GOVERNMENT OF HIMACHAL PRADESH

HANDBOOK ON QUALITY CONTROL

Part- B

Jal Shakti Vibhag

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PREFACE

The Government of H.P. felt its necessity that IQCS may be constituted to have an independent quality check and positioned in CM office. The squad shall be headed by the Team Leader and ably assisted by specialist/expert having vast experience in Civil Engineering works, Mechanical, Electrical works and IPH works being executed by the various departments.

WAPCOS Ltd., A Govt. of India Undertaking, Ministry of Jal Shakti, Chandigarh office has been entrusted with the task of implementing this program for total quality management concept aimed at embedding awareness of quality in all infrastructure departments of Govt. of H.P. including but not limited to PWD, IPH, HPSEB, Urban development, Forest, Tourism, RDD and HPSIDC etc.

In this respect this handbook has been prepared which is brief, handy and instant helpful at site for field engineers. It is an effort just like to express too much in too few words. It summarizes all quality assurance, specifications and prepared on basic sources viz HPPWD specifications for building and roads, rural road manual, MORTH and handbook of quality control Vol.- 1 and Vol- 2. The IPH contents have been taken from CPEHEEO, AWWA manual, Pollution Control Board and Relevant Standard codes etc. The handbook has been prepared by in cooperating relevant extract from HPPWD specification keeping in view subsidiary departments also and prevalent practice being followed at present.

In preparing this handbook the sincere efforts have been made by the team of WAPCOS Ltd. along with the officers of Jal Shakti Vibhag, Himachal Pradesh.

We dedicate this effort to the state and hope this handbook shall be very useful for all the field engineers for various departments of Govt. of HP and advised that it may always be kept with them at site as ready and instant reference. We are further hopeful that the state authorities would evolve suitable mechanism to implement the needed quality assurance plan with objective of achieving the economic and social development of the State and improving the quality of life of people.

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Chandigarh Office

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HANDBOOK ON QUALITY CONTROL AND SPECIFICATIONS

PART- B

(JAL SHAKTI VIBHAG)

CHAPTER- 1

Standard Water Supply System in Village/ Town

Sources of Water

Ground water: Open well, tube well/bore well, hand pump are sources which make water available from ground.

Open Well: Where ground water is available at low depth (less than 15 meters - and water is available all year round, open well is used.

Hand Pump: Where safe ground water is available upto 60 m depth, hand pump is ideal choice for a cluster or habitation.

Bore Well/Tube Well: Where ground water is at greater depth and open wells or hand pumps are not viable, bore well or tube well is installed.

Surface Water: River, pond, dam site are sources where surface water is available.

Moreover, rain water can be harvested and store directly in storage tanks. The water is portable after first rain and can be used for drinking purpose also.

Classification of Water based on its Availability

A. **Local Source:** Sources which are available at village/town level like river, pond, open wells and bore wells.
B. **Distant source:** When perennial reliable and safe source is not available, pipeline from distant sources can be laid. This bulk water is available from river, pond, dam, bore wells or storage tank itself, where water is available.

Pump House and Pumping Machinery:

1. Pump is used to fetch water from source like bore well, open well, sump or ground water storage and supply it to pipelines or elevated storage.
2. Three main components of WSM :
   a) Pump, b) motor, c)Pump house (security and safety of machineries).

Rising Main: Delivery line carrying water from pump to storage tank (elevated or ground) is called rising main.

Storage Facilities

Elevated Surface Reservoir (ESR) or elevated storage tank:

1. ESR is constructed, where water is supplied at elevated height or distance is large or topography is undulating.
2. Generally, ESR height is more than 15 m.

Ground Service Reservoir (GSR):

1. The plinth level is generally not more than 3 m.
2. Its capacity based on pumping hours, demand and hours of supply, electricity available for pumping.
3. System with higher pumping hours requires less storage capacity.

Storage capacity of such tanks is half to one day daily water requirement.

Sump:

1. It is additional storage tank and not used for direct distribution of water.
2. It is used as intermediate or contingency storage to store water before it is pumped to ESR/GSR.
3. The capacity of sump is more than ESR or GSR or two to five days water requirement at village/town level or cluster level. It is not used for direct distribution of water.

1. **Service Reservoirs**

a) SRs have to be inspect regularly
b) Leakage from structure SR and through the pipes and valves has to be attended to on priority.
c) Internal corrosion is prevented by cleaning and painting at regular intervals.
d) Toxic paints should not be used for interior surface of SRs.
e) Painting of steel tanks once in a year and external painting with waterproof cement paint for exteriors of RCC tanks once in 5years is usually done.
f) After inside painting SRs shall be disinfected before putting into use for a period sufficient to give chlorine residuals of at least 0.2 mg/l.

Cleaning of service reservoirs: Routine inspection is the best way to determine when a tank requires maintenance and cleaning. The best time of the year to take up cleaning of SRs is during the period of lowest water consumption.

SPARES AND TOOLS: Spares and tools required are similar as tools and spares required for transmission main system.

Additional tools required for cleaning of service reservoirs are: Housekeeping accessories & coir brushes etc.

Annexure A: Check Lists For Clear Water Sump, ESR & GSR.

Water Distribution

For efficient distribution, water should reach tail end with required flow and pressure in the piping system / distribution system.

There are three main types of distribution system:-

A. Gravity Fed Distribution

a) Gravity Fed Distribution used when ground level of source is sufficiently high compared with the area to be served.
b) Such system is highly reliable and economical.

B. Pumping System

a) Water is supplied by continuous pumping at constant pressure without intermediate storage.
b) It requires stand by prime mover to maintain continuous water supply.
c) It works only in condition where continuous water supply, reliable water source is available and where intermediate storage cannot be installed.

C. Dual/Combination

a) Dual combination systems are used where there is variation in topography in area.
b) Minimum Residual pressure in a distribution system should be 7 m for single storied 12 m for two storied and 17 m for three storied building.

Distribution Lines:

The lines carrying water from storage to its end use (Stand Post/ household tap etc.) are called distribution lines.

Distribution pipelines consist of main pipeline connected from secondary storage; sub-main pipes connected from main pipeline and service/branch pipes connected from sub-main for distribution to households.

Stand Post: Stand post with one or more taps are installed at cluster level or near the storage tank, in the villages/towns where household tap connection is not available or possible.

It should have normal output of 12 litres/minute. One stand post is estimated for every 250 persons. In case of independent habitation, even if population is less than 250 and there is no potable water source, one stand post can be provided.

Moreover, stand posts should not be more than 500 m from any such targeted household.

Cattle Trough: These are masonry/RCC structures to provide water to cattle.

Bathing or Washing Cubicles: These masonry structures are generally constructed to facilitate washing clothes and bathing

Type of Water Supply

A. Continuous

a) Continuous water supply is possible where adequate quantity of water is available.
b) It remains fresh and rusting of pipes will be low.
c) Losses of water will be more in case of any leakage.

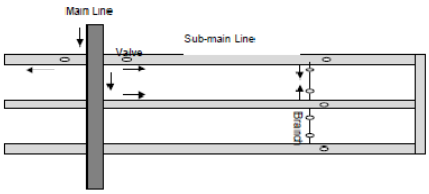
B. Intermittent

a) Intermittent supply is divided into zones and each zone is supplied with water for fixed hours in a day or as per specified day.
b) It is followed when there is low water availability.
c) Pipelines are likely to rust faster due to wetting and drying.
d) Maintenance can be easily done during non supply hours.

Pipeline Distribution Networks

1. Pipeline distribution network are aimed at design of suitable routes for piping.
2. It is important for proper water pressure, capital cost, operation and maintenance cost and maintenance (O & M) strategy adopted.

A. Dead end distribution system

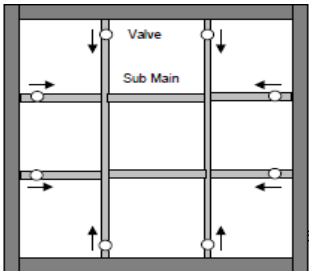


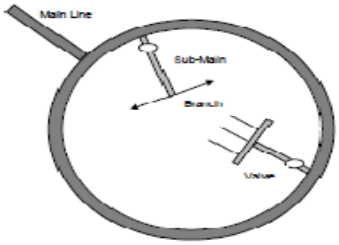
1. Sub main pipes are connected at right angle from main pipe line and branches pipes are connected to sub mains at right angles.
2. In case of failure in pipeline, it will be difficult to supply water to the area ahead of affected area.
3. Pressure at the tail end will be low compared to other area and there will be stagnation of water.

B. Grid System

1. Main, sub main and branch pipes are interconnected to each other.
2. Total length of pipeline required is high, but this helps in equitable water pressure.
3. Blockage of pipes in one area does not affect the supply in the rest of area as there are multiple supply points to any area.

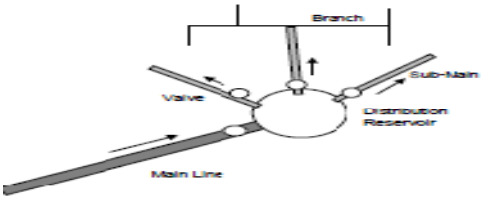
C. Ring System





1. The Whole system is enclosed by main pipeline in radial or rectangular shape.
2. Smaller areas are enclosed by sub main pipeline.
3. In case of failure of system, very small area will be affected.
4. The area ahead of affected area can get water from other point.

D. Radial System



1. The area is divided into different zones.
2. The water is pumped into the distribution reservoir kept in the middle of each zone and the supply pipes are laid radially ending towards the periphery.

Issues Causing Problems In The Distribution System

1. Intermittent system
2. Non-availability of required quantity of water
3. Low pressure at supply point
4. Leakage of water
5. Unauthorized connections
6. Extension of area of distribution system
7. Age of the system
8. Lack of records.

Note: List of spare parts tools, preventive maintenance and maintenance schedule is similar to the transmission system.

Annexure B Check list for Distribution System.

Rising Mains/ Transmission Mains:

Problems in Transmission Mains:

a) Leakage
b) Leakage through appurtenances
c) Air Entrainment
d) Water Hammer
e) Age of the system

Maintenance of Pipeline:

1. Main Breaks
2. Deterioration of pipes
3. Flushing of pipelines
4. Flushing and cleaning of pipelines
5. Cement Mortar Lining.

List of Spare Parts:

1. Check nuts
2. Spindle rods
3. Assorted bolts
4. Nuts and washers for flanged joints
5. Gaskets for a flanged joints for all sizes of sluice valves
6. Man hole covers
7. Gland rope
8. Grease
9. Cotton waste
10. Rubber gaskets
11. Spun yarn
12. Pig lead
13. Lead wool

List of Tools:

1. Key rods for operation of all sluice valves
2. Hooks for lifting man hole covers
3. Pipe wrench (Size 200 mm, 300mm, 450mm)
4. DE Spanner set
5. Ring Spanner Set
6. Screw Drivers
7. Pliers
8. Hammers
9. Chiesels
10. Caulking Tools for lead and spun yarn
11. Ladles and pans
12. Crow bars
13. Spades
14. Iron Buckets
15. Dewatering pumps

In case of large diameters

1. Excavators
2. Cranes
3. Diesel welding sets
4. Welding electrodes
5. Gas cutting accessories
6. Gas cylinders

Annexure C: Check Lists for Transmission Main

CHAPTER- 2

BASICS ON WATER PUMPING

Pumping Machinery is used for transfer of water from one place to another.

- **Project Execution and Design Period**

a) Project Execution Period

The time lag between Preparation, Design, Tendering, Construction and Completion/ Commissioning of the proposed scheme should not exceed as specified under:

i. Mini pipe water supply scheme upto 01 years
ii. Standalone water supply scheme 01 to 02 years
iii. Multi village water supply scheme 02 to 03 years

b) Project Design Period

Project components may be designed to meet the requirements of the following design period

S. No.	Items	Design period in years
1	**Source** a. Surface b. Ground Water	 30 20
2	Intake works	30
3	**Pumping**	
	i. Pump House (Civil Works)	20
	ii. Electric motors and pumps	10
4	Water Treatment Units	20
5	Pipe connection to several treatment units and other small appurtenances	20
6	Raw water and clear water conveying mains	20
7	Clear water reservoirs at the head works, balancing tanks and service reservoirs	20
	(overhead or ground level)	
8	Distribution system	20

- **Population**
- **Water Demand**
- **Present status of Water Supply and Sanitation**
- **Institutional set up and detail of formation of VWSC**
- **Details of preparation of Water Safety and Security Plans**

- **Proposed Scheme – Details of Scheme Components**
- **Cost Estimates**
- **Life – Cycle Cost Approach**

Reference - Manual for preparation of DPR for Rural Piped WSS, Ministry of Drinking Water & Sanitation GOI, February, 2013 Section 3 to 11.

Types of Pumps

(a) **Centrifugal Pump (IS: 1520)** It accelerates liquid in a radial direction from the rotating shaft.

Pump consists of following parts:

- Casing
- Delivery Pipe
- Delivery Valve
- Impeller
- Prime Mover
- Suction Pipe
- Strainer and Foot Valve

b) Turbine Pump It accelerates fluids liquid more toward the axis of the rotating shaft. It produces high head of over 300 mtrs at relatively low rpm as compared with other pumps.

(c) Submersible pump (IS: 8034) Motor (IS: 9283) It is a device which has a hermetically sealed motor close coupled with pump. It prevents pump cavitations. Such pumps are used for water yield of 1000 liters per minute.

The main parts of a submersible pump are:

(a) Electric motor enclosed in a stainless sleeve.
(b) Pump body with multiple impellers, foot valve and strainer.
(c) Rising main of GI or stainless steel pipes connected with sockets or PVC hose.
(d) Electrical cable for connecting the motor to the starting panel (power source).
(e) Starting Panel.

Criteria for Pump Selection for water supply

a) Type of pumping required, i.e. whether continuous, intermittent or cyclic.
b) Present and projected demand and pattern of change in demand.
c) The details of head and flow rate required.
d) Type and duration of the availability of the power supply.
e) Selecting the operating speed of the pump and suitable drive/driving gear.
f) The efficiency of the pumps and consequent influence on power consumption and the running costs.
g) Ease in installation.

Quality Assurance: Manufacturer quality control plan should be in such a way to meet the requirement of inspection and test plan. Engineer must be aware of the details of design and characteristics of the equipment for the witnessing of performance test by the 3rd party inspection.

Test of the Pumps at factory site.

1. **Material Inspection**

a) Certificate Number
b) Chemical Composition
c) Surface Finish
d) NDE applied result

2. **Run out test**
3. **Centrifugal Pump NPSH Test**
4. **Mechanical Ring Test**
5. **Performance Test**
6. **Centrifugal Pump dismantling inspection**
7. **Clearance Checking**
8. **Visual and Dimensional control**
9. **Name plate, painting and coating inspection & reporting.**

Erection of pumping set at site:

1. Erection on concrete foundation.
2. Installation of the base frame.
3. Alignment.

a) Pipe work.
b) Suction conditions.
4. Delivery condition.
5. Shaft ceiling arrangement.

Commissioning and Testing

1. **Before the pump is brought into service, the pipe work associated with the pumping unit must be disconnected and flushed through. This will clear scale or deposits.**
2. **Clean the Bearing & refilled with a correct grade and quality of a lubricant.**
3. **Centrifugal pumps must not be run when dry.**
4. **Pre - start Check**

a) Bearings are properly lubricated.
b) The delivery valve is closed and suction valve is fully open.
c) Power supply for the driving unit is available, and all relays, alarms trips and interlocks are operational and are set to their correct values.
d) Direction of rotation of drive motor in uncoupled condition. (Directional arrow is marked on the pump casing).

5. Starting and running checks.

a) Start the pump by pressing the manual start button or initiate the start sequence-refer to driving instructions.

b) Check that the pump rotates in the correct direction.

c) Check that the pump is generating not less than its rated delivery pressure as indicated on the name plate.

If the pump generates rated pressure as indicated on the pump name plate and the bearing temperature remains normal i.e. 40 – 60^{o} C, Gland is not overheating, and no interruption in balance flow, suction and delivery pressure and ampere meter indicating normal conditions than pump is okay. This procedure must be witnessed by competent engineers for Quality Control Assurance.

List of Spare parts.

1. Coupling Pin.
2. Coupling Bush.
3. Distance Sleeve.
4. Housing Bearing.
5. Gland (Split)
6. Impeller
7. Neck Rings.
8. Suction Cover
9. Logging Ring.
10. Air Cock.
11. Impeller Key
12. Coupling key.
13. Packing
14. Driving End Sleeve
15. Driving End Sleeve Nut.
16. Back End Sleeve.
17. Back End Sleeve Nut.
18. Neck Bush.
19. Balance Value.
20. Seating And Bush.
21. Guide Tips
22. Delivery cover.
23. Balance Valve cover
24. Partition Plate.
25. Middle plate.

Do's	Don'ts
1. Pump in series should be started and stopped sequentially. 2. Operate delivery valve gradually. 3. Pumps in parallel should be started with time lag. 4. Before starting always check pump is free to rotate. 5. Before starting check water level in the tank.	1. Don't run pump out side, the recommended range. 2. Don't run pump with liquid other than specified. 3. Don't run pump with less NPSH than recommended. 4. Don't run pump when misaligned.

Motors

1 Directly coupled motor.
2 Squirrel cage Induction motor.
3 Wound Rotor Induction or slip ring motor.
4 Synchronous motors.

General principle of motor:- a current carrying conductor will experience a force when placed within a magnetic field. The principle of electric motor is that it converts electric energy into Kinetic energy through the interaction of the two magnetic fields.

For Inspection of motor at manufacturer shop following test are required:

- Visual and dimensional check.
- Dielectrically and insulation test.
- Measurement and calculation of no load and short circuit characteristics efficiency, power factor current slip, losses torque etc.
- Measurement and control of alignment air – gap, bearings.
- Heat run test.
- Noise and vibration measurement.
- No load test.
- Final report.
- Handling and Storage.

Erection of Motor at Site.

1. Erecting on concrete foundation.
2. Installation of the base frame.
3. Alignment.
4. Attachment with lubrication piping system if the cooling of the motor is done with the coolant / lubrication.
5. Running of Motor on no load
6. Running of Motor on load.
7. If all the parameters required are normal as per the desired standard the motor may be recommended for use and this process at site should be witnessed with the competent engineers to ensure the quality assurance of the machinery.

Spare parts.

1. Drive end shield.
2. End shield fixing bolt.
3. Drive end out seal.
4. Pre load washer.
5. Drive end bearing.
6. Eye bolt.
7. Bearing retention circlip.
8. No drive end bearing.
9. Bearing circlip.
10. Fan cover.

11. Terminal board.
12. Fan Circlip.
13. Detachable feet.
14. Pad mounting bracket.
15. Fan end shield.
16. Winding wire.
17. Fire cloth.
18. Varnish.
19. Wooden Stick.
20. Cable.

Do's	Don'ts
1. Do add a controlled bleed off loop to the pump's outlet to limit its minimum speed, also, an accumulator can allow the pump to get turned off at dead load condition. 2. Do limit the pump speed change rate to stay above the pump minimum inlet pressure to avoid cavitation. 3. Bearing ordered direct from bearing manufacturer must be specified as 63-90 CN bearing. 100 – 355 C_3 bearing.l 4. Do break down the cycle by pressure flow and time compute each segment for power. 5. Do use the larger of the two computed HP Values compare flow at maximum pressure and pressure at maximum flow.	1. Don't operate the motor below the minimum recommended pumps speed. It may damage the pump. 2. Don't accelerate / deaccelerate a pump too fast. 3. Don't just use maximum flow and maximum pressure to compute power. 4. Don't oversize the electric motor have large drives to power.

Repair and Maintenance of Pump House, Pump Motor, Stater and Panel system.

Maintenance of Pumping Station for Screens

i. Screen should be cleaned at a frequency depending on ingress load of floating matters.
ii. Cleaning frequency should be at least once in a week, or, if head loss in screen exceeds 0.20 m.
iii. The screen, catch tray and screen handling arrangement shall be thoroughly inspected once in six months and any item broken, eroded, corroded should be rectified.

Maintenance of Different Valves are as under:

1. Foot Valve

a) Clean foot valve once in 1-3 months depending on ingress of floating matter.
b) Clean flap of the foot valve once in 2 months to ensure leak proof operation.
c) Inspect the valve thoroughly once in a year.

2. Sluice Valve and Knife gate Valve

a) Check gland packing of the valve at least once in a month.
b) Ensure that packings inside the stuffing box are in good trim and impregnated with grease.
c) Ensure that the leakage is within the limit.
d) Grease should be applied to reduction gears and grease lubricated thrust bearing once in 3 months.
e) Check tight closure of the valve once in 3 months.
f) A valve normally kept open or closed should be operated once every three months to full travel of gate.
g) Inspect the valve thoroughly for flaws in guide channel, guide lugs, spindle, spindle nut, stuffing box etc. once in a year.
h) Don't operate sluice valve with oversized hand wheel or cap or spanner as this practice may result in rounding of square top.
i) Valve should never be operated under throttled condition. Such operation may result in chatter, wear and failure of valve spindle.

3. Reflux (non-return) valve

a) Check proper operation of hinged door and tight closure under no-flow condition once in 3 months.
b) Particular attention should be paid to hinges and pins and soundness of hinged door.
c) Dampening arrangement should be thoroughly examined once in a year and necessary maintenance and rectification as per the manufactures instruction shall be carried out.
d) Dampening arrangement checks for oil leakage and replace oil once in a year.

4. Butterfly valve

a) Check seal ring and tight shut-off once in 3 months.
b) Lubricate gearing arrangement and bearing once in 3 months.
c) Inspect the valve thoroughly including complete operations once in a year.
d) Change oil or grease in gearing arrangement once in a year.

5. General

a) Operate bypass valve wherever provided once in 3 months.
b) Flange adapter / dismantling joint provided with valve shall be loosened and retightened once in 6 months to avoid sticking.

Maintenance of Pumping Station for Sump / Intake well

i. Floating matters in the sump / intake should be manually removed once in a month.
ii. It should be disposed off away from pump house.
iii. Desilting of intake / sump should be carried out once in year after monsoon.
iv. The entire intake after monsoon should be disinfected

v. The sump/ intake should be fully dewatered and inspected once in a year

vi. For leakage test sump should be filled to FSL and drop in water level for reasonably long duration (2-3 hours) should be observed.

vii. If leakage is beyond limit rectification work may be done.

Maintenance of Pumping Station for pump house

i. The pump house should be cleaned daily. Good house keeping and cleanliness are necessary for pleasant environment.

ii. Entire pump house, superstructure and sub-structure shall be adequately illuminated.

iii. Wooden flooring and M.S. grating wherever damaged should be repaired on priority

iv. All the Roof leakages should be rectified on priority. All facilities in sub-structure i.e. stair case, floors, walkways etc. should be cleaned daily.

v. Painting of civil works should be carried out at least once in two years.

Note:-

The manufacturer's O & M manual must be followed with diligence.

Operation & Maintenance of Pumping Machinery and Pump House

- Generally failures in water supply are attributed to pumping machinery.
- Timely inspection, follow up actions on observations of inspection and planned periodical maintenance can avoid sudden failures.

Important points for Pump Operation

- Voltage range should be within the range ±10% of rated voltage.
- In low and medium specific speeds pumps need to be started against closed delivery valve. High specific speed draws more power at shut off such pumps started with delivery valve open
- Delivery valve should be operated gradually.
- Parallel pumps should be started and stopped with a time lag between two pumps to restrict change of flow velocity to minimum and to restrict dip in voltage in incoming feeder
- Series pump should be started and stopped sequentially.

(i) Pumps should be started and stopped sequentially but with minimum time lag. Any pump next in sequence should be started immediately after the delivery valve of previous pump is even partly opened.

(ii) Due care should be taken to keep the air vent of pump next in sequence open before starting that pump.

Drip of leakage in stuffing box should be 80 drops per minute as per the manual

The running of duty pumps and stand by pump should be scheduled so that no pump remains idle for long period and all pump are in ready to run condition

- Undue vibration should be checked and rectified.
- By-pass valves of all reflux valve sluice valve and butterfly valve shall be kept in closed during normal operation of the pumps.
- Frequent starting and stopping should be avoided

Don't /Undesirable Operation

- The pump should never be operated either at head higher than maximum or minimum recommended.
- Operation on higher suction lift resulting in cavitations in the pump.
- Throttlling results in inefficient running as energy is wasted.
- Clogged foot valve also causes cavitation in the pump similar to operation on higher suction lift.
- Low submergence gives rise to vortex phenomenon causes excessive vibration.

Checking of pump before starting

- Power is available in all three phases
- Trip circuit for relays in healthy state
- Check voltage in all phases. Voltage is in almost same and within ±10% of rated voltage
- Check function of lubrication system in case of lubricated
- Check stuffing box to ensure that it is packed properly
- Check and ensure the pump is free to rotate.
- Check over current setting if the pump is not operated for week or long period
- Before starting check water level in the sump.

Starting and Operation of Pumps

- For starting centrifugal pump priming should be done.
- Close the delivery valve and then loosen slightly
- Switch on motor check direction if pump does not rotate. It should be switched off immediately
- If the pointer on vacuum gauge gradually rise and become steady the priming is proper
- The delivery pressure gauge should rise steadily to shut off head.
- When motor attains steady speed and pressure becomes steady the delivery valve should be gradually opened in steps to ensure the head does not drop below recommended limit
- Ammeter reading should be less than rated motor current
- Check for undue vibration
- After 10-15 minutes check the bearing temperature stuffing box packing end leakage through mechanical seal

- Voltage should be checked every half an hour and should be within limit

Stopping The Pump Under Normal Condition

- Close the delivery valve gradually.
- Switch off- the motor.
- Open the air vent in case of VT and submersible pump.
- Stop lubricating oil or clear water supply used for lubrication.

Stopping after Power Failure / Tripping

- On tripping the pumps should not start automatically on resumption of power supply.
- There may be sudden increase in flow velocity in pumping main causing sudden rise in pressure may prove disastrous to pumping main.
- It may cause overheating of pump.
- Restarting of all pumps shall also cause overloading of electrical system.

To Prevent Auto - Restarting On Resumption Of Power

- Close all delivery valves on delivery piping of pump.
- All switches and breakers shall be operated to open i.e. off position.

Starting of the pumps in case of tripping

- Open air vent in case of VT & submersible pump
- Close lubricating system oil or clear water supply in case of lubricated or clear water lubricated VT pump.
- Information about power failure should be given to all concerned particularly to upstream pumping station to stop pumping.

Preventive Maintenance of Pumping Machinery

- Lack of preventive maintenance can cause premature failure of the equipment.
- These guidelines should not be considered as total as characteristics of equipment and site conditions differ from place to place.

Daily Maintenance of Pumps

- Clean the pump motor and other accessories
- Check coupling bushes / rubber spider.
- Check stuffing Box

Routine observation of irregularities

- Change in sound of running pumping set.
- Abrupt change in bearing temperature.
- Oil leakage from bearings.
- Leakage from stuffing box or mechanical seal.
- Change in voltage and current.
- Change in vacuum and pressure gauge.

Monthly Maintenance

- Check free movement of gland of the stuffing box and check gland packing replace if necessary.
- Clean and apply oil to the gland bolt.
- Inspect the mechanical seal for wear and replace if necessary.
- Check condition of bearing oil and replace or top up if necessary.

Quarterly Maintenance

- Check alignment of pump and drive end play in bearings.
- Clean oil lubricating bearing and replenish with fresh oil or greasing accordingly.
- Tighten the foundation bolts and holding bolts of pump and motor mounting on base plate or frame.
- Check vibration level.
- Clean all instruments in the pump house.

Annual Inspection and Maintenance

- It requires thorough and critical inspection.
- Clean bearing and bearing housing and check bearing play.
- Check stuffing box gland lantern ring mechanical seal rectify if necessary.
- Check clearance in wearing ring.
- If discharge indicates reduction beyond limit 5 – 7 % require repairs.
- Check impeller, diffuser, volute and casing for rough surface.
- All vital instruments used should be calibrated.
- Conduct performance test of the pump for discharge head and efficiency.

Guideline for overhauling of Pumps

- Submersible pump - 5000 to 6000 Hours
- VT pump - 12000 Hours
- Centrifugal Pump - 15000 Hours

Safety Procedures & Practices In Electrical Work

Following Indian Standards (IS) detail comprehensive guidelines for safety in electrical installation

- IS 5216 (Part I) – General
- IS 5216 (Part II) – Life Saving Technique
- IS 5216 (Part III) – Safety Posters
- IS 5216 (Part IV) – Special guidance for safety in electrical work in hazardous areas.
- General guidelines and precautions as follows should be observed for safe working in electrical installations

Test Instruments

- Insulation tester
- Tongue tester
- AVO meter
- Test lamp
- Earth resistance tester
- Wattmeter, CT and PT
- Dial gauge.
- Tachometer

Daily Maintenance of Motor

- Examine earth connections and motor leads
- Check temperature of motor
- Check whether oil rings are working in bearing housing.
- Check for any abnormal bearing noise.

Monthly Maintenance Schedule of Motor

- Check belt tension
- Blow dust from motor
- Examine oil in oil lubricated bearing for contamination
- Check insulation resistance by meggering

Quarterly Maintenance Schedule for motors

- Like pump clean oil lubricated bearings and bearing housing
- Check contact faces of brushes of slip-ring motors. If contact face is not smooth file to proper shape and full contact over slip rings
- Check insulation resistance of the motor
- Check tightness of cable gland lug and connecting bolts.
- Check tightness of foundation bolts and vibration level
- In half yearly maintenance clean winding of motor and varnish if necessary and check slip rings.

Annual Inspections and Maintenance of Motors

- Like pump clean bearing & bearing housing of motor
- Blow out dust from windings of motors thoroughly with clean dry air.
- Air pressure should not damage the insulation
- Clean and varnish dirty and oily windings
- Check condition of stator, stamping insulation terminal box fan etc.
- Check insulation resistance to earth and between phases of motor windings.
- Check air gap
- Check resistance of earth connections.

L.T. Starters Breakers & Panel

Circuit diagram of breaker/relay circuit should be pasted on door of switch gear and original copy should be kept in record

I. Daily

- Clean the external surface
- Check for any spark or leakage current
- Check for overheating

II. Monthly

- Blow the dust and clean internal components in the panel, breaker and starter
- Check and tighten all connections of cable, wires, jumpers and bus-bars. All carbon deposits shall be cleaned

III. Quarterly

- Check all connections as per circuit diagram.
- Check fixed and moving contacts and clean with smooth polish paper, if necessary.
- Check oil level and condition of oil in oil tank. Replace the oil if carbon deposit in suspension is observed or colour is back.
- Check relay setting.
- Check insulation resistance.
- Check condition of insulators.

IV. Yearly

- Check and carry out servicing of all components, thoroughly clean and reassemble.
- Calibrate voltmeter, ammeter, frequency meter etc.

H.T. Breakers Contactors & Protection Relays

Circuit diagram of breaker/relay circuit should be pasted on door of switch gear and original copy should be kept on record

I. Monthly

- Check spring charging mechanism and manual cranking arrangement for operation
- Clean all exposed insulators
- Check trip circuit and alarm circuit.
- Check opening & closing timing of breaker.

II. Quarterly

- Check control circuits including connections in marshalling boxes of breakers and transformer
- Check oil level in MOCB/LOCB/HT OCB and top up with tested oil

III. Yearly/Two yearly

- Testing of protection relay with D.C. injection shall be carried out once in a year
- Servicing of HT breaker and contactor shall be carried out once in 2-3 years
- Check dielectric strength of oil in breaker and replace if necessary
- Check male & female contacts for any pitting and measure contact resistance

CHAPTER - 3

PIPE MATERIAL FOR PIPE LINE & WATER DISTRIBUTION

Define Standards Codes and Specifications

Standard

Standard can be defined as a set of technical definitions and guidelines

- "how to " instructions for designers and manufactures
- They serve as a common language to defining quality and establishing safety criteria for the product

  Examples ASTM, ISO, API, MSS etc

Code

A code is a standard that has been adopted by one or more governmental bodies and can be enforced by law

Or

when it has been incorporated into a business contract

- Requirements are mandatory only if said code is law.
- If not code will serve a generally accepted guidelines for design fabrication construction and installation

  Examples ASME Code BIS, DIN, IS etc

Specification

- Specifications provide specific/ addition requirements for materials components or services beyond the code or standard requirement.
- Often generated by the private companies to address additional requirements applicable to specific product or application.
- Must meet requirement.

Type of Pipe

1. Galvanized Iron (GI) Pipes IS: 1239(1): 2004 & Part (2): 2011

- Affected by acidic or alkaline water. It is highly suitable for distribution system and are available in light, medium, heavy grades depending on the thickness of pipe.
- Medium grade pipes thickness is as per IS: Codes. IS: 1239(1): 2004 & Part (2): 2011
- Normally 15 -150 mm pipes are used for water supply system

Quality Assurance / Control

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

It shall conform to IS: 1239 (I) -2004 with respect to dimension, weight per meter and Hydraulic test pressure.

The Galvanizing of pipes shall also conform to relevant IS: Codes as given below:

Test	Frequency	Ref Codes	Acceptance/Standard
1. Mass of Zinc Coating	One test per lot	IS: 6745-1972	360 g/m^2 minimum total mass of Zinc (inside and outside) per surface area (inside and outside) of the coated surface. The Zinc coating shall be free from imperfection like flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, rums, rust, blister, white deposit etc.
2. Visual Test	One test per lot	IS: 2629-1985	
3. Free Bore Test	One test per lot	IS: 2633-1986	
4. Uniformity of Galvanized Coating	One test per lot	IS: 4736:1986 (Amendment No. 4 Nov, 2007).	
5. Adhesion Test	One test per lot	IS: 2629:1985	

2. Steel Pipes IS: 3183 : 2012 & 3589 : 2001.

- Available in various diameters for water supply and cut lengths of different sizes & thickness.
- Pipes are joined with flanged / butt welded joints.

Inspection/ Tests is witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

It shall conform to IS : 3183 & 3589 with respect to dimension, weight per meter and Hydraulic test pressure , Flattening Test, Bend test, Weld Tensile Test, Longitudinal Tensile Test, Transverse Tensile Test & all longitudinal and transverse tensile test shall include yield strength, tensile strength and elongation determination is in accordance with IS codes.

3. Poly Vinyl Chloride (PVC unplasticised) Pipes

- Available in size 20 – 315 mm (Nominal internal diameter) for water supply with pressure class of 2.5 , 4, 6, 8, 10, 12.5 kg per cm^2 for water supply.
- Ideally pipes with 6 kg per cm^2 should be used.
- Jointing of PVC pipe can be made by solvent cement or rubber ring joint

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARD

The dimension test should be carried out in the field and other types should be carried out in the laboratory before use.

Pipes of 1.0 m length each size should be sampled out for test.

Field test	Ref. Codes	Standards
Length of pipe Mean outside dia.(Min/ Max) Diameter at any point.(Min/ Max) Wall Thickness .Average (Min/Max) Visual appearance Dimensions of sockets	IS: 4985- 2000	As per Table-1 ,, ,, ,, Smooth, clean, both end square cut Ls = 0.5dn + 6mm Ls = minimum socket length dn = nominal outside dia of pipe

Lab Test	Ref. Codes	Standards
Reversion test	IS : 12235(5)-2004	Shrinkage not more than 5%
Short term hydro static pressure test 4.19xPN (MPa) at 27oC for one hour	IS : 12235 (8)-2004	Pipe shall not fail during the prescribed test duration.
Resistant to external blows at 0◦C	IS : 12235 (9)-2004	TIR not more than 10%
Vicat softening temperature	IS : 6307-1985	VST of specimen shall not be less than 800◦C
Density Sulphated ash content	IS : 13360 (3) Sec- I- 1995	Density of pipe shall be between 1.40 and 1.46 gm /cc 11.0 % (Max.)

3. HDPE

- Normally, 20 - 315 mm diameters pipes are used for water supply and distribution system and pressure ranging from 6 – 10 kg per $cm^{2.}$
- Available in coils in small diameters upto 110 mm dia.
- Above 110 mm diameter, available in length starting from 6 m.

HDPE pipes from 16 mm to 1000 mm nominal diameter of pressure rating from .25 Mpa to 1.6 Mpa in material grade PE63, PE80, and PE100.

For use of buried water mains and services and water supply above ground. both inside and outside buildings.

Material should free from toxic hazard, not support microbial growth etc. and anti-oxidant percentage shall not more than .3% by mass of finished resin as per IS: 10141 – 1982.

Inspection / Tests are witnessed with 3rd party inspection at factory site.

METHOD AND STANDARDS

The pipe shall conform to IS: 4984-1995

Test	Acceptance/ Standard
1.**Dimensions** (i) Outside Dia. (ii) Wall thickness 2. Hydraulic Characteristics 3. Reversion Test	As per Table No localized swelling, leakage, weeping, or bursting during subjecting to internal pressure creep test. Longitudinal reversion shall not be more than 3%
Density 3. Melt Flow Rate (MFR) 5. Carbon Black Content and Dispersion	 940.5 to 946.4Kg/m3 at 270C and shall not differ from the nominal value by more than 3kg/ m3 0.41 to 1.10 at 1900C with nominal load of 5kg and shall be within 20% of the value declared by the manufacturer. 2.5+ 0.5% with uniform dispersion.

4. Ductile Iron Pipes (IS: 8329 : 2000)/ Cast Iron Pipes (IS:1536 : 2001)

- DI pressure pipe available in range from 80- 1000 mm diameter in lengths from 5.5- 6 m
- Available in thickness class K7 and K9 with barrel wall thickness arranging from 5- 13.5 mm
- Available in pressure class (C25, C30, C40) etc.

Inspection/ Tests are witnessed with 3rd party inspection at factory site.

Size, length, internal diameter, wall thickness, tolerances on external diameter, ovality shall in accordance with specified coed, standards and specifications, permissible deviation from straight and flanges etc shall in accordance with specified standard code and specification & Hydrostatic test, Zinc Coating, Cement Mortar lining, Bituminous Coating accordance with IS:8429.

Test	Frequency	Ref. Code	Acceptance/ Standard
1. Tensile test.	One test per lot	IS: 1608	**As per table 10.1.2 in IS 8329 : 2000**
2. Brinell hardness test	One test per lot	IS: 1500	**Not exceed 230 BHN on the external unmachined surface.**

Inspection / Tests are witnessed with 3rd party inspection at factory site for Quality Control / Assurance

METHOD AND STANDARDS

It shall be as per IS: 458-2003 and should also conform the test requirement as per IS: 3597-1998.

Test	Frequency	Ref. Code	Acceptance/ Standard
1. Tolerances in Dimensions Wall Thickness	At the start of work for source approval Once for every Lot for each size	IS: 458-2003	Up to and including 30 mm + 2mm, -1mm Over 30 mm and up to and including 50mm + 3mm, - 1.5 mm Over 50 mm and up to and including 65mm + 4mm,- 2.0 mm Over 65 mm and up to and including 80mm + 5mm, - 2.5 mm Over 80 mm and up to and including 95mm + 6mm, - 3.0 mm Over 95 mm + 7mm, - 3.5 mm
Internal Dia. Of pipe or socket	IS: 458-2003		Up to and including 300 mm ± 3mm Over 300 mm and up to and including 600 mm ± 5mm Over 600 mm ± 10 mm
Overall Length	IS: 458-2003		±1% of standard Length
2. Three Edge Bearing	IS: 458-2003		Shall withstand the design Load
3. Water absorption	IS : 3597-1998		After 10 minutes, 2.5 % of dry Mass Max, and total absorption at the end of 24 Hours shall not exceed 6.5% of dry mass
4. Hydrostatic test			No leakage under the design pressure.
5. Straightness			The deviation from straightness when tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed 3 mm for every m length
6. Reinforcement	IS: 458-2003		On breaking the Pipe and extracting the reinforcement, it shall be as per the provision

Asbestos Cement pressure pipes, IS: 1592

- The classis of the pipes is C5, C10 , C15, C20, C25 & there working pressure are 2.5, 5, 7.5, 10, & 12.5 Kg/cm^2 respectively and there random lengths are available 3 to 4 m
- From nominal dia of pipe 50 mm to 1000 mm
- Joints of these pipes are PI detachable joint / victolic Joints. AC coupling joints.

Inspection / Tests are witnessed with 3rd party inspection at factory site for Quality Control / Assurance

METHOD AND STANDARDS

It shall conform to IS: 1592 with respect to dimension, Thickness of wall and external diameter, Length, Tolerances, Bursting, Crushing, Bending.

Hydraulic pressure tightness test, Hydraulic pressure bursting test, Transverse crushing test, Longitudinal bending test , Hydraulic pressure bursting non-immersed test , are carried out as per IS: 5913 and there No. of samples for test in accordance with the IS: 7639.

Test	Ref. Code	Acceptance / Standard
Line test	IS 6530	On 100 m length of laid pipeline for at least each size ordered above 5000 m'. This is to be done at random at factory of origin.

LAYING OF DISTRIBUTION PIPELINES

Critical Activities of pipeline:

- Excavation
- Completion of excavation Trenches for Pipe laying.
- Laying and jointing of pipes in correct alignment.
- Pressure / leakage Testing of pipeline.
- Backfilling in layers and watering & proper compaction of the at least 3 layers.

