different parts of boiler and its accessories. 6. High pressure welding in boilers. 7. Arrangement of pulverised fuel boiler in a modern thermal power station.	10
V	Water conditioning, pretreatment and demineralisation.	4
VI	Ash handling – electrostatic precipitation and mechanical dust collector-function and description of two types.	2
VII	Turbine and turbine house auxiliaries: 1. Fundamental principle of steam turbine. 2. Theory and operation of steam turbine. 3. Governing and protection of turbine.	5
VIII	Handling of turbines and boilers under emergency conditions	4
IX	Condensor and vacuum extraction plant: 1. Purpose and function. 2. Construction of surface condensor and vacuum pumps.	3
X	Regenerative feed water heating-Constructional details of low pressure and high pressure feed water heaters, deaerators and evaporators.	2
XI	Cooling water systems and cooling towers.	1
XII	Flow diagrams of basic cycles: 1. Coal handling. 2. Steam and condensate. 3. Ash and slag handling. 4. Station services, domestic water, airconditioning, ventilation, lifts. 5. Air services, air compressors, switchgear.	12

1.	2.	3.
	6. Bearing cooling and general service water systems.	
	7. Circulating water systems.	
	8. Feed water and reheating plant.	
	9. Fuel oil system.	
	10. Station batteries and battery charging equipment.	
	11. Station lighting, power supply and distribution Boards.	
XIII	Station instrumentation and controls.	8
XIV	Fire fighting installations in a thermal power station.	2
XV	Electric shocks, 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 readings, unusual occurrences, expected behaviour, discipline, sincerity, cleanliness and love for machines	3
XVII	Personnel safety 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
		82

APPENDIX IV

1. SPECIALISED ELECTRICAL COURSE FOR SKILLED PERSONS WHO WILL BE ENGAGED ON THE ELECTRICAL SIDE OF THE POWER PLANT.

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	4
IV	Motor winding and repairs	4

1.	2.	3.
V	Maintenance of internal telephones and primary air systems	3
VI	Meggering and testing of wiring and cable faults	3
VII	Maintenance of electrical motors	6
VIII	Maintenance of electrical switchgear	8
IX	Fuses-rewirable type-catridges 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 rating.	8
X	Motor starters and their applications direction line, star-delta, rotor resistance	5
XI	Meggers, avometers, voltmeters, ammeters, wattmeters, energy meters-general information about their use	6
XII	Maintenance of transformers & Tap changer	6
XIII	Jointing of low & medium voltage cables	4
XIV	Connections, earthing, principles of operation of all small distribution transformers	2
XV	Current & potential transformers, purpose, connection and use	2
XVI	Various types of drive	2
XVII	Elementary knowledge of Engineering material & their properties	2
XVIII	Lubrication & cooling system	4
		74
	Common course for electrical and mechanical	82
	Supplementary course for electrical	74
	Total Hours	156

2. SPECIALISED MECHANICAL COURSE FOR SKILLED PERSONS WHO WILL BE ENGAGED IN THE MECHANICAL SIDE OF THE POWER STATION.

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Types of bearing and their uses	2
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 valves and their applications.	5
III	Pressure gauges-Bourden type gauge, monometer, vacuum gauge, barometer, principles of operation, absolute pressure, gauge and vacuum pressure and their inter relationship.	5

1.	2.	3.
IV	Temperature indicators, mercury thermometers, resistance thermometers, thermocouples, pyrometers, gas thermometers, temperature alarm	4
V	Level gauges-different types-Level Alarm	3
VI	Flow meters-steam and water-general principles	3
VII	Couplings-different types, rigid, flexible, magnetic and fluid couplings	2
VIII	Clutches-different types and uses	2
IX	Maintenance of pneumatic measuring instruments, servometers, power cylinders and other thermostats, monostats	2
X	Maintenance of instruments, recorders, clocks	4
XI	Vibration-general knowledge of their causes, effects, remedies, misalignment, wornout bearings, vibration-fed to foundations, cracking, eccentricity and differential expansion, their causes, remedies.	5
		40
	Common course for electrical and mechanical	82
	Supplementary course for electrical	40
	Total Hours	122

APPENDIX V

SYLLABUS FOR OPERATION AND MAINTENANCE STAFF WHO WILL BE ENGAGED IN THE OPERATION AND MAINTENANCE OF HYDRO-ELECTRIC GENERATING STATION.