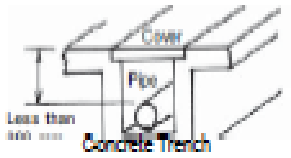
i. Preparation Prior to Laying of Pipes

- **Trenches excavation.**

Type of pipe	Minimum cover below road (mm)	Minimum clearance from either side of pipe in trenches (mm)
Steel (MS/GI/DI)	1200	200
Plastic (PVC/HDPE)	1000	200

Nominal Pipe Size (Inches)	Trench Width (Inches)	Nominal Pipe Size (Inches)	Trench Width (Inches)
3	27	20	44
4	28	24	48
6	30	30	54
8	32	36	60
10	34	42	66
12	36	48	72
14	38	54	78
16	40	60	84
18	42	64	88

- Maintain levels after excavation. Place extra formworks and shuttering where needed in case the soil is soft to prevent collapse of soil.
  If excavation is done more than planned size, fill with the soil and compact it.
  If the soil is hard or rocky the depth may be reduced.
  In hard rock, use blasting for excavation.
- Rock Excavation: Rock must be excavated so that it will not be closer than 6-inches to the bottom and sides of the pipe for diameters up to 24-inches and no closer than 9-inches for diameters 30-inches or larger
  If excavation is not possible, PVC pipes should be encased in masonry/concrete or steel pipes to prevent breakage and pressure of moving vehicles.



Encasement of pipe with polythene

- **Installation methods**

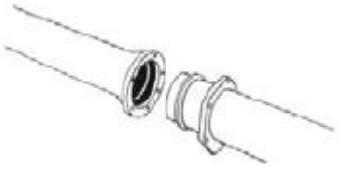
  Encasing the pipe in loose polyethylene from corrosion provides an effective and economic method of protection

Minimum Flattened Polythylene Tube Widths for Push-on Joint Pipe.

Nominal Pipe Size (inches)	Flat Tube Width (inches)	Nominal Pipe Size (inches)	Flat Tube Width (Inches)
3	14	20	41
4	14	24	54
6	16	30	67
8	20	36	81
10	24	42	81
12	27	48	95
14	30	54	108
16	34	60	108
18	37	64	121

1. In case of PVC, tape should be fixed with the help of blow lamp on the pipe.
2. A Polythylene / PVC tape should be fixed on joints after jointing the pipe.

Preparation



- All care should be taken to clean the inner surface of the pipe before laying.
- Proper cleaning of pipes and joints are required before jointing the pipes.
- **Jointing of pipes**

  Pipes should be laid and joined with fittings on side of trenches in suitable lengths and lowered after suitable lengths are prepared.

Lowering of pipes

Lower the cut pipes and fitting into trench manually. Care should be taken that they are not thrown in trenches. Mechanical device for lowering pipes can be done only in case large size pipes (>160 mm) are used. After laying, the open end of the pipes should be temporally plugged to prevent access of water, soil or any other foreign matter

Joining and Laying of MS Pipeline

Preparatory

- Cut the pipes as per required length and thread with threading die and filed for proper cleaning where needed Clean the edge and surfaces with clean cloth. Light sand paper or emery can be used lightly for cleaning if needed.

Jointing of pipes

a) Threaded joint:

- Below 200 mm threaded pipes are lowered down in trenches and lay to aligned.
- White lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned and tightened.
- In case of MS Pipe below 200 mm threaded pipes are lowered down trenches and lay to aligned and gradient.
- White lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned and tightened.
- Any threads exposed after jointing should be painted or coated with approved anti-corrosive paint to prevent corrosion.

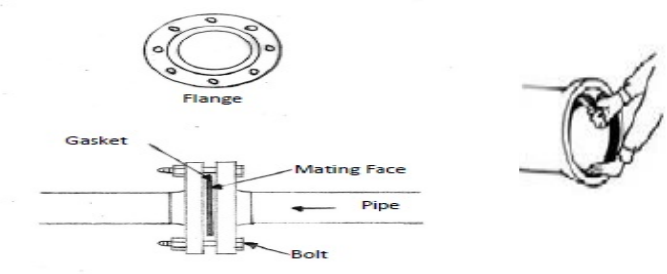
b) **Push-on Joints:**

- The push-on joint consists of a special bell, plain end, and rubber gasket. The bell is provided with an internal groove in which the appropriate gasket is seated.
- The plain end is beveled, and the joint is assembled by pushing the plain end into the bell, which compresses the gasket and forms a watertight seal.

(c) **Mechanical Joints:**

The mechanical joints have four parts. A flange cast with the bell; a rubber gasket that fits in the bell recess; a gland, or follower ring, to compress the gasket; and tee head bolts and nuts for tightening the joint.

(d) **Flange Joint:**

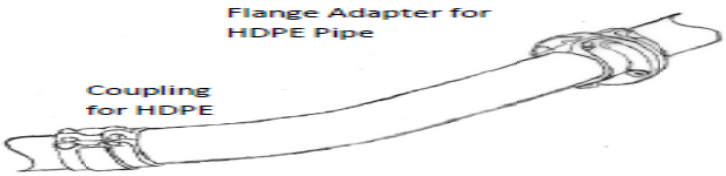


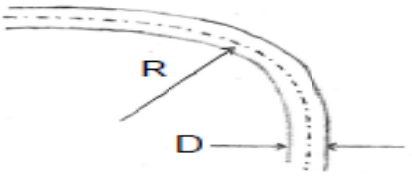
1. Welding:

- Large diameters pipes, normally above 200 m are joined by welding.
- Pipes are first lowered down manually or with chain pulley.
- Pipes are laid in level alignment before joining.
- Pipe ends are butted against each other.
- Cement mortar is applied after welding.

Joining and Laying HDPE Pipeline (Mainly for Service/Branch Connections)

- Small diameter pipes are flexible and available in coils and do not need special like bend, elbows etc.
- The radius (R) of the bend should be greater than 20 times the outside diameter of the pipe (D).
- Small radius bend can be made easily by the application of heat.
- The pipe should be heated to a temperature of 130°C in an inert liquid.
- After the pipes are bent, they are joined with mechanical joints, and fixed with bolts.
- Use of synthetic rubber gasket can also be done with it to improve water tightness of pipes.
- For joining HDPE pipes to any other pipe, HDPE-to-metal transition couplings, outlets and fittings are used.
- The pipe line may be laid along side of the trench and jointed there.
- There after the jointed pipeline shall be lowered into the trench carefully without causing undue bending, manually or with chain pulley, sling etc .
- The pipeline shall be laid inside the trench with a slack/looseness of about 1.0 m per 100 m of pipe line as they contract later on.
- For mechanical joints, thrust anchor are required in trenches for support it.

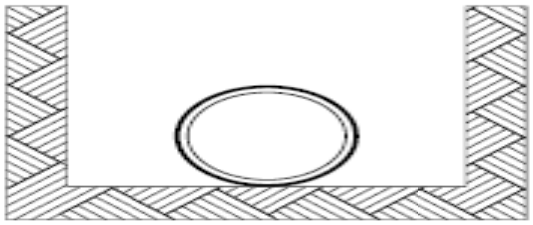




Pipe Installation:

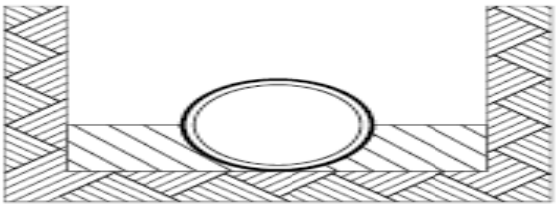
- **Type 1**

Flat-bottom trench. Loose backfill, (Fully consolidated).



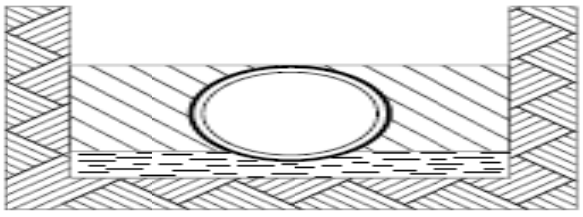
- **Type 2**

Flat-bottom trench. Backfill lightly consolidated to centerline of pipe.



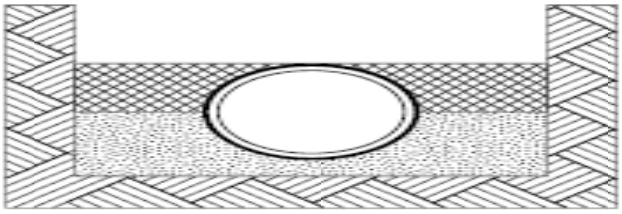
- **Type 3**

Pipe bedded in 4-inch minimum loose soil. Backfill lightly consolidated to top of pipe



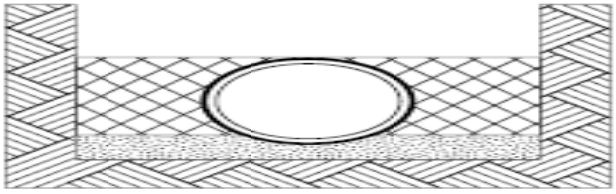
- **Type 4**

Pipe bedded in sand, gravel, or crushed stone to depth of 1/8 pipe diameter, 4-inch minimum. Backfill compacted to top of pipe.



- **Type 5**

  Pipe bedded to its centerline in compacted granular material, 4-inch minimum under pipe. Compacted granular or select material to top of pipe.



iii. Filling Excavated Pit after Laying of Pipes and Testing of Piping System

- All backfill material should be free from cinders, ashes, slag, rubbish, vegetable or organic matter, boulders etc. Sand used for back fill should be natural sand, fine or course.
- Gravel used for back fill should be natural gravel with no boulders larger than 50 mm.
- Back fill can be done with excavated materials like clay, sand, gravel, etc.
- After laying of piping system, fill the trench upto 300 mm and compact by tamping.
- Carry out leakage testing of piping system after partial back filling.

The Welding of pipes in the field should comply with IS: 816- 1969. Electrodes used for welding should comply with IS 814: 1991.

1. The welded joints shall be tested in accordance with procedure laid down in IS 3600 (Part 1) 1985. One test specimen taken from at least one field joint out of any 10 shall be subjected to test.
2. Non- destructive testing of the completed weld may be carried out on pipelines by radiographic (see IS 4853:1982) or ultrasonic method (see IS 4260: 1986) as agreed upon between the user and the manufacturer / dye penetrate test.

TESTING OF PIPE FOR LEAKAGE

The leakage can be detected in 2 ways:

1. Direct observation - spots of wet places in the pipeline indicates leakages.

2. Hydraulic test with pressure.

- Leakage test can be carried out after every 500-1000 m for such test and mainly for the mains.
- Pressure gauge should be fixed at lowest end of pipe.
- The water should be filled in from lowest point in network to be tested and air vents should be provided at higher points.

- Filling of the pipe system shall not exceed the amount of water charged into the system as follows:

Up to DN200 diameter	1.5 litres/second
Up to DN300 diameter	3.0 litres/second
Up to DN400 diameter	6.0 litres/second
Up to DN500 diameter	9.0 litres/second
Up to DN600 diameter	14.0 litres/second
Up to DN800 diameter	22.0 litres/second

- The test pressure shall be applied by a suitable pump equipped with connection valves and gauges, etc. to the satisfaction of the Engineer's Representative. The gauges and meters shall be new and accompanied by a certificate for test and calibration.
- During such filling of pipe line with water, air should be released from air vent pipes and care should be taken to close air vents only when complete air has been released from the pipe line and smooth flow of water starts.
- Calibrated tank can be installed for water supply and collection.
- For leakage test, 1.5 times the working test pressure of the pipes selected is done.
- The period for test pipe should be 24 hours.
- If the drop in pressure occurs the quantity of water added in order to re-establish the test pressure should be measured.
- Standard Allowable Volumes of leakage by diameter (Liters/Per Kilometre/Per Hour.
-

Nominal Pipe Diameter	**Leakage Rate (Litres/ Km/ Hours)**
100 mm	0.18
150mm	0.41
200mm	0.72
300mm	1.13
350mm	1.62
350mm	2.21

400mm	2.88
450mm	3.65
500mm	4.50
600mm	6.48
700mm	8.82
800mm	11.52
900mm	14.58
1000mm	18.00

- About 1 to 2 percent of the total volume of test water in the pipe will be needed as makeup water due to the expansion of HDPE pipe in the initial phase
- It is recommended that plastic pipes should be tested only upto 1.5 times the rated working pressure for a duration of 1 to 2 hours without any leakage.
- The maximum allowable leakage should not exceed .365 / 1000 m length of pipe/ cm dia of nominal bore per kg of test pressure.
- It will vary with the pipe length, number of joints in pipeline and diameter of pipe. Consult the site engineer for its details.

Note: solvent joined pipes should not be tested before 24 hours of fixing.

Fill the remaining pit in layer of 50mm with required compaction and watering.

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- Fill the remaining pit in layer of 50mm with required compaction and watering

Disinfection of Pipeline

- The mains of water supply line should be disinfected before it is used.
- Flush the pipe with water of sufficient velocity to remove dirt and other foreign material.
- Later disinfection with chlorine water can also be done. Chlorine concentration of 20 mg/litre can be used for chlorination of mains.
- Chlorine water should remain for 24 hours in the main for proper disinfection.
- Hence, all the valve, etc. should be closed along mains before the procedure.
- The chlorine water can then be disposed off and pipeline be cleaned with fresh water.

CAUSES OF FAILURE IN PIPELINES

1. HANDLING AND STORAGE OF PIPES

a) Damage during transport & careless unloading etc.

b) Defective stacking and storage.

2. LAYING OF PIPELINES

a) Deviation form proper laying procedures and improper welding.

b) Improper bedding support after laying and slipping & sinking of trench sides.

c) Poor backfill material, improper compaction, overburden on pipe trenches, point loads, traffic vibration etc. are the main problems in laying of pipe lines.

3. JOINTING OF PIPES

a) Defective jointing materials.

b) Slipping of jointing material like rubber rings and lead etc.

4. CHARACTERSISTICS OF SOIL

5. EXCESSIVE TEMPERATURE CHANGES

6. **INTERNAL PRESSURE**

a) Excessive test pressure, pressure surge, water separation, vacuum etc.

Special Observation on Failure of Pipes.

1. **Pipe Barrel**

Brittle type fractures

It generally occurs in cast iron asbestos cement and PVC. It occurs as circumferential breaks or longitudinal cracks which may run straight but more often irregularly curved along the pipe barrel.

2. Ductile type failures

It occurs in polythene and ductile iron pipe.

3. Blow outs

It is usually associated with high pressure e.g. pumping surges in weakened brittle materials.

4. Pinholes

It is localized chemically or electrically induced corrosion which thins and weakens the pipe wall until a small plug is blown out by internal pressure.

5. Generalised Deterioration

It is a manufacturing defect and it is usually the result of some form of chemical attack.

FAILURE OF JOINTS:

1. General

a) Failure of joints occur due to careless installation practices causing displacements of the seal / or eventual separation of the mating surface.

b) Stress cracking of pipe material around the joint.

c) Biodegradation of the sealing components.

2. Flanged Connections

Flange connections due to unequally tightened bolts.

3. Crushing of pipe ends.

When pipe ends touches or bind and are then subjected to high compressional or bending force.

4. Lead joints.

Hardening of lead in association with joint movement may lead to more serious leakage.

5. Sealing rings or gaskets.

Do's & Dont's/ Safety Practices during Repair and Operation of Water Mains

1. Planning

a) A safety practice during construction and maintenance of the water distribution system has two major aspects - preparation & planning and operation.

b) Usually previous methods are followed and these are revised on past experience.

c) Proper maps of the system must be maintained and studied. A study of the character of the area in which the work is to be carried out is an accident prevention item.

2. Traffic Control

a) Warning signs must be placed well ahead of the work area.

b) Vehicles can be parked between work area and the coming traffic.

c) Use red warning lights or flashers during the night.

d) Use a flag man for one way operation.

e) Traffic police must be informed and their help taken.

SAFETY PRACTICES IN REPAIR AND LAYING OF PIPES

1. Excavations should be closely watched. Type of soil must be studied and necessary precautions taken to provide adequate side slopes or to shore up the trench. The proximity of poles and building must be taken into consideration.
2. All soil must be stacked at least three feet from the edge of the trench.
3. Repair of broken mains is a hand job. The ground is usually saturated or washed out. Care must be taken to protect other utilities especially electric cables which can be dangerous. Welding must be done in dry conditions.
4. The workmen must use safety hats and other protective equipment.
5. Only one trained and experienced man should give signals to a crane operator.

6. The inspection of the equipment to be used should be done before it is sent to the site. In case of a burst main, the advance crew should carry plans showing the location of valves to be closed, barricading equipment, signage, valve and chamber keys etc. Portable pumps to drain out the water should also be sent.
7. The pipe for replacement must be blocked to prevent it from rolling. Proper equipment should be used when lowering it into the trench. Sufficient men should also be engaged.
8. When the job is completed, cleaning up must be done to prevent hazards to others.

WELDING AND TESTINGOF WELDING

- A Welding joint is a point or edge where two or more pieces of metal or plastic are joined together according to the particular geometry
- Butt, Corner, Edge, Lap, Tee are welding joints

(American Welding society AWS)

Welding Codes used in Welding

• Electrodes shall be confirm to	IS: 814
• Welding Symbol	IS : 813
• Workmanship quality of weld etc. should be in accordance with	IS : 823
• Inspection and testing reference should be made to	IS : 822
• Operates qualification should be in accordance with	IS: 817
• Should be subjected to appropriate qualifying test specified in	IS: 1181
• Safety requirements reference be made to	IS: 818

Electrode Coding

- B.S or BEAMA: British standard or British electro coal and Allied Manufacturing Association) method.
- AWS or ASTM: American Welding Society or American Society of Testing Material) method
- IS (Indian Standard) method

Electrode Sizes

- The electrode size refer to the diameter of its core wire each electrode has certain current range.
- Welding current increases with the electrode size (diameter)
- Size are generally for are welding are 3.15 mm 2.5mm – 4mm
- Standard length of electrodes are generally manufactured in the length of 250 mm to 450 mm

Welding layers

- Thickness of the weld generally equal to the thickness of the plate up to 4 to 5 mm.
- For above thickness the weld thickness should be as per following table

Thickness-of plate (mm)	3-5	6-8	10-16	18-24	26-55	over 58
Thickness - of Weld (mm)	3	5	6	10	14	20

Procedure of Welding

1. Joint Preparation (CAS code pressure piping) (ANSI for end preparation)
2. Treatment before welding
3. Tacking
4. Final Welding

Welding Defects

External defects:

External defects are undercut, cracks, blow holes and porosity etc.

Internal Defects:

Internal defects are blow hole, porosity, flag inclusion, internal stresses root penetration etc.

Welding Testing

Inspection of Welds can be carried out by following methods.

A. **Radiography**

Placing the radiation source on one side of the the pipe and attaching the film on the other side.

B. **Liquid Penetrant Test**

i. **Dye Penetrant Test**

- It contains two different solutions (i) Red Liquid (Dye) (ii) Volatile Liquid (as Developer).
- Apply a red Liquid (dye) by spraying brushing or dipping the metal surface and allowing it to penetrate into the cracks and crevices.
- A dwel time of at least 15 to 30 minutes.
- The surface is then cleaned with cloth or cleaner.
- A fine white powder highly volatile liquid (Developer) is carefully sprayed or brushed over the metal surface.
- Evaporation of volatile liquid will leave the dry white powder on the metal surface.
- The dye previously penetrated in the cracker will be observed by the white powder outlying the crack in red.

ii. **Fluorescent Penetration Test**

- In this case the surface is illuminated under near ultraviolet or black light.
- The liquid where there are discontinuities in surface will then delineate them by fluorescence.

Repairs of Defective Weld:

- Defect are generally removed by grinding chipping or machining.
- After welding the weld should be cleaned properly.
- Satisfactory repair can be carried out more readily on the first attempt.

CHAPTER- 4
WATER TREATMENT AND QUALITY CONTROL

1. Water Quality and Testing

Water Source	Type of quality issues
	Surface Water
Lakes and Ponds	Development of algae on top, development of Micro organisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of waste water.
River, irrigation canals	Organic debris, mineral salts (health of river depends upon BOD, MPN, DO level and silt). May be affected by organic and chemical pollutants by disposal of waste water.
	Ground water
Well, tube wells, hand pump etc.	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

Annexure D <u>Tolerance and Classification of Water</u> IS Code: 2296-1982

Annexure E IS Code: 10500-1991 potable drinking water

Types of tests to be conducted:

a. Physical test.

b. Chemical test. c. Bacteriological test.

Bacterial Indicator:

- Many type of harmless bacteria colonize the human intestinal track and are routinely shed in the feces
- Each person discharges from 100 to 400 billion coli-form bacteria per day in addition to other kinds of bacteria.
- Domestic waste water contains wide variety and concentration range of non pathogenic and pathogenic bacteria .

<u>E- Coli</u>

- The E-coli is one of the coli-form bacteria population and is more representative of fecal sources than other coli-form genera
- E-coli = Escherichia-coli
- E-coli is taken as a specific indicator of fecal contamination and possible presence of enteric pathogen (standard method 1998).

Viruses

- Enteric viruses multiply in the intestinal tract and are released in the fecal matter of infected persons. (.02 to .08 micrometer).
- The viruses are extremely small particles ranging from 20 to 80 nano meters (nm) in diameter in comparison a human red blood cell average 7600 nm in diameter
- Replication of viruses can only take place in a living host cell

Sampling Frequency CPHEEO Guideline

Minimum Sampling Frequency and number from Distribution System		
Population	**Maximum Intervals between successive sampling**	**Minimum number of samples to be taken from entire distribution system**
Upto 20,000	One Month	1 sample per 5,000 population per month
20,000 – 50,000	Two Weeks	
50,000 – 100,000	Four days	
>100,000	One day	1 sample per 10,000 of population per month

Where there are issues of biological contaminations, samples should be taken every week from the specified water source.

Sampling Methods

a. Sampling for physical and chemical test

- Samples should be collected in inert materials like glass or polythene.
- Sample bottle must be cleaned prior to taking samples as directed by laboratories.
- About 2.5 litres is required for testing from each sample.
- Prior to filling, the sample bottle must be rinsed 2-3 times with water to be collected.
- Sample should reach the testing place within 72 hours of collection.
- Certain parameters like pH, temperature chlorine etc may change during transport and it is advisable if they are tested on spot by specific kits.
- Samples collected from wells should be taken only after the well has been pumped for sufficient times so that the sample will represent ground water.

b. Sampling for bacteriological test

- Sterilized bottle, as directed by laboratory should be used for sample collection.
- While collecting sample, hand should not touch the bottle neck or stopper. Bottle should be held from the base, filled without rinsing and stopper be closed immediately. Bottle should have some air space left and should not be filled completely. Finally, brown paper should be wrapped for avoiding further contamination of water.
- Size of sample should be at least 250 ml (1/4th of litre).

- The sample should preferably be analysed within one hour after collection. The test of the sample should be done maximum within 24 hours.

Note for collecting sample from various sources

- While taking sample from river, lake, etc. sample should be taken from middle of bank. Stagnant water should be avoided for sample.
- While taking sample from tap (HH or stand post), water should be allowed to flow for two to three minutes prior to taking sample. Tap from which sample is collected should be clean and free from grease etc.
- While taking sample from hand pump, water should be allowed to flow for four to five minutes prior to collection of sample.
- While collecting sample from well/bore well, sample be collected from discharge end through fitted mechanical pump.

Water Testing Kits

Several testing kits are available in market to test water quality at village/town level.

1. **FTC (Field test kits)**

   Such kits include testing of water for turbidity, pH, hardness, chloride, iron, nitrate, fluoride, residual chlorine, arsenic and bacteriological quality.

2. **Jal Tara Water Testing Kits (Designed by Development Alternatives)**

   A standard Jal Tara kit can test 14 parameters:

Physical: pH, Temperature, turbidity, hardness

Chemical: chlorine, fluoride, iron, nitrate, residual chlorine, dissolved oxygen phosphorous, ammonia

Biological: Coliform bacteria

100 tests can be performed by this kit. However, 10 test for Coliform can be done.

<u>Testing Procedure in Laboratories</u>

TEST FOR TURBIDITY:

Purpose

i. Water which appears dirty and unclean on visual examination must be tested for determining its level of turbidity.
ii. Insoluble suspended particles originating from soil, silt, clay mineral matters, organic debris, carcass, plankton etc
iii. Microscopic organisms are the general cause of turbidity in water. Turbidity of usable water should not exceed 10 NTU (Nephelometric Turbidity Unit)

Result

i. Turbidity of water upto 10 NTU is acceptable

Reaction

i. Turbidity water decreases Consumer acceptance

ii. Sudden increase in turbidity is often indicative of bacterial growth

TEST FOR pH:

1. pH scale is used for determining the nature of water.
2. pH is the unit for measuring the acidic or alkaline property of water.

Purpose

i. The chemical or biochemical reaction of water depends on the pH value of that water.

ii. The pH value of water should, therefore, be determined before using.

iii. A special kind of paper is available for pH test.

iv. The colour of the paper, when dipped in water changes depending on the nature of water.

Result

Water is acceptable if the pH value ranges between 6.5 to 8.5

Reactions

i. Water pipelines get corroded if the pH value is too low, means the water is acidic

ii. If pH is high sedimentation occurs in pipelines may reduce diameter of pipe.

iii. pH plays an important role in such water treatment processes as chlorination, coagulation, softening and corrosion control.

TEST FOR CHLORIDE

Purpose

1. Chloride is almost universally present in water.
2. The presence of little amount of these salts in water does not cause any harm.
3. Access presence of chloride definitely affects our health.
4. It necessitates the need for the amount of chloride present in water to be determined.

Reagents required to test Chloride

1 - 5% w/v Potassium Chromate solution in distilled water (Chloride Free).

2 - 47.91 g Silver Nitrate dissolved in 1000 ml Chloride free distilled water and solution standardized against Sodium Chloride Solution.

Result

To carry out this test it requires two Reagent.

After adding Reagent No.2

i. If the colour changes from yellow to brick red, the water is acceptable (chloride less than 1000 mg/l)

ii. If the colour remains same as before i.e. yellow, the unacceptable. (Chloride more than 1000 mg/l)

Reaction

i. If the chloride content is high in water the water becomes salty
ii. Consumption of water with high chloride content is bad for health and corrodes water supply pipelines and other tools.

TEST FOR IRON

Purpose

i. Iron content is generally high in water, specially in ground water.
ii. Presence of iron in drinking water is usually considered good for health provided it does not cross the limit.
iii. The maximum permissible limit for iron is 1 mg/l or water.
iv. This makes this test necessary the iron content in usable water

Reagents required to test iron

1. 40% w/v Citric acid solution
2. Thioglycolic acid (Reagent grade)
3. Ammonia solution containing 20% w/w NH3.

Result

If the iron content of water

i. 1.0 mg per litre the water is acceptable

Reaction

If the iron content is too high A bad odour develops

i. Water becomes reddish and turbid, and clothes get rusty stains
ii. Brownish-red scales appear on the walls of storage vessels
iii. Excess iron content in water promotes growth of iron bacteria

TEST FOR NITRATE

Purpose

1. Presence of small amount of nitrate in drinking water is not unusual.
2. The presence of nitrates in excess is indicative of organic pollution.
3. It is of utmost importance to detect the amount of nitrate in water.

Reagents required to test nitrate

1. 5 g Brucine dissolved in 90 ml Glacial Acetic acid and 10 ml distilled water
2. Sulphuric acid concentrated, Nitrogen free.

Result

Excess of 45 mg/l the water is unacceptable

Reaction

In case of excess nitrate in water

i. Infants suffer from blue baby disease (methemoglobinemia)
ii. Miscarriage in oriparous creatures often occur
iii. Death of cattle offsprings (mostly in cows and pigs) may take place

TEST FOR FLUORIDE

Purpose

1. Fluoride helps build up strong and healthy bones and teeth in children and it prevents dental diseases.
2. Excess fluoride more than 1.5 mg/l in usable water may adversely effect human health.
3. It is essential to test the amount of fluoride present in water before using.

Reagents required to test fluoride

8 - 0.3 g Ziconium Oxychloride and 0.07 g Alizarins dissolved separately in distilled water and mixed and diluted to 1000 ml with mixed acid solution (112 ml HCL in 500 ml distilled water and 37 ml Sulphuric acid in 500 ml distilled water).

Result

i. 1.5 mg/l, the water is acceptable

Reaction

If the fluoride content in water exceeds the limit (i.e. 1.5 mg/l)

i. Teeth are affected, and higher amount may cause Skeletal fluorosis
ii. Vomiting, gripe, blood in stool, cramps, nervous disorders, etc. may occur in case of acute toxicities with excess fluoride in water. Liver and heart muscles gradually get destroyed If the water does not contain any fluoride
iii. Dental diseases may develop

Fluoride content in water should be as low as possible

TEST FOR RESIDUAL CHLORINE

Purpose

1. Chlorine is not only used as a disinfectant but it is also a strong oxidizing agent.
2. Chlorine in water completes its action within 25-30 minutes.
3. The amount of residual chlorine in usable water should not exceed 0.2 – 0.5 mg/l.

Reagents required to test residual chlorine

1. Ortho-Toluidine Solution- 1.35 gms of Ortho- Toluidine dihydrochloride in 500 ml distilled water.

Add this solution with constant stirring to a mixture of 350 ml of distilled water and150 ml Conc. HCL

Result

i. Ranges between 0.2 – 0.5 mg/l, the water is acceptable

Reaction

An unpleasant taste and odour develops due to an excess amount of residual chlorine in water

TEST FOR ARSENIC

Purpose

1. The amount of arsenic present in drinking water exceed 0.05 mg/l consumption of such water is extremely dangerous for health.
2. So it necessitate it to detect the amount of arsenic present in drinking water.

Reagents required to test Arsenic

1. Lead Acetate- 10 gm Lead Acetate of AR/GR/EXCELAR grade Pb $(C_2H_3O_2)_2.3H_2O$ in 100 ml distilled water.
2. Conc. Hydrochloric Acid (HCl)- AR/GR/EXCELAR grade
3. Potassium Iodide Solution- 15 gms of AR/GR/EXCELAR grade Potassium Iodide (KI) in 100 ml distilled water and store it in dark coloured bottle.
4. Stannous Chloride Solution- 40 gms of Arsenic free Stannous Chloride ($SnCl_2.2H_2O$) of AR/GR/EXCELAR grade in 100 ml Conc. HCl and warm.

Result

i. If the colour of the mercuric bromide paper does not change, the water is acceptable
ii. If the colour changes to reddish yellow, there is presence of Arsenic in water and it is unacceptable
iii. If it is confirmed by this test that there is arsenic in water, the water sample has to be sent to the nearest laboratory for detailed analysis.

Reaction

If the quantity of arsenic exceeds the permissible limit, prolonged consumption of such water can cause

i. Cancer of skin, lungs and liver
ii. Loose motions
iii. Impairment in the functions of heart, lungs, reproductive organs and nervous system
iv. Acute toxicity in the body if the arsenic content is too high

BACTERIOLOGICAL TEST

Purpose

1. Many micro – organisms cause infection / disease through water.
2. So water should be free from disease causing bacteria, virus etc.
3. It causes disease likepolio, jaundice, cholera, typhoid, dysentry, diarrhoea or enteric diseases.
4. Therefore, bacteriological test of water is very essential to ensure its safety.

Result

i. If the colour of the water in the bottle does not changes, water is safe and acceptable
ii. If the water in the bottle turns black/Yellow, the water is unacceptable
iii. The screw cap bottle need to be thoroughly washed and boiled for at least 10 min before use.

ASSESSMENT OF MICROBIOLOGICAL QUALITY

Colour code Scheme for Thermotolerant Coliform or E.Coli in water

Count per 100 ml	Category & Colour Code	Remarks
0	A (blue)	In conformity with WHO guidelines
1-10	B (green)	Low risk
10-100	C (yellow)	Intermediate risk
100-1000	D (orange)	High risk
>1000	E (red)	Very high risk

SAFETY IN THE LABORATORY/ Do's and Don'ts

1. **SAMPLING SAFETY**

a) Never take field samples with bare hands. Always wear gloves.
b) Do not climb over or go inside guardrails. Use poles, ropes, dippers, or other long distance samples.
c) When collecting gas samples, do not open tank cover completely. Install a sampling port, if needed.
d) Wear an effective gas mask when taking gas samples.

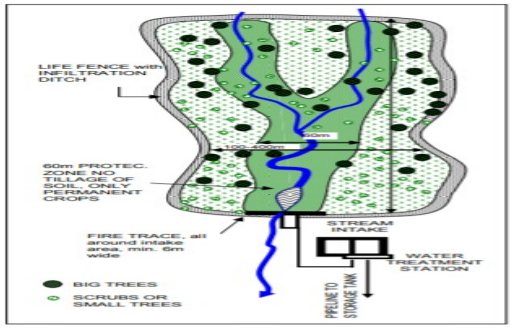
2. Regarding Housekeeping, Safety with Chemicals, Safety with Equipments, Safety with Glass, Safety in Laboratory Procedures, First Aid and Fire Prevention in the Laboratory, Standard Operating Procedure should be followed.

CHAPTER- 5

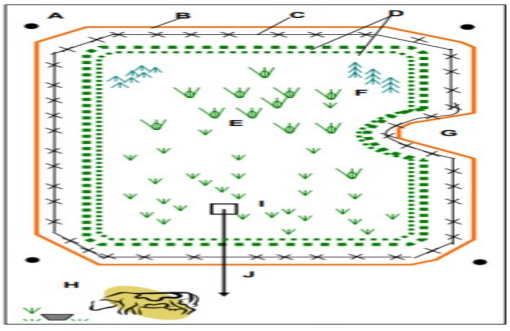
PROTECTION FOR WATER SOURCES & TREATMENT SYSTEM

Surface Water / Sanitation of catchment area

- Spring catchment area should have a minimum size of 100mx300m long but this can vary according to local conditions. Most successfully protected catchment are not larger than 50,000 m2 or 5 hectares bigger areas difficult to maintain
- For stream of River – An area of 30 m wide on both banks of streams should be fully protected up stream from the intake point
- An addition strip of 50 to 100m wide can only be used for farming that does not involve soil tilling or the use of chemicals. The length of protected banks upstream of the water intake should generally be between 500 and 1000m depending on local conditions
- For bigger scheme a distance of 10 km upstream and 2 km down stream from the point of proposed intake should be protected -



River catchment



Spring catchment

Tube Wells Protection / Sanitation

The annular space between casings should be sealed by gravel packing to a depth of 6 m & casing pipe should be set into the bed rock for rocky areas.

Protection for water sources

(Hand pump)

- Concrete platform including drain need to be constructed to ensure discharge of waste about 10 metres away from the hand pump
- Diameter of tube well platform should not be less than 185 cm
- Properly sloped (1:2) masonry apron should be constructed around the well to prevent accumulation and percolation of dirty water just around the well.

Protection of surrounding of the hand pump

- Defecation near the well site and indiscriminately anywhere in the village should be stopped by common agreement and enforcement by social pressure.

- Compost and garbage pits, Laundary, bathing, watering and washing of animals should not be allowed within at least 10 metres radius of the tube well.

Protection for water sources

(Open wells/Dug wells)

- At least 1 metre wide masonry apron should be constructed around the well to prevent accumulation of dirty water just around the well and its percolation
- A smooth drainage channel should be constructed at least upto 2 metres from the well to prevent stagnation of water around the well as well as seepage into the well
- A leak proof parapet about 1m height should be made around the well.
- Lining constructed should be leak proof
- It is desirable to cover the well with a concrete slab.

Do	Do Not
• Inform and involve all stakeholders in the water catchment protection activities. • Settle compensations. • Obtain catchment land title for WMC. • Train caretakers. • Use life poles in dead fence. • Plant trees. • Dig storm water gutters. • Plant Vetiver rows against erosion. • Do fire tracing. • Collect user fees and pay caretaker. • Meet with the WMC at least twice per year. • Give support to WMC when necessary. • Communicate regularly with stakeholders.	• Upset people by not including them. • Make the catchment too big. • Use force on unwilling stakeholders when there is room for talk. • Allow farming in the catchment. • Allow grazing in the catchment. • Allow fire in the catchment. • Allow hunting in the catchment. • Allow excreting in the catchment. • Let the caretaker do all the work alone. • Let people use the water if they do not pay the fee. • Give money without monitoring the result.

Water Treatment Systems

Type of Filtration	Purpose	Type of unit
Sedimentation	Removal of suspended solids like sand, clay, silt etc.	Sedimentation tanks
Sedimentation with coagulation	Removal of suspended solids, colour, odour, taste, turbidity etc.	Sedimentation with chemical input
Filtration	Removal of micro organism and colloidal matter	Slow / rapid sand filter

Water softening plant	Removal of water hardness / salts	RO (reverse osmosis plant)
Disinfection	Removal of pathogenic bacteria	Chlorination
Specialised water treatment plants	Removal of fluoride	De-fluoridation units, Nalgonda System

Village/Town Level Water Treatment Systems

- The treatment units should be located in such a manner where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required.
- Sufficient area should be reserved near the treatment units for further expansion in future.

Types of Water Treatment System at Village/Town Level

1. **Primary Screening**

   Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. **Sedimentation**

   In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

Jar Test

- Jar test which determines the most effective dose of chemicals by trial and error method
- Commonly use coagulants are alum & lime (Powder hydrated line)

3. **Coagulation and Flocculation**

- The purpose of coagulation and flocculation is to remove particulate impurities especially settlable solids (particularly collides) and colour from the water being treated.
- Alum dosing recommended chemical dose of [$Fe_2(So_4)_3Al_2(SO_4)_324H_2o$] (IS:299)
- Excessive turbidity may cause increase in dose it may be double or more to the recommended dose.
- Only 20-30% alumina can is used to settle to colloidal turbidity and remaining is wasted.

Monsoon	Winter	Summer
50mg/l	20mg/l	5mg/l

Factors influencing the sedimentation

i. Size shape and weight of floc.

S. No.	Type of Material	Dia (mm)	Rate of settlement (m/h)
1	Coarse sand	0.1 0.5	365.75 193.84
2	Fine Sand	0.25 0.10	97.53 29.26
3	Silt	0.05 0.005	10.61 0.14
4	Fine clay	0.001 0.0001	0.005 0.00005

Rating of Sedimentation Tank		
Idle efficiency	**Good efficiency**	**Poor efficiency**
Above 63%	30 to 50%	5 to 30%
Efficiencies of the sedimentation tanks should be given due consideration to reduce load in next stages of water treatment plant.		

ii. Viscosity and temperature of water

iii. Effective average period available for sedimentation (Detention period)

iv. Effective depth of tank

v. Surface Area.

vi. Surface overflow rate or surface loading

vii. Velocity of Flow.

viii. Inlet and outlet design

4. Flocculation equipment

The main requirement of mix is that all the coagulant be rapidly mixed with all the water instantly.

Plant below 300m^3/hr requires mixer like Gravitational or hydraulic mixing, Mixing and stirring Devices, Baffled channels of Basins, Tangential Flow, Pipe flocculation etc.

5. Mechanical mixture

Plant above 300m^3/hr requires mechanical mixer called flash mixer

- More flexibility in operation least head loss of the order .4 to 1m.
- Detention time 30 to 60 seconds

Velocity of flow .9m/sec

Depth 1 to 3 m

RPM of blades 400- 1400

6. Flocculation

After flash mixing, subsequent Flocculation process requires controlled agitation with Velocity of flow of speed of a pedal ranging from .2 to .6m/sec.

Depth of tank 3 to 4.5m

Detention time 10 to 40 min

Normally 30min

Velocity of Flow .2 to .8m/sec

Normally .4m/sec.

Total pedal area 10 to 25% of cross-sectional areal.

7. Sedimentation with Coagulation / Clarifier

- In this process certain chemical / coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain means.
- Coagulants are added based on pH of water. They are added in powder or solution form to raw water through some mechanical means.

8. Filtration

Slow Sand Filter

- Schmutzdecke layer at the top of the filter bed is formed called house of micro organisms to consume bacteria and also remove, color, odor, and taste form water.
- Such filter is made up of tank containing sand in top layer (size 0.2-0.3mm) up to thickness of 750-900 mm.
- Average flow of water from such filter is about 2400-3600 litres/m^2/day. .
- The sand needs to be replaced every 6-8 weeks as it gets clogged with impurities. Gravel can be washed and cleaned and replaced again.

Rapid Sand Filter

- Discharge. 4.8 to 6 m^3/m^2/hr.
- The layer of sand usually 60 to 75 cm.
- The depth of water over the sand top varies between 1m to 2m.
- The free board shall be at least 50 cm.

Under drain system

- Supporting media is replaced by v-wire screen (s.s) and discharge is between 5 to 7 $m^{3.}/m^2$/hr.
- Remaining features are similar to RSF.

Annexure F Operational parameters for Water Treatment Plant units for tests.

Do's & Don'ts / Safety in Plant Maintenance

Maintenance Hazards, Cleaning, Painting, Assess to equipment, Lighting, Ventilation, Safety from Equipment, Lubrication Safety, Safety in confined spaces, Standard Operating Procedure should be strictly followed.

CHAPTER - 6
DISINFECTION

Type of Disinfection

1. **Physical Disinfection**: Boiling
2. **Chemical Disinfection**: Chlorination , Liquid Chlorine IS:646- 1986 (Second revision- Reaffirmed 1991)
3. **Chlorinated Lime**: (Bleaching Powder) / Hypochlorination IS- 1065- 1989 Reaffirmed 1996.

Chlorine Demand

This is the difference between the amount of chlorine added to water and amount of free or combined available chlorine remaining at the end of specified contact period.

Disinfection of dug wells.

4 mg of bleaching powder for every litre of dug well water very effectively destroys the micro-organisms in water and the residual chlorine remains in the range of 0.2-0.5 mg/l.

Volume of water = $\frac{3.14 \times \text{diameter}^2 \times \text{height}}{}$ x 1000 litre

Disinfection of Tubewell

A strength of 60 mg/ litre chlorine is maintained in the water column of the tube for 30 minutes. When Residual chlorine becomes nil, the tube well is allowed to be used for the users.

Water chlorination

Bleaching powder Ca(ocl)2 it contains 34% of available chlorine by weight .

	Quantity of Chlorine	
Quantity of water to be used (litres)	**Powder form chlorine / bleach (grams)**	**Chlorine Solution (milliliter)**
	25-30% powder	5% Solution
1000	5	25
5000	15	125
1 Lakh	500	1500
5 Lakh	2500	12500

Chlorine dose may be increased/ decreased in accordance of pH of water

pH Value	Contents of residual,%			Chlorine dose to give the same efficiency of kill
	Cl2	HOCl	OCl	
4.0	0.5	99.5	0.0	
5.0	0.0	99.5	0.5	0.1
6.0	0.0	96.5	3.5	0.1027
7.0	0.0	72.5	21.5	1.27
8.0	0.0	21.5	72.5	3.7
9.0	0.0	1.0	99.0	28.0

Minimum chlorine residuals for drinking water at 20°C (After Butter Field)

PH	6-7	7-8	8-9	9-10	10-11
Free available Chlorine mg/l after 10 min	.2	.2	.4	.8	.8

Disinfection By Product (Waste Water Engineering by METCALF & EDDY)

- When chlorine is added to water containing organic matter a variety of organic compounds containing chlorine is formed known as disinfection by products (DBPs)
- Many of them are known as suspected potential human carcinogens
- Typical classes of compounds includes
- Trichaloromethanes (THMs) halo acetate acids (HAAs)
- Trichlorophenol and aldehydes
- More recently N-nitrosodimethlamine (NDMA) has been found in the effluent from waste water treatment plants. It is most powerful carcinogens known
- NDMA appears to be formed during the chlorination process

Pre-chlorination

- Pre- chlorination is done at (i) Source (ii) in the flocculation basin (iii) at the filter inlet
- It removes colour odor taste producing substances and prevent algal growth from raw water

Post-Chlorination

- Post chlorination is the application is the application of chlorine after the treatment process
- It is added here principally to destroy pathogenic organism including the virus

Re chlorination

- Where the distribution is very large it becomes difficult to maintain minimum chlorine residual of .2 mg/l at the end of the system
- It may be done in service reservoirs or directly into distribution system

Super chlorination

- When raw water is with doubtful quality or subjected to rapid fluctuation in quality
- Chlorine dose 10 to 14 mg/l for 10 to 30 minute
- But it necessitates dechlorination of treated water before use with sodium thiosulphate.

  In case of virus in water residual chlorine should be 0.5 Mg per litre for atleast one hour with dose of 8 mg per litre may deactivate the virus.

Equipments for Chlorination at Cluster/Village/Town Level

a) **Differential Pressure Type Chlorinator (with use of bleaching powder).**
b) **Drip type equipment.**
c) **Gas Chlorinator:**
d) **Nalgonda System for Fluoride Removal**
e) **Reverse Osmosis System (RO)**

Household Water Treatment Systems

- Basic filtration and boiling.
- Domestic chlorination

CONVENTIONAL CHLORINATION

The conventional chlorination facility i.e. adding chlorine for disinfection of water treatment consists of three essential parts:

1. Chlorine supply system
2. Metering system
3. Diffuser system

In addition to above, there are ancillary equipment, safety equipment, metering & control instrumentation and chlorine residual analysers.

CHLORINE SUPPLY SYSTEM

a) Chlorine Gas Supply System
b) Evaporator Supply System or Liquid Chlorine Supply System
c) Chlorine Gas Filter
d) External Chlorine Pressure Reducing Valve

METERING SYSTEM: CHLORINATOR

A chlorinator is a device for feeding chlorine to a water supply. It also serves as gas metering device. Chlorinators are classified into two categories.

- Pressure type
- Vacuum type

PRESSURE TYPE CHLORINATOR

a) Dry Feed Type
b) Aqueous Solution Feed Type

Operation of Pressure Chlorinator with Aqueous Solution – Gravity Feed Type.

a) **Start up of the chlorinator**
b) **Shutting down**

Operation of Pressure Chlorinator with Aqueous Solution – Injector Solutionizer Type

a) **Start up of the Chlorinator**
b) **Shutting down**

Vacuum Type Chlorinator

Start up of Gas Chlorine System

Start up of Liquid Chlorine System

Procedure for stopping the plant.

Maintenance of Chlorination Equipment

SUGGESTED MAINTENANCE OF CHLORINE EQUIPMENT PRESSURE CHLORINATIOR – AQUEOUS SOLUTION FEED TYPE …….. REFER TABLE 6.1.

SUGGESTED MAINTENANCE OF CHLORINE EQUIPMENT AND FITTINGS – VACUUM TYPE CHLORINATOR…….REFER TABLE 6.2

COMPARISON OF CHLORINATORS ……REFER TABLE 6.3

IMPORTANT FACTS ABOUT CHLORINE FROM SAFETY POINT OF VIEW ……..REFER TABLE 6.4

SAFETY ASPECTS OF CHLORINE

CYLINDERS

TONNERS

CONTAINDER VALVES

STORAGE & HANDILING OF CHLORINE CYLINDERS

Chlorine is stored in special grade steel containers. As per IS:4379-1967, the colour of Chlorine container should be ‘golden yellow’.

(a) Storage Area

(b) Cylinder & Drum Containers

(c) Use of Cylinders & Drum Containers in Process System

(d) Disconnecting Containers from Process System

(e) Loading and Unloading of Containers

(f) Transportation of Container

(g) Emergency Kit

(h) Health Hazards

(i) First Aid - Trained Personnel and Equipment

(j) Fire & Explosion Hazards:

(k) Emergency Measures

(l) Personal Protective Equipment

(m) Employees Selection

(n) Employees Training

(o) Neutralisation of Chlorine

(p) Emergency Response Planning…….Refer clause 6.5.5 (a) to (p) of CPHEEO Manual 2005.

Reference: Manual on Operation & Maintenance of Water Supply System CPHEEO, 2005 Clause 6.4 & 6.5.

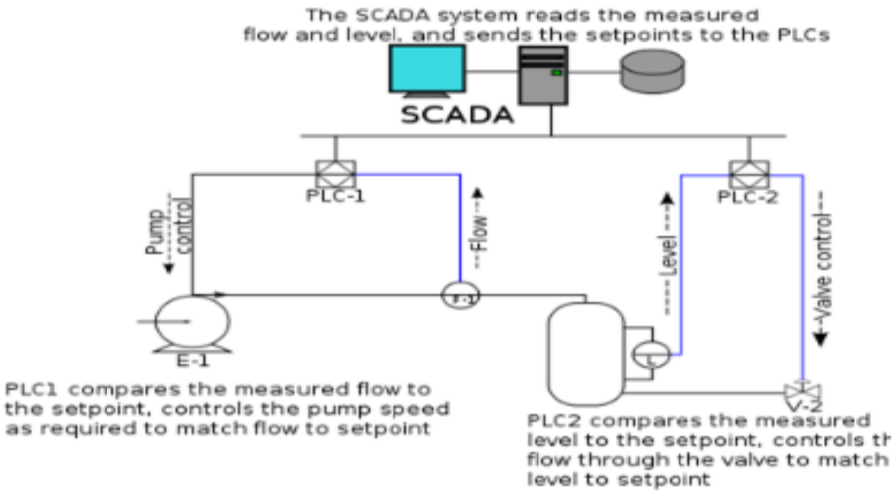
Do's & Don'ts / Safety measures

a) Chlorine is stored in special grade steel containers. As per IS:4379 – 1967, the colour of Chlorine container should be 'golden yellow".
b) Both chlorine cylinder as well as tonners must be fitted with standard valves conforming to IS:3224
c) Obtain storage licence from controller of explosives under Gas Cylinder Rules 1981 if the quantity of Cl_2 containers to be stored is more than 5 Nos.
d) Two portable foam type fire extinguishers should be provided in the premises.
e) Corrosive substances shall not be stored nearby which react violently with each other.
f) Unauthorized person should not be allowed to enter into the storage area.
g) The floor level of storage shed should be preferably 30 cms higher from the ground level to avoid water logging.
h) Ensure that tall containers are properly fitted with safety caps or hooks.
i) Chlorine should not be stored in open area with direct sunlight as it will disintegrate. Chlorine containers should be closed immediately after its use.
j) Chlorine should not be used in excessive amounts in drinking water as it may lead to health problems.
k) Potential problems

a. Chlorination is less effective in alkaline water (pH above 8.0);
b. When the water contains excessive organic matter or suspended material, it will need to be pretreated;
c. Chlorination affects the taste of water.

CHAPTER- 7
SCADA System

1. SCADA stands for supervisory control and data acquisition.
2. It is a type of software application program for process control.
3. IT is a central control system which consists of controller's network interfaces, input/output, communication equipment, and software.
4. It is used to monitor and control the equipment in the industrial process which includes electrical power, water distribution system etc.
5. It takes the reading of the meters and checks the status of sensors in regular intervals so that it requires minimal interference of humans.



1. This SCADA system used to gather data from sensors and instruments located in remote areas.
2. The computer then processes this data and presents it promptly.
3. It gathers the information (like a leak on a pipeline occurred) and transfers the information back to the system while giving the alerts that leakage has occurred and displays the information in a logical and organized fashion.
4. The SCADA system used to run on DOS and UNIX operating systems.

Architecture:

1. The SCADA system is a centralized system that monitors and controls the entire area.
2. It is a pure software package that is positioned on top of the hardware.
3. It gathers data on the process and sends the commands control to the process.
4. The SCADA is a remote terminal unit which is also known as RTU.

5. Most control actions are automatically performed by RTUs or Programmable Logics Controller (PLC).
6. The RTUs consists of the programmable logic converter which can be set to specific requirement.
7. The SCADA system monitors the overall performance of the loop.
8. The SCADA system is a centralized system to communicate with both wired and wireless technology to Clint devices.

EX: If too much pressure is building up in a gas pipeline the SCADA system can automatically open a release valve.

Hardware Architecture:

It is classified into two parts:

- The Clint layer which caters for the man-machine interaction.
- The data server layer which handles most of the process data activities.

1. The SCADA station refers to the servers and it is composed of a single PC.
2. The data servers communicate with devices in the field through process controllers like PLCs or RTUs.
3. The PLCs are connected to the data servers either directly or via networks or buses.
4. The SCADA system utilizes a WAN and LAN networks, the WAN and LAN consist of internet protocols used for communication between the master station and devices.
5. The physical equipment like sensors connected to the PLCs or RTUs.
6. The RTUs convert the sensor signals to digital data and sends digital data to the master.
7. According to the master feedback received by the RTU, it applies the electrical signal to relays.
8. Most of the monitoring and control operations are performed by RTUs or PLCs.

Software Architecture

1. The servers are responsible for data gathering and handling.
2. It consists of a software program to provide trending, diagnostic data, and manage information such as scheduled maintenance procedures, logistic information, detailed schematics for a particular sensor or machine, and expert-system troubleshooting guides.
3. It means the operator can see a schematic representation of the plant being controlled.

EX: alarm checking, calculations, logging, and archiving; polling controllers on a set of parameters, those are typically connected to the server.

Working Procedure of SCADA system:

It performs the following functions:

- Data Acquisitions
- Data Communication
- Information/Data presentation
- Monitoring/Control

Data Acquisitions:

1. The real-time system consists of thousands of components and sensors.
2. It is very important to know the status of particular components and sensors.
3. Some sensors measure the water flow from the reservoir to the water tank and some sensors measure the value pressure as the water is a release from the reservoir.

Data Communication:

1. The SCADA system uses a wired network to communicate between users and devices.
2. Real-time applications use a lot of sensors and components which should be controlled remotely.
3. The SCADA system uses internet communications.
4. All information is transmitted through the internet using specific protocols.
5. Sensor and relays are not able to communicate with the network protocols so RTUs used to communicate sensors and network interfaces.

Information/Data presentation:

1. The normal circuit networks have some indicators which can be visible to control but in the real-time SCADA system, there are thousands of sensors and alarm which are impossible to be handled simultaneously.
2. The SCADA system uses the human-machine interface (HMI) to provide all of the information gathered from the various sensors**.**

Human-machine interface:

1. The SCADA system uses the human-machine interface.
2. The information is displayed and monitored to be processed by a human.
3. HMI provides access to multiple control units which can be PLCs and RTUs.
4. The HMI provides the graphical presentation of the system.
5. It provides a graphical picture of the pump connected to the tank.
6. The user can see the flow of the water and the pressure of the water.
7. The important part of the HMI is an alarm system that is activated according to the predefined values.

For example, The tank water level alarm is set 60% and 70% values. If the water level reaches above 60% the alarm gives a normal warning and if the water level reaches above 70% the alarm gives a critical warning.

Monitoring/ Control:

1. The SCADA system uses different switches to operate each device and displays the status of the control area.
2. Any part of the process can be turned ON/OFF from the control station using these switches.
3. SCADA system is implemented to work automatically without human intervention but in critical situations, it is handled by manpower.

Chapter - 8

QUALITY ASSURANCE/ QUALITY CONTROL FOR WATER TREATMENT PLANT

Rationale for Adopting QA/QC Measures

- Keys to ensuring clean, safe and secure water drinking water is to implement QA/QC measures throughout the drinking water system, from source to the consumers tap; this will enable to curtail the entry of pathogens and chemical contaminants at any point in the drinking water supply system Additional benefits of implementing QA/QC measures include:
- Public health protection by providing safe water to the consumers;
- protected source waters;
- Well maintained treatment and distribution systems;
- Good management of costs involved in treating and supplying the water;
- Identification of potential hazards and elimination of the hazards through risk assessment;
- provides a framework for communication with the consumers (public) and with employees;
- provides an opportunity for water utility managers and employees to identify their areas of responsibility and become involved;
- increased involvement of stakeholders and public;
- Reduction in health care costs; and
- Increased environmental protection

Risk Based Approach to QA/ QC

Hazard refers to a source of (potential) harm to the functioning of any aspect of the drinking water system or human health. Risk refers to the chance or possibility of a hazard causing this harm to the functioning of any aspect of the drinking water system or human health.

Potential Hazardous/Contamination Events

a) Catchments, groundwater systems, storage reservoirs, and intakes:

- Variations in raw water quality;
- Sewage, industrial, and septic tank discharges;
- Chemical (fertilizer or pesticide) use in catchment areas;
- major spills;]
- surrounding land use (eg: agriculture, forestry, industrial area, mining, disposal or landfill sites);
- storm water flows and discharges;
- unconfined and shallow aquifers;
- groundwater under direct influence of surface water;
- inadequate well-head protection and unhygienic practices;

- saline aquifers, contaminated aquifers;
- seasonal variations (heavy rain falls, droughts);
- open/uncovered reservoirs;
- Unsuitable intake location;
- algal blooms;
- Soil erosion; and
- bush fires and natural disasters.
- Sabotage and natural disasters.

b) Treatment systems: significant flow variations through water treatment;

- Inappropriate treatment processes;
- Improper design of treatment units;
- Use of unapproved or contaminated water treatment chemicals and materials;
- Chemical dosing failures;
- Inadequate mixing;
- Inadequate filter operation and backwash recycling;
- Inadequate operational monitoring;
- Inadequate disinfection;
- Equipment malfunctions;
- Failure of alarms and monitoring equipment;
- Power failures;

c) Storage Reservoirs and Distribution Systems:

- Open/ uncovered reservoirs;
- Human, animal, and bird access;
- Sediment builds up and slimes;
- Use of unapproved coating materials;
- Aged pipes;
- Corrosion of reservoirs and piping system;
- Contamination due to cross-connections and backflow;
- Biofilms, sloughing and regrowth;
- Pipe breaks/leaks;
- Inadequate system flushing and reservoir cleaning;
- Commissioning new pipe mains;
- Inadequate disinfection after construction;
- Inadequate pressure;
- Insufficient chlorine residual;

- Formation of disinfection by-products;
- Failure of alarms and monitoring equipment; and
- Natural disasters and sabotage.

d) Consumer's Potential Consumer Misuse; and

- Inappropriate plumbing and construction material.

As a general guidance, the QA/QC measures need to address the following key elements of the DWQMS:

- policy and commitment to safe drinking water;
- evaluation of drinking water supply system;
- implementation of operational procedures and process control;
- verification of treated water quality;
- emergency response plan;
- training of water utility personnel; and
- record maintenance and reporting

Policy and Commitment to Safe Drinking Water

It is important for all of the water utility personnel to consider formalizing their commitments and priorities related to drinking water by developing policy statements that support public health goals.

Evaluation of Drinking Water Supply System

- the water treatment utilities should know what pollution sources are close to their intake and what type of contaminant(s) gain entry into the system.
- There are many potential raw water quality problems for a surface water source, including:
- Turbidity – can be difficult to remove depending on the size and concentration of particles;
- Pathogens – can cause intestinal illness and other diseases;
- Natural organic matter (NOM) – difficult to remove and can form carcinogenic compounds while combining with certain disinfectants;
- Algae – can cause taste and odor problems; and
- Synthetic organic compounds (SOCs) and inorganic compounds (IOCs) – can cause adverse health effects and affect treatment decisions.

One of the most important requirements for any water treatment system is the ability to meet the water quantity demands of consumers at all times, because prolonged interruptions or reductions in the source water supply may cause low pressures in the distribution system that pose a public health hazard.

Groundwater is obtained through wells dug or drilled into aquifers.

Aquifers are geologic formations, or groups of formations that yield significant quantities of water to springs and wells. For ground water, many of the contaminants originally found in the surface water are removed as it seeps into the ground and through the aquifer, due to the natural filtration effect as water passes through soils and long travel times in the aquifer. Groundwater generally moves quite slowly, especially under non-pumping conditions. Gravity and pressure differences are important factors in groundwater movement.

Unconfined aquifers interact closely with streams and lakes. In conditions where unconfined aquifers are close to the surface water, the aquifer feeds the stream or lake by discharging to the surface water. In these conditions, if drinking water is drawn from a surface water source, it is necessary to assess the nearby-unconfined aquifer. In the case of water treatment utilities drawing groundwater under the direct influence of surface water, direct influence shall be determined in order to make an assessment of a system's vulnerability. The determination shall be based on site-specific measurement.

Implementation of Operational Procedures and Process Control

All components of a process control program shall be documented with copies available to all. Documentation needs to include a description of:

- operational procedures for relevant activities;
- authorities and their responsibilities;
- operational monitoring plans including: o operational parameters to be monitored;
- inspection requirements;
- sampling location and frequency;
- sampling methods and equipment;
- checking and interpreting results; and
- documentation and records management including how monitoring results are recorded and stored;
- reporting and communication requirements;
- maintenance procedures; and
- preventive and corrective actions to be implemented

The water treatment utility authorities shall ensure that the equipment and infrastructure associated with rapid mixing, flocculation, sedimentation, filtration and disinfection are designed properly and have sufficient capacity (size, volume, and detention time) to handle peak flow rates

Requirements include:

- where available, the use of online measuring devices which monitor operational parameters continuously;
- automation where possible to respond to any changes in water quality;

- backup equipment if failure of processes occurs;
- backup facilities to protect against failure of power supplies;
- the capability to control plant flow rates including filtration and backwash rates;
- provisions to control the addition of chemicals at different dosages;
- provisions for effective mixing facilities; and
- suitable filter media and sufficient surface wash and backwash capability.

The use and maintenance of appropriate monitoring equipment is also essential to providing accurate process control information

Only appropriate chemicals and materials shall be used in the water treatment facilities. It shall conform to IS: specification

- Examples of some preventive and corrective actions for which operational procedures need to be documented include:
- reducing plant flow rate (reducing loading to the system);
- switching to alternate water source, if possible;
- jar testing for coagulant control and optimization;
- changing treatment chemicals;
- varying chemical feed rates and feed points;
- adjustment of pH;
- varying mixing intensity in rapid mix units;
- cleaning of accumulated sludge and mud from sedimentation basins;
- checking and changing the detention time of sedimentation basins;
- checking and changing the loading rate to sedimentation basins and filters;
- checking and changing the backwash flow rate;
- changing disinfectant dose; and
- mains flushing and cleaning.

Verification of Treated Water Quality

Verification of treated water quality provides an assessment of the performance of the system and the quality of water supplied to the consumers. This incorporates monitoring of treated water quality, which is considered as only one aspect of an overall preventive strategy to assure a safe and reliable drinking water supply to the consumers.

Key health-related characteristics under treated water quality monitoring include:

- microbiological organisms (coli forms);
- chemicals used in treatment processes, disinfectant residuals, and any DPBs;
- turbidity; and
- any health-related characteristic that can be reasonably expected to exceed the guideline
- value.

However, characteristics related to significant aesthetic impacts shall also be monitored. The treated water quality monitoring plan that is to be adopted by all of the water utilities is shown in Appendix

Annexure- G List of Measurements, Alarms, Status Indicators, etc. (SCADA)

CHAPTER- 9
SEWERAGE TREATMENT PLANT

A sewage treatment plant ("STP") has to handle the designed quantity of sewage and deliver satisfactory quality of treated water, on a consistent, sustained basis over typically 10-15 years.

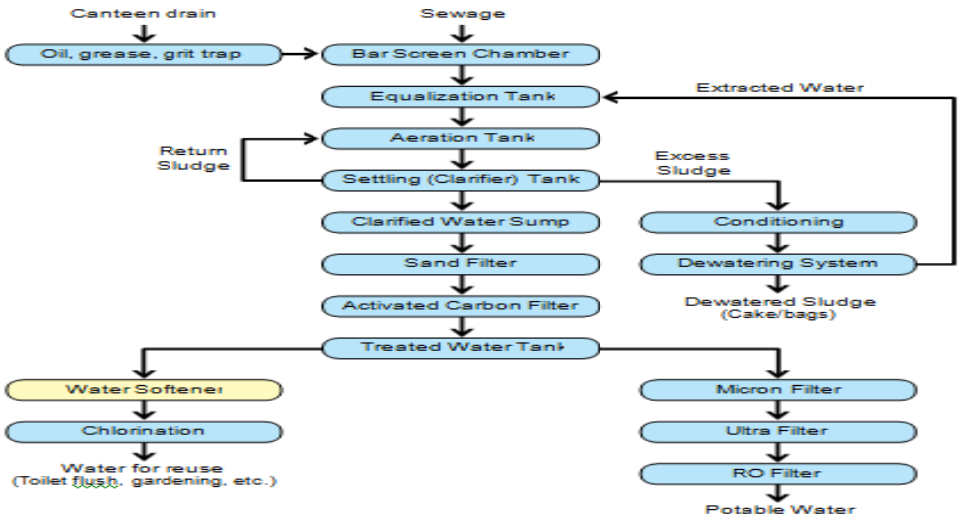
The Operating Principle of STPs

It is a simple process:

A small amount of microorganisms converts a large mass of polluted water into clean water. This process also produces a co-product: A vastly reduced, compact solid biomass (the excess microorganisms produced by growth and multiplication of the original population of microorganisms).

Typical Process in an STP

The flow chart of a typical STP is shown below (optional units are shown in yellow)



The following table illustrates the quality of water obtainable from a well-designed, engineered and operated STP at very affordable treatment costs[2]

Parameter	In Raw Sewage	After Treatment	What it means to you…
pH	6.5-7.5	6.5-7.5	The acidity/alkalinity balance is not affected/ altered.
BOD	200- 250 mg/L	< 10 mg/L	The biodegradable material in the sewage consumes oxygen when it degrades
Turbidity	Not specified	< 10 NTU[2]	The outgoing treated sewage has low turbidity (suspended particles that cloud the water).
E. Coli	Not specified	NIL	The STP removes the harmful bacteria completely.

UNDERSTANDING THE STP STAGES

Bar Screen Chamber

Function

The function of the bar screen is to prevent entry of solid particles/ articles above a certain size; such as plastic cups, paper dishes, polythene bags, condoms and sanitary napkins into the STP.

- The gaps between the bars may vary between 10 and 25 mm.
- Larger STPs may have two screens: A coarse bar screen with larger gaps between bars, followed by a fine bar screen with smaller gaps between bars.
- In smaller STP's a single **fine bar screen** may be adequate..

Oil and Grease/Grit Trap

Function

The grease and grit trap is placed at the discharge point of the canteen/ kitchen area itself to arrest solid and fatty matter at source. The wastewater output from this unit is taken to the equalization tank.

Equalization Tank

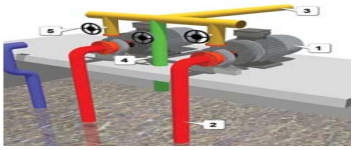
Function

Its main function is to act as buffer: To collect the incoming raw sewage that comes at widely fluctuating rates, and pass it on to the rest of the STP at a steady (average) flow rate.

Raw Sewage Lift Pumps

Function

To avoid deep excavations, a pumping stage is introduced to lift sewage to the next unit in the STP, which is the aeration tank in small STPs rated below 5000 m^3/day.



This strategy yields a double benefit:

a) All downstream units may be placed at a convenient level above ground, resulting in cost savings. At the same time, the maintenance of STP becomes easier.

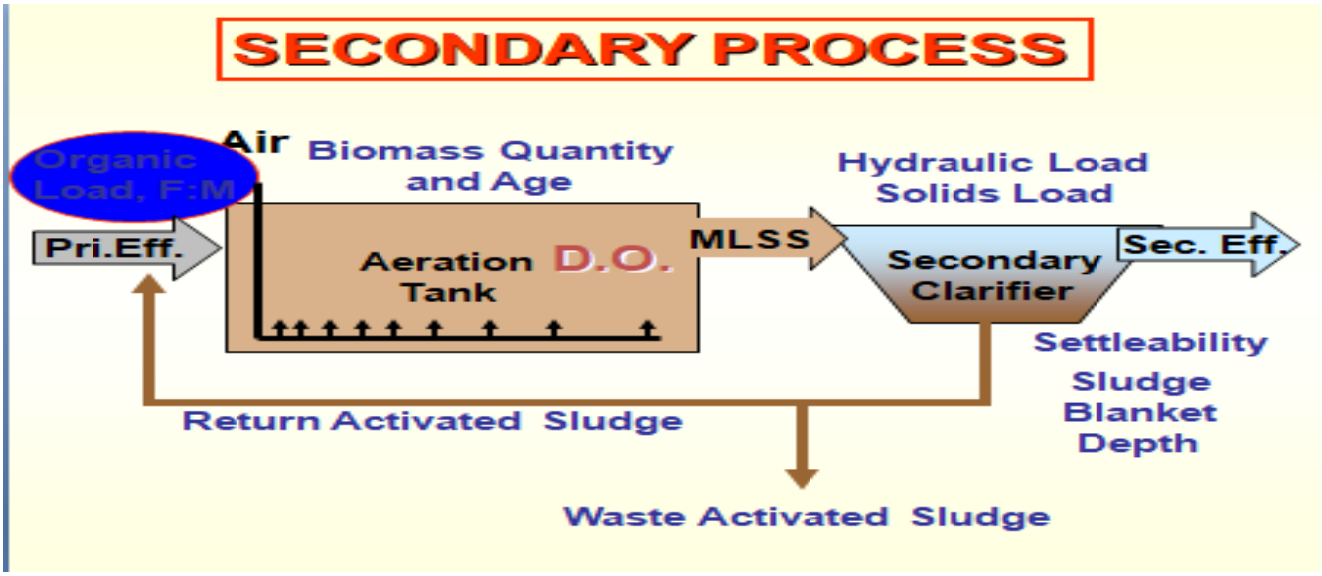
b) The pumping rate can be set at a calibrated uniform flow, so that downstream units are not affected by fluctuating flows.

Aeration Tank

Function

The main function of the Aeration tank is to maintain a high population level of microbes. This mixture is called MLSS (Mixed Liquor Suspended Solids).

The mixed liquor is passed on to the clarifier tank, where the microbes are made to settle at the bottom. The settled microbes are recycled back to the aeration tank. Thus they are retained for a long period within the system.



Biological Decomposition

Oxidation:

$COHNS + O_2 + \text{Bacteria} \longrightarrow CO_2 + H_2O + NH_3 + \text{Energy} + \text{Other end products}$

It forms sum end product such as minerals that remains in the solution and as discharged with effluent.

Synthesis:

$COHNS + O_2 + \text{Bacteria} + \text{Energy} \longrightarrow C_5H_7NO_2$

It transforms the colloidal and dissolved matter into new cells that forms in term the dense biomass that can be removed by sedimentation.

Endogenous Respiration:

$C_5H_7NO_2 + 5O_2 \longrightarrow 5CO_2 + NH_3 + 2H_2O$

Biological Wastewater Treatment

Three Steps

1. Transfer of Food from Wastewater to Cell.

- Adequate Mixing
- Enough Detention Time

2. Conversion of Food to New Cells and Byproducts.

- Acclimated Biomass
- Useable Food Supply
- Adequate D.O.
- Proper Nutrient Balance
- 100 : 5 : 1
- C : N : P

3. Flocculation and Solids Removal

- Proper Mixing
- Proper Growth Environment
- Secondary Clarification

TERMINOLOGY USED IN THE BIOLOGICAL TREATMENT

- ✓ **MLSS**
- ✓ **MLVSS**
- ✓ **F/M RATIO**
- ✓ **DO**
- ✓ **HRT**
- ✓ **SRT**
- ✓ **SVI**
- ✓ **AEROBIC**
- ✓ **ANAEROBIC**
- ✓ **ANOXIC**

Secondary Clarifier/ Settling Tank

Function

- Allow settling of biomass solids in the Mixed Liquor (biomass slurry) coming out of the aeration tank, to the bottom of the clarifier.
- To thicken the settled biomass, in order to produce a thick underflow.
- To produce clear supernatant water, in the overflow from the clarifier.

Mechanized Clarifier Tank

In a mechanized clarifier tank, the sludge settles at the bottom over a wide area, and a few rubber wiper blades (called “squeegees”) sweep it to a pit at the center of the tank, from where a pump takes it to the aeration tank.

Sludge Recirculation

Function

The indivisible combination of the aeration tank, settling tank and sludge recirculation constitutes an “activated sludge biological treatment system”. All three must be fine-tuned to act in unison to produce the desired high level of treatment.

The optimum desired age of the microbes is between 25 to 30 days. At the same time, an STP needs to maintain a high level of microbes in the aeration tank. Both these objectives are achieved by recirculating the sludge from the settling tank, and also bleeding out of excess microbes from the system at regular intervals.

Clarified Water Sump

Function

Overflow water from the clarifier is collected in an intermediate clarified water sump; This sump acts as a buffer tank between the secondary and the tertiary treatment stages in an STP.

In a well-run STP, the treated water quality at this stage is good enough for reuse on lawns and gardens with sufficient disinfection, and water for garden use may be directly taken from this sump, without having to overload the tertiary units.

Also, during lean inflow periods to the STP, backwashing of the filters is carried out. At this time, this tank must hold sufficient buffer stock of water for backwash purposes.

Pressure Sand Filter (PSF)

Function

The pressure sand filter (PSF) is used as a tertiary treatment unit to trap the trace amounts of solids which escape the clarifier, and can typically handle up to 50 mg/l of solids in an economical manner.

This unit is essentially a pressure vessel that is filled with graded media (sand and gravel)

The water filtered with PSF is passed on to the next stage in the STP chain: the Activated Carbon Filter.

Activated Carbon Filter (ACF)

Function

An activated carbon filter, like the Pressure Sand Filter, is a tertiary treatment unit. It receives the water that is already filtered by the Pressure Sand Filter and improves multiple quality parameters of the water: BOD, COD, clarity (turbidity), color and odor.

Disinfection of Treated Water

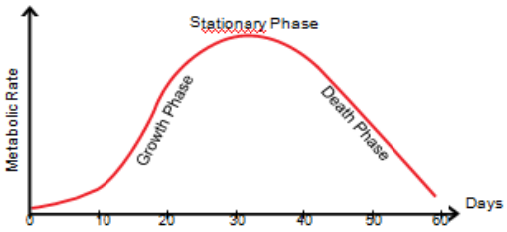
Function

- The treated water is disinfected to destroy and render harmless disease-causing organisms, such as bacteria, viruses, etc.
- The most common methods of disinfection include Chlorination, Ozonation and UV radiation.
- Of these, Chlorine finds widespread application. The primary action of the chemical involves damaging the cell wall, resulting in cell lysis and death.
- In most STPs, the common form of Chlorine used is Sodium Hypochlorite (Hypo) available commercially at 10-12 % strength, being safe, easy to handle and having a reasonable shelf life.

Excess Sludge Handling

Function

Biological treatment of wastewater perforce produces excess biological solids due to the growth and multiplication of bacteria and other microorganisms in the system. The excess biomass thus produced needs to be bled out of the system, and disposed off efficiently.



Managing the Microbes

The desired median age of microbes to be maintained in the system is 25-30 days, because they can digest the sewage at the maximum rate at the age of 25-30 days, as shown below. However, the sewage remains for less than 20 hours in aeration tank and settling tank.

Microbes are much like humans in their metabolic activities, although they are life forms that are orders of magnitude lower than an average human being. They feed on the pollutants (= food) present in the wastewater: They require Oxygen (from the air pumped into the aeration tank) for their respiration.

They need vitamins and minerals in the form of nutrients such as Nitrogen and Phosphorus (already present in abundance in domestic sewage), and a whole lot of other elements at nano levels for their health and well being, to grow and to multiply.

Any imbalance in even one of the above ingredients in the recipe (Population density, Food, Oxygen, or Nutrients) will render the process extremely vulnerable to failure. Indeed, Microbes are much more sensitive to the slightest of environmental disturbances than humans.

The basic biochemical reaction occurring in an Aeration tank may be summarized by the following simplistic equation:

Microbes + Pollutants (food) + O_2 More microbes + CO_2 + H_2O + energy release + byproducts

A typical growth reaction with a number of other products, the most important of which is Carbon Dioxide:

- Accumulated Carbon Dioxide gets converted to Carbonic acid and corrodes metallic parts in the STP.
- The carbonic acid also depresses the pH of the wastewater, thus affecting treatment performance.

MLSS

MLSS (Mixed Liquor Suspended Solids) is a measure of bacteria that is contained in the aeration tank.

In the strict sense, MLSS is a gravimetric unit – mg/L and the normal design level is between 3500 to 4000 mg/L in the Aeration Tank. However, in the field, since the operator does not have ready access to an electronic weighing machine, we do a volumetric measurement using a 1 liter measuring cylinder (or jar).

Take one liter of the Aeration Tank sample (The Mixed Liquor) and allow to settle in the jar for 30 minutes. At the end of the 30 minutes, measure the volume occupied by the settled sludge. If it is 350 mL, we take the MLSS to be 3500 mg/L. If it is 400 mL, the take MLSS to be 4000 mg/L.

The assumption here is that the STP is functioning normally, and therefore the so-called "Sludge Volume Index – SVI) is 100, meaning dry solids weighing 1 gram occupy 100 mL volume after 30 minutes of settling. And so, 4 gram of microbes (4000 mg) will occupy 400 mL volume in the cylinder.

The STP is operated within a band of say 3500 mg/L (350 mL) and 4500 mg/L (450 mL). When the MLSS exceeds 450 mL, the excess sludge is taken out of the system to bring the MLSS down to the say 350 mL, and the process continues until the sludge again builds up to 450 mL.

Normally STP should be operated in a smaller band within the allowable MLSS limits.

MLSS level can be less than the design level only under the following conditions :

1. The STP is in the start-up phase.
2. STP design and engineering is poor, so sludge is slipping out of the system.
3. STP operation is poor.
4. There has been a sudden shock to the STP (pH drop/ toxic elements etc.)

Chapter- 10

QUALITY ASSURANCE AND QUALITY CONTROL OF SEWERAGE TREATMENT PLANT

Calibration and Quality Control Procedures

a. Lab Facility. The lab is kept clean and orderly at all times. Specific facility tasks are addressed in the checklist in following table

Cascade STP Laboratory Quality Assurance Checklist				
General				
		Yes	**No**	**Comments**
1	Is the Quality Assurance (QA) Manual up-to-date and available to all lab personnel?			
Laboratory Procedures				
		Yes	**No**	**Comments**
1	Are EPA approved methods (e.g. Standard Methods) used and readily available to, and used by, all lab personnel?			
2	Are calibration and maintenance of instruments/equipment satisfactory?			
3	Does a written schedule for required equipment maintenance exist?			
4	Are quality control (QC) procedures in the QA Manual used consistently?			
5	Are QC records adequate to determine if lab is in control?			
Laboratory Facilities and Equipment				
		Yes	**No**	**Comments**
1	Is distilled or demonized water available (as required by the method)?			
2	Is dry, uncontaminated, compressed air available (if needed)?			
3	Is the fume hood air-flow measured periodically and is it adequate?			
4	Is the laboratory sufficiently lighted?			
5	Are adequate electrical sources available in the lab?			
6	Are instruments appropriate for the method and in good condition?			
7	Are troubles shooting procedures and written requirements for daily operation of instruments available to each instrument operator?			

8	Are standards available to perform required QC checks?			
9	Is proper volumetric glassware used?			
10	Is glassware cleaned?			
11	Are solvents and standard reagents properly stored?			
12	Are calibration and check standards frequently cross-checked?			
13	Are standards discarded after recommended shelf-life has expired?			
14	Are reagent bottles marked with date received, date opened, and when known, the expiration date?			
15	Are blanks run each day for appropriate analyses (e.g. BOD, TSS)?			
16	Are sufficient SOPs on hand for lab operations (e.g. clean-up, hazard response)			
17	Are gas cylinders replaced at 100-200 psi?			
18	Are the thermometers used in incubators (e.g. BOD, fecal coliform incubators) traceable to a NIST-certified thermometer?			
Laboratory's Precision, Accuracy, and Control Procedures				
		Yes	**No**	**Comments**
1	Are duplicates analyzed for all analyses and are the results recorded?			
2	Are control samples required by the QA Manual introduced into the train of actual samples to ensure valid data are being generated?			
3	Are control charts maintained and used routinely?			
4	Is the lab within control (i.e. is precision good)?			
Data Handling and Reporting				
1	Are round-off rules documented and uniformly applied?	**Yes**	**No**	**Comments**
2	Are significant figures established for each analytical procedure?			
3	Are results checked by at least one person other than the analyst?			
4	Are correct formulas used to calculate final results?			
5	Do report forms exist to provide complete data documentation and permanent records and to facilitate data processing?			

6	Are data reported in proper form and units?			
7	Are lab records maintained for three years?			
8	Is all data recorded in indelible ink with corrections initialed?			
9	Is a list of initials, identifying to whom they belong, filed in the lab?			
10	Are lab notebooks and pre-printed data forms bound permanently to provide good and defensible documentation?			
11	Does an efficient filing system exist?			
Laboratory Personnel				
		Yes	**No**	**Comment**
1	Are enough analysts present to perform necessary analyses?			
2	Do analysts have on-hand necessary references for procedures being used			
3	Are analysts trained in procedures performed?			

b. Instrument Calibration. Instruments are calibrated on a daily basis just before use and every two hours during prolonged periods of use on any given day. Those requiring calibration are the pH meter/probe, and the DO meter/probe. Equipment calibration requirements are indicated in Table

Minimum quality control procedures frequency.

Parameter	Calibration	Check Standards	Blanks	Duplicates
BOD	Air calibrate DO probe each day	Each day	Each day 1	More than 1 dilution of final effluent each day
TSS	Balance check each month & each year by a service rep	1 per month	Each day 1	10% of effluent samples
pH	Each day	At end of each set of samples	N/A	1 per month on final effluent
Chlorine residual	N/A	1 per month	Each day 1	1 per month
Fecal Coliforms	N/A	Positive control (diluted influent) for each media lot	Beginning and end of each filtration series	More than 1 dilution of final effluent each day

c. **Equipment Maintenance.** For maintenance of equipments manual should be used diligently.

d. **Analytical Reagents**. Only analytical grade reagents are used

e. **Lab ware Cleaning.** After each use, glasswares and sample bottles and equipment for microbiological evaluations are sterilized in accordance with the current approved Standard Methods.

f. **Quality Control Analyses.** QC measurements are made for all analyses related to "plant performance" samples as indicated by "PP" in Table

Plant Performance Parameters.