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Concept of a modern hydro station:Type of stations, its role in the power systems, base load, peak load operation, plant layout, capacity; underground power station, hydraulic and electrical design, features, interconnection with other stations	3
II	Hydraulic system; reservoirs-type of reservoirs, storage capacity, operation of reservoirs, intake tower, surge tank, tunnels, forebays and penstocks, protection against water hammer and negative pressure in penstocks, provision for draining penstocks.	3
III	Types of valves-Butterfly valve, spherical valve, needle valve, their operation and control	3
IV	Water turbines-types of turbines; their characteristics, ratings, specifications, constructional details	2
V	Governing system; control circuit for governing, types of governors, pendulum, hydraulic, electronic	3

1.	2.	3.
VI	Generator: type and rating, cooling and ventilation system, bearing cooling arrangements, lubrication system, construction and characteristics of generators, split-phase double layer winding, synchronising, loading, grounding of generator neutral	3
VII	Excitation system, types of excitors, voltage, control, automatic voltage control, amplidyne control, magnetic amplier	5
VIII	Generator protection: earth fault (rotor and stator), negative phase sequence, differential protection, backup protection, reverse power protection, under voltage protection, constructional details of the relays used, method of setting and their testing.	10
IX	Hydraulic and electrical protective devices, load frequency control	3
X	Starting, shutting down and operation procedure	3
XI	Power transformer connections, parallel operation, three single phase unit versus three phase unit, regulation, voltage control, tap changing, weights and size, grounding	5
XII	Transformer protection: Buchholz relay, over current, differential and earth fault protection, types of relays used, their construction, testing and settings	5
XIII	Transformers-commissioning: Dielectric strength of oil, insulation resistance tap changer, filtration of oil, precommissioning testing	3
XIV	Cooling system for transformers	2
XV	Circuit breakers, isolators, disconnectors, busbar arrangements, charging and synchronising with the grid, disconnecting for repairs, maintenance of switchgear contactors	4
XVI	Maintenance of equipments in the outdoor switchyard current transformers, potential transformers and lightning arrestors, erection, operation and maintenance	4
XVII	Cables-high voltage, oil filled cable, types of cables used, rating of cables, layout, testing	4
XVIII	Principle of electronic controls and transistorised circuits	3
XIX	Pneumatic and electric transmitters and receivers, servomotors	3
XX	Control Board-layout, indicating and recording instruments for monitoring and supervision, remote control of various equipments, signalling and interlocking, automatic reclosure of breakers on outgoing lines and annunciation system	3
XXI	Interlocking sequential control circuits, details of components used	4
XXII	Calibration and testing of various types of instruments, indicating, recording and analysers	4
XXIII	Study of communication system	1
XXIV	House turbine set-its functions and use	1
XXV	Station transformers, alternating current, auxiliary supply, essential auxiliaries, auxiliaries in emergency, study of single line diagrams	3
XXVI	Station Direct Current system-storage battery, rectifiers, motor generator set etc. their control and operation, standby source of station power, automatic change over to standby source of supply	3
XXVII	Records-(hourly, daily, monthly, annually) of operations	2

1.	2.	3.
XXVIII	Flow diagram and single line diagram for hydraulic and electrical system in the station	5
XXIX	Air conditioning and ventilation plant, compressors	2
XXX	Operation under emergency conditions	2
XXXI	General plant maintenance procedures	3
XXXII	Cranes, hoists-characteristics and controls	2
XXXIII	Statutory Electricity Acts and Rules, permit procedure	2
XXXIV	Fire fighting	6
XXXV	General safety precautions, first-aid	6
XXXVI	Personnel management, duties and responsibilities, labour laws & labour welfare	4
Total Hours		124

APPENDIX VI

SYLLABUS FOR OPERATION AND MAINTENANCE STAFF IN EXTRA-HIGH VOLTAGE SUB-STATION.