Sampling Location	Sample				Standard Methods	Preservation	Holding Times	Container Requirements
	Analysis	Use	Freq.	Type				
Primary Treatment								
Primary influent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P,G
	pH	PC	W	G	EM 4500-H APHA 23rd Edition	None Required	Stat	P,G
	COD				OR 5220 B of APHA 23rd Edition			
	O & G				PG 5520 A of APHA 23rd Edition.			
Primary effluent	BOD	PP	W	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	W	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P, G
	F Col	PP	D	G	9221 G & E APHA 23rd Edition.	Cool, 4<8 ^{O}C 0.008% $Na_2S_2O_3$	2 hours	P, G
	pH	PP	D	G	EM 4500-H APHA 23rd Edition	None Required	Stat	P, G

Activated Sludge								
Primary effluent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4^{O}C	6 hours	P, G
	TSS	PP	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4^{O}C	7 days	P,G
	pH	PC	D	G	EM 4500-H APHA 23rd Edition.	None Required	Stat	P,G
Mixed Liquor	DO	PC	D	G	4500-O	None Required	Stat	P,G
	Temp	PC	D	G	2550	None Required	Stat	P,G
	TSS	PC	D	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4°C	7 days	P,G
	NO_3	PC	D	G	EPA 353.2		48 hours	P,G
Return sludge	TSS	PP	W	C	2540D Gravimetric of APHA 23rd Edition	Cool, 4°C	7 days	P, G
Final effluent	BOD	PP	D	C	IS 3025 Part 44	Cool, 4°C	6 hours	P,G
	TSS	PP	D	C	2540D	Cool, 4°C	7 days	P,G
	F Col	PP	D	C	9221 G & E APHA 23rd Edition	Cool, 4<8°C, 0.008% Na2S2O3	2 hours	P,G
	Cl Res	PP	D	C	4500-Cl	None Required	Stat	P,G
	pH	PP	D	C	EM 4500-H APHA 23rd Edition.	None Required	Stat	P,G

Cl Res = Chlorine residual
VS = Volatile solids
G = Grab
TS = Total solids
EM= Electrometric Method
PG= Partition Gravimetric
TSS = Total Suspended Solids
W = Once per week
Temp = Temperature
OR= Open Reflux
VSS = Volatile suspended solids
D = Once per day
NO3 = Nitrate nitrogen
PC = Process control
P,G = Plastic or glass
F Col = Fecal Coliforms
PP = Plant performance
C = Composite
Stat = 15 minutes

EDTA ethylenediaminetetraacetic acid

DOs

- Electrical supply to the treatment plant must be maintained constantly.
- Check aeration pattern in the treatment zone is evenly distributed.
- Check air pumps inlet free from dirt and filter changed if necessary.
- Be aware before you put anything down the sink, toilet or drains.
- When using cleaning product little and often so the treatment plant isn't overloaded.
- Bleach can be used sparingly.
- It's best to spread your washing throughout the week.
- Use the same washing, cleaning, dishwashing, and all other cleaning products. The bacteria in the sewage treatment plant work more effectively with cleaning products they are familiar with.
- Service engineer to carry out regular service schedule in accordance with you 'Operation and Maintenance Manual'.
- The tank to be emptied of excess sludge – the interval is based on the size of the plant and its loading.

DON'Ts

- Turn off electrical supply to the sewage treatment plant.
- Strong chemicals, house hold bleach, medicine, mouthwash, garden chemicals, disinfectants, etc. down toilet or sink.
- Put incontinence pads, cotton wool, baby wipes, disposable nappies, tampons, sanitary towels, condoms, etc down the toilet.
- Service the sewage treatment plant unless your trained service engineer.
- Use any replacement parts other than recommended manufactures part.
- Make any alterations, modify, repairs, other than permission from the manufacture. Works must be carried out by a trained service engineer.
- Surface water or roof water to enter the sewage treatment plants.
- Macerator fitted to the kitchen sink.

Chapter - 11

Mechanism of Quality Assurance / Quality Control for Purchasing & Construction

Responsibilities of Key Organizations

S. No.	Task	Activities	Unit
1	Technical approval of Design, Drawing and Cost Estimates	Approval	Concerned Dept.
2	Tender, Allotment and Upkeep of Contract Documents	Invitation, Receive tenders, evaluation	Concerned Dept.
CONTRACT ADMINISTRATION AND OVERALL SUPERVISION			
1	Administration and management of contracts including interpretations of technical specifications.	Management	Concerned Dept.
2	Revised drawings and designs	Submission, review and approvals	Concerned Dept.
3	Provide layouts / levels for works. Checking of levels and layouts	Primary Secondary	Contractor Concerned Dept
4	Adequacy of the input such as material, labour, equipment with reference to technical requirement.	Primary Secondary	Contractor Concerned Dept
5	Material register	Documentation Review	Contractor Concerned Dept
6	Maintain work site in neat, orderly and safe manner.	Primary Secondary	Contractor Concerned Dept
7	Minimize inconveniences to the public.	Primary Secondary	Contractor Concerned Dept
8	Inter departmental coordination		Contractor Concerned Dept
9	Continuous on sites supervision during construction and ensuring safety.	Primary Secondary	Contractor Concerned Dept
10	Monitoring of progress , find cause of delay, remedial measures and issue instructions to contractor	Primary Secondary	Contractor Concerned Dept
11	The contractor fulfills all contractual obligation, proper storage of materials, regulations , contract conditions, specifications and instructions.	Primary Secondary	Contractor Concerned Dept

12	Ensuring that site order book are properly maintained	Primary Secondary	Contractor Concerned Dept
13	Test records and results are available for review and assessment	Primary, Secondary	Contractor Concerned Dept
14	Contractor prepares and submit monthly progress report in time.		Contractor
15	Preparation of drawing of completed works.	Primary Secondary	Contractor Concerned Dept
QUALITY ASSURANCE AND INSPECTIONS			
1	Training on using manual to contractor staff	Training	Concerned Dept
2	Provide effective supervision of the works in order to ensure the quality and conformity with the standards and specifications prescribed in the contract.	Primary Secondary	Contractor Concerned Dept
3	Inspect all work sites regularly to ensure that the work is being implemented in accordance with the approved standards and that the quality control procedures set forth under the contract are followed.	Primary Secondary	Contractor Concerned Dept
4	Take samples and test independently testing wherever considered necessary. Insure that proper records of the tests conducted are maintained	Primary Secondary	Contractor Concerned Dept
5	Inspect interim work as required to accept or reject completion stages before permitting the contractor to proceed with further works. Enter all approvals in the site order book and have it signed by all parties	Primary Secondary	Contractor Concerned Dept
6	Inspect the completed works insuring that any defects in materials or workmanship are properly identified in a timely manner	Primary Secondary	Contractor Concerned Dept.
7	Conduct monthly inspections and site coordination meetings for all works to review the overall progress and quality of the works.	Primary Secondary	Contractor Concerned Dept
8	If any work item or construction material is sub standard or unacceptable, deduct such work or	Primary Secondary	Contractor Concerned Dept

	supply of material from the progress payment or defer payment until the contractor rectifies the deficiencies		
MEASUREMENT AND PREPARING BILLS AND PAYMENTS			
1	Conduct joint measurements of the works with the contractor and record them in the stipulated format for payment.	Primary Secondary	Contractor Concerned Dept
2	Prepare necessary release order of security and payment after completion of the defect liability period as per the contract.	Prepare and verified Hand receipt	Concerned Dept
REPORTING			
1	Submit monthly project progress report.	Submission	Contractor
2	Prepare and submit Monthly Progress Reports in the approved format that includes Quality Control Status, physical and financial progress	Submission	Contractor Concerned Dept
3	Submit a quarterly progress report.	Submission	Contractor Concerned Dept
INTER DEPARTMENTAL AFFAIRS			
1	Identify power connection, road crossings, pipe line inter connections with existing system, permission for use of land, etc.	Primary Secondary	Contractor Concerned Dept
2	Obtain permissions from other departments and organizing the works as required through them.	Primary Secondary	Contractor Concerned Dept
OTHER RESPONSIBILITIES			
1	QA/QC Training module for IPH DEPT. engineers	Training	Consultant
2	QA/QC Training module for contractors	Training	Contractor Concerned Dept
3	QA/QC Training to GPWSC	Training	Contractor Concerned Dept
4	QA/QC Module	Linked to MIS	Consultant

Quality Assurance /Quality Control Duties

Activity/Item	Contractor's QA/QC Duties
Designs/Drawings for contract	• Maintain design / drawing register at site • Use only approved drawings for construction
Test laboratory and equipment	• Intimate Concerned Dept. the details, date of completion with requisite manufacturers' and calibration certificates of equipments. • Maintain the equipments in good condition and calibrate as necessary
Material receipts Materials testing	• Enter receipts in material register • Materials to be tested only in approved laboratories • Prepare concrete mix proportions as per volume as required by contract and submit test results to Concerned Dept. • Take test samples in presence of Concerned Dept. when requested • Perform material tests. • Submit test reports to Concerned Dept. with monthly reports Maintain test log
Rejected materials	• Entries to be made in material register at site. • Tag and record all rejected materials. • Intimate Concerned Dept. in writing the proposed date of removal of material from site and confirm after removal
Material consumption	• Enter daily consumption of materials in material register and indicate balance quantity
Construction equipment	• Intimate Concerned Dept. the details, date of mobilization along with requisite insurance certificate • Maintain equipments in good working condition. • Intimate breakdown of construction equipments.
Construction	• Intimate Concerned Dept. in writing when construction is going to commence and what activities are proposed to be undertaken • Intimate Concerned Dept. in advance when critical works, such as concreting, embankment, paving, pipeline laying and jointing, testing, etc., would be undertaken, along with the test certificates of the materials proposed to be used in

	these works. No critical activity shall start unless the material is tested. Certificates are verified and approved by the Engineer. • Concreting to take place only after pour card is signed. • To provide any other necessary QA/QC requirement.
Daily work progress	• To maintain in daily log
Testing of works in progress	• Perform tests as per contract requirements. • Submit test reports to Concerned Dept.. • Maintain test log during the execution of works.
Rejected work items	• Intimate Concerned Dept. in writing the proposed date of removal from site and confirm after removal. • Rectify defective work and invite Concerned Dept. for re-inspection.•
Instructions from Engineer	• Enter change orders, site instructions, letter and minutes of meetings issued by the Engineer and Consultants in the Instruction Log.
Inspection of Engineer	• Take instructions in Site Order Book. • Intimate Concerned Dept. of compliance.
Progress scheduling and control	• Prepare and maintain project schedules and undertake work in accordance with approved schedule.
Reporting	• Prepare and submit Monthly Progress Reports and other reports as per contractual requirements.
Records	Maintain the following records on Site/Contractor's Office/Laboratory as given in Annexure C. • Site Order book • Material Register • Daily Progress Report. • Concrete pour Register • Test Record • Design &Drawing Record • Non conforming item record • Cube test record
Workmanship	All the work executed against the contract shall be of good workmanship
Disposal Of Debris	All the Debris should be disposed of properly after completion of construction work.

QUALITY ASSURANCE BY DEPARTMENTAL ENGINEERS DURING INSPECTION

S. No.	Key parameters of Quality Assurance	SE	EE	AE
1	**SITE DOCUMENTS**			
	Site Order book	✓	✓	✓
	Material Register	✓	✓	✓
	Daily Progress Report.	-	-	✓
	Test Record	✓	✓	✓
	Design and Drawing Record	-	✓	✓
	Non Conforming Item Record	✓	✓	-
2	**MANDATORY TESTING**			
	Hydro testing of sewer	-	-	✓
	Hydro testing of pipeline	-	-	✓
3	**AVAILABILITY OF FIELD AND LAB EQUIPMENTS**	✓	✓	✓
4	**MANUFACTURING CERTIFICATES**			
	GI Pipe / GI Fittings/ PVC /MS /SW /RCC Pipes	✓	✓	✓
	Manhole covers and Footrest	-	✓	✓
	Electrical cables/fans and fixtures	-	-	✓
	Switches/sockets and boards	-	-	✓
	Flow measuring devices	-	✓	✓
	Control Panel	-	✓	✓
	Lightening arrestor	-	✓	✓
	Level indicator and controllers.	-	-	✓
	Silver ionization plant / Chlorination Plant / RO / UV	✓	✓	✓
	Any other item as per agreement	-	-	✓
5	**DEPARTMENTAL TEAM INSPECTION**			
	DI, CI,PVC, MS,SW,HDPE/MDPE	✓	✓	-
	Pumps , Motors & D.G. Sets	✓	✓	-
	Manhole Frames and covers	✓	✓	-
	R.C.C. Pipes	✓	✓	-
6	**CHECK LIST GUIDE FOR WORKS**			
	Tube well/surface water	-	✓	✓
	Laying and jointing of pipeline, Back filling, Hydro testing	-	✓	✓

	Pump & machinery of Tubewell / Cannal / Surface Water	-	✓	✓
	Disinfecting plant		✓	✓
	Pump chamber	-	✓	✓
	Development of water works	-	✓	✓
	O.H.S.R / U.G.S.R	-	✓	✓
	Water treatment plant (canal based)	-	✓	✓
	Sewer laying & treatment plant	-	✓	✓
	Control panel for 3 phase pump & motor	-	✓	✓
	Centrifugal pump and motor	-	✓	✓
7	**PERIODICAL SITE INSPECTIONS**	✓	✓	✓
8	**POST QUALITY INSPECTION OF FINISHED WORKS**	✓	✓	-
9	**QUALITY CERTIFICATION**	-	✓	✓
10	**MONTHLY REPORTING AND REVIEW MEETINGS**	✓	✓	-

QUALITY FIELD INSPECTION REPORT

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td>Name of scheme</td><td>:</td><td></td></tr>
<tr><td>2</td><td>Name of Block</td><td>:</td><td></td></tr>
<tr><td>3</td><td>Name of District</td><td>:</td><td></td></tr>
<tr><td>4</td><td>Technically sanctioned Estimated Cost in Lacs</td><td>:</td><td></td></tr>
<tr><td>5</td><td>Name of Agencies with Agreement No.
Package No 1 :
Package No 2 :
Package No 3:
Package No 4:</td><td>:</td><td></td></tr>
<tr><td>6</td><td>Detail of Package with Tendered Cost in Lacs ,Date of commencement, completion and progress in Percentage.
Package No 1 :
Package No 2 :
Package No 3 :</td><td>:</td><td>
<table>
<tr><th>Pack No.</th><th>Tend. Cost in lacs</th><th>Date of start</th><th>Date of Compl.</th><th>% progress</th></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>7</td><td>Name of Circle</td><td>:</td><td></td></tr>
<tr><td>8</td><td>Name of Division</td><td>:</td><td></td></tr>
</table>

9	Name of Sub-division	**:**	
10	Name of S.E	**:**	
11	Name of E.E	**:**	
12	Name of A.E	**:**	
13	Name of J.E	**:**	
14	Name of Head of deptt. E-in-C	**:**	
15	Scheme Inspected by C.E with date/ reference	**:**	
16	Scheme Inspected by S.E with date/ reference	**:**	
17	Scheme Inspected by E.E with date/ reference	**:**	
18	Scheme Inspected by E.E (QMSW) with date reference	**:**	
19	Date of field inspection	**:**	

Annexure H: CHECKLIST GUIDE FOR WORKS

S. No.	Description of Work	Form No.	Remarks
1	Tube well.	Q/CL-1	Mandatory
2	Laying and jointing of pipe line, back filling, hydro testing	Q/CL-2	Mandatory
3	Pumping machinery & fittings of delivery pipe in pump chamber (Tube well based scheme)	Q/CL-3	Mandatory
4	Pump chamber.	Q/CL-4	Mandatory
5	Development of water works.	Q/CL-5	Mandatory
6	O.H.S.R	Q/CL-6	Mandatory
7	Water treatment plant (Canal based scheme)	Q/CL-7	Mandatory
8	Laying of sewer & Treatment plant.	Q/CL-8	Mandatory
9	Control panel for 3 phase pump & motor.	Q/CL-9	
10	Centrifugal pump, motor & fittings of delivery pipe in pump chamber (Canal based scheme)	Q/CL-10	
11	Quality certificate.	Q/CL-11	Mandatory

Quality Control of WTP
Check list for Water Treatment Plant, Rising Mains, Distribution System & Tanks.
Annexure- A
Check list for Clear Water Sump and Reservoir

S. No.	Checks required/ undertaken	Status	Frequency of reporting
1	Proper closure of washout valves; any abrupt stoppage during operation.		
2	Proper operation of inlet valves; any abrupt stoppage during operation.		
3	Proper operation of outlet valves; any abrupt stoppage during operation.		
4	Proper operation of bye pass valves; any abrupt stoppage during operation.		
5	Does any valve pass water even after closure?		
6	Leaks through valves; glands and bolts and nuts.		
7	Leaks through pipes and joints at SR.		
8	Status of valve chambers and their covers.		
9	Status of finial ventilators; fly proof mesh intact or is to be replaced.		
10	Status of manhole covers; are they corroded?		
11	Functioning of water level indicators.		
12	Functioning of flow meters.		
13	Status of ladders and railing: are they corroded?		
14	Check whether quality of the water in the SR is OK.		
15	Possibility of SR water getting polluted.		
16	Check for the need for cleaning and disinfecting the SR.		
17	Check for the presence of residual chlorine in the water stored in SR.		
18	Check for signs of corrosion of interior of roof due to chlorine.		
19	Check for Structural damages of the SR.		
20	Check for Leaks through the structure of the SR.		
21	Status of interconnecting pipe work? Is it corroded?		
22	Status of lighting arrestor.		
23	Status of out-fall drains of scour and overflow at SR.		
24	Availability of :		
24.1	Spares		
24.2	Consumables		
24.3	Tools		
25	Check for need for painting.		
26	Check for availability of drawings and designs of the SR.		

Annexure B
Check list for Distribution System.

S. No.	Checks required / undertaken	Status	Suggested frequency of reporting
1	Check whether the Operation of valves is smooth without any abrupt stoppage during closure.		
2	Check whether closures of a valve results in complete stoppage of flow or if any flow passes the valve (passing valve).		
3	Check for status of scouring and then proper closure of washout valves.		
4	Check for leaks through pipes.		
5	Check for leakage through valves at gland, bolts or any other place.		
6	Check for leaks at the appurtenances.		
7	Check for any signs of corrosion of pipelines.		
8	Check for the status of Manhole covers over the chambers; are they corroded.		
9	Inspect for any possibilities of pollution of the distribution system water stored.		
10	Status of out-fall drain for scour and overflow.		
11	Assess the need for painting of the piping work.		
12	Check for availability of spares for valves and pipes and jointing materials.		
13	Review the method of giving consumer connections in the field.		
14	Preparation of water budget for each zone served by one reservoir.		
15	Number of connections given.		
16	Number of meters out of order.		
17	Status of hydrants and PSPs.		
18	Status of Distribution System.		
19	Review of pressure.		
20	Review of flows.		
21	Age of pipes/C value of pipes.		
22	Corrosive water.		
23	Study of inflows and outflows		
24	Identify source of leakage.		
25	Metering.		

26	Status of bulk metering and consumer.		
27	Review facilities for repair of consumer meters.		
28	Unauthorized connections if any.		
29	Status of fire hydrants and PSPs.		
30	Availability of updated system map.		
31	Need for any interconnections.		

Annexure C
Check Lists For Transmission Main

S. No.	Check required / undertaken	Status	Suggested frequency of reporting.
1	Check whether the operation of valves is smooth without any abrupt stoppage during closure.		
2	Check whether closure of a valve results in complete stoppage of flow or if any passes the valve (passing valve)		
3	Check for status of scouring and then proper closure of washout valves.		
4	Check for leaks through pipes.		
5	Check for leakage through valves at gland, bolts or any other place.		
6	Check for leaks at the appurtenances including expansion joints.		
7	Check for any signs of corrosion of pipelines.		
8	Check for the status of manhole covers over the chamber covers; are they corroded.		
9	Inspect for any possibilities of pollution of the transmission system.		
10	Check status of out-fall drain for scour valves and chances of contamination oat scours.		
11	Assess the need for painting of the exposed piping work.		
12	Check for availability of spares for valves, expansion joints and pipes and jointing materials.		
13	Carry out review of pressures.		
14	Carry out review of flows.		
15	Check age of pipes / C value of pipes.		
16	Check for corrosive water.		
17	Study inflows and outflows into the reservoirs linked to the transmission system.		
18	Identify source of leakage.		
19	Metering		
19.1	Status of bulk meter.		
19.2	Review facilities for repair of meters.		
20	Availability of updated system map.		

Annexure - D
Tolerance and Classification of Water
IS Code: 2296-1982

Class of Water

Classifications	Type of use
Class A	Drinking water source without conventional treatment but after disinfection
Class B	Outdoor bathing
Class C	Drinking water source with conventional treatment followed by disinfection.
Class D	Fish culture and wild life propagation
Class E	Irrigation, industrial cooling or controlled waste disposal

Tolerance Limit

Sl	Parameter and Unit	A	B	C	D	E
1	Taste	None	--	--	--	--
2	Odour	Unobj	--	--	--	--
3	Colour (True) (Hazen unit)	10	300	300	--	--
4	pH (max) (min : 6.5)	8.5	8.5	8.5	8.5	8.5
5	Conductivity (25oC) uS/cm	--	--	--	1000	2250
6	DO (mg/L) (minimum)	6	5	4	4	--
7	BOD (3d, 27oC) (mg/L)	2	3	3	--	--
8	Total Coliforms (MPN/100 mL)	50	500	5000	--	--
9	TDS (mg/L)	500	--	1500	--	2100
10	Oil and Grease (mg/L)	--	--	0.1	0.1	--
11	Mineral oil (mg/L)	0.01	--	--	--	--
12	Total Hardness (mg/L as CaCO3)	300	--	--	--	--
13	Chlorides (mg/L as Cl)	250	--	600	--	600
14	Sulfates (mg/L as SO4)	400	--	400	--	1000
15	Nitrates (mg/L as NO3)	20	--	50	--	--
16	Free CO2 (mg/L)	--	--	--	6	--
17	Free NH3 (mg/L as N)	--	--	--	1.2	--
18	Fluorides (mg/L as F)	1.5	1.5	1.5	--	--
19	Calcium (mg/L)	80.10	--	--	--	--
20	Magnesium (mg/L)	24.28	--	--	--	--
21	Copper (mg/L)	1.5	--	1.5	--	--
22	Iron (mg/L)	0.3	--	50	--	--
23	Manganese (mg/L)	0.5	--	--	--	--

Agriculture

Being an agrarian economy, this is a very compelling use for India, but should never be used for edible crops or plants that produce millets, etc.

Key Principles should be paid attention before deciding use of treated sewage for agriculture.

Refer CPHEEO Manual on Sewage & Sewerage Treatment Systems (Part A), Nov 2013- Section 7.3.1.1(a) to (g).

The deleterious effects of the constituents of the irrigation water on plant growth can result from

i. direct osmotic effects of salts in preventing water uptake by plants,
ii. direct chemical effects upon the metabolic reactions in the plant and
iii. any indirect effect through changes in soil structure permeability and aeration.

Annexure E

IS Code: 10500-1991 Portable Drinking Water

Parameter	Desirable Value	Maximum Permissible Value	Effects if not controlled
Colour	5 hazen unit	25 hazen unit	Unacceptable by people
Odour	Odourless	Odourless	Unacceptable by people
Turbidity	5 NTU	10 NTU	Unacceptable by people
Soluble Salts/TDS	500 mg/l	2000 mg/l	Stomach ache
pH	6.5 – 8.5	6.5 – 8.5	Intestinal problems
Hardness	300 mg/l	600 mg/l	Not appropriate for cooking, washing clothes. Flaking in pipes.
Calcium	75 mg/l	200 mg/l	Not appropriate for cooking.
Chlorides	250 mg/l	1000 mg/l	Corrosion, taste differs
Sulphate	200 mg/l	400 mg/l	Indigestion, stomach problems
Magnesium	30 mg/l	100 mg/l	Stomach ache
Nitrates	45 mg/l	100 mg/l	Can lead to Blue baby (1-6 months child)
Fluorides	1.00 mg/l	1.50 mg/l	Fluorosis of teeth, bones and muscles
Alkalinity	200 mg/l	600 mg/l	Taste differs
E-coli	Count 0 in 100 ml		Infectious disease and intestinal problems
Coliform	<10 in 100 ml	Not detected in more than 50% sample in year	

Annexure F
Operational Parameters for Water Treatment Plant Units for tests.

Operational Parameter	Treatment Step / Process					
	Raw Water	Coagulation	Sedimentation	Filtration	Disinfection	Distribution System
pH		✓	✓		✓	✓
Turbidity (or particle cont)	✓	✓	✓	✓	✓	✓
Temp	✓		✓		✓	✓
Dissolved Oxygen	✓					
River / Stream flow	✓					
Total coliforms	✓				✓	✓
Background bacteria					✓	✓
Colour	✓					
Conductivity	✓					
Alkalinity	✓	✓	✓			
Organic carbon	✓		✓			
Algae and algal toxins	✓					✓
Chemical Dosage		✓			✓	
Flow rate		✓	✓	✓	✓	
Headloss					✓	
CT					✓	
Disinfectant residual					✓	✓
Disinfection by -products					✓	✓
Pressure						✓

Annexure – G

List of Measurements, Alarms, Status Indicators etc.

For plants of 1 ML/d (220,000 igpd) capacity and greater, the following instruments should be provided as a minimum for the relevant processes listed.

Raw Water Instrumentation:

- low-level switches to shut down the raw water pumps. These should be hard-wired to the starters;
- running and trip indication for raw water pumps; and
- raw water turbidity, pH, pressure, flow rate, and flow volume.

Rapid Mixer:

- Running and trip indication.

Flocculators:

- Running and trip indication; and
- speed (if variable speed type).

Solids Contact Clarifiers:

- recirculator speed indication;
- Running and trip indication;
- level indication;
- blow down valve status; and
- turbidity and pH following clarification.

Softening:

- if lime softening is used, pH following recarbonation; and
- recarbonation CO_2 feed status.

Filter Instrumentation:

- turbidity on each individual filter effluent and filter to waste. This can be a single instrument for each filter if piping arrangement permits;
- for constant rate filters: differential head loss across the filter media;
- filter flow rate;

where the backwash sequence is automated, provide open and close limit switches or position on all filter valves and status on backwash equipment; and

- **filter run time.**

Backwash Instrumentation:

- running and trip indication for backwash pump(s);
- running and trip indication for air blowers (if air scour is used);
- backwash flow rate and flow total; and
- elapsed time since last backwash.

Clear well and Distribution Pump Instrumentation:

• level indication for clearwell and other tanks;
• running and trip indication for the distribution pumps;
• low-level switches to shut down the distribution pumps. These should be hard-wired to the motor starters;
• turbidity, chlorine residual, fluoride residual (if fluoridation is practised), pH, pressure, flow rate, and flow total on plant discharge;
• for variable speed pumps, indicate the pump speed.

Chemical Systems:

• running and trip indication for chemical loading, batching and pumping equipment;
• low and high level alarms in storage bins, silos or tanks;
• level indication for tanks;
• weigh scales for hydrofluosilicic acid day tanks or storage if no day tank is used;
• weigh scales for gaseous feed chemicals such as chlorine or sulphur dioxide;
• speed indication on variable speed pumps;
• rotameters (or other flow monitoring device) for carrier water feed systems; and
• chemical feed flow rate is desirable but not mandatory.

Miscellaneous Instrumentation:

• run time meters on all pumps and major electrically driven equipment;
• speed, run time, oil pressure and temperature gauges, fault signal switches and manual start and shut down on engines;
• where the plant is automated or operated remotely from either within the plant or outside, provide open and close limit switches or position indicators on all major valves, status on all major equipment and security instruments including door switches, building temperature switches and smoke alarms; and
• any additional instrumentation recommended by equipment manufacturers.

Alarms and Status Indication

As a minimum, the following alarms need to be provided:

• high turbidity on the raw water, clarifier effluent (if applicable), filter effluent, and plant discharge;
• high and low pressure on the raw water line;
• high flow rate on the raw water line.
• high and low level in clarifiers or flocculators;
• high torque on solids contact clarifier recirculator and rake;
• high torque on flocculators;
• high level in filters;
• high and low level in chemical storage tanks;

• high and low chemical feed rates (if measurement is provided);
• high flow rate on each filter individually (also low flow rate on declining rate filters);
• high and low levels in each clearwell, pumpwell, and reservoir;
• high and low pH on the raw and treated water (if on-line measurements are provided);
• high and low chlorine residual on the plant discharge (where online measurements are provided);
• high head loss on the filters (if constant rate type);
• trip or failure to run on each pump;
• high and low pressure on the plant discharge line;
• high flow rate on the plant discharge line;
chlorine gas detection in the chlorine storage rooms;
• chlorine scale low weight (where scales are equipped with transmitters); and
• valve operation failure (where valves are provided with limit switches.

Field Instruments

Level Instruments

Where access to the top of the reservoir is convenient (such as in a clearwell), an ultrasonic level transmitter should be used. Where access to the bottom of the reservoir is convenient (such as at a tower or above-ground reservoir), a pressure transmitter can be used.

Flow Instruments

On-line flow meters should generally be one of the following types:
• turbine (or nutating disk);
• magnetic; and
• ultrasonic (either transit-time or Doppler).

All of these types of instruments can be equipped to provide both flow rate and flow total measurements.

Price, line size, flow rate, flow range, pipe material, required accuracy, and water quality will dictate the selection of the type of instrument.

Water Quality Instruments

The most frequently used water quality measurements are turbidity, pH, and chlorine residual. On-line turbidity measurement is relatively inexpensive and should be provided in any plant, on the raw water, flocculator or clarifier effluent (if applicable), each filter effluent, and final plant discharge lines. In larger plants, on-line pH and chlorine residual are generally used, but manual testing can be done in smaller plants.

Process Controls

Pumping Systems

Regardless of the function of the pumping system, its control will normally be achieved through monitoring level, flow and/or pressure. The choice of control parameter(s) will depend on the system's function and features. Controls and monitoring for raw water pumping and finished water pumping are normally required.

Treatment Processes

Travelling Screens

Two methods may be used to control the operation of travelling screens:

• simple manual start/stop which requires the presence of the operator to start and stop the screen. This method is not recommended where sudden changes in raw water quality could result in heavy debris accumulation on the screens; and

• automatic activation by differential level or time. This method uses the differential level across the screen to provide the start condition. Once started, the screen needs to be run at least one "cycle" and stop automatically when the differential level is returned to the clean screen value.

Chemical Feed Systems

Liquid/Gas Chemical Feed

Basic chemical dose rate control can be achieved by flow pacing (i.e., adjusting chemical feed rate based on the flow of the stream it is to be injected into). This can be achieved using a variable speed metering pump (liquid) or flow control valve (gas) linked to a flowmeter on the receiving stream. For finer dosage adjustment, feed rate can also be controlled based on downstream instrumentation (e.g., residual chlorine analyzer providing feedback signal to chlorine dosing pump). *Dry Chemical Feed*

Dry chemical feed systems typically include a packaged bulk storage combination feeder and mixer. The feeder can be gravimetric or volumetric, and will be controlled by a 4-20 mA signal from the flow transmitter on the plant flowmeter.

Rapid Mixing

Control of the rapid mixer will be simply on or off; the unit should operate continuously whenever the plant is in operation.

Flocculation

Flocculation requirements should be addressed in terms of the unit process parameters.

Clarification

Careful monitoring and control is most important to successful clarification. Adequate instrumentation to measure water quality parameters (e.g., turbidity) prior to and after clarification is essential.

Dissolved Air Flotation (DAF)

The process variables in DAF are:

• flow rate;

• recycle rate; and

• float removal cycle.

Filtration

Two types of filtration are used for water treatment:

• Rapid gravity filtration; and

• Slow sand filtration.

Rapid Gravity Filtration (RGF)

Constant Rate: Flow through a constant rate RGF is controlled by a flow control valve on the filter effluent or by influent flow splitting and filter level control. For the flow control type, the effluent valve position is controlled by a flow rate signal from a flow meter, usually located on the filter effluent. For the level control type, the effluent valve position is controlled by the water level in the filter.

A filter run will be terminated, and the bed backwashed, based on one or any of the following:

• run time;

• headloss across the bed;

• effluent turbidity; and

• effluent particle count (optional).

Declining Rate: Flow through a declining rate RGF is not directly controlled as is the case with constant rate RGF. The rate simply decreases as the filter plugs. An effluent valve with manually adjustable stops is set to ensure the flow rate through a clean bed is not excessive. Once set, this valve will return to the set position after backwash (or after being closed for maintenance, etc.).

A filter run will be terminated based on one or any of the following:

• run time;

• effluent flow rate;

• effluent turbidity; and

• effluent particle count (optional).

A time initiated backwash can be automatic. Smaller plants feeding smaller systems may benefit from backwashing overnight when demand is low - and the operator is not present. In such cases, a timer can be hard-wired into the filter control panel to initiate the backwash, or alternatively, the time control can be programmed into the plant's programmable logic controller (PLC).

Slow Sand Filtration

Because of the very slow flow rate through SSF, head loss, flow rate, and effluent quality can remain very stable for many weeks. Adjustments to the flow rate can be made manually by the operator.

Instrumentation should be provided to routinely monitor raw and treated water quality. A sudden increase in head loss accompanied by a reduction in flow rate signals that the filter is plugged.

Disinfection

The dosage is controlled on the basis of the measured residual; an analyzer/ controller measures the residual downstream of the point of injection and adjusts the rate of injection accordingly via a control signal to the metering pump (liquid feed) or gas flow control valve (gas feed).

Control System Documentation

The following documents need to be provided following completion of the control system:

• Record drawings to show any changes to the original design and including any drawings produced during construction;

• annotated listings of control system programs and packaged system configuration;

• manufacturer's literature for all control and instrumentation components;

• final wiring diagrams complete with wire and terminal coding;

• motor control schematics;

• instrument loop diagrams;

• panel wiring and layout details;

• PLC or DCS wiring schematics;

• instrument calibration sheets; and

• operating instructions.

Annexure H

Check lists for Work done in Water Supply System & Sewerage Treatment System

FORM No. Q/CL-1

CHECK LIST FOR TUBEWELL

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S. No.	Description of Work	Form No.	Remarks
1	Whether tube well site is prone to flooding and free from filled up earth?		
2	Whether any village pond is located adjacent to water works site?		
3	Whether the drilling point of tube well is as per approved lay out plan?		
4	Whether tube well site was investigated hydro geologically & geo-physically to assess the availability of water? (applicable to area where there is water scarcity)		
5	Whether Geologist/Hydrologist has been engaged for installation of tube well?		
6	Whether the type of drilling, size of tube well boring is as per contract agreement?		
7	Whether samples of strata was collected accurately and kept in boxes for further analysis?		
8	Whether electric logging has been done?		
9	Whether screen slot size and gravel size has been designed by proper sieve analysis from approved agency?		
10	Whether M.S. Pipes used are of proper thickness, free from rust and with bituminous painted as per approved specification, Test certificate obtained and Departmental inspection conducted?		
11	Whether Stainless steel wire cage strainers are of proper thickness, and as per approved specifications, Test certificate obtained and Departmental inspection conducted?		
12	Whether the tube well assembly has been approved by concerned S.E.?		
13	Whether lowering of tube well assembly has been done in the presence of SDE in-charge and SDE deputed by Superintending Engineer?		
14	Whether Cement/clay, seal plug is provided between the annular spaces of boring & lowering assembly to prevent contamination of good quality water bearing strata as per recommendations of the Geologist / Hydrologist?		
15	Whether certificate to the effect that “Certified that the lowering of the pipe assembly and screen/ strainer has been done in our presence and that the quality, sizes and length of pipes and screen/strainer are as per record / entry made and are correctly located and lowered in the bore” has been recorded and is duly signed by SDE–in-charge & SDE deputed for lowering from other division and duly countersigned by the Executive Engineer- in-charge?		

16	Whether verticality of tube well is checked and recorded?		
17	Whether capacity of Air Compressor (Both CFM and PSI) used is as per specifications given in bid document and is certified by the Engineer-in-charge?		
18	Whether capacity of Submersible pumping set used for development is sufficient w.r.to developed and designed discharge?		
19	Whether tube well development hours are as per contract and log book maintained? a) With compressor b) With submersible pump set.		
20	Whether running hours of air compressor and submersible pumping set are witnessed and certified by authorized officer of IPH DEPT. and representative of GPWSC?		
21	Whether final performance test done & recorded?		
22	Whether strata chart and assembly chart showing all details of tube well has been submitted by contactor to IPH DEPT./ GPWSC?		
23	Whether result of water sample tests (Physical/Chemical/ Biological Examination) after development with submersible pumping set are conforming to drinking water standards?		

FOR CONTRACTOR Signature : Name : Date :	FOR DEPARTMENT Signature : Name : Designation : Date :

FORM No. Q/CL-2

CHECK LIST FOR LAYING AND JOINTING OF PIPE LINE, BACK FILLING, HYDROTESTING

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B.No.:

S. No.	Description	Yes/No/NA	Remarks
A. Stage 60% Payment schedule: - Supplying of pipe and valves, excavation, laying, jointing, and fixing of valves.			
1	a) Whether pipes are of proper specifications and as per approved make as per DNIT? b) Whether pipes have been tested at manufacturer's premises an has been inspected by two officers deputed as per instructions of th department and test certificates are available?		
2	Whether the Sluice Valve/Air Valves etc. are as per specification and MC/department has been obtained?		
3	Whether the CI/GI/PVC specials are as per specification and department has been obtained?		
4	Whether the trenches have been excavated to correct depth as per specifications and dimensions?		
5	Whether the pipe line has been laid true to the alignment with proper bedding made as per specifications?		
6	Whether Jointing material used as per specification?		
7	Whether all the lanes are provided with pipe lines as per approved drawing?		
8	Whether the completion drawing of pipe line prepared and submitted with running bills?		
B. Stage 40% Payment schedule :- Completion, testing and commissioning.			
1	Any busting of pipeline noticed in the village.		
2	Whether all the leakages observed during testing have been repaired properly?		
3	Whether the trenches were backfilled in layers, and properly watered and consolidated as per specifications?		
4	The filling is carried out to required level and without any settlement?		
5	Field compaction / density test conducted?		
6	Whether the road metal was separately collected and all type of		

	roads reinstated properly after laying of pipes?		
7	Whether GPWSC/Panchayat are satisfied with restoring of roads and streets and a certificate to this effect has been given by the GPWSC/Panchayat before clearing payments of brick paving/ cement concrete restoration work?		
8	Whether the valve chambers constructed as per drawing and tested for water tightness?		
9	Whether the distribution system hydraulically tested?		
10	Whether the distribution system properly disinfected before providing connections to consumers?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-3

CHECK LIST FOR PUMPING MACHINERY & FITTINGS OF DELIVERY PIPE IN PUMP CHAMBER (TUBEWELL BASED SCHEME & Chlorinator)

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether submersible pump and motor conforming to approved specifications and make as per contract agreement, the MC obtained and Departmental inspection done?		
2	Whether Sluice valve, reflux valve and Air valve are ISI marked and as per specifications & the MC has been obtained?		
3	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		
4	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
5	Is Air Valve/Non Return Valve installed properly?		
6	Is double earthing done for machinery and is in order?		
7	Whether diameter and length of column pipe lowered is as per approved specification?		
8	Whether the jointing of column pipes is done properly to prevent leakage of water?		
9	Whether discharge available from the pump is close to actual discharge of pump? (Actual measurement of discharge by filling OHSR/ or through V-Notch)		
10	Is motor taking normal current?		
	CHLORINATOR		
1	Whether chlorinator and accessories is as per specification?		
2	Whether permission has been obtained and inspection has been conducted by competent authority		
3	Whether the chlorinator is installed and working properly?		
4	Whether testing kit for residual chlorine test available for water sample testing?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-4

CHECK LIST FOR PUMP CHAMBER

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No.

S.No.	Description	Yes/No/NA	Remarks
A. Stage 40% Payment schedule :- Up-to roof level			
	UPTO PLINTH LEVEL		
1	Whether Bench Mark pillars are fixed and layout is correct as per approved drawing for excavation of foundation?		
2	Whether Depth of foundation is correct as per approved drawing?		
3	Whether Earth bedding condition checked?		
4	Whether following materials used are as per specifications and Test for materials conducted as per frequency? Bricks Fine aggregate Coarse aggregate		
5	Whether following manufactured materials used are as per specification and Test for materials conducted and MC obtained? Cement Steel for reinforcement		
6	Whether Concrete bedding laid as per specification?		
7	Whether proper arrangement of curing and curing period maintained as per specification?		
8	Whether Ist class Brick work in foundation and plinth is as per specifications and necessary test for mix proportion of mortar conducted?		
9	Whether Horizontal / vertical D.P.C. provided as per specifications?		
	UPTO ROOF LEVEL		
10	Whether Ist class brick work in super structure is as per specifications and proper wet bricks are used. Test for mix proportion of mortar conducted?		
11	Whether Brick work in super structure is in true plumb and top of all walls are in level?		