Item No.	Particulars	Number of Hours
1.	2.	3.
I	Layout and location of 220/132/66/33 K.V. sub-station	4
II	Main equipments used together with their specifications	3
III	Construction of high voltage lines, types of towers, types of insulators and their electrical and mechanical characteristics	3
IV	High tension feeders, their load carrying capacities	1
V	(i) Alternating and direct currents, relation between voltage, current, power, reactive power & common units in use. Power factor, Ohm's Law, resistance, reactance, impedance, percentage impedance. Three phase vectors, phase displacement between current and voltage	3
	(ii) Basic principle of transformation, magnetisation, hysteresis, reluctance, retentivity, electromagnets Flux density, ampereturns, equation for transformation etc.	4
	(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 connections.	4
	(iv) Transformer fixtures e.g. Buchholz relay, on-load and off-load tap changer, breathers, conservators, bushings of different types, thermometers, indicators, alarms.	4

1.	2.	3.
	(v) Cooling of transformer and oil, different methods of cooling, importance of oil filtering and drying-out of transformers, dielectric strength of oil, different varieties of filters and their comparison, types of raidators.	4
	(vi) Transformer tests-failures and causes, maintenance and repairs	3
	(vii) Parallel operation, regulation, voltage control, tap changing, commissioning test	5
VI	Breakers:	
	(i) Functions of breakers, their action	
	(ii) Different types of outdoor and indoor breakers e.g. bulk oil, minimum oil and airblast, principles and their applications.	
	(iii) Operating mechanism, manual, spring, hydraulic, pneumatic, motor.	
	(iv) Current rating, rupturing capacity, clearance time.	
	(v) Breaker maintenance, failures and their causes, commissioning procedure.	8
VII	Busbars:	
	(i) Indoor busbars, their capacity, forces on them during short circuit, busbar mountings and their clearances.	
	(ii) Strung and tabular type busbars, their current ratings, supports, jumpers, clearances.	
	(iii) Busbars fittings and connectors.	
	(iv) High Voltage and Extra-high voltage cables, types, their maintenance and testing.	6
VIII	Current and potential transformers:	
	(i) Types of current and potential transformers, their working principles, ratings, accuracies.	
	(ii) Functions of current and potential transformers	
	(iii) Failures of current and potential transformers, their causes	3
IX	Isolators:	
	(i) Tilting and rotating isolators, with and without arcing horns, earthing blades, current ratings, breaking of circuits by isolator, interlocking with circuit breaker	
	(ii) Maintenance of isolators	3
X	Lightning arrestors:	
	(i) Simple description of lightning phenomena and surges.	
	(ii) Construction of lightning arrestors and the principles of their working.	
	(iii) Different type of lightning arrestors and ratings.	
	(iv) Earthing and location of lightning arrestors	3

1.	2.	3.
XI	Control Room: (i) Necessity and function of a control board, types of boards, instruments on the board. (ii) Functions of the various relays and indicators, Mimic diagram indicators, annunciator and alarm characteristics of relays, testing and setting of relays. (iii) Remote control of breakers, isolators, tap changers, indicators on the control board. (iv) Control and power cables.	10
XII	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	3
XIII	Clearance and Compliance of I.E. Rules, 1956: (i) Minimum clearance for different voltages between phases and phase to ground (ii) Indian Electricity Rules pertaining to sub-stations	3
XIV	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 resistances	3
XV	Maintenance: (i) Maintenance of log sheet and other records (ii) The importance of maintenance of good records	3
XVI	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
XVII	Interlocking and sequential operation of different equipments	1
XVIII	Synchronising, charging and discharging of high voltage lines. Live line testing	3
XIX	Calibration and testing of various types of equipments indicating and measuring equipments, recorders, analysers	4
XX	Handling emergency conditions	3
XXI	Diagnosing troubles in the plant from instruments and annunciation	3
XXII	Study of carrier system	2
XXIII	Auxiliary equipments such as compressors, Station lighting etc.	1
XXIV	Fire fighting equipment – their operation, maintenance and refilling	1
XXV	Personnel management, duties and responsibilities, labour welfare and labour laws	4
Total Hours		115

APPENDIX VII
(I) ASSESSMENT FORM FOR OPERATING AND SUPERVISORY STAFF

Name of the Trainee

Period : From to (extended period).