12	Whether Thickness of joints in brickwork is kept 1 cm± 20 %?		
13	Whether All horizontal and vertical joints are being filled correctly?		
14	Whether proper curing period maintained as per specification?		
15	Whether size of doors/windows and other joinery work as per drawing has been kept?		
16	Whether proper section and gauge of hollow pressed steel chowkhats have been provided with proper grouting?		
17	Whether foot rest provided as per drawing and specification?		
B. Stage 60% Payment schedule: - Completion & finishing			
1	Whether Proper Centering and shuttering has been provided for R.C.C. slab?		
2	Whether steel Reinforcement laid as per design and drawing?		
3	Whether R.C.C. Slab is laid of required thickness and in level?		
4	Whether proper size of Girder (proper I-section) has been provided (Medium weight)?		
5	Whether proper size of opening in the roof has been provided with cover as per drawing for lowering of pump?		
6	Whether surface cleaned of all loose mortar and efflorescence before plastering?		
7	Is the finishing of plaster inside/outside is proper and mix is as per required proportion?		
8	Whether the floor has been laid in panels, correct thickness and proper sand filling done under floor?		
9	Whether proper underground conduit for electric cable has been provided for machinery etc?		
10	Whether electrical fixtures installed are as per approved specifications and quantity?		
11	Whether top finishing and slope of floor is correct?		
12	Whether proper tile terracing has been done on roof as per specification?		
13	Whether proper quality and type of wood has been used with correct thickness of shutters as per specification?		
14	Whether thickness of Glass used in window panes is correct as per specification?		
15	Have grills been provided as per standard drawings?		
16	Whether Gravel Pit of proper size has been constructed, channels		

	grouted and MS Sheet cover provided as per drawing?		
17	Whether V-notch houdi with proper specifications has been constructed according to drawing?		
18	Whether Quality of distemper/cement based paint (Snowcem) is as per specification?		
19	Whether Quality of paint used on wood work/steel work and on other components is as per contract?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-5

CHECK LIST FOR DEVLOPMENT OF WATER WORKS

1. Name of work : 3. Name of contractor :

2. Contract Agreement No. :

S. No.	Description	Yes/No/NA	Remarks
1	Whether Bench Mark pillars are fixed and layout is correct as per approved drawing for excavation of foundation?		
2	Whether Depth of foundation is correct as per approved drawing?		
3	Whether Earth bedding condition checked?		
4	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) □ Coarse aggregate		
5	Whether following manufactured materials used are as per specifications and Test for materials conducted and MC obtained? a) Cement b) Structural steel		
6	Whether Concrete bedding laid as per specification?		
7	Whether Ist class Brick work in foundation and plinth is as per specifications and necessary test for strength of mortar conducted?		
8	Whether D.P.C. provided as per specifications?		
9	Whether Ist class brick work in super structure is as per specifications and proper wet bricks are used. Test for mix proportion and strength of mortar conducted?		
10	Whether Brick work in super structure is in true plumb and top of all pillars in level?		
11	Whether Thickness of joints in brickwork is kept 1 cm± 20 %?		

12	Whether All horizontal and vertical joints are being filled correctly?		
13	Whether proper curing period maintained as per specification?		
14	Whether Gate Pillars and corner Pillars have been		
15	Whether proper size and number of Iron pickets has been embedded in PCC of approved mix as per drawing?		
16	Whether proper size/ type of D-hooks have been provided as per drawing?		
17	Whether barbed wire provided as per IS : 278-2009 and is of proper gauge and fully stretched in correct alignment?		
18	Whether proper size of iron Gate has been fixed with proper fittings and in alignment as per drawing?		
19	Whether paths at water work has been constructed according to proper section and camber as per drawing?		
20	Whether Quality of paint on steel work and on other components is as per specification?		
21	Whether proper sign board according to specifications has been installed?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-6

CHECK LIST FOR OHSR

1. Name of work: 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor
4. R.B. No. :

S. No.	Description	Yes/No/NA	Remarks
A. **Stage 30% Payment schedule:- Foundation and column up-to ring beam**			
1	Is Soil Bearing Capacity has been got checked from approved/ reputed institute?		
2	Whether Bench Mark pillars and center pillar were fixed and layout/depth of foundation is correct as per approved drawing?		
3	Earth bedding condition checked for any filled up soil.		
4	Whether following materials used are as per specifications and W Test for materials conducted as per frequency? a) Fine aggregate b) Coarse aggregate		
5	Whether following manufactured materials used are as per specifications and Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement		
6	Whether all requisite tests have been conducted for the following items as per frequency?. a) Excavation and bedding b) Plain cement concrete c) R.C.C. (Slump test, Compressive strength)		
7	Whether PCC laid as per drawing and specifications?		
8	Whether proper steel centering and dent less shuttering is being used ?		
9	The reinforcement in the following members provided is as per drawing/design and whether it has been checked by EE/SDE? a) Foundation b) Columns c) Braces d) Landings		

10	Whether Concrete Mixer/Vibrator was used at site and standby arrangement made?		
11	Whether Concrete pour Register with date of casting each bit of concrete is being maintained?		
12	Whether R.C.C. in the following members laid as per dimensions given in approved drawing with desirable smooth finishing? . a) Foundation b) Columns c) Braces		
13	Whether verticality of R.C.C. columns checked before and after pouring of concrete?		
14	Whether proper curing period maintained as per specification?		
B. **Stage 30% Payment schedule: - From ring beam up-to roof slab and completion of stair case.**			
1	Is the reinforcement in the following members provided is as per drawing/design and whether it has been checked by EE/AE? a) Bottom Ring beam b) Bottom dome and gallery c) Tank wall d) Top ring beam e) Top dome f) Staircase and landings		
2	Whether R.C.C. in the following members laid as per dimensions given in approved drawing with desirable smooth finishing? a) Bottom Ring beam b) Bottom dome and gallery c) Tank wall d) Top ring beam e) Top dome f) Staircase and landings		
3	In Stair Case whether G.I. Pipe railing and angle iron pickets is as per drawing and specification?		

4	Whether Bell Mouth Puddle collars, Double Flanged Puddle Collars have been fixed in position and are of proper specifications and approved make?		
5	Whether proper curing period maintained as per specification?		
C. Stage 40% Payment schedule: - Arrangement and erection of C.I D/F pipe and specials, all balance work including plinth protection, automatic water level controller and testing of structure etc.			
1	Whether the CI/ DI/ DF pipes are as per specifications and MC obtained and pipes have been fixed in true plumb?		
2	Whether inlet and overflow pipes have been properly installed in the tank so as to ensure proper working depth of OHSR and a free board of 0.60 mtr.?		
3	Whether following C.I. valves, specials have been fixed in position and are of proper specifications and approved make?		
3.1	Duck Foot Bends (IS 13382-1992)		
3.2	Sluice Valves		
3.3	Expansion Joints (IS 1536-1989)		
3.4	M.S. Clamps		
3.5	Joining Material (Nut Bolts/Rubber insertion)		
4	Is pipes extended by 2.75 mtr. Length beyond Duck Foot Bends?		
5	Is overflow pipe further extended by providing D/F Bend at its end and vertical pipe of 2 mtr. Length and a D/F Bend duly fitted with expanded metal mesh of 10 mm sq. provided at end?		
6	Whether angle posts are painted in two coats after primer?		
7	Whether **R.C.C. roof ventilator is** provided with proper ail (mesh) cover as per drawing?		
8	Is **water level indicator** with proper specification and polythene ball of minimum 30 cm dia. Has been provided as per drawing and Whether plumb/ indicator is as per size and specifications? Or if, Electronic float		

	system is provided it is as per specification and working properly?		
9	Whether **water sealed Manhole Cover** of suitable size with proper specifications / Drawing with locking arrangement have been provided?		
10	Whether **Lightening Conductor** with proper earth electrode and specifications and drawing has been provided?		
11	Whether **Steel Ladder** from balcony landing to top of the Dome provided as per drawing and specification?		
12	Whether **Aluminum Ladder** inside the tank provided as per specifications and drawings and one end fixed to the top dome and other end with the bottom dome?		
13	Whether vertical pipes, clamps, railings, steel ladder and fittings are painted with two coats of paints after applying primer coat?		
14	Whether the OHSR has been tested for water tightness and found no leakage or seepage?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-7

CHECK LIST FOR WATER TREATMENT PLANT (CANAL BASED)

1. Name of work : 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No. :

S. No.	Description	Yes/No/NA	Remarks
1	Whether Bench mark Pillars constructed for every units and the foundation, invert, hydraulic and formation levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications? Whether Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate d) Filter media		
3	Whether following manufactured materials used are as per specifications? Whether requisite Tests for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) LDPE sheet d) Manhole cover and Footrest e) Vent pipes		
4	Whether all requisite tests have been conducted for the following items as per frequency?. a) Excavation and bedding b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		
5	Whether Intake chamber has been constructed as per drawing with screen?		
6	Whether the sedimentation cum storage tank has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness? Whether the float arm has been provided as per drawing /specification and working properly?		

7	Whether the scour cum suction well has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness?		
8	Whether the high level tank has been constructed to correct dimensions as per drawing/ specifications and tested for water tightness?		
	Whether following units of water treatment plant are constructed as per approved design drawing and specifications? a) Sedimentation tank b) Flash mixer. c) Clariflocculator. d) Chemical house. e) Back wash over head tank.		
9	Whether the filter beds has been constructed to correct dimensions as per drawings /specifications and tested for water tightness?		
10	Whether Filter Media is from approved quarry and placed in filter beds to correct position and thickness as per drawing and specification?		
11	Is the clear water tank has been constructed to correct dimensions as per drawing / specification and tested for water tightness?		
12	Whether the Valves and specials are as per specifications and MC obtained?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

Note : Check list for components namely OHSR, Pump chamber, Centrifugal pump and motor, Control panel, Development of water works compound and Disinfecting unit shall be required to be filled separately on prescribed format .

FORM No. Q/CL-8

CHECK LIST FOR SEWER LAYING & TREATMENT PLANT

1. Name of work : 4.R.B. No. :
2. Contract Agreement No. :
3. Name of contractor :
4. R.B. No.

S.No.	Description	Yes/No/NA	Remarks
A : SEWER LAYING JOINTING AND APPURTENENT WORKS			
1	Whether Bench mark Pillars for site rail constructed for every line and the foundation, invert levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate		
3	Whether following manufactured materials used are as per specifications? Whether Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) Manhole cover and Footrest d) Ventilating shaft		
4	Whether following manufactured materials used are as per specifications? Whether Departmental Inspection for materials conducted and MC obtained? a) PVC / SW /CI /DI / RCC pipes etc. b) Manhole cover and Footrest		
5	Whether all requisite tests have been conducted for the following items as per frequency?. a) Foundation bedding b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		

6	Whether the alignment of sewer is in accordance with the approved plan?		
7	Whether the trenches have been excavated as per specifications?		
8	Whether the shoring and strutting has been done as per specifications?		
9	Whether the excavated earth has been kept away from trench as per specifications?		
10	Whether the suitable diversion has been made for proper movement of traffic?		
11	Whether the sewer has been laid true to the alignment and gradient with proper bedding in all streets as per drawing and specifications?		
12	Whether the jointing material used as per specification and joint tested before backfilling?		
13	Whether Oblique junctions are laid against each house?		
14	Whether the trenches were backfilled in layers, and properly watered and consolidated as per specifications?		
15	Field compaction / density test conducted?		
16	Whether all type of roads metal was separately collected and road reinstated properly after laying of sewers?		
17	Whether the manhole chambers constructed as per drawing and specifications and tested for water tightness?		
18	Whether Ventilating shaft are erected at suitable places as per drawings?		
19	Whether the completion drawing of sewer line with L- section prepared and submitted with running bills?		

B : SEWAGE TREATMENT PLANT			
1	Whether Bench mark Pillars constructed for every units and the foundation, invert, hydraulic and formation levels have been ensured as per drawing?		
2	Whether following materials used are as per specifications and Test for materials conducted as per frequency? a) Bricks b) Fine aggregate c) Coarse aggregate		
3	Whether following manufactured materials used are as per specifications? Whether Test for materials conducted and MC obtained? a) Cement b) Steel for reinforcement c) LDPE sheet d) Vent pipes		
4	Whether all requisite tests have been conducted for the following items as per frequency? a) Excavation in foundation b) Plain cement concrete c) Cement Mortar d) R.C.C. (Slump test, Compressive strength)		
5	Whether following units of sewage treatment plant are constructed as per approved design drawing and specifications? a) Collecting tank/sump Pump chamber as per checklist B/CL-5 a) Facultative pond / Maturation pond b) Sludge Drying Beds c) Sludge Curing Platform d) Composting Pits etc.		
6	Whether construction of rest room including toilet as per type design, drawing and specification has been constructed?		
7	Whether the sewage pumps, control panels are as per specifications and installed properly?		
8	Whether Sluice valve and reflux valve are ISI marked and as per specifications & the permission has been obtained by the competent authority?		

9	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		
10	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
11	Is Valves and fittings installed properly?		
12	Whether the efficiency of the plant checked?		
13	Whether Generating set has been installed as per required capacity/specifications on proper foundation?		
14	Completion drawing with actual hydraulic line prepared and submitted with running bill?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

Note: Check list for components namely Pump chamber, Development of water works compound shall be required to be filled separately on prescribed format .

FORM No. Q/CL-09

CHECK LIST FOR CONTROL PANEL FOR 3 PHASE PUMP & MOTOR

1. Name of work :

2. Contract Agreement No. :

3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether the main switch is of suitable capacity of L&T or any other reputed make?		
2	Whether the MCB/ MCCB units are of specified make?		
3	Whether the 3 Phase starter is of suitable capacity L&T or any reputed make?		
4	Whether the single phase preventor of L&T or reputed make is provided and working properly?		
5	Whether the panel box is of approved thickness and has been power painted?		
6	Whether it is suitable for 415 V AC. With variations up to 6 % on either side?		
7	Whether Shunt Capacitor is of proper KVAR capacity and of reputed make, or approved by HPSEBL?		
8	Whether Ampere meter is of suitable range and of L&T make or any other reputed make?		
9	Whether Volt meter is of suitable range (500V) and of L&T make or any other reputed make?		
10	Whether the ELCG is of L&T /Havell or reputed make?		
11	Whether three phase Indicators lamps are of L&T/Alstom (22.5mm Led type or equivalent reputed make?		
12	Whether Fuse bases and HRC fuses are of L&T/Havell make or equivalent?		
13	Whether selector switch for Ammeter and Voltmeter are of L&T, Kaycee make or equivalent?		
14	CT for Ammeter are of AE,EE, GE make or equivalent?		
15	Contractors relays and timers are of L&T, Siemen make or equivalent?		

16	Switch fuse unit is of L&T, Siemen, GE make or equivalent?		
17	Wires are of Finolex, Kent, Plaza make or equivalent?		
18	Whether Permission from competent authority has been obtained and inspection is carried out accordingly ?		
19	Whether the control panel has been fitted properly?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

FORM No. Q/CL-10

CHECK LIST FOR CENTRIFUGAL PUMP, MOTOR & FITTINGS OF DELIVERY PIPE IN PUMP CHAMBER (FOR CANAL BASED SCHEME)

1. Name of work :
2. Contract Agreement No. :
3. Name of contractor :

S.No.	Description	Yes/No/NA	Remarks
1	Whether the pumping set is of reputed make as per technical specifications, permission obtained and inspection conducted by competent authority?		
2	Whether the shaft, impeller and bearing are as per technica specifications?		
3	Whether the speed of motor is as per specifications?		
4	Whether the actual discharge of pump is as per specifications?		
5	Whether the alignment of the shaft is correct?		
6	Whether it is suitable for 415 V AC. with variations up to 6 % on either side?		
7	Whether combined efficiency of pump set is as per specifications?		
8	Whether head and discharge are correct as per specifications?		
9	Whether foundation and base plate are as per specifications and foundation bolt are of proper size and length?		
10	Whether the pump set has been power painted?		
11	Whether the suction lift is with in the limit (4.5 m IS: 9694 Part-I)?		
12	Whether the suction pipe joints are airtight and pump starts without priming?		
13	Whether Sluice valve, reflux valve and Air valve are ISI marked and as per specifications & the MC has been obtained?		
14	Whether the pipes and specials, rubber packing, nut and bolts are as per specifications?		

15	Is there any leakage from fittings? a)Inside the pump chamber b) Outside the pump chamber		
16	Is Air Valve/Non Return Valve installed properly?		
17	Is double earthing done for machinery and is in order?		
18	Is there any excess vibrations observed on running of pump?		
19	Is there any over heating of bearings?		
20	If the velocity in suction and delivery pipe is with in the limit(Less than 1.5m,not exceed 2m)?		

FOR CONTRACTOR	FOR DEPARTMENT
Signature :	Signature :
Name :	Name :
Date :	Designation :
	Date :

QUALITY CERTIFICATION

1. Name of Work:
2. Contract Agreement No:
3. Name of Contractor :
4. Name of Structure / Location:

QUALITY CERTIFICATE

This is to certify that we have inspected the conduct of the works in accordance with established Quality Control procedures and that the items included in this Interim Payment Certificate satisfy the required quality of works and are acceptable with regard to the specifications and standards as prescribed under the Contract. Requisite Test Certificates are attached.

Enclosures

1
2
3
4
5
6
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9
10

Signature / Date:

Date: ---------- J.E/A.E. E.E.

(Concerned Department)

Note: This Quality Certificate shall be completed and attached t each Interim Payment before payment is made.

Brand of Material and Equipments

S. No.	Material/ Equipment	Make / Brand
1	Reinforcement steel	TISCON,SAIL, Rathi, Kamdhenu, RINL
2	Structural steel	IISCO,TISCO,SAIL, Rathi, Kamdhenu, Ispat
3	Water proofing	Cico, Dr. Fixit, Dr. Forex
4	AC Sheets	Everest, Armco, Charminar, Uppal
5	SW pipes	Burn & Co., Perfect Potteries, Girco, Navroji, Oriental ceramics
6	CI/DI pipes	Jindal saw, Electrosteel, Electrotherm
7	MS pipes	SAIL, Jindal ,Tata, Surya, EST or equivalent
8	UPVC pipes & fittings	Supreme, Polygold, Finolex, Devendra, Diplast, Prakash, Swastika, Tirupati
9	GI pipes	Jindal, Tata, TTC, TST, Tirupati
10	HDPE Pipes	Dura line
11	Oil distemper and other paint	Shalimar, British paint, any Asian brand, Berger
12	Water proof cement	Snowcem, Asian, Berger
13	Metallic Red oxide primer	Shalimar, Asian brand, Berger
14	Paint	Nerolac, Jhonson Nicholson, Asian, Berger
15	CI valves	Kirloskar, IVC
16	CI fittings	BRM/HSCC / Electrosteel / Oriental / Upadhyay/Bir
17	GI fittings	UNIK, SVW, NMC
18	Sluice gates and screens	Jash
19	Flush Doors	Dura, Green Ply, Euro
20	Ply Board	Dura, Green Ply, Euro
21	Door fittings	Classic (Al.) ,304 (S&S)
22	Glass pane	Glass pane
23	Ceramic Tiles	Somany, Jonson& Jonson, Perry, Kajaria
24	Sanitary ware	Perry ware, Hindustan, Cera , Jonson
25	CP fitting	Jaquar , Roca, ARK
26	Storage tank	Syntex , Polycon
27	SS Strainer	Johnson, Super or equivalent
28	Filter media	From Pathankot or other approved source Conforming to IS : 8419 (1).
29	LDPE Film	Conforming to IS : 2508
30	Electric motors	Crompton greeves, Kirloskar, Siemen, Jyoti, ABS
31	Pumps	KSB, BS, Crompton, WIPL
32	Cables	Asian/ FGI/ Dalton/ FCI / CCI/ Universal

33	Three Phase Starter	L&T/ Unilec/ Kilburn/ Siemen/ ABB/ GE
34	Switch gear	L&T/ Siemen
35	Shunt Capacitor	GE/ Asian/CGL/ Madhav or approved by PSEB
36	MCB up to 10 HP MCCB above 10 HP	Havells/ Datar/ S&SCS Havells/ Datar/ S&SCS
37	Contractors, Relays and Timers	L&T / Siemen
38	Indicating lamps	L&T /Alstom/ Siemen,(22.5mm Led Type)
39	Ampere meter/ Voltmeter	GE, EE, L&T, AE
40	Transformer	NGEF, KEC, Kanohar, Marson
41	Panel board	L&T , Havell, GE
42	ELCB	L&T, Havell, MDS
43	Fuse bases	Havell, L&T, GE
44	HRC fuses	Havell, L&T, GE
45	Selector switch for ammeter and voltmeter	L&T, Kaycee
46	CT for ammeter	AE, EE, GE
47	Wire	Finolex, Kent, Plaza
48	Thimbles	Dowell,
49	Single phase preventor	L&T, Minillec
50	Switch fuse unit	L&T, Siemen, GE
51	Chlorinating Plant	Aqus ,Servel
52	Silver Ionization Plant	Jet clear, Bharti water

Light / Medium & Heavy Duty Machinery being used in the department at present (Mechanical Wing)

Chapter - 1

Heavy Duty Construction Equipments

Heavy construction equipment are used for various purposes in large projects.

Selection of different types of heavy equipment depends on the size of the work and economy of the project. These make construction process easier and faster.

Types of Heavy Construction Equipment

1. Excavators
2. Backhoe
3. Dragline Excavator
4. Bulldozers
5. Graders
6. Wheel Tractor Scraper
7. Trenchers
8. Loaders
9. Tower Cranes
10. Pavers
11. Compactors
12. Telehandlers
13. Feller Bunchers
14. Dump Trucks
15. Pile Boring Machine
16. Pile Driving Machine

Do's and Don'ts of Lifting Equipment

Do's

- Check the equipment is right for the job, including all the associated parts.
- Make sure all the parts are suitable for the weight you need to lift.
- Use the equipment according to the manufacturer's guidelines.
- Wear the correct safety gear. Items such as hats, jackets, and safety shoes should all be used relevant to the machine being used.
- Only used certified equipment.
- Attain, and then keep hold of, thorough examination reports.
- Make sure your load is securely and properly attached.
- Find the centre of gravity when lifting an unbalanced load at a low height – there will be less harm if it drops.
- Rehearse the lift if possible.

Don’ts

- Remove any safe guards on the machine; they are there for safety after all.
- Distract anybody operating the machinery.
- Wear lose fitting clothes or anything that could cause a problem. Long hair should be tied back securely and jewellery should not be worn.
- Use unsuitable equipment such as damaged or makeshift chains.
- Exceed the stated maximum lifting load possible by the machine.
- Use equipment that has a danger sign on it, unless you are qualified to do so.

Dos and Don’ts of Machinery Safety For Workers

Do’s

- Check the machine is well maintained and fit to be used, ie appropriate for the job and working properly and that all the safety measures are in place – guards, isolators, locking mechanisms, emergency off switches etc;
- Use the machine properly and in accordance with the manufacturer’s instructions;
- Make sure you are wearing the appropriate protective clothing and equipment required for that machine, such as safety glasses, hearing protection and safety shoes.

Don’ts

- Use a machine or appliance that has a danger sign or tag attached to it. Danger signs should only be removed by an authorized person who is satisfied that the machine or process is now safe;
- Wear dangling chains, loose clothing, rings or have loose, long hair that could get caught up in moving parts;
- Distract people who are using machines;
- Remove any safeguards, even if their presence seems to make the job more difficult.

Do’s And Don’ts of Heavy Equipment Maintenance

Do

- **Follow Service Schedules –** It is a vital part of maximizing the life of equipment. From oil changes and track adjustments to scheduling annual maintenance inspections and replacing critical components, service schedules are like a roadmap to achieving maximum return on investment.
- **Perform Daily Inspections –** The best way to stay in tune with the health of your equipment is by training your operators to perform daily inspections. Walk-around inspections are done at the beginning and the end of shifts, with operators reviewing dozens of fault points and using all of their senses to identify signals the equipment may require immediate services or repairs.

Don't

- **Ignore Warning Signs** – Dashboard warning lights and audible alarms are never a welcome sight, but we should be thankful they're there to tell us when there's an issue with our equipment. Additional signs not to be ignored include diminished performance, unusual sounds coming from the engine, power train, transmission or hydraulics, low fluid levels and leakage, the smell of noxious fumes or smoke coming from the exhaust system.
- **Cut Corners** – There's never a time to choose cheap products or trust unreliable sources when maintaining heavy equipment. Using quality products and partnering with a reputable service provider helps reduce long-term operating costs, eliminates safety concerns and extends the life of your equipment.

List of Spare Parts for Heavy Duty Machinery Dozer D-50 A15 & Wheel Dozer BEML G-14, D- Chassis Parts.

S. No.	Description
1	Stg. Clutch Service Kit
2	Hyd. System. Ser. Kit
3	Cutting Edge (5 Hole)
4	Bit End – LH
5	Bit End – RH
6	Bolt
7	Bolt
8	Nut
9	Hyd. Cylinder Seal Kit – 90 mm (BEML)
10	Element Hyd. Tank
11	Link Track shoe
12	----------do----------
13	Pin Master
14	Bushing Master
15	Bolt shoe
16	Nut Shoe
17	Carrier Roller assy
18	Track Roller assy
	(Single Flange)
19	----------do---------- (Double Flange)
20	O-Ring
21	O-Ring
22	Bolt
23	Bolt (T.R.)
24	Shaft
25	Bearing Needle
26	Plate Pressure
27	Universal Joint assy.
28	Bolt Cross Pin
29	Nut
30	Cross Pin assy.
31	Seal Oil
32	Lever Main Clutch Booster
33	Washer Spring

List of Spare Parts for JCB (3D & 3DX) Parts.

S. No.	Description
1	Pre Cleaner assy.
2	Seal Bonnet Pre Cl.
3	Pipe Exhaust Ext.
4	Fuel line Main
5	Feed pump rep. kit
6	Banjo Bolt 19mm
7	Water pump assy
8	Water pump pulley
9	Diesel flexible pipe 24” long
10	Diesel flexible pipe 60” long
11	Bolt
12	Nut
13	Kit Drive Plate
14	Kit spider (rear drive shaft)
15	Strap
16	Screw
17	Bolt (rear drive shaft)
18	Nut
19	UJ Kit (rear drive shaft)
20	Wipe arm
21	Wiper blade
22	Fan Belt
23	Combination switch
24	Fuse 60 Amp
25	Fuse 20 Amp

26	Fuse 15 Amp
27	Fuse 10 Amp
28	Fuse 5 Amp
29	Solenoid switch Mico 12 V
30	Toe Plate (8 Tooth)
31	Tooth
32	Locking spacer
33	Pivot pin
34	Pivot pin
35	Pivot pin
36	Pivot pin
37	L.T. Wire
38	Insulation tape
39	Battery Terminal
40	Fuel leak off pipe
41	Bulb 1141
42	Bulb 67 No.
43	LT Tube 12V
44	Head light assy. 12V
45	Bimetal Bush
46	Bimetal Bush
47	Seal Kit (Bucket ram)
48	Seal Kit (Dipper Ram)
49	Hose top
50	Hose water pump
51	Hose Bottom radiator

List of Spare Parts for JCB Robot – 135/155 Parts.

S. No.	Description
1	Toe Plate – 1676 mm- wide 14 holes. (Weld On)
2	Strip wear
3	Cutter Upper
4	Bush
5	Bush 50x40x60L
6	Seal
7	Shim
8	Bolt M10x80 mm
9	Bolt M10x90mm
10	Nut Lock M10
11	Pin Pivot Grooved
12	Pin Pivot Q-H RHS -40 Dia 184
13	Pin Pivot Q-H RHS – 40 Dia 138
14	Plunger
15	Spring
16	Pin Release
17	Engine Oil Filter
18	Pump Water
19	Gasket
20	Hose by Pass
21	Elmt. Fuel Sed.
22	Elmt. Filter Safety
23	Elmt. Filter Prymery
24	Head ligh assy 12 V vertical
25	Front Glass

List of Spare Parts for D-50/G14-D 1 ENGINE PARTS (CUMMINS)

S. No.	Description
1	M. oil Filter
2	Diesel Filter
3	Hose radiator
4	Fan belt C-51
5	Fan belt B-44
6	Water pump assy
7	Hose diesel flexible tank to filter
8	Ampere meter
9	Gasket copper
10	Manifold fuel supply
11	Alternator assy 24V
12	HL Bulb 24 V
13	HL TUBE 24 V
14	Armature assy 24 V
15	Half clutch assy 24 V
16	Copper brush set 24 V
17	Field coil auxiliary 24 V
18	Brush box assy

Chapter - 2

Light / Medium Vehicles

Routine light / medium Vehicle Maintenance

Get in the habit of conducting regular vehicle maintenance and you'll avoid potentially costly breakdowns as well as extend the life of your vehicle. You can handle basic routine vehicle maintenance yourself, by following a regular schedule as outlined in your owner's manual.

1. **Acquaint yourself with your owner's manual.**

Take note of the intervals for maintenance items as the engine oil and filter, tire rotation, belts and hoses, and so on.

1. **Change your oil and oil filter.**

Oil is your engine's life blood. It serves as a lubricant, keeping important engine parts from grinding against each other and destroying the engine. Motor oil not changed regularly can also damage your engine as accumulated contaminants cause friction, rubbing parts together.

2. **Check your tires monthly.**

The only thing separating vehicle from the road is its tires. They need to be properly inflated to do their job, as well as to lessen the chance of a blowout.

3. **Inspect all other fluids.**

Motor oil isn't the only fluid to check. Your vehicle has brake and transmission fluids, coolant, and washer fluid.

Like motor oil, you'll check transmission fluid with a dipstick. Determine brake fluid, coolant, and washer fluid levels by removing related covers and visually inspecting each. By the way, NEVER remove the radiator cap to check coolant.

4. **Examine belts and hoses.**

Inspect the hoses and belts in the engine bay. These hoses direct coolant flow to ensure the engine doesn't overheat. If a hose has separated or shows cracks or bulges, then have it replaced.

Similarly, check the belts too. The timing belt, as found in most vehicles and small SUVs, is critical to the operation of your engine.

5. **Check Transmission Fluid:** It is essential that you have your transmission fluid checked and changed when needed to avoid costly transmission damage or replacement. Follow the vehicle manufacturer's recommendations.

6. **Check Transmission Case Fluid:** In four-wheel or all-wheel drive vehicles, the transfer case is what shifts power from the transmission to the axles. You'll need to have the transfer case fluid checked according to the vehicle manufacturer recommendations to make certain that it is properly filled and leak-free.

7. **Inspect shocks and Struts:** The shocks and struts on your vehicle function to control the impact and rebound as your vehicle passes over bumps in the road and are an essential part of your auto's steering system. They should be inspected by a professional every 50,000 miles.

8. **Coolant Fluid Exchange:** The radiator in your vehicle is a vital component that helps keep your engine cool and functioning properly. Check your vehicle manufacturer's recommendation to find out how often your coolant should be exchanged,

9. **Spark Plugs:** If your spark plugs aren't functioning properly, your engine will lose power and won't run at optimal capacity. Have a professional check and replace any faulty spark plugs depending on vehicle mfr recommendations or when you feel a decrease in your engine's power.

10. **Serpentine Belt**: Visually inspect the belt to ensure that it is free of cracks or other wear and tear. Replace id damaged or according to your vehicle manufacture's recommendation.

11. **Front and Rear Differential:** Like many parts of your vehicle, the differentials need to be kept lubricated to ensure proper functionality. Have a professional check and change fluid whenever your vehicle manufacturer recommends it.

Seasonal Checkups

1. **Replace windscreen wipers:** Windshield wipers need to be replaced about once every year, or whenever the effectiveness is compromised.

2. **Check battery performance:** Extreme temperatures affect the performance of the battery so regular battery testing will ensure that battery will perform when you need it to.

3. **Change Tires:** Depending on where you live and the winter driving conditions you might encounter, you might want to switch your tires in cold, snowy months to a winter/snow

tire. When the temperature hovers at or below freezing consistently, the tire compounds in non-winter tires hardens, decreasing traction and handling performance while increasing braking distance. Winter tires are have tread patterns and compounds designed to remain soft in the cold and provide grip in snow, slush, and icy driving conditions.

4. **Check Coolant Level:** It's also important to check your antifreeze levels in your radiator in winter months to keep your radiator or engine components from freezing. A 50/50 mix of antifreeze to water is generally recommended, but check your owner's manual or with a professional to be certain. Sticking to a car maintenance schedule, and keeping good records of what you've done, can help extend the life of your vehicle and protect you against breakdowns, expensive repairs, and other unwelcomed surprises.

5. **Change oil if pH declines**

List of Spare Parts for Light / Medium Vehicles

M&M Bolero - Camper

S. No.	Nomeclature of spare part	15	Clutch release and contact
1	Insulator front SD25, engine	16	Assy. Clutch cable
2	Gasket cylinder head	17	Washer plain
3	Ring piston set SD	18	Bush nylon
4	Gasket , rocker arm cover	19	Gasket air cleaner
5	Gasket, inlet manifold (BS II)	20	Filter element assy (straine)
6	Gasket, oil pan	21	Hose air cleaner to inelt m
7	Plug, drain magnetic	22	Assy accel.cable comp (ball)
8	Gasket, injection pump	23	Rubber pad foot plate
9	Pipe leakoff pipe assy	24	Head lamp assy (Lumax)
10	Bolt, banjo M12x1.5	25	Snchronizer ring land 2
11	Injector assy	26	Tie rod socket assy left
12	Temperature sensor (BS II)	27	Tie rod socket assy Right
13	Copper washer (BS II)	28	Disc brake
14	Clutch driven plate	29	Assy. Pad & anti rattle spring

List of Spare Parts for Light / Medium Vehicles

Maruti Swift Dezire & Ciaz

S. No.	Nomeclature of spare part
1	Spark Plug
2	Cover Clutch
3	Disc Clutch
4	Release Bearing with retaine
5	Unit Head Lamp L
6	Unit Head Lamp LH
7	Lamp unit RR & RH
8	Lamp unit RR
9	Blade Assy
10	Arm Assy front (D)
11	Service kit (D)
12	Service kit (P)
13	Arm Assy front
14	Arm Assy rear
15	Wheel Cups
16	Arm Assy Rear with Dom b
17	Arm Assy Rear with Dom b

List of Spare Parts for Light / Medium Vehicles

Maruti 800cc

S. No.	Nomeclature of spare part
1	Spark plug
2	Filter, oil
3	Mounting engine front
4	Mounting Transmission
5	Fly wheel
6	Bearing
7	Belt timing
8	Element air cleaner
9	Pipe exhaust
10	Pump assy water
11	Disc clutch
12	Bearing clutch release
13	Bush bar mounting
14	Hub front wheel
15	Bearing font wheel
16	Bearing rear wheel
17	Pad front brake
18	Disc front brake
19	Bumper front
20	Bump rear

List of Spare Parts for Light / Medium Vehicles

Tata, S/Mazda and Ashoka ley lands.

S. No.	Nomeclature of spare part
1	Fan belt 1210
2	Radiatior assy 1210
3	Engine foundation part 1210
4	Engine foundation Reas 1210
5	Fuel pipe set main 1210
6	Fuel Flexible pipe small- 1210
14	Stearing worm
15	Stearing Bearing
16	Tie Rod end Kit
17	Drag Line Kit
18	Frot Main Leaf
19	2nd Leaf Front
20	Rear main leaf
21	Rear leaf 2nd
22	Frond Shakle
23	Front Bracket
24	Rear Shackle assly
25	Rear Bracket assly
26	Fly wheel Ring
27	Clutch Plate
28	Pressure plate
29	Clutch Bearing 1210
30	Clutch Bearing 1612
31	1st Speed gear 40
32	2nd Speed 40
33	Gear Sleeve 1st Rev.
34	Gear Sleeve 2nd 3rd
35	U.J. cross 1210
36	U.J. cross 1216
37	Universal joint
38	Front wheel oil seal 1210

7	Fuel Flexible pipe big – 1210
8	Water pump assy 1210
9	Fuel Pressure Line Set 1612
10	Hose pipe Set 1612
11	Cyl head gasket 1612
12	Tappet gasket 1612
13	Fan Belt 1612
39	Rear Wheel oil seal 1210
40	F.W. Bearing 32308
41	Rear wheel bearing 32216
42	Crown Wheel Pinion
43	Crown big 47487
44	Pinion big 307
45	Axle geas 1210
46	Bevel gear 1210
47	Diff. Splines 1612

Note:- The Mechanical Equipments and Material are being used in I&PH Department has already been mentioned with relevant chapters including their spare parts list & maintenance and operation procedure.

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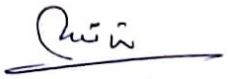
NOTE

This Handbook has been approved as a reference by Jal Shakti Vibhag, Govt. of Himachal Pradesh vide letter no. JSV-SE(P&I-I)-D-1-Tech Committee/2020-21-3404-10 dated 05/03/2021. However, the provisions in the relevant manuals (CPHEEO – Water Supply, Sewerage & Sewerage Treatment System, O&M), CPWD Manual & relevant IS Codes with upto date amendments shall supercede the provisions in this handbook in case of any variation.

For WAPCOS Ltd.



(Sumitt Mittal)
Addl. Chief Engineer & Project Manager
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GOVERNMENT OF HIMACHAL PRADESH

HANDBOOK ON QUALITY CONTROL

Part-A

Public Works Department

Prepared by:

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PREFACE

The Government of H.P. felt its necessity that IQCS may be constituted to have an independent quality check and positioned in CM office. The squad shall be headed by the Team Leader and ably assisted by specialist/expert having vast experience in Civil Engineering works, Mechanical, Electrical works and IPH works being executed by the various departments.

WAPCOS Ltd., A Govt. of India Undertaking, Ministry of Jal Shakti, Chandigarh office has been entrusted with the task of implementing this program for total quality management concept aimed at embedding awareness of quality in all infrastructure departments of Govt. of H.P. including but not limited to PWD, IPH, HPSEB, Urban development, Forest, Tourism, RDD and HPSIDC etc.

In this respect this handbook has been prepared which is brief, handy and instant helpful at site for field engineers. It is an effort just like to express too much in too few words. It summarizes all quality assurance, specifications and prepared on basic sources viz HPPWD specifications for building and roads, rural road manual, MORTH and handbook of quality control Vol. -1 and Vol.-2. The IPH contents have been taken from CPEHEEO, AWWA manual, Pollution Control Board and Relevant Standard codes etc. The handbook has been prepared by in cooperating relevant extract from HPPWD specification keeping in view subsidiary departments also and prevalent practice being followed at present.

In preparing this handbook the sincere efforts have been made by the team of WAPCOS Ltd. along with the officers of Public Works Department, Himachal Pradesh.

We dedicate this effort to the state and hope this handbook shall be very useful for all the field engineers for various departments of Govt. of HP and advised that it may always be kept with them at site as ready and instant reference. We are further hopeful that the state authorities would evolve suitable mechanism to implement the needed quality assurance plan with objective of achieving the economic and social development of the State and improving the quality of life of people.

WAPCOS Limited
A Govt. of India Undertaking
Ministry of Jal Shakti
Chandigarh Office

CONTENTS

HANDBOOK ON QUALITY CONTROL

PART-A
(PUBLIC WORKS DEPARTMENT)

CHAPTER-1

QUALITY ASSURANCE & QUALITY CONTROL

1.1 General:

Quality Assurance, in its wide sense, represents a system which, in the context of Highway Engineering, is aimed at ensuring that the end product is a road with the desired level of serviceability and that it would serve the traffic at the design level of riding over the service life for which it is designed.

Quality Assurance enters all the broad aspects of road development: Design, Construction and maintenance right at the design stage, the quality assurance system needs to be considered since the choice of materials in the various layers of the pavement and thickness of these layers would significantly influence the riding quality. Thereafter, during construction and maintenance also, quality assurance plays a vital role in making sure that the quality envisaged at the design stage is indeed realized over its service life.

Quality control and specifications in road construction must cover workmanship and materials. The two most important means of specifying a finished product are:

- By method
- By end result

The more reliable is the latter, but there are circumstances where this cannot be applied and a method specification must be used. An example is in the production of concrete. It is usual to require an end product (a set strength for the concrete that the designer can rely on his design). While it is possible to test the end product by cutting and testing cores, it is more usual to control the production by method (gauging the aggregate, cement and controlling the amount of water added and the mixing time). Check testing is carried out during production, with the finished product, which are crushed after curing to ensure compliance as a check. However, control of production is largely by method.

1.2 Quality Control in India:

1.2.1 Present practice: Under the systems presently practiced in India, quality control work is generally carried out under a 2-tier system or even a 3-tier system depending on the total workload of a particular Department at a particular time.

1.3 Primary or Division Level Control: Working on the principle that the unit responsible for construction should also be responsible for its quality, the primary level of control and check testing is entrusted with the Engineer-in-Charge of the work and his staff. Generally it will be Executive Engineer under whose jurisdiction the work falls.

The primary level check consists of:

a) Carrying out at least the minimum number of mandatory tests in respects of all materials and processes.
b) Ensuring that only materials duly approved by a competent authority and from approved sources (borrow area, quarry, etc.) and those manufactured materials having an

appropriate certificate of quality from the manufacturer have been incorporated into the works.

c) The equipment used is as per specification, and is in good working order and processes followed are as specified.

1.4 Supervisory or Circle Level Control: The second level of quality control is at the supervisory level under the control of Superintending Engineer-in-Charge of the circle, or by his staff.

The work of the team includes:

a) Carrying out random checking of the quality of materials including verification of the use of approved products or materials from approved sources.
b) Verification that records of field tests are being kept properly.
c) Carrying out important tests (in the regional laboratory) if equipment and arrangement for such tests are not available in the field laboratory.

1.5 Third Level (Optional) Quality Control: The third level of quality control, where considered necessary, may be carried out by the Core Cell under the charge of the Chief Engineer of the project.

The Core Cell may monitor the effectiveness of the control being exercised by the circle and Division Level units and carry out such tests, as it deems necessary.

The Core Cell also acts as an apex body in respect of all quality problems and may lay down norms for modification/updating of updating of control and test procedures as well as changes in Specifications for future works.

1.6 Elements of Quality Assurance System: The need for Quality Assurance System is the client desire to have value for his investments in terms of best design criteria, specification, construction practices, control and inspection over construction. Thus, the elements of a Quality Assurance System for a Highway Project are as under:

a) Assessment of requirement of road project
b) Choice of quality materials and design
c) Development of technical specifications and acceptance criteria
d) Choice of construction method/equipment/plant
e) Field supervision and quality control
f) Assessment of quality of finished road
g) Periodic inspection and maintenance measures

1.7 Choice of Quality Materials and Design: More often than not, there would be alternative materials of different engineering characteristics available for the project. A choice of the materials to be incorporated in the pavement crust would largely depend on the design riding quality requirements. Both the thickness (pavement crust) and composition (selected materials) requirement can be worked out by following a suitable design procedure for the assessed traffic, sub-grade soil and climatic conditions.

1.8 Development of Technical Specifications and Acceptance Criteria: Technical specifications embodying the best practices of construction, selection of materials and use of equipment are standardized by P.W.D.

Additional specifications have been drawn up, based on practices elsewhere for similar works. Depending on the type of road facility and related acceptance criteria for various items of work have been set forth. The bid document specifies the Technical Specifications to be followed as per CPWD/MORD /MORTH specification.

1.9 Choice of Equipment/Plant: The selection of the right type of equipment/plant is the key to the achievement of good results.

1.10 Field Supervision and Quality Control: The quality of a work is generally influenced by the nature of the field supervision and the organization structure responsible for it. Duties and responsibilities must be carefully demarcated. Quality Control is the task of:

a) Inspection and testing of materials, production process and the end product
b) Measuring variations from the pre-determined standards
c) Taking corrective action to minimize adverse variations
d) Accepting or rejecting the work.

1.11 Responsibility for Quality: Quality is something like health and cannot be isolated or pinpointed in the functioning of any one particular organ or limb of the body. It has to be present in the entire body system and it depends upon the well being and smooth functioning of all the constituent components of the body. The common misconception about achieving quality in work by getting the job done only by hiring tough inspectors is fast wearing out. The personnel involved are:

a) The owner
b) The designer/engineers
c) The contractor
d) The quality monitor

1.12 Methodology for Quality Assurance:

a) Systemic control shall be exercised on all operations from the selection and production of material to the completion of the curing of concrete in order to take care of all technical specifications.
b) The quality of product is ensured and maintained by following a documented “Quality Plan” which sets out specific quality practices, including Quality Control, which are operational techniques of controlling the quality.
c) Quality assurance includes all those planned actions necessary to provide adequate confidence that the product will meet the requirements and is essentially a system of planning, organizing and controlling human skills to ensure quality.

1.13 Quality Assurance Plan for Road: It should eventually comprise of the following aspects:

a) Organization
b) Control of data & documentation, both product (road) related documents and quality records
c) QA procedure for setting out works and temporary works.
d) Methodology of working
e) Control of materials
f) Calibration (of HMP, Batching and mining plant, lab, equipments, survey equipments etc.)

g) Control of workmanship aspects.
h) Protection during construction stage.
i) Non-conforming products.
j) Quality audits i.e. the process of systematic examination of a quality system. The QA plan will be submitted by the contractors. Basically it is gist of A to Z of delivery of quality products. However since the DPR is prepared by the Employee the contractor is mainly concerned with quality control of each activity of road/bridge work.

1.14 Quality Assurance Plan for Basic Construction Materials: Every construction activity starts with the use of basic materials which may be either in raw shape like stone aggregate, sand, stones, bricks etc. or manufactured materials like cement, steel and bitumen. Some basic material to be procured at site for use is concerned in the following chapters with there as per Punjab/HPPWD technical specifications during execution. In all cases however it is important that all uses of this handbook understand that the contract documents including the specifications are the controlling documents for the supervision of the construction.

1.15 Procedure for Conducting Inspection: Primary purpose of conducting inspections and control should be the fulfillment of the specification requirement. Field inspection and testing of materials and operations shall be carried out according to a preplanned schedule.

a) Supervision:
b) Daily inspection reports: on all major projects, the W.I. or Engineer-in-Charge shall make a daily inspection report to the Executive Engineer on the format devised by the organization. The daily report should include condition and progress of the work important factors affecting such condition and progress and daily test data. The test data should include frequency; type and location of samples taken as per the design mix/job mix formula.

1.16 Quality Assurance Measures of Concrete: In order that the properties of the completed structure are consistent with the requirements and the assumptions made during the planning and the design, adequate quality assurance measures shall be taken. The construction should result in satisfactory strength, serviceability and long term durability so as to lower the overall life-cycle cost. Quality assurance in construction activity relates to proper design, use of adequate materials and components to be supplied by the producers, proper workmanship in the execution of works by the contractor and ultimately proper care during the use of structure including timely maintenance and repair by the owner.

CHAPTER-2

MAINTENANCE AND CALIBRATION OF EQUIPMENTS

Heavy investments are made on procurement of road construction machinery. It is obvious that the machinery will require maintenance after regular use. It is also likely that the machines will go out of calibration with frequent use. It must be ensured that adequate maintenance and calibration facilities are available. Some of the factors requiring attention are as under:

2.1 General:

a) Appropriate equipments are to be positioned at appropriate locations.
b) Conditions of equipments checked positioning/use.
c) Conditions of equipments must be safe, secure and away from dangerous areas.
d) Adequate spares, right types of fuel/oils are available.
e) Well trained mechanics for periodical maintenance are required during
    i. Idle period
    ii. Operation

2.2 Effect of Cold on Mechanical Equipments & Counter Measures at low temperatures

a) Metal develops brittleness, welds tend to fracture.
b) Moving parts becomes sluggish.
c) Many parts like pins, screws, nuts etc become loose.
d) Rubber materials, hoses, fan belts, tyres etc harden and crack.
e) Insulation of electric cable fails.
f) Spring loose tension & fails due to fatigue.
g) All plants should have heated cabins for efficient operations.
h) Efficiency of operators is 35% in cold but in heated cabin is 75%.

2.3 Safety of men and machines is necessary

a) All machines/men are deployed in dispersed manner to guard against avalanches. At the end of the day, they parked safely.
b) Anti freeze chemicals are added to radiator water and draining radiators in the night are necessary measures.
c) Winter grade diesel, fuels, and equipments should be used.

2.4 Efficiency

a) 10% decrease in efficiency of mechanical equipment for every 1000 m above mean sea level.
b) There's a need to indigenize the machinery equipment. Machines imported from abroad, are not according to Indian conditions and face maintenance problems, which are frequent and difficult.
c) Calibration of Equipments (MORT&H Specifications of sections 1000, clause 1015.4 Testing of approval plant and equipment)

All plants & equipments used for

a) Preparing

b) Testing
c) Production of materials shall be in accordance with manufactures specifications and shall be got approved by the Engineer before use. This statement binds both Contractor and Engineer:
   i. Before use-&-during use (Time to Time make sure that specifications are not lost because of use)
   ii. Hence, before use- equipments not outdated are below standards.
   iii. The manufacturer has to be reliable.

Calibration certificates for the laboratory & equipments are necessary and kept at site for inspection by the concerned authorities.

“Quality means doing it right when no one is looking. “

Henry Ford

SPECIFICATIONS FOR BUILDINGS

CHAPTER-3

MATERIALS FOR BUILDINGS

3.1 The following Indian Standards shall be followed:

a) IS: 383-1970 Coarse and fine aggregate from natural sources for concrete.
b) IS: 1542-1960 Sand for plaster.
c) IS: 2386-1963 (Part I to VIII) Methods of test of aggregates for concrete.
d) IS: 3466-1967 Masonry cement.
e) IS: 5640-1970 Method of test for determining aggregate impact value of soft coarse aggregate.
f) IS: 5913-1970 Method of test for asbestos cement products.

3.2 General: Aggregate most of which is retained on 4.75 mm. I.S. Sieve and containing only as much final material as is permitted for the different types are described as coarse aggregates. This shall be broken from hard stone obtained from the approved quarry. The quarry shall be approved by the Executive Engineer. The aggregates shall be hard, strong, dense, durable clean, free from veins, adherent coatings, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky, scoriaceous and elongated pieces shall be avoided; it shall also be free from soft, friable, thin, elongated or laminated pieces and shall be roughly cubical in shape. It shall be clear from dirt. If coarse aggregates contain more than the prescribed limits of clay or mud etc. It shall be properly washed and dried before mixing with other ingredients to make concrete.

3.3 Aggregate: Most of which is retained on 4.75mm I.S. sieve.

Do's	Don't
Course aggregate shall be hard, clean and graded	Flaky and elongated avoided.
	Aggregate containing harmful impurities such as iron pyrites, coal, mica and clay.

3.3.1 Important test on material: Aggregate will be tested for its different quality control tests:

I. **Aggregate crushing value:** The aggregate crushing value, when determined in accordance with IS: 2386 (Part IV)-1963, shall not exceed 45% for aggregate used for concrete other than for wearing surfaces, and 30% for concrete for wearing surfaces, such as runways, roads and pavements.
II. **Aggregate impact value:** The aggregate impact value may be determined in accordance with the method specified in IS: 2386 (Part IV)-1963. The aggregate impact value shall not exceed 45% by weight for aggregates used for concrete other than for wearing surface and 30% by weight for concrete for wearing surfaces, such as runways, roads and pavements.
III. **Aggregate abrasion value:** Unless otherwise agreed to between the purchaser and the supplier, the abrasion value of aggregates, when tested in accordance with the method specified in IS: 2386 (Part IV)-1963 using Los Angles machine, shall not exceed the following values:

a) For aggregate to be used in concrete for wearing surfaces ---- 30%
b) For aggregate to be used in other concrete ---- 50%

IV. Soundness of aggregate: For concrete liable to be exposed to the action of frost, coarse and fine aggregates shall pass a sodium or magnesium sulphate accelerated soundness test specified in IS: 2386 (Part V)-1963, the limits being set by agreement between the purchaser and the supplier, except that aggregates failing in the accelerated soundness test may be used if they pass a specified freezing and thawing test satisfactory to the user.

3.3.2 Aggregate Crushing Value: As an alternative, the aggregate impact value may be determined in accordance with the method specified in IS: 2386 (Part IV)-1963. The aggregate impact value shall not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways, roads and pavements.

3.4 Size and Grading of Aggregates: The coarse aggregates shall be supplied in the nominal size as given in table.

COARSE AGGREGATES

I.S. Sieve Designation	Percentage Passing for Single-Sized Aggregate of Nominal Size						Percentage Passing for Graded Aggregate of Nominal Size			
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
1	2	3	4	5	6	7	8	9	10	11
80 mm	100	-	-	-	-	-	100	-	-	-
63 mm	85 to 100	100	-	-	-	-	-	-	-	-
40 mm	0 to 30	85 to 100	100	-	-	-	95 to 100	100	-	-
20 mm	0 to 5	0 to 20	85 to 100	100	-	-	30 to 70	95 to 100	100	100
16 mm	-	-	-	85 to 100	100	-	-	-	90 to 100	-
12.5 mm	-	-	-	-	85 to 100	100	-	-	-	90 to 100
10 mm	0 to 5	0 to 5	0 to 20	0 to 20	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	-	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10

3.4.1 Recommended coarse aggregate for different items

S. No.	Item of Construction	Maximum nominal size of coarse Aggregate
1	RCC well curb, RCC well steining and RCC piles	40 mm
2	PCC well steining	63 mm
3	Well cap or pile cap, Solid type piers, abutments, and wing walls and their pier caps.	40 mm
4	RCC works in cross girders, deck slab, wearing course kerb, light posts, ballast walls, approach	20 mm

	slab etc. and hollow type piers, abutments, wing walls and the pier caps.	
5	RCC bearing	20 mm
6	For any other item of construction not covered by item (1) to (5) above.	As specified on the drawings or as desired by the Engineer-in-Charge in case it is not specified on drawings.

The coarse aggregates proposed to be used for the concrete work shall be got approved from the Engineer-in-Charge before the start of the work. All subsequent supplies shall preferably be obtained from the same source.

ALL – IN – AGGREGATE

3.5 General: All in aggregate shall be composed of fine and fine and coarse aggregates collected directly from pit, riverbed or crushing plants.

If combined aggregate containing both fine and coarse aggregate are available. These need not be separated into fine and coarse but necessary adjustments shall be made in the grading by addition of single-sized aggregates/fine aggregates to obtain the specified grading. For 40mm and 20mm nominal size of all-in-aggregate, the final grading shall be as under:

I.S. Sieve Designation	Percentage passing for all – in aggregate of:-	
	40 mm	20 mm
	Nominal size	Nominal size
80 mm	100	-
40 mm	95 to 100	100
20 mm	45 to 75	95 to 100
4.75 mm	25 to 45	30 to 50
600 micron	8 to 30	10 to 35
150 micron	0 to 6	0 to 6

3.6 Water: Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

The *p*H value of water shall be not less than 6. The seawater is not recommended for mixing or curing of concrete because of presence of harmful salts in water. Under unavoidable circumstances seawater may be used for mixing or curing in plain concrete with no embedded steel.

3.7 Sand: It shall be hand clean and free from organic matter. Sand which contains 90% of particles of size greater than 0.06mm and less than 0.2mm is fine sand. Sand which contains 90% of particles of size greater than 0.6mm and less than 2.0mm is coarse sand.

The grading of fine aggregates, when determined as described in (IS: 2386 (Part I)-1963 shall be within the limits given in the below table and shall be described as fine aggregates, Grading Zones I, II, III and IV.

Zoning: Acc. To IS: 383:1970

IS Sieve Designation	Percentage Passing For			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

Note1: Where concrete of high strength and good durability is required, fine aggregate conforming to any one of the four grading zones may be used, but the concrete mix should be properly designed. As the fine aggregate grading becomes progressively finer, that is, from Grading Zones I to IV, the ratio of fine aggregate should be progressively reduced. The most suitable fine to coarse ratio to be used for any particular mix will, however, depend upon the actual grading, particle shape and surface texture of both fine and coarse aggregates.

Note2: It is recommended that fine aggregate confirming to Grading Zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

Grading of coarse sand:

IS Sieve Designation	% By weight passing IS Sieve
4.75mm	100
2.36mm	90-100
1.18mm	70-100
600 micron	30-100
300 micron	5-70
150 micron	0-15

3.7.1 Fineness Modulus: Fineness modulus is a ready index of coarseness or fineness of the material. It is an empirical factor obtained by adding the cumulative percentage of aggregate retained on each of the standard sieve ranging 80 mm to 150 micron and dividing this sum by arbitrary number 100.

Greater is the fineness modulus – coarser is the material. Its limit 2.0 to 3.5 (Page No. 368 of section 1008 of MORTH specification 4th revision).

The following example illustrates the computation of fineness modulus of a sample of sand:

Sieve description as per IS	% Retained on each sieve respectively	Commutative retained on successive sieve	Percentage
4.75mm		0	---
2.36mm		1.0	1.0

1.18mm		10.5	11.5
600 micron		49.0	60.5
300 micron		33.5	94.0
150 micron		5.0	99.0
Pan		1.0	266.0
		100.0	**266.0**
	Fine Modulus	**266.0**	
		100.0	
		2.66	

Don'ts:

I. Should not be containing harmful impurities, which affect the ductility of concrete.
II. Used for work where reinforcement is used shall not contain any material liable to affect the steel reinforcement.

3.8 Cement: It shall conform to the following I.S. specification:

a. Ordinary Portland cement, (ii) Rapid hardening Portland cement and (iii) low heat Portland cement shall conform to IS: 269: 1976.
b. Portland blast furnace slag cement shall confirm to IS: 455:1976.
c. Portland pozzolana cement shall confirm to IS: 1489-1976.
d. Masonry cement shall conform to IS: 3466-1967.
e. White Portland cement shall conform to IS: 8042-1976.

3.8.1 Tests for physical property:

Soundness: Expansion by the Le Chatelier test not more than 100mm or 5mm after 7 days aeration, time of boiling being 3 hrs.

3.8.2 Setting time:

a. Initial setting time not less than 30 mins for OPC
b. Final setting time not more than 600 mins for OPC

3.9 Compressive strength: The average compressive strength of at least three mortar cubes of the cement.

a. 3 days not less than 115 kg/cm^2
b. 7 days not less than 175 kg/cm^2

3.10 Quantity of Cement: Minimum quantity of cement to be used in controlled concrete shall be not less than 220kg/cum in plain concrete and not less 300kg/cum in RCC structural members. The minimum quantity of cement for pre-stressed concrete work shall not be less than 360 kg/cum of concrete nor it shall be more than 540 kg/cum of concrete.

CHAPTER-4

CONCRETE WORK

4.0 The following Indian Standards shall be followed:

a) IS: 383-1970 Aggregate coarse and fine from natural sources for concrete.
b) IS: 432-1966 (Part-I) Mild steel and medium tensile steel bars.
c) IS: 1139-1966 Deformed bars for concrete reinforcement and rolled mild steel and medium tensile.
d) IS: 1789-1966 Cold twisted steel bars for reinforcement concrete.
e) IS: 2090-1962 High tensile steel bars used in pre-stressed concrete.
f) IS: 6003-1970 Indented wire for pre-stressed concrete.
g) IS: 6006-1970 Uncoated stress & relieved strand for pre-stressed concrete.
h) IS: 3384-1965 Bitumen primers for use in water proofing and damp proofing.
i) IS: 456-1964 Plain and reinforced concrete code of practice.
j) IS: 1799-1959 Sampling and analysis of concrete.
k) IS: 1200-1974 (Part-II) Measurement of building and Civil Engineering work method, concrete work.
l) IS: 1516-1959 Method of test for strength of concrete.
m) IS: 2386-1963 Test for particle size and shape (Part-I)

The cement concrete shall be classified as:

a) **Ordinary Cement Concrete:** The cement concrete in which the proportion of aggregate to cement and water is not designed by preliminary tests of the materials to be used.
b) **Controlled Cement Concrete:** The cement concrete in which the proportions of aggregate to cement and water are determined by lab test, so as to give concrete of the specified crushing strength.

4.1 Grades of Concrete: The controlled concrete shall be in different grades, designated as M200, M250, M300, M350, M400, M450, M500, M550 and M600.

In case of ordinary concrete, it shall be in four grades designated on M100, M150, M200 and M250.

Strength Requirements of Concrete		
All values in kg/cm2		
Grades of concrete	**Compressive Strength of 15 cm cubes at 28 days**	
	Preliminary test min.	**Works test min.**
M100	135	100
M150	200	150
M200	260	200
M250	320	250
M300	380	300
M350	440	350
M400	500	400

Note 1 Preliminary Test: A test conducted in a laboratory on the trail mix of concrete produced in the laboratory with the object of:

- Designing a concrete mix before the actual concreting operation starts.
- Determining the adjustments required in the designed mix when there is a change in the materials used during the execution of work.
- Verifying the strength of concrete mix.

Note 2 Works Test: A test conducted either in the field or in a laboratory on the specimens made on the works, out of the concrete being used on the works.

4.2 Admixtures: Admixtures are the special ingredients added during concrete mixing to enhance the properties and performance of fresh concrete. Various types of admixtures are available in the market, which is used in construction work.

Functions of Admixtures:

a. To accelerate or retard the setting time of fresh concrete.
b. To improve the workability or flow ability of concrete.
c. To increase the strength and durability of concrete.
d. To reduce the heat of hydration.
e. To reduce the segregation and bleeding.
f. To decrease the permeability.
g. To achieve other desired properties.

Types of Admixtures:

a. Accelerating Admixtures
b. Retarding Admixtures
c. Air-Entraining Admixtures
d. Water Reducing Admixtures

Special Admixtures:

a. Super plasticizing admixtures.
b. Corrosion-inhibiting admixtures.
c. Grouting admixtures.
d. Coloring admixtures etc

4.3 Proportioning: Proportioning shall be done by volume. Boxes of suitable size shall be used for measuring sand aggregate. The size of the boxes (materials) shall be 35x25cm and 40cm deep. The unit of measurement for cement, shall be a bag of cement weighing 50 kgs and this shall be as 0.035 cubic meter. While measuring the aggregate and sand the boxes shall be filled without shaking, ramming or hammering. The proportioning of sand shall be on the basis of its dry volume.

4.4 Concrete mixes used for various types of works: Concrete mix shall be as specified in the contract. If nothing is mentioned in the contract, it shall be as specified by the Engineer-in-Charge in writing. A rough guide regarding the use of nominal mixes is given below:

Nominal size	Type of work for which used
1:8:16	Foundations of buildings and light structures.
1:6:12	Base course of floors.
1:5:10	Foundations of heavy buildings, plum concrete, hearting of abutments and piers and retaining walls with stone faces in hilly areas.
1:4:8	Mass concrete and foundations of hydraulic works.
1:3:6	Mass concrete, bedplates, concrete blocks, canal lining.
1:2:4	General RCC buildings and similar works namely beams, slabs panel walls,

	stairs, columns retaining walls, pavements, floors, bedplates.
1:1.5:3	Important RCC structures, piles arches, impermeable construction against water heads.

4.5 Mixing of Concrete: Mixing of cement concrete shall, as a rule is done in a mechanical mixer. However, the Engineer-in-Charge may permit hand mixing in specific cases where in his opinion it is not practicable to resort to mechanical mixing either on account of the quantity of cement concrete required is small or for any other reason. In such cases he should ensure that the inferior quality of concrete produced by hand mixing will not adversely affect the structure.

4.6 Mechanical vibration: The number and type vibrators shall be subject to the approval of the Executive Engineer. If nothing is specified, only, vibrators of the internal type of shall be used. Mechanical vibrator shall be adequately powered and capable of transmitting vibrations of the required frequency to the concrete. A sufficient number of mechanical vibrators shall be provided on the batch so that each batch may be thoroughly compacted immediately after placing and that there will be no delay in placing and compacting of ensuing batches. The intensity and duration of vibration shall be sufficient to cause complete settlement and compaction without any stratification of the successive layers or separation of ingredients.

Types of vibrations:

a) **Internal vibrators:** Which consist of metal spud or rod, which is inserted into newly, placed concrete and which vibrates while it is being withdrawn.
b) **External or 'Form' vibrators:** Which are attached to form work and external shuttering of walls, column etc. Forms transmit the vibrating action to the concrete.
c) **Surface vibrators:** Which are mounted on screeds or platforms and which are chiefly used for consolidating road slabs, floors etc.
d) **Vibrating tables:** Which are used for precast products.

4.7 Strength Requirement of Concrete: The compressive strength requirement for various grades of controlled concrete as well as ordinary shall be as given in table below. Where rapid hardening Portland cement is used, the 28 days compressive strength requirements specified in table below shall be met at 7 days.

For controlled concrete, the mix shall be so designed as to attain in preliminary tests or strength of at least 33% higher than that required on work tests. Preliminary tests need not be made in case of ordinary concrete.

Grade of Concrete	**Compressive Strength of 15 cm Cubes at 28 days**	
	Preliminary Test Min.	**Works Test Min.**
M100	135	100
M150	200	150
M200	260	200
M250	320	250
M300	380	300
M350	440	350
M400	500	400

Grade of Concrete	Compressive Strength of 15 cm Cubes Min. at 7 days	Modulus of Rupture by beams Test, Min.	
		At 72 ± 2hous	At 7 days
M100	70	12	17
M150	100	15	21
M200	135	17	24
M250	170	19	27
M300	200	21	30
M350	235	23	32
M400	270	25	34

4.8 Proportioning: Proportioning shall be done by volume. Boxes of suitable size shall be 35*25*40 cm deep. The unit of measurement for cement will be its weight 50 kgs and which shall be as 0.35 cum. The proportioning of sand and aggregate shall be on the basis of its dry volume and filled without shaking or ramming.

4.9 Compaction: Concrete when deposited shall have a temperature of not less than 4.5^0C and not more than 38^0C. It shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly designed agitators, operating continuously, when this time shall be within 2 hours of the addition of cement of the mix and within 30 minutes of its discharge from the agitator.

Except where otherwise agreed to by the Engineer-in- Charge, concrete shall not be deposited in horizontal layers to a compacted depth of not more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter in all other cases.

Unless otherwise agreed by the Engineer-in-Charge, concrete shall not be dropped into place from a height exceeding 2 meters. When trucking or chutes are used they shall be kept clean and used in such a way as to avoid segregation.

4.10 Consistency: Quantity of water shall vary in the field with the quality of aggregate. Consistency required and surface water present in the aggregate. Therefore the amount of water required shall be determined in the field by carrying out slump/V.B. consistometer test. The following slumps are adopted for different works.

S. No.	Type of work	Slumps	
		When vibrators are used.	When vibrators are not used.
1	Mass concrete in foundations, footings, retaining walls and pavements.	10mm to 25mm	30mm to 75mm
2	Thin floorings of less than 74mm thickness.	25mm to 40 mm	75mm to 100mm
3	Reinforced Cement Concrete work.	75-125mm	

4.10.1 Slump Test for Concrete Consistency:

i) The test specimen shall be formed in a mould in the form of the frustum of the cone with internal dimension as follow:
   a) Bottom diameter 20cm

b) Top diameter 10 cm
c) Height 30 cm

ii) Care shall be taken to ensure that a representative sample is taken.

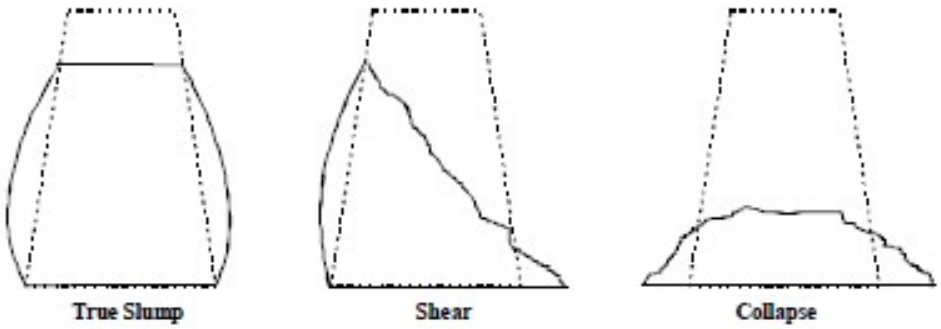
iii) Samples of concrete for test shall be taken from the mixer or ready mixed concrete. Such samples shall be obtained by repeatedly passing a scope or pail through the discharging stream of concrete starting the sampling operation of the beginning of discharge and repeating the operation until the entire batch is discharged. The sample thus obtained shall be taken to the moulding of the specimen and to counteract segregation. The concrete shall be mixed with shovel.

iv) The internal surface of the mould shall be thoroughly clean, dry and free from set cement.

Procedure: The mould shall be placed on a smooth flat surface. The mould shall be filled to about one fourth of its height with the concrete and tempted using 25 strokes of 16mm dia steel rod, o.6m long and bullet painted at the lower end. The mould shall than be removed by rising vertically immediately after filling. The moulded concrete then be allowed to subside and the height of the specimen measured after coming to rest. The consistency shall be recorded in millimeter of subsidence of the specimen during the test, which is known as the slump.

The slumped concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. If a shear or collapse slump is achieved, a fresh sample should be taken and the test repeated.

Only a true slump is of any use in the test. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which the slump test is not appropriate. Very dry mixes having slump 0 – 25 mm are typically used in road making, low workability mixes having slump 10 – 40 mm are typically used for foundations with light reinforcement, medium workability mixes with slump 50 – 90 mm, are typically used for normal reinforced concrete placed with vibration, high workability concrete with slump > 100 mm is typically used where reinforcing has tight spacing, and/or the concrete has to flow a great distance.



Workability	Compaction Factor	Slump (mm)
Very Low	0.78	0 - 25
Low	0.85	25 - 50

Medium	0.92	50 - 100
High	0.95	100 – 175

Placing conditions	Degree of Workability	Slump (mm)
Building concrete, shallow sections	Very low	See note 2
Mass concrete; lightly reinforced sections in slabs, beams, walls, columns, floors, hand placed pavements, canal lining, strip footings	Low	25-75
Heavily reinforced section in slabs, beams, walls columns	Medium	50-100
Slip form work, pumped concrete	Medium	75-100
Trench fill, in situ pilling	High	100-150
Tremie concrete (watertight pipe)	Very high	See note 3

Note 1: For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of the reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

Note 2: In the 'very low' category of workability where strict control is necessary, e.g. pavement concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS: 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

Note 3: In the 'very high' category of workability, measurement of workability by determination of flow will be appropriate (IS: 9103).

4.11 Tests for Compression Strength of Concrete: This method comes compression tests on concrete made in accordance with IS: 516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. The samples concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cum of concrete or as part thereof. However if concreting done in a day is less than 15 cum, the minimum no. of cubes can be reduced to 6 with the specific permission of the Engineer-in-chief. The average strength of the group of cubes cast for each day shall not be less than the specified works cube strength. The results shall be recorded in the register maintained at for record.

4.11.1 Additional Tests for Concrete: In case concrete fails when tested for compression of concrete following check tests may be carried out at the direction of Engineer to satisfy the strength of the concrete laid. All testing expenditure shall be done by the contractor. For purpose of payment the cube results shall be the criteria:

a) **Cutting Cores:** This method involves drilling and testing cores from the concrete for determination of compressing strength. In suitable circumstances the compressive strength of the concrete in the structure may be assessed by drilling

cores from the concrete and testing. The procedure used shall comply with the requirements of IS: 119-1959 and IS: 516-1959.

b) **Ultra sonic test:** If an ultrasonic apparatus is regularly used by trained personnel, and continuously maintained individual charts are kept showing a large number of readings, the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structure.

c) **Rebound hammer test**: If a rebound hammer is regularly used by trained personnel and continuously maintained individual charts are kept showings a large number of readings, the relation between the readings and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure or element. When making rebound hammer tests each result should be the average of at least six readings. Readings should not be taken within 25mm of the edge of concrete members.

d) **Load tests on individual present units**: The load tests described in this clause are intended as check on the quality of the units and should not be used as a substitute for normal design procedures. Where members require special testing such special testing procedures shall be in accordance with the specifications. The test loads shall be applied and removed incrementally.

4.12 Sampling procedure: A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested. It means sampling should be spread over the entire period of concreting and covers all mixing units.

Frequency of Sampling: The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

Sr. No.	Quantity of Concrete in work m^3	No. of Samples
1	1-5	1
2	6-15	2
3	16-30	3
4	31-50	4
5	51 and above	4 plus one additional sample for each additional 50 cum or part there of

Do's:

a) The proportion of the ingredients in concrete shall be determined through preliminary tests on concrete made from representative sample of ingredients.

b) The water cement ratio for specified compressive strength should be determined by lab tests.

c) Slump shall be determined at the point of placement after the concrete has been deposited.

d) The amount of bulk cement and all aggregates shall be directly weighed for batching.

Don'ts:

a) Cement in standards sacks or bags need not to be weighed.

b) Water should not be in abundance as to avoid exceeding the proper slump.

c) To avoid segregation, concrete should not be dropped from a height more than 1 meter.

d) To avoid sticking of concrete, formwork should be oiled before concreting.

4.13 Concreting Under water: Concrete shall not be placed in water having a temperature below 5^0C. The temperature of the concrete, when deposited, shall be not less than 16^0C and not more than 40^0C.

Concrete shall contain 10 percent more cement than that required for the same mix placed in the dry. The materials shall be so proportioned as to produce a concrete having a slump of not less than 100 mm, and not more than 180 mm.

Cofferdam or forms shall be sufficiently tight to ensure still water conditions and shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Concrete shall be deposited continuously until it has been brought to the required height. Drop bucket method or any other method approved by the Engineer may be used for depositing concrete under water.

4.14 Working in Extreme weather: Where concrete is to be deposited at or near freezing temperatures, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5^0C and that the temperature after the concrete has been placed and compacted is maintained above 4^0C until is has thoroughly hardened. When, necessary the concrete ingredients shall be heated before mixing but the cement shall not be heated artificially other than heat transmitted to it from other ingredients of the concrete.

Generally heating of the mixing water alone may be sufficient for this purpose. The temperature of water shall not however be more than 65^0C. The concrete shall be carefully protected after placing.

Salt or other chemicals shall not be used to prevent water from freezing. No frozen material or materials containing ice shall be used. All concrete damaged by the frost shall be removed. It is recommended that concrete exposed to freezing weather shall have entrained air and water cement ratio shall not be more than 0.60.

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40^0C while placing. This shall be achieved by stacking aggregates under the shade and keeping them moist, using cold water, reducing the time between mixing and placing to the minimum, cooling the form work by sprinkling water and restricting concreting, as far as possible, to early mornings and late evenings. When ice is used to cool mixing water, it will be considered a part of the water for the purpose of working out the water-cement ration in the mix.

4.15 Construction joints: Concreting shall be carried out continuously up to the construction joints, the position and details of which shall be shown on approved drawings or as directed by the Engineer-in-Charge. Such joints shall, however, be kept to the minimum.

For a critical construction joint, a stopping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or plugging when concrete is compacted against it. Concreting shall be continued right up to the board. The board shall not be removed before the expiry of the specified period for removal of vertical forms.

Before resuming work at any construction joint when concrete has not yet fully hardened, all laitance shall be removed thoroughly, care being taken to avoid dislodgement of coarse aggregates.

When work has to be resumed on a surface which has hardened it shall be thoroughly hacked, swept clean, wetted and covered with a layer of neat cement grout. The neat cement grout shall be followed by a 13mm thick layer or mortar mixed in the same proportion as in concrete and concreting resumed immediately thereafter. The first batch of concrete shall be rammed against the old work to avoid formation of any stone pockets, particular attention being paid to corners and close spots.

4.16 Tests and standard of acceptance: For controlled concrete preliminary tests shall consist of three sets of separate tests, and in each set, tests shall be conducted on six specimens. Not more than one set of six specimens shall be made on any particular day. On the six specimens in each set, three shall be tested at seven days and the remaining three at 28 days. The preliminary tests at 7 days are intended only to indicate the strength likely to be attained at 28 days.

All work shall be carried out under the supervision of a qualified and a competent Engineer who will supervise proportioning, placing and compacting of concrete at all stages.

4.17 Damp proof course: It is of two types namely horizontal and vertical. Horizontal D.P.C. shall usually consist of cement concrete 1:2:4 or cement mortar 1:2 as specified. In temporary and inferior buildings, the horizontal D.P.C. may consist of cement mortar. In important buildings and in special localities, the thickness of the cement concrete layer may be as per the approved drawings/direction of the Engineer-in-Charge.

Vertical D.P.C. may also be provided as per the approved drawings/direction of the Engineer-in-Charge.

Concrete or the plaster layer shall in all cases be covered with two layers of bitumen.

Unless otherwise stated, horizontal D.P.C. in external brick walls shall be located about 75 to 15 cm above the final ground level. In internal brick walls, damp proof course shall be located at the ground floor level. Damp proof courses of the external and internal walls shall be joined up by means of bonding, bricks or concrete blocks soaked in bitumen. To prevent the ingress of moisture from the soil under floor, the inside of the external wall shall be provided with vertical damp proof course, extending from horizontal damp proof course to floor level.

Damp proof course shall not be laid until level of work/stone work have been checked and the brickwork or masonry work have been passed by the Assistant Engineer.

The surface of brickwork or stone works shall be leveled and prepared before laying cement mortar/cement concrete. All exposed surfaces of damp proof course shall be finished smooth and flush with masonry surface. Side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. When the sides are removed, the surface should come out smooth without any honeycombing. If holes show up, they shall be grouted up flush with surface. The upper and inside surface shall be left rough to afford a key to the plaster and masonry above.

Damp proof course shall be cured for at least 7 days after which it shall be allowed to dry.

The concrete or plaster will be allowed to dry for one day after curing, and to course of bitumen then given after dusting of the surface. If the concrete or plaster does not dry up fully in cold season, the first coat shall consist of bitumen emulsion in lieu of bitumen. The bitumen shall be heated to the specified temperature and spread on the concrete in two coats using 1.70 kg/sqmt bitumen of damp proof course. The layers of bitumen must be sanded immediately they are laid. The bitumen shall be applied over the dried up surface of cement concrete, properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. The bitumen shall be applied uniformly all over so that no blank spaces are left anywhere.

4.18 Requirement of Concrete Cover: The protection of the steel in concrete against corrosion depends upon an adequate thickness of good quality concrete.

4.19 Transportation:

a) The procedure of mixing, transporting, placing and compacting concrete should not take more than 90 minutes in any case.
b) No water shall be lost from the mix during transportation.
c) The permissible time of transport of concrete should be determined within the laboratory.
d) The concrete combine should be protected from drying in hot weather and from rain during transport from the place of mixing to the position of placing.

4.20 Curing: Curing is the process of preventing loss of moisture from the concrete. When water is mixed in concrete a chemical reaction called hydration takes place. This hydration continues rapidly for first few days, after the concrete is placed, for this hydration to take place without interruption, favorable temperature and moisture conditions are to be maintained. The act of protection of hydration in concrete is in broad terms called curing. Thus, it can be concluded that to facilitate the hydration in cement, the water that is added in concrete during the construction should be prevented from evaporation.

Effect of curing in achieving the strength in concrete		
Sr. No.	**Curing days**	**Compressive strength percent of 28 days moist cured concrete**
1	No curing after laying	50% to 55%
2	Just 3 days curing	75% to 80%
3	7 days curing	95% to 100%
4	Full 28 days curing	120% to 125%

Note: Freshly laid concrete shall be protected from rain by suitable covering.Concrete should not be placed during rain.

RCC

4.21 Reinforcement: All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or any other substances, which may destroy or reduce bond. Sand blasting or other treatment is recommended to clean reinforcement. Special precautions like coating of reinforcement may be required for reinforced concrete elements in exceptional cases and for rehabilitation of structures.

4.22 Bending of Reinforcement: Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer-in-Charge using a proper bar bender, operated by hand or power to attain proper bend.

Bars shall not be bent or straightened in a manner that will injure the material.

Bars bent during transport or handling shall be straightened before being used on work, they shall not be heated to facilitate bending, unless permitted by Engineer-in-Charge.

Unless otherwise specified a U type hook at the end of each bar shall invariably be provided. The radius of the bend shall not be less than twice the diameter of the round bar and the length of the straight part of the bar beyond the end of the curve shall be at least four times the diameter of the round bar. In the case of bars which are not round and in the case of deformed bars, the diameter shall be taken as the diameter of a circle having an equivalent effective area.

The hook shall be encased to prevent any splitting of the concrete.

4.23 Laps in Bars: The length of lap in bars shall not be less than:

a) For bars in tension:

Bar diameter	Permissible Stress
	Four times the bond stress given in table IS: 456 or 30 bar diameters whichever is greater.

b) For bars in compression:

Bar diameter	Permissible Stress
	Five times the bond stress given in table IS: 456 or 24 bar diameters whichever is greater.

4.24 Distance between reinforcement bars:

a) The distance between two parallel reinforcement bars shall be except as provided under not less than the greatest of the following three distances: -

i. The diameter of either bar, if their diameter is equal.

ii. The diameter of the larger bar, if the diameter is unequal.

iii. 6 mm more than the nominal maximum size of the coarse aggregate comprised in such concrete.

Note: A greater distance should be provided when convenient.

b) The vertical distance between two horizontal main steel reinforcements, or the corresponding distance at right angles to two inclined main steel reinforcements shall be not less than 13mm except at a splice or lap and except where one of such reinforcements is transverse to the other.

c) The pitch of the main bars in a reinforcement concrete solid slab shall not be more than four times the effective depth of such slab.

d) The pitch of distributing bars in a reinforcement concrete solid slab shall not be more than four times the effective depth of such slab.

4.25 Nominal Cover to Reinforcement:

a) However for a longitudinal reinforcing bar in a column nominal cover shall in any case not be less than 40 mm, or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bars do not exceed 12 mm, a nominal cover of 25 mm may be used.

b) At each end of a reinforcing bar not less than 25mm nor less than twice the diameter of such rod or bar.

c) For longitudinal reinforcing bar in a beam, not less than 25mm nor less than the diameter of such rod or bar.

d) For tensile, compressive, shear or other reinforcement in a slab, not less than 13mm nor less than the diameter of such reinforcement.

e) For any other reinforcement, not less than 13mm nor less than the diameter of such reinforcement.

f) For all external

For footings minimum cover shall be 50 mm.