Working in

Section

Department

Particulars	Marks allotted	Marks given	Remarks
1.	2.	3.	4.
1. Punctuality and attendance	+(5)		
(a) Is he reluctant to continue on overtime	-(1)		
(b) Is he in the habit of taking leaves at the eleventh hour	-(1)		
(c) Does he insist on compensatory off	-(1)		
2. Intelligence and grasp:			
(a) 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)		
(b) Is he industrious, hard working and painstaking	+(5)		
(c) Has he shown any special skill of operation in saving plant & equipment in trouble or emergency ?	+(10)		
3. Temperament and behaviour:			
(a) Behaviour with superiors/colleagues and subordinates	+(5)		
(b) Capacity to take quick and correct decisions	+(5)		
(c) Capacity to handle independent responsibility	+(10)		
4. Any special qualifications-capacity to execute a particular or difficult job economically, intelligently, resourcefully or with special skill	+(10)		
5. 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	Very good	Good	Average	Below average
100-91%	90-71%	70-61%	60-51%	Below 51%

Special Remarks if any:-

Station Superintendent

Section-in-Charge

(II) ASSESSMENT FORM FOR OPERATING AND SUPERVISORY STAFF

(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:

Test	Date	Written (75)	Viva (25)	Total
I Test				
II Test				
III Test				
Final Test				

8. Percentage of marks secured in all the tests:
9. Gradation : (A, B, C, etc.)
10. General Remarks and Recommendations:

Director of the Institute

(III) ASSESSMENT FORM FOR SKILLED PERSONS TO ASSIST OPERATORS AND SUPERVISORS

Name of the Trainee

Period : From to (extended period).

Working in

Section

Department

Sl. No.	Particulars	Marks allotted	Marks given	Remarks
1.	2.	2.	3.	4.

1. Punctuality and attendance:
 - (a) Does he attend the duty punctually or remain absent without prior intimation frequently + (5)

	(b) Is he reluctant to continue on overtime	-(1)
	(c) Is he in the habit of taking leaves at the eleventh hour	-(1)
	(d) Is he even prepared to take leave without wages	-(4)
	(e) Whether he availed medical leave often	-(1)
2.	Intelligence and grasp:	
	(a) 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)
	(b) Is he industrious, hard working and painstaking	+(5)
	(c) (i) Has he shown any special skill of operation in saving plant & equipment in trouble or emergency .	
	OR	
	(ii) Has he shown any special skill or innovation in any maintenance job.	+(10)
3.	Temperament and behaviour:	
	(a) Behaviour with superiors/colleagues	+(5)
	(b) Capacity to take quick and correct decisions by himself or to point out the discrepancies to superiors promptly while attending auxiliary plant and equipment.	+(5)
	(c) Capacity to take independent charge as auxiliary plant attendants (Name of the auxiliary plant)	+(10)
4.	Any special qualifications:	
	(a) Is he suitable for any other plant other than the one mentioned above at 3(c)	+(10)
	(b) Can he record the readings correctly	
	(c) Is he suitable for any particular skilled maintenance job as an artisan.	
	(d) Has he specialised in any particular trade such as winder, high pressure welding, etc.	
5.	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%
Special Remarks if any:-	
Station Superintendent	

Section-in-Charge

ASSESSMENT FORM FOR SKILLED PERSONS TO ASSIST OPERATORS AND SUPERVISORS

(For use of the Training Department)

1. Name of the Trainee
2. Date of birth/age
3. Training period : Fromto(Months)
4. Highest technical qualification
5. Specialisation, if any
6. Practical experience

7. Marks secured in periodical tests:-

Test	Date	Written (60)	Viva (40)	Total
I Test				
II Test				
III Test				

8. Job test (110 Marks)
9. Percentage of marks secured in all the tests:
10. Gradation : (A, B, C, etc.)
11. General remarks and recommendations:

Director of the Institute