4.26 Joints: Joints shall be provided as shown in the drawings or as directed by the Engineer-in-Charge.

4.26.1 Construction Joint: For large works, where it is not practicable to carry on concreting continuously, the position of leaving off points or construction joints and the details of which shall be shown in the drawings or as directed by the Engineer-in- Charge. Such joints shall be kept to the minimum and shall not be located in

valleys. The joints shall be kept at places where the shear force is the minimum and these shall be straight and at right angles to the direction of main reinforcement. In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head and the portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

When stopping the concrete on a vertical plane in slab and beams, an approved stop-board shall be placed with necessary slots for reinforcement bars to pass freely without bending or any other obstruction. The construction joint shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints of stop-board be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

Walls shall be left off at any convenient height but the last layer shall be at the same level all round the structure.

When the work has to be resumed, on a surface, which has hardened (i.e. more than 48 hours old), the joint shall be thoroughly cleaned with wire brush and loose particles removed. It shall then be covered with a 13 mm layer of freshly mixed mortar comprising of cement and coarse sand in the same ratio as the cement and coarse sand in the concrete mix shall be applied before fresh concrete is laid.

When the work has to be resumed on a surface, which has not fully hardened (i.e. less than 48 hours old) the joint shall be thoroughly cleaned with wire brush and loose particles removed. The surface shall first be thoroughly wetted and all free water removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square meter shall then be applied on the roughened surface before fresh concrete is laid.

4.26.2 **Expansion Joints:** Expansion joints shall be provided as shown in drawing or as directed by the Engineer-in-Charge. The filling of these joints with bitumen filler, bitumen felt or any such material and the provision of copper or brass plate etc. (as may be specified) shall be described and paid for separately.

4.26.3 **Expansion Joints in Bridges:** Wherever, expansion joints are provided in the main structure of a bridge, expansion joints must be provided in the concrete flooring immediately above them, such joints should be constructed with two sheets of tarred paper previously laid on the support and be filled with preformed plastic material 13 mm thick which should be placed in the forms before concrete is laid so as to give a projection above the top surface of the concrete; this projection being trimmed of flush with the surface after the concrete has set.

CHAPTER-5

STONE MASONRY

5.0 The following Indian Standards shall be followed:

a) IS: 1125-1974 Method of test for weathering of natural building stones.

b) IS: 1126-1974 Method of test for durability of natural building stones.

c) IS: 1129-1972 Dressing of natural building stones.

d) IS: 1200:1979 (Part-IV) Method of measurements of stones.

e) IS: 1597-1967 Code of practice for construction of stone masonry.

f) IS: 1597-1967 (Part-I) Code of practice for construction of Rubble stone masonry.

g) IS: 1597-1967 (Part-II) Code of practice for construction of Ashlar stone masonry.

h) IS: 4101-1967 (Part-I) Stone facing

i) IS: 2185-1967 Code of practice for hollow cement concrete blocks.

Stone used for stone masonry shall comply with the specifications as below:

5.1 Quarried stone in Blocks (undressed): The stone shall be of the specified variety (such as granite, sand stone, quartzite etc.). The stone shall be hand sound, durable and free from defects like cavities, cracks or soft material etc. the minimum crushing strength of building stone shall be 200 kg/cm2 unless higher minimum strength is specified in any particular case.

5.2 Through Bond Stone and Quoins: The bond stones or through stones running right across the thickness of the walls shall be provided in walls up to 600mm thick. In thicker walls 2 stones overlapping each other by at least 150mm shall be provided across the thickness of the wall to form bond stone. There shall be at least 1 bond stone for 0.5m2 of wall surface. The bond stone marked by the distinguishing latter during construction for subsequent verification and shall be laid in staggered in subsequent layers.

Where bond stones of suitable lengths are not available CC block of 1:3:6 min shall be used.

5.3 Quoins: A quoin is the external angle of a wall or building. The quoin or corner stone shall be selected neatly dressed with hammer/chisel to form required corner angle and laid header and stretcher alternately. No quoins stone shall be smaller than 0.025 cum in volume and it shall not be less than 300 mm in length, 25% of it being not less than 500 mm in length.

5.4 Joints: Joints parallel to the external pressure must be staggered and should not be continuous. In other words, the stone in any course shall overlap the joint in the course below. All stones shall be laid full in mortar both in bed and in vertical joints. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar.

5.5 Stone for wire crates: The stone used shall be fairly regular and subject to marked deterioration by water or weather shall not be used.

The size of stone shall be as large as possible. In no case any fragment shall be less than 40 kg. The specific gravity of stones shall be as high as possible and it shall not be less than 2.50.

5.6 Testing of Stone:

a) **Water Absorption:** Stone with round surface shall not be more than 5% when tested for water absorption in accordance with IS: 1124-1974.

b) **Crushing Strength:** The minimum crushing strength of building stone shall be 200 kg/cm^{2}under higher minimum strength is specified in any particular case.

5.7 Dry Rubble Masonry: Dry rubble masonry shall be used in c/o breast wall and retaining walls, revetments walls and parapets.

In appearance dry rubble masonry will be like squared rubble built to courses. Each course shall be built through the entire thickness of the wall without mortar but with chips and spalls. The stones shall be roughly dressed to secure the maximum bedding surface without unduly reducing the size of stones. The largest stones shall be used in such construction, the larger being used in the lower courses. The face stone's average breadth shall not be less than the height and average length not less than 1½ times the height for stones up to 20 cm height and not less than 1-1/3rd the height or 30 cm whichever is more, for stones exceeding 20 cms in height. Dry stonewalling should not have a face batter steeper than 1:12 and until otherwise specified, batter shall be 1:4. The back of the wall shall be vertical; foundations as well as the courses must run at right angles to the face batter and not horizontally. Through or bond stones shall be provided in each course at intervals of 5 feet (2 meters) with specifications.

Dry stonewall higher than 20 feet (6 meters) should be strengthened by laying three consecutive courses of squared rubble masonry coursed in lime or cement mortar at every 10 feet(3 meters) interval.

5.8 Long walls: Long length of dry rubble walls should be divided into panels separated from one another by short lengths of walls 2 meters long built with squared rubble courses in lime or cement mortar at intervals of say 6 to 9 meters in order to confine damage, if any, only to the panels affected and thereby to minimize the repairs required.

5.9 Weep holes: It shall be provided in dry stonewalling when built against earth or hill slopes subject to saturation by surface or ground water flow. Weep holes shall be backed by coarse gravel and important walls by graded filters composed of coarse sand and gravel.

Filling immediately behind dry stonewall must, wherever possible consist of stone refuse or chips or coarse gravel clayey and silly soil should not be used where stone refuse or gravel is available.

5.10 Random Rubble Masonry: Random rubble masonry consists of stones, which are not squared but are of irregular shapes and are laid in specified mortar.

In this type of work scrabbled or quarry dressed stones are used and no further dressing is done except to knock off weak or angular corners. Care is taken to select stones of as uniform a shape as possible. Each stone will be laid on its quarry bed and will be wedged or pinned strongly into position in the walls by spalls or chips.

5.10.1 **Polygonal Random Rubble Masonry:** In this type of random rubble masonry the face stones are of very irregular shape most of them forming polygons. The stones are used as they come out of the quarry and if sufficient stones with polygonal faces are not forth coming some of the stones are hammer dressed to give polygonal faces.

Stones are laid to a random arrangement. Care being taken to lay them as close to each other as possible.

In all other respects, the work will conform to specification for random rubble masonry.

5.10.2 **Stonework Individual Items:**

a) Dry Random Rubble Masonry (Uncoursed/Bought to Course): Dry Random Rubble Masonry or dry stone walling shall be used in constructing breast and retaining walls, revetments walls and parapets.

The stone shall not be less than 15cms in any direction except the packing stone. The face stone's average breadth shall not be less than the height and average length not less than 1½ times the height for stones up to 20 cm height and not less than 1-1/3rd the height or 30 cm whichever is more, for stones exceeding 20 cms in height.

b) Dry polygonal random rubble masonry: In this type of masonry the face stones are of very irregular shape most of them forming polygons. The stones are used as they come out of the quarry and if sufficient stones with polygonal faces are not forthcoming some of the stones are hammer-dressed to give polygonal faces. Polygonal random rubble masonry of this type can either be uncoursed or it can be brought up to course by leveling after 45cms to 60 cms vertical interval.

c) Coursed rubble masonry first sort/coursed rubble masonry second sort: For first sort coursed rubble masonry, face stones shall be hammer dressed so as to give approximately rectangular blocks. They shall be squared on bed and side joints. The bed joints shall be rough chisel dressed for a depth of at least 50mm back from the face, and the side joints shall be so dressed to a depth of at least 40mm back from the face, such that no portion of the dressed surface is more than 6mm from a straight edge held against the surface. The bushing on the face shall not project by more than 40mm on an exposed face and 10mm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 25 mm along the four edges of the face of the stone. All the courses shall be laid truly horizontal. The height of course shall not be less than 150 mm nor more than 300mm.

d) For second sort coursed rubble masonry the stones shall be dressed as for first sort masonry described above except that no portion of dressed surface shall show a depression of more than 10mm (as against 6mm for first sort) from the straight edge placed against the dressed surface.

5.11 Precast Block Masonry:

5.11.1 Hollow Cement concrete blocks:

a) These shall conform to IS: 2185-1967 and shall be made of concrete mix as specified in the respective items.

b) A hollow block can have one or more than one hole or cavity passing through the block and having solid material between 50 percent and 75 percent of the total volume of block calculated from the overall dimensions.

c) All blocks shall be sound free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of blocks or impair the strength or performance of the structure.

5.11.2 Solid cement concrete block:

a) Solid cement concrete blocks shall be precast with concrete of specified mix.

b) A block shall be deemed to be solid if the solid material is not less than 75 percent of the total volume of the block calculated from the overall dimensions.

c) The concrete mix used for blocks shall not be richer than one part by volume of cement to 6 parts by volume of combined aggregate.

d) The material used for concrete shall conform to relevant I.S. Specifications. The size of the blocks shall be of one of the following size:

Size Designation	Nominal size cm.			Actual size cm.		
	Length	Breadth	Height	Length	Breadth	Height
Size A	40	30	20	39	30	19
Size B	40	20	20	39	20	19
Size C	40	10	20	39	10	19

Sizes other than these specified may also be used with the approval of the Engineer-in-Charge.

1. The blocks may be either machine made or handmade. The concrete mix, the mixing of concrete, the manufacture of blocks, curing and drying shall be in accordance with para 6 to 10 under IS code 2185-1967.

2. Faces of the blocks shall be flat and rectangular. Surface finish shall be rendered smooth or plastered with cement mortar 1:3 (1 cement : 3 course sand).

3. The average compressive strength of eight blocks when determined in manner described in IS: 2185-1967 shall not be less than 50kg/cm^2 of the gross area. The

strength of the lowest individual block shall not be less than 75 per cent of the average compressive strength of eight blocks.

5.12 Laying:

a) The blocks need to be wetted before or during laying in the walls. In case climatic conditions so require the top and the sides of block may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

b) Operations of laying of precast cement concrete block masonry shall be carried out in accordance with instructions detailed in IS: 6042-1962 para 10.2

5.13 Quoins and closers: Specials quoins blocks (with a return face equal to length to half the normal face) shall be cast for all building blocks and slabs for external work. Proper half-length closers shall be cast and not cut from full size blocks. The returned ends of blocks for door and window reveals and quoins shall be finished with a fair face in the moulds.

5.14 Do's:

a) Dressing of stones shall be as per the specifications for an individual type of masonry work.

b) Through and bond stones shall broadly be stacked separately from ordinary building stones.

c) All stones for masonry in cement mortar must be thoroughly wetted before laying.

d) Stones shall be laid on their natural quarry beds.

e) Cross walls must be carefully bonded into main wall.

f) Joints in masonry shall be staggered i.e. the stone in any course shall overlap the joint in the course below.

Don'ts:

a) Filling up the space between the masonry faces with fine, small or dry stone backing shall not be permitted.

b) No dry or hollow space shall be left anywhere in the masonry.

c) No mortar should fall or left on stone and should be immediately removed

CHAPTER-6

BRICK WORK

6.0 The following Indian Standards shall be followed:

a) IS: 3102-1971 Classification of burnt clay solid bricks.

b) IS: 3495-1973 (Part I to IV) Clay building bricks-method of tests.

c) IS: 1200-1974 (Part-III) Measurements of building and Civil Engineering works: method of brickwork.

d) IS: 2212-1962 Brick work code of practice.

e) IS: 1077-1970 Common burnt clay-building bricks.

f) IS: 5454-1269 Method for sampling of clay building bricks.

6.1 Sizes of Bricks: Unless otherwise specified bricks required for buildings or architectural works shall measure 19cm*9cm*9cm (actual) or 20cm*10cm*10cm (nominal) so that every 10 courses when laid with horizontal mortar joints shall measure one meter in height. A tolerance up to ± 6.5mm in length, ±3mm in width and ±3mm in height shall be permitted.

6.2 Classifications: Bricks shall be classified as follows:

a) **First class Bricks:** The first class brick shall conform to the following specifications:

i) They shall be made from good brick earth, free from saline deposits and shall be sand moulded.

ii) They shall be thoroughly burnt without being vitrified and shall have uniform deep red, chary or copper color.

iii) They shall be regular and uniform in shape and size with sharp and square arises and parallel faces.

iv) They must homogenous in texture and emit a clear ringing sound on being struck.

v) A first class brick shall not absorb water more than 20% of its own dry weight after 24 hours immersion in cold water.

vi) The first class bricks shall have a minimum crushing strength of 105 kg/cm^2 when tested. The crushing strength of any individual brick shall not fall below the average crushing strength by more than 20%.

vii) They shall not show any appreciable sign of efflorescence either in dry state or subsequent to soaking in water.

b) 2nd class brick:

i) They shall be as well burnt as first class brick or slightly over-burnt but not vitrified in any part.

ii) They must give a clear ringing sound when struck.

iii) They may have slight irregularities in size, shape and color provided these irregularities are not such as to give uneven courses when used for construction.

iv) The minimum crushing strength of second-class brick shall be 70kg/cm2 when tested. The crushing strength of an individual bricks shall not fall below the average strength by more than 20%.

v) They shall not show any appreciable sign of efflorescence either in dry state or subsequent to soaking in water.

c) 3rd class bricks:

i) These are not be so fully burnt as first or second class. These may be slightly under-burnt or slightly over-burnt.

ii) They may be distorted and have rounded edges and may not be uniform in shape. These defects, however, shall not be such as to cause difficulty in obtaining uniform courses with their use.

iii) They shall not absorb water more than 25% of their own dry weight after 24 hours, immersion in cold water.

iv) Third class bricks may show moderate signs of efflorescence when tested for efflorescence.

Third class bricks shall not be used anywhere without the specific orders of the Executive Engineer in writing.

6.3 Soaking: Bricks required for brickwork in cement or lime mortars, shall be thoroughly soaked in clean water immediately before use for one hour or till the complete cessation of air bubbles. Bricks shall be placed in the tank by hand, one at a time and not thrown or tipped in. The soaked bricks shall be kept on wooden planks or brick platforms to avoid earth being smeared on them. Bricks need not to be soaked for brickwork in mud mortar.

6.4 Laying:

a) Brickwork shall be laid in English bond i.e. alternate courses of header and stretcher unless otherwise specified with frogs upwards. Half or cut bricks shall not be used except where necessary to complete the bond. Closers in such cases shall be cut to the required size and used near the ends of the walls.

b) In exposed brickwork, selected bricks of the specified class shall be used for the face work.

c) A layer of mortar shall be spread in full width over a suitable length of the lower course. Each brick shall be properly bedded and taken up truly plumb.

d) All iron fixtures, pipes, outlets of water, hold fasts of doors and windows which are required to be built up into the walls shall be embedded in mortar or cement concrete.

e) The flue of the chimney shall be pargeted i.e. plastered with mud gobar mortar (3 mud: 1 gober) as the work proceeds. Nothing extra shall be paid for this par getting.

6.5 Half Brick Masonry:

a) When it is necessary to economics on space or to reduce dead weight partition walls of half brick thickness or even less are constructed. Such walls shall bear no weight except their own. When built on suspended floors, there must be a beam underneath to take the load or the floor itself designed to take its load.

b) Such walls of thickness 5cm or 7.5cm shall invariably be constructed with hoop iron reinforcement. Walls of thickness 10 cm shall be constructed without hoop iron reinforcement when any of the following conditions exist:

i) The height is not more than 2 meters.

ii) The supported length is not more than 3 meters.

iii) There are no doors and windows provided in the walls.

iv) The work is in first storey below plinth level.

In all other situations, these partition-walls of thickness 10 cm shall be reinforced with hoop iron. The hoop iron reinforcement shall be 25mm wide and 1.6mm thick. The hoop iron band shall be embedded in cement mortar as follow:

a) Walls constructed with metric bricks-every third course.

b) $4^{1/2}$" thick walls constructed by non-metric bricks every 4th course.

c) 3" brick walls constructed with non-metric bricks every 3rd course.

The hoop iron shall be hooked (give in double lap) with minimum of 20 cm hooks, at all angles junctions. Hoop iron band shall be continued for 20 cm into the main wall on which the partition wall abuts 5cm length of the hoop iron being bent up or down so as to take a firm grip of the brickwork.

Before laying the hoop iron, it shall be cleaned of rust and loose flakes with a wire brush. The hoop iron shall lie quite flat on the mortar. Half the mortar for the joint shall first be laid and other half laid after the hoop iron has been laid in position so that it is fully embedded in the mortar. When hoop iron is not available, the Engineer-in-Charge may allow equivalent reinforcement in the form of rods.

6.6 Cavity walls: Hollow walls or double with a cavity between them shall be built where specified, in order to exclude dampness or in order to keep the interior of the building cool in summer and warm in winter.

The cavity between the two walls shall not be less than 5cm. The outer wall should be half brick thick i.e. 10cm. in metric bricks 41/2" thick in non-metric walls. The bricks shall be provided for half brick thick masonry.

The internal may be half brick thick or one brick thick depending upon the load coming on the wall. The ratio of cement sand mortar in which the internal wall should be built will also depend upon this consideration. The normal rule is that combined thickness of the walls (excluding cavity) should be equal to the thickness demanded for any solid wall with the given conditions for height and lengths. If the internal wall is half brick thick, it shall be laid in cement sand mortar 1:4 and reinforced with hoop iron as the outer wall.

Where cavity walls have been specified to exclude dampness, the cavity must continue below the damp-proof course, which shall be at the ground level for the outer wall and at the plinth level for the inner wall.

6.7 Mortar Dropping: During construction of cavity wall, mortar droppings are quite likely to fall into the cavity and get lodged over ties and become a constant source of transmittance of moisture. For preventing this, a wooden batten should be kept over ties during the construction the construction of wall to catch any mortar droppings.

The batten should be lifted up every time when the next row of ties is reached and the process repeated as the construction of wall proceeds. The inner surface of outer leaf of the wall should not encourage splash of dripping water that may penetrate through the outer leaf and thus transmit dampness to the inner leaf. To avoid this, projections from outer leaf extending into the cavity should not be allowed.

6.8 Solids Portions: The cavity walls shall be built solid at the corners and either side of all openings for a width of half brick thickness i.e. 10 cm in case of metric bricks and 41/2" in case of non-metric bricks. The top of three courses under the roof shall also be built solid. The tops of arches or lintels shall be plastered during construction with neat cement so as to stop penetration of moisture into the inner wall.

6.9 Cleaning out Holes: Small openings shall be left in the exterior leaf approximately 2 meters apart at the start of masonry so as to facilitate hand cleaning out by means of a rake. These holes should be closed at the end of the construction of the wall after doing the necessary cleaning of the cavity.

6.10 Ventilation of Cavity: The cavity in hollow walls shall be ventilated at the bottom and near the top by providing airbricks or openings having 6mm x 6mm grating. The openings near the bottom shall be so placed as to allow the escape of any condensed moisture that may have collected.

6.11 Hollow Portion Walls: Hollow partition walls which do not carry any load except their own weight, shall be made 5cm thick each with 5cm cavity in between. In case of non-metric bricks, the thickness of each wall shall be 3 inches with 2 inches cavity in between. The brick work shall be reinforced every third course with bands of hoop iron as specified in case of half brick thick masonry. Instead of metal ties the two walls shall be bonded together by header bricks at every one-meter interval and in every alternate course.

6.12 Testing of Bricks:

6.12.1 Absorption Test on Bricks: Water absorption is an important property of the bricks since it has tremendous effect on the durability of the structure. Less value of water absorption indicates the more strength and durability.

Recommendation: For a good quality brick the amount of water absorption should not exceed 20% of weight of dry brick.

6.12.2 Strength Test on Bricks: A minimum value of compressive strength of a good brick as specified by IS: 3495 Part I, 1976 is 35 to 40 kg/cm^2.

Apparatus:

a) Compressive testing machine, the platens of which shall have a ball seating arrangement.

b) Two plywood planks of 3mm thick each.

Do's:

a) Bricks required for brickwork in cement mortar shall be thoroughly soaked in clean water.

b) Brickwork shall be laid in English Bond with frogs upward.

c) Thickness of joints shall be 8mm and shall not exceed 12mm.

d) For a surface, which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15mm.

e) Plastering shall be started from top and worked down.

Don'ts:

a) Bricks need not be soaked for brickwork in mud mortar.

b) The work done per day should not be more than one-meter height.

c) No portion of the surface to be plastered shall be left out initially to be patched up later on.

CHAPTER-7

MISCELLANEOUS BUILDING WORKS

7.1 Plinth Protection: Plinth protection shall be provided all-round the building in specified width. Plinth protection shall be of cement concrete or of bricks as specified in the item of work. Outer edge shall be lined with brick laid on edge and joints grouted with cement mortar. Plinth protection shall be laid with a minimum outward slow of 1 in 48.

7.2 Preparation of ground: The ground shall be prepared to the required slope around the building. The high portions of ground shall be cut down, hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform out-ward slope. Bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any shall be disposed of, with in a lead of 50 meters.

7.3 Flag stone flooring: Flag stone flooring shall be over a bed of 15cm thick well-rammed earth. It shall be laid over a base of 75mm thick lean concrete 1:4:8 (1 cement: 4 sand: 8 graded stone aggregate 40mm and down gauge, the thickness of flag stone flooring shall be 40mm, with cement pointing 1:3 (1 cement: 3 sand). Stone used for flag stone flooring shall be got approved from the Engineer-in-Charge. Plinth protection shall be laid with minimum out ward slope of 1 in 48. The work shall be executed as per direction of Engineer-in-Charge.

7.4 Cement concrete plinth protection: It shall be laid over a base of 75mm thick lean concrete 1:4:8 (1 cement: 4 sand: 8 graded stone aggregate 40mm and down gauge). 50mm thick cement concrete 1:3:6 (1 cement: 3 coarse: 6graded stone aggregate 20mm nominal size) shall be laid in alternate panels as described in workmanship of section 'Paving and Flooring' except that the top shall not be finished with neat cement slurry but shall be finished with only wooden floats. The finished surface shall have a minimum outward slope 1 in 48.

7.5 Brick plinth protection: After the preparation of ground 75mm thick base of lean cement concrete 1:4:8 (1 cement: 4 sand: 8 graded stone aggregate 40mm and down gauge) shall be laid. Flooring with bricks (laid flat or on edge) of class I. modular or conventional as per specified in cement mortar 1:6 (1 cement: 6 sand) shall be laid as described in Section 'Paving and Flooring.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 fine sand) as described in section 'Plastering and Pointing' Plinth protection shall be laid with minimum outward slope of 1:48.

7.6 Brick edging: Brick edging will be done with the bricks of class I modular or conventional as specified. Trenches of required depth shall first be made along the edge of the plinth protection to receive bricks. The bed of trenches shall be compacted to a firm and even surface and then bricks shall be laid true to line with lengths parallel and abutting against the plinth protection with their tops flush with the concrete surface. The joints shall be grouted with cement mortar 1:4 (1 cement: 4 fine sand).

7.7 Laying: Fire clay refractory bricks shall be dipped into water immediately before use. Its inside face shall buttered with a layer of fire clay mortar and bricks laid in contact with each other. A layer of thin paste of fire clay enough to fill up the irregularities of their faces and give them a

solid baring shall be spread on a lower course and each brick placed in position and set home by gentle tapping with the handle of trowel or wooden mallet. The fire clay mortar shall be mixed up so thin that it cannot be well laid on with trowel, an iron spoon being preferable.

7.8 Joints: Fire clay refractory bricks shall be so laid that all the joints are quite full of fire clay mortar. The joints shall be struck flush and finished at the time of laying. The face of fire clay refractory brick work shall be cleaned and all mortar droppings removed.

PAVING AND FLOORING

7.9 General Specification:

7.9.1 Sand filling: The earth filling shall be stopped at such a height so as to allow to full thickness of sand, of cement concrete and the correct thickness of surfacing. In areas, where the water table is near the ground surface, a suitable treatment shall be provided to prevent the rise of moisture into the floor. This treatment shall be paid for separately.

7.9.2 Base Concrete: Base concrete shall be laid in accordance with the specifications laid in one operation in a uniform layer, absolutely true and parallel to what is required on the finished surface and to the satisfaction of Engineer-in-Charge.

7.9.3 Leveling: A reference level mark shall be marked around on the walls (15 cms) or so above the floor level with the help of a water level. Water level consists of a can of water connected with rubber tubing to a glass tube, which shows the level of water in the can. With the help of this level truly horizontal lines can be marked with string and lime on the walls. These horizontal can be marked with string and lime on the walls. These horizontal lines shall serve as a datum from which all levels for base layer and topping etc. shall be measured off.

7.9.4 Paving to bond with base concrete: The finishing surface or paving shall not be laid before the base concrete has set for at least seven days. While the surface is still soft enough to receive and retain the impression, it should be brushed with stiff-bristled broom. This is very necessary in order to remove laitance, scum and inadequately embedded coarse aggregate. In addition to the brushing, scour and pits the surface so as to provide a mechanical bond for the topping. During the interval between the finish, the base shall be thoroughly cured and protected from the deposition of grease, pitch, paint or any other foreign subsistence.

7.9.5 Levels and Slopes: Unless otherwise specified, all floors shall be perfectly leveled, except bathroom and verandah floors, which shall have an outward slope 1 in 60. The layers of sand concrete shall be uniform in thickness and any slope required is to be obtained by making the outer walls lower than the inner ones by the necessary amounts.

7.9.6 Straight edges and spirit levels: The contractor shall provide and keep available wherever flooring work is proceeding, straight edges of a length not less than 2.5 meters

and with parallel sides, as well a 25 cms spirit level for the purpose of testing the trueness of the floor being laid.

7.10 Precast Interlocking Paver Blocks: Precast concrete Paver blocks shall be conforming to IS 15658:2006 – Specification for Precast concrete blocks for paving. Paver blocks shall be sound and free from cracks or other visual defects. The tolerance on length or breadth of paver blocks shall be +2mm and tolerance on thickness of tiles shall be +3mm. Water absorption shall not be more than 6 percent by mass.

Shapes shall be triangular, Zigzag, Hexagon or other shape as indicated. Color of paver blocks shall be as indicated or as decided by Engineer-in-Charge. Thickness and grade of concrete of paver blocks is decided based on intensity of traffic, which is as under:

Traffic Category	Paver block thickness	Grade of concrete
Light traffic	60mm	M-35
Medium traffic	80mm	M-40
Heavy traffic	100mm	M-40

7.11 White Glazed tiles in flooring, treads of step and landings

7.11.1 Sub-grade: Sub grade shall be of concrete or of R.C.C. slab.

7.11.2 Bedding: Bedding over which the tiles shall be laid shall be of 12 mm average thickness in cement mortar 1:3 (1 cement: 3 coarse sand).

7.11.3 Laying: Sub grade shall be cleaned, wetted and mopped. The bedding shall be laid evenly over the surface, tamped and corrected to desired levels and allowed to harden enough to offer a rigid cushion to tiles and to enable the mason to place wooden planks across and squat on it. Before laying the tiles grey cement slurry of honey like consistency at 3.3 kg/square meter shall be applied over the bedding at a time. Area to accommodate about twenty tiles shall be applied with cement slurry. Tiles shall then be washed clean and fixed in the grout one after the other, each tiles being gently tapped in line with adjoining tile. The joints shall be as thin as possible in straight line or as per the pattern.

7.11.4 Jointing and Finishing: The joints shall be cleaned of grey cement grout with wire brush or trowel to a depth of 5mm and all dust and loose mortar removed. White cement shall then be used for flush pointing the joints. The floor shall be cured for seven days. The surface then be washed and cleaned. The surface shall not sound hollow when tapped.

7.12 Cement Concrete flooring with Metallic Hardener Topping

7.12.1 General: Wherever floors are required to withstand heavy wear and tear, use of floor hardeners shall be avoided as far as possible by using richer mixes of concrete unless the use of a metallic hardener is justified for reasons of cost. Where metallic hardener topping is used, it shall be 15mm thick.

7.12.2 Metallic Hardening Compound: The compound shall be of approved quality consisting of uniformly graded iron particles, free from ferrous metal particles, oil grease, sand and soluble alkaline compounds.

7.12.3 Under-Layer: The under-layer shall consist of cement concrete (1:2:4) of specified thickness with 20mm nominal size aggregate and the top surface shall be roughened with brushes while the concrete is still green and the forms shall be kept projecting up 15mm over the concrete surface, to receive the metal hardening compound topping.

7.12.4 Topping: This shall consist of 15mm thick layer of mix 1:2 (1cement: 2 stone aggregate 6mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1:4 (1 metallic concrete hardener: 4 cement) used by weight. Concrete hardener shall be dry mixed thoroughly with cement on a clean dry pucca platform. This dry mixture shall be mixed with stone aggregate 6 mm nominal size or as otherwise specified in the ratio of 1:2 (1cement: 2 stone aggregate) by volume, and well turned over.

7.13 Kota stone Flooring

7.13.1 Bedding: Bedding for the marble slabs shall either is lime mortar 1:1:1 (1 lime putty: 1 surkhi: 1 coarse sand) of average thickness 20mm or cement mortar 1:4 (1 cement: 4 coarse sand) of average thickness 20mm as given in the description item.

7.13.2 Laying: Sub grade shall be cleaned, wetted and mopped. Mortar of the specified mix and thickness shall then be spread on an area sufficient to receive one slab. The slab shall be washed clean before laying. It shall be laid on top, pressed and tapped gently to bring to bring it in level with the other slabs. It shall then be lifted and laid a side. Top surface of the mortar at hollows or depressions. The mortar is then allowed to harden a bit. Over this surface, cement slurry of honey like consistency @4.4 kg of cement per square meter shall be applied. The edges of the slabs already paved shall be buttered with gray cement with pigment to match the shade of the Kota stone slabs as given in the description item. The slab shall then be gently placed in position and tapped with wooden mallet till it is properly bedded in level with close to the adjoining slab. The joint shall be as fine as possible. Surplus cement on the surface shall be removed. The slabs fixed in the floor adjoining the walls shall enter not less than 10 mm under the plaster, skirting or dado.

7.13.3 Grinding, Polishing and Finishing: Grinding shall normally be commenced after 14 days of laying the tiles except for skirting or small areas. Machine shall be used for the purpose. First grinding shall be done with carborundum stone of 48 to 60-grade grit fitted in the machine. Water shall be properly used during grinding. Pinholes are covered with a thin coat of grey or white cement, mixed with or without pigment to match the color of the toppings of the tile. This grout shall be kept moist for a week. There after second grinding shall be started with carborundum of 120 grit. Grouting and curing shall follow again. Final grinding shall be done when other works are finished. The machine shall be fitted with carborundum of grit 220 to 350 using water in abundance. The floor shall then be washed clean with water. Oxalic acid power shall be dusted at 33 grams per square meter on the surface and the surface rubbed hard with pad of woolen rages. The floor

shall be washed clean and dried with a soft cloth or linen. The finished floor shall not sound hollow when tapped with a mallet.

If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

Don’ts:

1. First polishing with coarse grade carborandum stone shall not be done.
2. Cement slurry with or without pigment shall not be applied to the surface before polishing.

"The social and cultural aspect of a road is not in any way less important than the economic aspects. The traffic of ideas also takes place through social intermingling, which is made possible by roads. This last aspect of roads is, in my opinion, of fundamental importance, particularly for a country like ours."

Dr. Rajendra Prasad

SPECIFICATIONS AND QUALITY CONTROL FOR STATE/RURAL ROADS.

LIST OF IS CODES FOR ROADS AND BRIDGES

The following Indian Standards shall be followed:

1. IRC 019-2005 Standard Specifications and Code of Practice for Water Bound Macadam.
2. IRC 109-1997 Guidelines for Wet Mix Macadam.
3. IRC 014-2004 Recommended Practice for Open Graded Premix Carpet (Third Revision).
4. IRC 016-2004 Standard Specifications and Code of Practice for Prime and Tack Coat (Second Revision).
5. IRC 028-1967 Tentative Specifications for the Construction of Stabilized Soil Roads with Soft Aggregate in Areas of Moderate and High Rainfall.
6. IRC 034-2011 Recommendations for Road Construction in Areas Affected by Water Logging, Flooding and/or Salts Infestation.
7. IRC 037-2012 Tentative Guidelines for the Design of Flexible Pavements.
8. IRC 047-1972 Tentative Specification for Built-Up Spray Grout
9. IRC 056-2011 Recommended Practice for Treatment of Embankment and Roadside Slopes for Erosion Control (First Revision).
10. IRC 082-1982 Code of Practice for Maintenance of Bituminous Surfaces of Highways.
11. IRC 090-2010 Guidelines of Selection, Operation and Maintenance of Bituminous Hot Mix Plant (First Revision).
12. IRC 110-2005 Standard Specifications and Code of Practice for Design and Construction of Surface Dressing.
13. IRC 112-2011 Code of Practice for Concrete Road Bridges.
14. IRC SP 013-2004 Guidelines for the Design of Small Bridges and Culverts.
15. IRC SP 042-2014 Guidelines on Road Drainage (First Revision).
16. IRC SP 063-2004 Guidelines for the Use of Interlocking Concrete Block Pavement.
17. IRC SP 075-2008 Guidelines for Retrofitting of Steel Bridges by Prestressing.
18. IRC SP 097-2013 Guidelines on Compaction Equipment for Road Works.
19. IS: 2720-1970 Method of test for soils.

CHAPTER-8

EMBANKMENT & SUB GRADE

8.1 Methodology:

8.1.1 Suitable soil: Which can be compacted and is stable.

Unsuitable fill material:

a) Materials from swamps, marshes and bogs (spongy ground).
b) Peat, log, perishable material, any soil classified as OL, OI, OH or Pt (IS 1498).
c) Instantly combustible.
d) Sodic soils pH > 8.5
e) Clay with LL > 70
   PI > 45
   Free swelling index > 50
f) Frozen material
g) Soils having soluble sulphates content more than 1.9gms of sulphates (as SO3) per liters or total sulphate content more than 0.5% (as SO3) by wt. of soil. These eat away the cement and make the mortar like powder, when in contact with concrete structures.

- Suitable soil – {Local and Imported}
- Stack 150mm top-agricultural-mineral rich soil for re-spread.
- Embankment any height 97% light compaction.
- Sub grade top 300mm 100% light compaction.
- Layers not > 150mm thick compacted.
- Compaction at OMC {+1%, -2%}
- If clayey/BC soils at OMC {-Nil, +2%}

8.1.2 Sub grade: The construction is similar to embankment. The CBR requirement is higher and the degree of compaction is minimum 100% of normal proctor density. When CBR is poor such as on BC soil, the improved sub grade with lime, cement stabilization or mechanical stabilization can be used to improve the CBR, if it is cost effective vis-à-vis replacement with good soil.

8.1.3 Compaction: It is the volume change produced artificially by momentary load application such as rolling, tamping or vibration. The air present is expelled with 5-10% voids left. Coming of grains together increases the load carrying capacity of the soil. The soil grains are packed closer. The weight of roller and number of passes has a great role to play to get the desired compaction.

8.1.4 Speed of Roller: It can be from 3km/hr to 6km/hr. It depends upon nature of the soil, thickness of layer and weight of roller.

10 ton smooth wheel roller having minimum of 54.5kg/ linear cm moving at 4km/hr with 8 passes should be adequate for compacting about 200mm layer.

For clayey soil, clayey silts, Sheep Foot Roller (SFR) are suggested. For all other soils vibratory roller is best.

8.2 Quality Control Requirements:

1. Materials:

a. The size of coarse material shall not ordinarily exceed 75mm when placed in embankment and 50mm when placed in sub grade.

b. The materials should satisfy the density requirements given in Table

Density requirement of embankment/sub grade materials

Sr. No.	Type of work	Max. Laboratory dry unit weight
1.	Embankment not subject to flooding - Height up to 3m - Height more than 3m	 Not less than 1.44gm/cc Not less than 1.52gm/cc
2.	Embankment subject to flooding	Not less than 1.52gm/cc
3.	Sub grade, earth shoulders	Not less than 1.65gm/cc

2. **Horizontal Alignment:** The alignment will be reckoned with respect to the centre line of the carriageway. The edges of the roadway as constructed shall be correct within a tolerance limit of (±) 30m there from.

3. **Surface levels:** The tolerance in surface level for sub grade will be (±) 25mm.

4. **Surface regularity:** The maximum permitted number of surface irregularities shall be given in table:

Irregularities	4mm		7mm	
Length (m)	300	75	300	75
Number of irregularities	50	25	6	3

5. **Density of Compaction:** The density of compaction should satisfy the requirements given in table:

Sr. No.	Type of work/material	Relative compaction
1.	Sub grade and earth shoulders	Not less than 100% standard proctor
2.	Embankment	Not less than 97% standard proctor

Acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus $(1.65 - \frac{1.65}{\sqrt{\text{No. of samples}}})$ × standard deviation.

8.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	For borrow pits along the road, ridges of minimum 8m width should be left at	The material for earthwork in embankment should not contain any logs,

	intervals not exceeding 300m. Small drains should be cut through the ridges to facilitate drainage.	stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the sub grade.
2	The depth of borrow pits should be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case be limited to 1.5m.	The following types of material should not be permitted. ▪ Materials from swamps and marshes. ▪ Peat, log, stump and perishable material. ▪ Materials susceptible to spontaneous combustion. ▪ Materials in frozen condition. ▪ Clay having LL exceeding 70 and PI exceeding 45. ▪ Materials with salt resulting in leaching. ▪ Expansive clay having free swelling index exceeding 50. (Where the ground on which an embankment is to be built has any of the above materials, such material must be removed to a depth of at least 500mm and replaced with acceptable fill material before commencing work of embankment.
3	The area of the embankment foundation should by kept dry.	No damage should be caused to works, crops or other property while discharging stagnant water found in the embankment foundation.
4	Test the material (soil) for embankment at least 7 days before commencement of compaction.	Do not allow clods or hard lumps of earth larger than 75mm when spreading soil for each layer of embankment.
5	Maintain a camber/cross fall of 4% during construction for effective drainage and prevention of ponding of water.	

8.4 Quality Control Test (Frequency):

The quality control tests and their frequency for earthwork in embankment/sub grade.

Tests and their frequency		
Sr.No.	**Test**	**Frequency**
A	**Borrow Area**	
i.	Sand content	1 test per 4000cum.
ii.	Plasticity Index	1 test per 4000cum.
iii.	Compaction	1 test per 4000cum.
iv.	Natural moisture content	1 test per 500cum.

v.	CBR	1 test per 5000cum.

B	**Construction Operation**	
i.	Moisture content prior to compaction	1 test / 250 cum/min. 4tests per day.
ii.	Thickness of layer	Regularly
iii.	Density of compaction	1 set of tests per 2000sqm comprising 6 measurements.

CHAPTER-9

GSB

9.1 Methodology

- Approve source a month advance
  - Natural (sand, moorum, gravel)
  - Crushed (stone, slag, brick, metal, kankar)
- Compaction layer thickness
  - 100mm 3-pin roller (80-100 kN wt.)
  - 150mm-225mm vibratory roller of 80-100kN wt.
    98% heavy at OMC + 1%
    (Atleast100% compaction) - 2%
- Level tolerance
  - +10mm
  - -20mm
- Surface regularity
  - Longitudinal 12mm
  - Transverse 10mm
- Engineer's Specific Approval.
  - Crushed slag
  - Brick bats
  - Concrete rubble
  - Kankar
- Grading prefers coarse grading: Grade-I.
- Remove vegetation from sub grade.
- Light water sprinkle and two passes of roller.
- Spread GSB with tractor toed blade.
- Water to be added with truck/tractor toed water tanker filled with perforated spray bar.

9.2 Quality Control Requirements:

1. **Materials:**
   - Fraction passing 425 micron
     - LL not > 25%
     - PI not > 6%
     - Soaked CBR not > 20% (15% with specific approval of Engineer if material is not suitable within economic load)
     - Wet AIV not > 50
   - Density of compacted layer – 2000 sq.m(6 sets)
   - CBR - 1 in 1000 cubic m
   - Grading of coarse graded GSB:

Sieve	Grade I % passing	Grade II	Grade III
75mm	100	-	-
53mm	-	100	-
26.5mm	55-75	50-80	100
4.75mm	10-30	15-35	25-45
0.075mm	<10	<10	<10
0.025mm	<5	<5	<5 on clayey sub grades
CBR	30	25	20

Note: It will be seen that gradation of GSB Gr.I and drainage layer are same except on sieve of 75 micron.

2. **Horizontal Alignment:** The edges of the sub-base shall be correct within a tolerance limit of (±) 30mm.

3. **Surface levels:** The tolerance in surface level for granular sub-base will be (±) 20mm. (A grid of 10-15mm may be formed to check the surface level).

4. **Surface regularity:** The maximum permitted number of surface irregularities shall be given in table:

Irregularities	**4mm**		**7mm**	
Length (m)	300	75	300	75
Number of irregularities	50	25	6	3

5. **Density of Compaction:** Minimum value of field density shall be 98% of IS heavy compaction density. Acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus (1.65-$\frac{1.65}{\sqrt{\text{No. of samples}}}$) × standard deviation.

9.3 Do's and Don'ts:

Sr. No.	**Do's**	**Don'ts**
1.	Look for soft patches, if any, and rectify them by removing or adding fresh material and compacting the same thoroughly.	Do not permit organic or other deleterious materials.
2.	While preparing the sub base/ base, where predominant exists, make sure that the surface profile is corrected before spreading the gravel/ soil-aggregate mix.	Do not use materials like crushed slag, crushed concrete, brick metal and kankar without specific approval of the Engineer.

9.4 Quality Control Test (Frequency):

Sr. No.	**Test**	**Frequency**
1	Gradation	Two tests per 500 cum or per day
2	Atterberg limits	Two tests per 500 cum or per day
3	Moisture content prior to construction	Two tests per 500 cum or per day
4	Compacted thickness	Regularly
5	Density of compacted layer	One set of tests per 2000 sqm comprising 6 measurements
6	CBR Test	One test per 5000 cum

CHAPTER -10

WATER BOUND MACADAM

10.1 Methodology:

- Prepare the surface true to profile.
- Template at 6m interval and spread material uniformly.
- Roll the surface with three wheeled roller 80-100 kN wt. or tandem or vibrating roller of same weight and start applying screening after partial rolling.
- Light sprinkle of water, sweep screening to fill interstices and roll till aggregates are keyed in, 2-3 operations. Ensure an overlap of half width of roller in successive passes.
- After application of screening water shall be copiously sprinkled, wet screening broomed in & rolled.
- Apply binding material in two-three layers (PI 4-6) if screenings are non-crushable type.
- No screening for soft aggregates (brick metal, kanker etc.)
- No rolling if sub grade is soft.
- No traffic till curing of WBM.
- Binding materials normally have PI 4 to 6. It should pass 100% through 425-micron sieve.

10.2 Quality Control Requirements:

1. Materials:

Coarse Aggregates:

- **AIV** Not > 50% (sub base)
  Not > 40% (base)
  Not >30% (unsurfaced roads)
- **Flakiness index** Not > 30% sub base
  Not > 25% base
- **Water absorption** Not > 6% sub base (as per Rural Road Manual)
  Not > 3% base

Grading Requirements of Course Aggregates for WBM

Grading No.	Size Range	IS Sieve Designation	%age by weight passing
1.	90mm to 45mm	125mm	100
		90mm	90-100
		63mm	25-60
		45mm	0-15
		22.4mm	0-5
2.	63mm to 45mm	90mm	100
		63mm	90-100
		53mm	25-75
		45mm	0-15
		22.4mm	0-5
3.	53mm to 22.4mm	63mm	100
		53mm	95-100
		45mm	65-90
		22.4mm	0-10
		11.2mm	0-5

NOTE: The compacted thickness for layer with Grading 1 shall be 100mm while for layer with Grading 2 and 3, it shall be 75mm. For base course, Grading 2 and 3 may be preferred. Grading 1 will be used for sub base only.

Grading for Screening

Grading Classification	Size of Screenings	IS Sieve Designation	%age by weight passing the IS Sieve
A	13.2mm	13.2mm	100
		11.2mm	95-100
		5.6mm	15-35
		180 micron	0-10
B	11.2mm	11.2mm	100
		5.2mm	90-100
		180 micron	15-35

2. Surface Level:

The tolerance in surface levels of the WBM would be as under:

a) Sub base course ±20mm
b) Base course
   i. Machine laid ±10mm
   ii. Manually laid ±15mm
   (A grid of 10-15m may be formed to check the surface levels).

3. Surface regularity:

The maximum permitted number of surface irregularities shall be given in table:

Irregularities	**4mm**		**7mm**	
Length (m)	300	75	300	75
Number of irregularities	50	25	6	3

4. Rolling: Rolling shall be done with 80-100kN roller from lower to higher edge & continue till road metal is thoroughly keyed and creeping of stone ahead of roller not visible, light water sprinkle be given.

10.3 Do's and Don'ts:

Sr. No	Do's	Don'ts
1	Check aggregates for grading, Los Angeles Abrasion Value or Aggregate Impact Value, Water Absorption and Soundness and Screenings for grading, LL and PI.	Do not use material other than crushed or broken stone or crushed slag.
2	Use templates at about 6m apart to prepare surface to profile.	Coarse aggregates should not contain excess flat, elongated soft disintegrated particles, dirt and deleterious material.
3	Ensure an overlap of half width of roller in successive passes.	Do not use screenings if aggregate is soft. (E.g. brick metal, kankar, etc.)

4	Build shoulders simultaneously along with WBM courses.	Do not allow segregation or pocket of coarse/fine material on the layer.
5		Do not spread coarse aggregate more than 3 days in advance of any subsequent operations.
6		Do not roll if sub grade is soft or yielding or causes a wave like motion while rolling.
7		Do not use screenings to make up depressions.
8		Do not allow traffic till macadam is fully set.

10.4 Quality Control Tests Frequency:

Sr. No	Test	Frequency
1	Aggregate impact value	1 test per 250 cum or per day
2	Grading of aggregate and screenings	2 tests per 250 cum or per day
3	Flakiness index	1 test per 250 cum or per day
4	Atterberg limits of binding material, if required	1 test per 50 cum or per day
5	Water absorption	1 test per source (three representative specimens for each source)
6	Thickness	Regularly

CHAPTER-11

WET MIX MACADAM

11.1 Methodology:

Material passing 425 micron shall have PI<6

Mixing: In pan type mixer or other suitable mixing plant.

Optimum moisture content on size 4.75mm to 22.4 mm

Spread with paver/ motor grader.

Rolling: with vibratory roller

From lower edge to higher edge.

Q.C. in laying & compacting by camber templates/3M st.edge

Thickness control: by thickness block

Surface regularity checked with 3M st. edge 12mm.

11.2 Quality Control Requirements:

- Crushed graded aggregate and granular material premixed with water to a dense mass on a prepared sub grade/ sub base/ base or existing pavement laid with ordinary/vibratory 80kN and 100 kN road roller.
- Thickness 75mm with ordinary roller
  225mm with vibratory road roller.
- AIV 30%
- FI+Elong. 30% (SH/NH)
- Water absorption 2

If more than 2 have soundness test.

Grading

IS Sieve Designation	%age by wt. passing IS Sieve
53.00mm	100
45.00mm	95-100
26.50mm	----
22.40mm	60-80
11.20mm	40-60

4.75mm	25-40
2.36mm	15-30
600 micron	8-22
75 micron	0-8

11.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Ensure compliance of all material and plant requirements.	Do not use material other than crushed stone.
2	Check aggregate for soundness test when water absorption is more than 2%.	Do not allow segregation or pockets of coarse/fine material on the layer.
3	Build shoulders simultaneously along with WMM layers.	Do not allow any traffic on the WMM surface without covering it with a wearing course.
4	Remove BT surface before WMM is laid on an existing road.	

11.4 Quality Control Test Frequency:

Sr. No.	Type of Test	Frequency
1	Grading test	At least one test per day
2	Aggregate impact value	At random one test per km
3	Placement moisture content	At least three tests per day
4	Density of compacted layer	At least three tests per day
5	Thickness of compacted layer	At random

CHAPTER-12

MAINTENANCE

12.1 General: Condition of the roads is generally poor due to inadequate maintenance & lack of proper resources. Scientific approach is necessary for proper maintenance to ensure optimal utilization of available resources. Budgetary constraints & low priority for road maintenance are usual in management circles.

12.2 Prioritizing Maintenance: Normally, the practices of prioritizing or estimating the maintenance requirement are mainly based on visual survey & thumb level method. Therefore the actual requirements of maintenance need cannot be compared technically. This leads to improper maintenance & failure of roads very often. In facts, it is necessary to have a priority model based on several interrelated parameters along with pavement condition. The system should be based on saving system for maintenance on priority ratings, which includes overall condition of the pavement & distress.

Suggested weightage factors for different Parameters		
Sr. No.	**Parameters**	**Suggestive relative weight (%)**
1.	Road surface condition	20
2.	Population served	15
3.	Regional development	15
4.	Socio-Economic development	10
5.	Traffic volume	10
6.	Relative importance of road (in terms of service)	10
7.	Safety	10
8.	Political aspects	10

12.3 Pavement Management System:

Modern methods of highway maintenance make use of good management principles, which are invaluable aids in planning, and programming of maintenance operations. Many Pavement Management System (PMS) have been developed and are extensively used worldwide. A PMS is a computer package, which facilitates advance planning of maintenance operations and optimal allocation of resources. Its main elements are:

1. A basic road data bank, built-up and updated periodically by road inventories and condition surveys.
2. A pavement performance model, which predicts the future performance of a given pavement system.
3. A transportation cost model, which calculates the road user costs for the given condition of the pavement.
4. Selection of intervention levels.
5. Prioritizing the maintenance needs (renewal and overlay) for a given budget.

It should be noted that for the survey data to be accurate, a stable system of longitudinal marking along the road is necessary to readily locate and identify the areas referred to in the condition survey. For example the person doing the visual inspection survey, must be able to

accurately identify the chainage at any point on the road, in order that the maintenance team can readily find the location.

Clearly, maintenance of the road pavement alone is not, and should not be, the only concern of any roads authority. Therefore, in order to allow the wider issues to be addressed in a properly structured manner, it is usual for the Pavement Management System to be an integral part of a larger overall Road Maintenance Management System (RMMS).

12.4 Failures: No matter how well & scientifically the roads may have been designed planned & constructed failures do occur. They may be:

- **Premature failures:** Roads not gone through full service/life.
- **Terminal failure:** Full life/mature failure. Such failures are anticipated.
- **Accidental failures:** Like from floods earthquake landslide vehicular accidents etc.

12.4.1 Causes of failure: It is important to know causes of failure so that actions could be taken accordingly. In general they are:

1. Defective materials and construction method.
2. Inadequate drainage.
3. Traffic intensity.
4. Environmental factors.
5. Other quality control measures.

12.5 Symptoms of Defects:

a. **Surface Defects:** It includes fatty surfaces, smooth surfaces, streaking and hungry surfaces.
b. **Cracks:** It includes hair-line cracks, alligator cracks, longitudinal cracks, edge cracks, shrinkage cracks and reflection cracks.
c. **Deformation:** Under this are grouped slippage, rutting, corrugations, shoving, shallow depressions and settlements and up heals.
d. **Disintegration:** Covering stripping, loss of aggregates, raveling, pot-holes and edge breaking.

12.6 Classification of Maintenance Operations: Maintenance operations can be classified into three groups:

1. Routine maintenance which is the day-to-day work that is necessary to preserve and keep a pavement as close to as constructed condition as possible. It embraces activities such as pothole patching, sealing of cracks etc.
2. Periodic Maintenance, which is the work, carried out periodically every few years to prevent deterioration of a payment. It covers work such as applying a seal or thin resurfacing course.
3. Rehabilitation and strengthening, which are substantially major works intended to restore or upgrade the pavement. The work covers thick overlays.

12.7 Periodicity of Maintenance & Calendar Thereof:

The various important items of maintenance activities and their execution schedule.

Maintenance Activities and Execution Schedule

Sr. No.	Description Of Item	Frequency of operations in One year	Maintenance Calendar
1.	Clearing of road side drains	Twice	Before & after rains
2.	Pot-holes filling (WBM & BT)	Make road pot holes free	As and when developed
3.	Filling of edges of asphalt surface of excavating borrow pit	Make road pot holes free	As and when developed
4.	Dressing of berms	Twice	Immediately before and after rains
5.	White washing guard stones	Twice	Immediately before and after rains
6.	Fixing disturbed caution board/ name board/ speed limit board etc.	Once	As and when developed specially after rain
7.	Re-fixing displaced guard stones	Once	As and when developed specially after rain
8.	White washing Geroo painting of trunks	Once	As and when developed specially after rain
9.	Cutting of branches of trees etc.	Once	As and when developed specially after rain
10.	Maintenance of catch water drains	Once	As and when developed specially after rain
11.	Clearance of CD works	Twice	As and when developed specially after rain
12.	Clearing of wild seasonal growth on berms	Once	As and when developed specially after rain
13.	White washing parapets of CD works	Once	As and when developed specially after rain
14.	Earth work in berms, desilting of drains etc.	Twice	Before and after rain

12.8 Identification of Defects & recording formats:

One register should be maintained by every JEN for recording inspection details of roads of his section under defect liability period.

The recording of defects shall be made in the proper format. If no defects are noticed, then a simple remark of this effect is written in the defect liability register.

12.9 Communication of Defects to agency:

As soon as maintenance defects are noticed, they shall be conveyed to the contractor asking for their rectification of defects is not done by the contractor, then those shall be attended by the department at the Risk & Cost of Contractor, as per agreement provisions.

Up keeping & maintenance of roads during the defect liability period is the top priority job, therefore, it is advised to follow given instructions strictly.

CHAPTER-13

PRIME COAT

13.1 Methodology:

- Bituminous primer should be slow setting bitumen emulsion, use of cutback being restricted to areas having subzero temperature or for emergency operations.
- The prime coat should be applied only on the top most granular base layer, over which bituminous treatment is to be applied. The granular base surface should be swept clean of dust and loose particles and where required.
- The primer should be sprayed uniformly over the dry surface of absorbent granular base, using suitable bitumen pressure distributor or sprayer capable of spraying primer at specified rates and temperature so as to provide a uniformly unbroken spread of primer. Normal temperature range of spraying emulsion should be 20^0C to 60^0C.
- A very thin layer of coarse sand may be applied to the surface of the surface of the primer to prevent it from getting picked up under the wheels of vehicles delivering materials for construction of bituminous layer.
- The surface should be allowed to cure preferably for 24 hours. Spread sand over the portions found uncured.

13.2 Quality Control Requirements:

- The viscosity requirements for bitumen emulsion will depend upon the type of surface as already given in table.

Rate Of Application of Bituminous Emulsion For Prime Coat				
Porosity	**Type of surface**	**Viscosity at 60^0C**		**Rate of application per 10 sq m (kg)**
		Kinematic Viscosity (Centistokes)	**SayboltFurol (seconds)**	
Low	WMM/WBM	30-60	14-28	6-9
Medium	Cement stabilized soil base	70-140	33-66	9-12
High	Gravel base	250-500	117-234	12-15

13.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Use slow setting emulsion and restrict the use of cutback to subzero temperature conditions or emergency operations.	Do not apply primer when the atmospheric temperature in shade is less than 10^0C or when the weather is foggy, rainy or windy.
2	Use only pressure sprayers.	Do not allow pouring of primer using perforated cans.
3	Preferably lay a trail section.	Do not allow traffic on primed surface.
4	The contractor to demonstrate at a spraying trial to ensure that the equipment is capable of producing a uniform spray.	Do not apply bituminous material to a wet surface.

13.4 Quality Control Tests Frequency:

Quality Control Tests During Construction		
Sr. No.	**Type of Test**	**Frequency**
1	Temperature of binder, when cutback is used	Regularly
2	Rate of spread of binder	At least two tests per day
3	Curing of primer	Before any subsequent treatment.

CHAPTER-14

TACK COAT

14.1 Methodology:

- The surface on which tack coat is to be applied should be clean, free from dust, dirt and any extraneous materials and dry.
- The binder should be sprayed uniformly over the surface using suitable bitumen pressure sprayer capable of spraying bitumen and emulsion at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen emulsion. For smaller jobs, a pressure hand sprayer may be used. Normal range of spraying temperature should be 20^0C-60^0C in case of emulsion and 50^0C-80^0C in case of cutback. The rate of application depends upon the type of surface.
- The surface should be allowed to cure until all the volatiles have evaporated.
- The surface should be allowed to cure preferably for 24 hours.
- The bituminous binder should be bituminous emulsion (rapid or medium setting). The use of cutback (RC-70 or MC-70) should be restricted to areas with subzero temperature.

14.2 Quality Control Requirements:

- Binder for Tack Coat: Rapid setting bituminous emulsion Grade RS-1 complying with IS: 1887 as specified in contract. For sites at sub-zero temperature: Cutback bitumen (Medium Curing Grade) as per IS: 217.

Rate of Application of Tack Coat		
S. No.	**Type of surface**	**Rate of application/10sqm**
1	Bituminous surfaces	2.5kg
2	Granular (primed)	3.0kg

14.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Plan the work so that no more than the necessary tack coat for the day's operation is placed on surface.	Do not apply tack coat when atmospheric temperature is less than 10^0C or when weather is foggy, rainy or windy.
2	Handle bituminous cutback carefully to avoid fire mishap.	Do not apply tack coat on a wet surface.
3		Do not allow any equipment or vehicles on tack coat.

14.4 Quality Control Test Frequency:

Sr. No	Test	Frequency
1	Quality of binder	1 test per lot or 10 tones
2	Temperature of binder	Regular close intervals
3	Rate of spread of binder	2 tests per 1000 sqm or per day

CHAPTER-15

SURFACE DRESSING

15.1 Methodology:

- Prepare the base on which surface dressing is to be laid to the specified lines, grade and cross- section. If the base is of granular material, a prime coat should be applied.

- Apply the binder (at specified temperature) as per rate of spread of binder or as designed with an appropriate bitumen distributor fitted with a spray bar. Binder shall be sprayed/distributed uniformly over the prepared base, with self propelled or towed sprayer, capable of supplying the binder at specified rate.

Nominal Rates of spread of Binder And Chippings			
Nominal chipping size (mm)	**Binder (Penetration grade bitumen) kg/m^2**	**Bitumen emulsion (kg/m^2)**	**Aggregate (cum/m^2)**
13.2	1.0	1.5	0.010
9.5	0.9	1.4	0.008
6.3	0.75	1.1	0.004

- The application temperature for the penetration grade binder used shall be as specified in table.

Spraying Temperatures For Binders				
Binder Grade	**Whirling spray jets**		**Slot Jets**	
	Min^{0}C	**Max^{0}C**	**Min^{0}C**	**Max^{0}C**
VG 10	180	200	165	175

- Immediately after application of binder, spread clean dry stone aggregate at the rate or as designed with the help of a mechanically operated chip spreader, in a single layer. In case of emulsion as a binder, the aggregate may be slightly damp.

- Immediately after spreading of aggregates, roll the surface with the help of suitable road rollers. Commence rolling from the edges and progress towards the center except in super elevated portions where it shall proceed from the lower edge to the higher edge. Each pass should have an overlap of not less than one-third of the track made in the preceding pass. Spread additional stone chips to make up irregularities, if any. Rolling should continue until all aggregate particles are firmly embedded in the bituminous binder and present a uniform closed surface.

- Where two-coat surface dressing is specified in the contract, the second coat should be applied after the first coat is exposed to traffic for 2 to 3 weeks. Procedures stated here in above will apply. The road may be opened to traffic 24 hours after the work of rolling is complete. In exceptional circumstances, traffic may be allowed immediately after rolling provided the traffic speed is limited to 20 km/h until the following day.

- Where use of precoated chips is specified, the first step will be to precoat chips. The stone chips will be heated to 160^0C and mixed with 0.75 to 1% of paving bitumen by weight heated to its application temperature. The precoated chips shall be cured for one week or till such time as they become non-sticky.

15.2 Quality Control Requirements:

1. Materials

(a) Stone Chippings

(i) Physical requirements: Stone chippings should satisfy the requirements given in table except that water absorption shall be 1% maximum.

(ii) Grading: The stone chippings should conform to the Grading given in table.

IS Sieve Designation (mm)	**Cumulative % by weight of total aggregate passing for the following nominal size (mm)**		
	13.2	9.5	6.3
19.0	100	--	--
13.2	85-100	100	--
9.5	0-40	85-100	100
6.3	0-7	0-35	85-100
4.75	--	0-10	--
3.35	--	--	0-35
2.36	0-2	0-2	0-10
0.60	--	--	0-2
0.075	0-1.5	0-1.5	0-1.5
Min. 65% by weight of aggregate	Passing 13.2mm retained 3.35mm	Passing 13.2mm retained 3.35mm	Passing 13.2mm retained 3.35mm

(b) Bitumen: The binder should be bituminous material, which may be as per the contract, or as decided by the Engineer.

- Paving grade bitumen (IS 73)
- Modified bitumen (IS 15462)
- Rapid setting bitumen emulsion (IS 8887)

(c) Where aggregate fails to pass the stripping test, an approved adhesion agent may be added to the binder, in accordance with the manufacturer's instructions.

2. **Horizontal Alignment:** The edges of the Surface Dressing should be correct within a tolerance limit of (±) 20 mm in plain and rolling terrain and (±) 30 mm in hilly terrain.

3. **Surface Level:** The tolerance in surface level of the surface dressing would be (±) 6 mm for machine laid and (±) 10 mm for manually laid surface dressing.

4. **Surface Regularity:** The maximum allowable difference between the pavement course and a 3 m straight edge shall not exceed 10 mm for longitudinal profile and 12 mm for cross profile respectively.

15.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Ensure correct rate and uniform spread of binder based on field trials.	Do not carry out work when atmospheric temperature is less than 10^0C or when weather is foggy, rainy or windy.
2	Add approved Anti-Stripping agent to binder where aggregate fails to pass the stripping test.	Do not carry out the work on wet surface.
3	Alternatively use precoated chips. Correct any excessive deposit of bitumen by blotting before spreading the chips.	Do not resort to excessive rolling as that may crush the stone chips.
4	Maintain the temperature prescribed for the time of spraying on the surface.	Do not allow traffic immediately after the work of rolling is over.

15.4 Quality Control Test Frequency:

Sr. No.	Type Of Test	Frequency
1	Rate of spread of binder	At least two tests per day
2	Rate of Spread of aggregate	-do-
3	Grading of Aggregate	At least one test per day
4	Temperature of binder during spraying	Regularly, at close intervals.
5	Storage stability Test for Bitumen Emulsion	One test per day
6	Aggregate impact value	At random one test per km

CHAPTER-16

PREMIX CARPET

16.1 Methodology:

- Prepare the base on which premix carpet is to be laid to the specified lines, grade and cross-section.
- Apply a prime coat followed by tack coat over a granular base preparatory to laying of the carpet.
- The quantities of material required for 20mm thick premix carpet should be indicated in table.

Quantities Of Material Required For 10m^2 Area		
S. No.	**Aggregate**	**Quantity**
1	Nominal size 13.2mm (passing 22.4mm sieve and retained on 11.2mm sieve)	0.18m^3
2	Nominal size 11.2mm (passing 13.2mm sieve and retained on 5.6mm sieve)	0.09m^3
	Total	**0.27m^3**
S. No.	**Binder**	**Quantity**
1	For 0.18m^{3}of 13.2mm nominal size stone at 52kg bitumen per m^3	9.5 kg
2	For 0.09m^{3}of 11.2mm nominal size stone at 56kg bitumen per m^3	5.1kg
	Total	**14.6 kg**

- Locate hot mix plant near the work site. The mixed material should be transported quickly to the site work and laid uniformly by suitable means.
- The premixed material shall be spread on the road surface with rakes.
- The temperature of bitumen at the time of mixing should be in the range of 150^{0}C to 163^{0}C and that of aggregates 155^{0}C to 163^{0}C, provided that the difference between the temperature of aggregate and the binder should not exceed 14^{0}C. The temperature at the time of discharge of the mixture should be 130^{0}C and 160^{0}C.
- Rolling with 80-100kN rollers (three-wheel or tandem type), beginning from the edge and progressing towards the centre longitudinally. (On super elevated portions, rolling should progress from lower to upper edge parallel to centre line of pavement). Each pass should have an overlap of at least one-third of the track made in the preceding pass.
- Correct any high spots or depressions noticed after the roller has passed over the whole area once by removing or adding premixed material and recompacting.
- Provide a seal coat to the surface immediately after laying the carpet.
- The road may be opened to traffic 24 hours after the work of laying the seal coat.

16.2 Quality Control Requirements:

- **Aggregates:** Aggregate shall confirm to the physical requirements indicated as below:

Physical Requirements of Stone Aggregate			
S. No.	**Property**	**Test**	**Specification**
1	Particle shape	Flakiness index	Max 25%
2	Strength	Aggregate impact value	Max 30%
3	Durability	Sodium Sulphate Magnesium Sulphate	Max 12% Max 18%
4	Water absorption	Water absorption	Max 1%
5	Stripping	Coating and stripping of bitumen aggregate mixture	Min retained coating 95%

- **Binder:** The binder shall be penetration grade bitumen of a suitable grade S-65/90 depending on climatic condition of the area or of the type as specified in the contract.
- **Horizontal Alignment:** The edges of the carriageway with Premix Carpet should be correct within a tolerance limit of (±) 20mm in plain and rolling terrain and (±) 30mm in hilly terrain.
- **Surface Level:** The tolerance in surface level of the surface dressing would be (±) 6mm for machine laid work and (±) 10mm for work executed manually.
- **Surface Regularity:** The maximum allowable difference between the pavement course and a 3m straight edge shall not exceed 8mm for both the longitudinal profile and the cross profile.

16.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Ensure that aggregates for premix carpet and seal coat conform to the prescribed physical and grading requirements and are clean and dry.	Do not allow manual mixing.
2	Exercise strict control over mixing and laying temperature as per specifications using appropriate thermometers.	Do not undertake the work in foggy, rainy or windy weather or when the atmospheric temperature in the shade is less than 10^0C or when the surface is wet.
3	Rolling operations should be completed before the temperature of the mix falls below 100^0c.	Do not allow any traffic without laying seal coat over the premix carpet.
4	The vehicle used for transporting the mix should be clean.	Do not allow the roller to stand on newly laid material.

16.4 Quality Control Test Frequency:

Sr. No.	Test	Frequency
1	Quality of binder	1 test per lot or 10 tonnes
2	Aggregate impact value	1 test per 250 cum
3	Flakiness and Elongation Index	1 test per 250 cum or per day
4	Stripping value	1 test per source

5	Water absorption	1 test per source
6	Grading	1 test per 50 cum or per day
7	Soundness	1 test per source
8	Temperature of binder at application	Regular close intervals
9	Binder content	1 test per lot or 10 tonnes
10	Thickness	Regularly

CHAPTER-17

BUILT-UP SPRAY GROUT

17.1 Methodology:

- Prepare the base on which built-up spray grout course is to be laid to the specified lines, grade and cross-section.
- Apply tack coat over the base preparatory to laying of the built-up spray grout.
- Spread the coarse aggregates uniformly by mechanical means or other suitable method at the rate of 0.5 cum per 10 sqm area. Remedy all high spots and depressions by removing or adding aggregates.
- Commence rolling with 80-100 kN rollers (three-wheel or tandem type), beginning from the edge and progressing towards the centre longitudinally. On super elevated portions, rolling should progress from lower to upper edge parallel to centre line of pavement.
- Correct any irregularities noticed after the roller has passed over the whole area once by loosening the surface and removing or adding the coarse aggregates followed by rolling. Care should be taken not to over compact the aggregate layer which may prevent free and uniform penetration of bitumen.
- Heat the bitumen to the temperature appropriate to the grade of bitumen and spray uniformly on aggregate layer at the rate of 15 kg per l0 sqm (measured in terms of residual bitumen content) by mechanical sprayers. Any excessive deposits caused by starting or stopping of the sprayers or for any other reason must be removed and made good.
- Immediately after first application of bitumen, spread the second layer of coarse aggregates and repeat the process.
- Apply a second bitumen spray of 15 kg per l0 sqm uniformly on the second layer of aggregate.
- Immediately thereafter, spread the key aggregates uniformly and evenly at the rate of 0.13 cum per l0 sqm area so as to cover the surface completely and roll. Rolling should continue until the key aggregates are firmly embedded in position.
- Provide a wearing course immediately after laying the built-up spray grout. If there is any delay in laying of wearing course, a seal coat would be required before opening to traffic.

17.2 Quality Control Requirements:

a) Materials

i) Coarse Aggregates and Key Aggregates

- **Physical requirements:** Aggregates should satisfy various physical requirements.
- **Grading:** The coarse aggregates and key aggregate should conform to the grading.

ii) Bitumen: The binder should be paving bitumen of penetration grade complying with IS: 73 or an appropriate grade of emulsion complying with IS: 8887, where permitted or specified in the contract.

b) Horizontal Alignment: The edges of the Built-up Spray Grout layer should be correct within

a tolerance limit of (±) 30 mm in plain and rolling terrain and (±) 50 mm in hilly terrain.

c) Surface Level: The tolerance in surface level of the Built-up spray grout should be (±) 6 mm.

d) Surface Regularity: The maximum allowable difference between the road surface and a 3 m straight edge should be 12 mm for longitudinal profile and 8 mm for cross profile.

Grading for course aggregates and key aggregates for built-up spray grout

IS Sieve Designation (mm)	Cumulative % by weight of total aggregate	
	Coarse Aggregate	Key Aggregate
53.0	100	--
26.5	40-75	--
22.4	--	100
13.2	0-20	40-75
5.6	--	0-20
2.8	0-5	0-5

17.3 Do's and Don'ts:

Sr. No.	Do's	Don'ts
1	Stone chippings for both built-up spray grout and seal coat should conform to grading specified and be dry and clean at the time of laying.	Do not undertake the work in foggy, rainy or windy weather or when the atmospheric temperature in the shade is less than 10^0C.
2	Maintain the temperature of bitumen as appropriate to the grade.	The difference between the temperature of stones chips and bitumen should not be more than 14^0C
3		Do not allow any traffic without laying wearing course or seal coat over the built-up spray grout.

17.4 Quality Control Test Frequency:

Sr. No	Type of Test	Frequency
1	Quality of Binder	1 test per lot or 10 tonnes
2	Temperature of binder at application	Regular close intervals
3	Aggregate Impact Value Test	One test per 250 cum or per day
4	Flakiness Index Test	One test per 250 cum
5	Stripping value	One test per source (3 representative specimens for each source)
6	Water Absorption	One test per source (3 representative specimens for each source)
7	Soundness	One test per source
8	Rate of spread	One test per 1000 sq m or per day
9	Grading	One test per 100 cum or per day

CHAPTER-18

BITUMINOUS MACADAM

18.1 Methodology:

- Prepare the base on which bituminous macadam course is to be laid and shape to the specified lines, grade and cross-section.
- Apply tack coat over the base preparatory to lay the bituminous macadam.
- Bituminous macadam should be prepared in a Hot Mix plant of adequate capacity.

Sr.	Bitumen Penetration	Bitumen mixing (^{0}C)	Aggregate mixing (^{0}C)	Mixed material (^{0}C)	Laying (^{0}C)	Rolling (^{0}C)
1	35	160-170	160-175	Max.170	Min.140	Min.110
2	65	150-165	150-170	Max.165	Min.130	Min.100
3	90	140-160	140-165	Max.155	Min.130	Min.100

- Transfer the mixed material quickly to site of work and lay by means of an approved self-propelled mechanical paver.
- Commence initial rolling with 80-100 kN rollers (three-wheel or tandem type), beginning from the edge and progressing towards the centre longitudinally. On super elevated portions, rolling should progress from lower to upper edge parallel to centre line of pavement. Thereafter, do intermediate rolling with vibratory or pneumatic tyred road rollers. This should be followed by final rolling while the material is still workable.
- Any high spots or depressions noticed after the roller has passed over the whole area once should be corrected by removing or adding premixed material. Rolling should recommence thereafter. Each pass should have an overlap of at least one-third of the track made in the preceding pass. Rolling should be continued till all roller marks have been eliminated.
- For single lane roads no longitudinal joint is required, while for double-lane roads longitudinal joints may be required depending on the paver width.
- For making longitudinal or transverse joint, cut the edges of the bituminous layer laid earlier to their full depth so as to expose fresh surface and apply a thin coat of binder. Lay adjacent new layer and compact flush with the existing layer.
- Cover the bituminous macadam with the wearing course within a period of 48 hours. If there is any delay in providing wearing course the bituminous macadam surface should be covered with a seal coat before opening to traffic.

18.2 Quality Control Requirements:

a) Material:

Physical Requirements for aggregates for Bituminous Macadam

Property	Test	Specification
Particle Shape	Flakiness index	Max. 25%
Strength	Aggregate impact value	Max. 30%
Durability	Soundness Loss in weight	

	Sodium Sulphate Magnesium Sulphate	Max. 12% Max. 18%
Water Absorption	Water Absorption	Max. 2%
Stripping	Coating and stripping of bitumen-aggregate mixtures	Min. retained coating: 95%

b) Horizontal Alignment: The edges of the bituminous macadam base should be correct within a tolerance limit of (±) 30 mm in plain and rolling terrain and (±) 50 mm in hilly terrain.

c) Surface Level: The tolerance in surface level of the bituminous macadam would be (±) 6 mm.

d) Composition of Bituminous Macadam:

IS Sieve (mm)	Cumulative % passing by weight of total Aggregate
26.5	100
19	90-100
13.2	56-88
4.75	16-36
2.36	4-19
0.03	2-10
0.075	0-5
Bitumen Content, % by weight of total mixture	3.3-3.5
Bitumen Penetration grade	35 to 90

e) Surface Regularity: The maximum allowable difference between the road surface and a 3 m straight edge would be 12 mm for longitudinal profile and 8 mm for cross profile.

18.3 Do's and Don'ts:

S. No.	Do's	Don'ts
1	Ensure that stone aggregate conforms to the physical requirements and grading requirements and are dry and clean.	Do not undertake the work in foggy, rainy or windy weather or when the atmospheric temperature in the shade is less than 10^0C.
2	In case the aggregate has poor affinity to bitumen use anti stripping agent with the approval of Engineer.	Do not allow the difference in temperature of binder and aggregate to increase beyond 14^0C at any time.
3	While transporting the mixture it should be suitably covered by tarpaulin.	Do not allow the premix material to adhere to the roller wheels. (Do not use excess water for the purpose. Light sprinkling should do.)
4	Rolling operations should be completed before the mix becomes unworkable	Do not use lubricating oil on the wheels of the roller to prevent mix from adhering.
5	Maintain strict control on temperature	Do not allow traffic until the mix has been

	while mixing and rolling.	covered with a wearing course.
6	Regulate the rate of delivery of material to paver to enable it to operate continuously.	Do not move roller at a speed more than 5 km/h.

18.4 Quality Control Test Frequency:

S.No.	Type Of Test	Frequency
1	Grading of Aggregate	At least one test per day.
2	Binder Content	Periodic or at least two tests per day.
3	Density of Compacted Layer	At least one test per day or 250cm^2
4	Temperature of Binder before mixing	Regularly
5	*Temperature of mix during laying and compaction	Regularly
6	Thickness of compacted layer	Regular, at close intervals
7	Aggregate impact value	At random one test per km or per 50m^3 of aggregate
8	Flakiness and elongation index	1 test per 250 cum or per day
9	Stripping value	One test per source (3 representative specimens for each source)

CHAPTER-19

BITUMINOUS CONCRETE

19.1 Methodology:

- Bituminous concrete layer is composed of a thoroughly compacted dense-graded bituminous mixture of very well graded coarse and fine aggregates with filler and relatively higher amount of bitumen compared to DBM and SDBC.
- The surface on which the bituminous concrete is to be laid shall be prepared as per the MOST clauses. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air.
- The application of tack coat shall be at the rate specified in the contract, and shall be applied uniformly. Before applying tack all the nozzles and valves of sprayer nozzle bar are thoroughly cleaned to get uniform distribution of tack coat.
- The thickness of the layer shall be 25mm/40mm/50mm.
- Bituminous material with a temperature greater than 145^0C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer.
- When laying the binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300mm short of the joint. It shall be laid by hand.

19.2 Quality Control Requirements:

a) Material:

Physical requirements for aggregates for bituminous concrete

Grading	**1**	**2**
Nominal aggregate size*	**19mm**	**13.2mm**
Layer thickness	**50mm-65mm**	**25/40mm**
IS Sieve (mm)	**Cumulative % by weight of total aggregate passing**	
45		
37.5		
26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	**5.2**	**5.4**

19.3 Do's and Don'ts:

S. No.	Do's	Don'ts
1	Ensure that stone aggregate conforms to the physical requirements and grading requirements and are dry and clean.	Do not undertake the work in foggy, rainy or windy weather or when the atmospheric temperature in the shade is less than 10^0C.
2	In case the aggregate has poor affinity to bitumen use anti stripping agent with the approval of Engineer.	Do not allow the difference in temperature of binder and aggregate to increase beyond 14^0C at any time.
3	While transporting the mixture it should be suitably covered by tarpaulin.	Do not allow the premix material to adhere to the roller wheels. (Do not use excess water for the purpose. Light sprinkling should do.)
4	Rolling operations should be completed before the mix becomes unworkable	Do not use lubricating oil on the wheels of the roller to prevent mix from adhering.
5	Maintain strict control on temperature while mixing and rolling.	Do not allow traffic until the mix has been covered with a wearing course.
6	Regulate the rate of delivery of material to paver to enable it to operate continuously.	Do not move roller at a speed more than 5 km/h.

19.4 Quality Control Test Frequency:

S. No.	Type Of Test	Frequency
1	Grading of Aggregate	At least one test per day.
2	Binder Content	Periodic or at least two tests per day.
3	Density of Compacted Layer	At least one test per day or 250cm^2
4	Temperature of Binder before mixing	Regularly
5	*Temperature of mix during laying and compaction	Regularly
6	Thickness of compacted layer	Regular, at close intervals
7	Aggregate impact value	At random one test per km or per 50m^3 of aggregate
8	Flakiness and elongation index	1 test per 250 cum or per day
9	Stripping value	One test per source (3 representative specimens for each source)

CHAPTER-20

ROAD SAFETY

Safety on hill roads is of prime importance. It is necessary that appropriate measures are taken to ensure safety. It can be improved in a number of ways, as follow:

20.1 Safety can be improved by following:

a. providing geometric standards of roads as per specifications

b. adequate warning, cautionary and information signs

c. regular maintenance of road

d. construction of protective structure for traffic like parapets, railings, snow sheds, boulder net, etc.

e. appropriate road markings

f. adequate drainage system

g. enforcement of traffic discipline, traffic rules/ regulations

h. introduction of gate system of traffic on crucial road sectors

20.2 Causes of accidents: Driving in hills, especially in adverse and inclement weather conditions, is a very complex, difficult and tiring task. Accidents occur at places where the rhythm of motion changes unexpectedly for a driver. Such happenings are not infrequent on hill roads due to following:

a. Traveling over sharp curves of sub-normal radius in conditions of inadequate sight distance needs frequent deceleration and acceleration.

b. Curves have to be negotiated in varying speeds due to varying degrees of curvature and applying brake when entering a curve and accelerating at the exit.

c. Alternating entry from major valley into a side-valley, crossing of streams by narrow bridges, causeways, etc.

d. Steep grades and alternating UP and DOWN grades and negotiation of high altitudes.

Considering the above, the aim of the highway engineer should be to duly consider the usual driving errors and response of the vehicles and design a highway, which will eliminate such errors and reduce stress on the drivers. A well-designed and constructed road will always be less prone to accidents and will add to safety.

20.3 Safety of hill roads

- Safety on roads in hills, like in the plains, is dependent on the same factors i.e. Driver, Vehicle, Road and Environmental Conditions. However, environmental factors affect a hill road very much due to severity of climatic and terrain conditions like torrential rains and

consequent slides (mud flow, rock fall rolling boulders, etc.) snow fall, snow drifts, avalanche/glacier activity icing problems, fog chilly winds, blizzards, etc. measures to improve safety on hill roads follow the usual pattern of Engineering, Enforcement and Education measures. However, while dealing with engineering measures in detail, as relevant to this manual, others are proposed to be touched upon only.

- Road condition plays a very significant part in road safety. Studies based on wide spread scientific research, involving analysis of road accidents, examination of interaction between vehicles, different road conditions and driver reaction to highway situations, has established a clear relationship between road condition and safety.

- There are elements of roadway that have a direct effect on safety, which include cross-section, vertical and horizontal alignments, access control and system of layout, inter-section design, pavement surface, illumination, road signs and barriers. The effect of these in combination and not individually determines the level of safety.

20.4 Engineering measures: Engineering measures to improve safety in hill roads can be classified into four aspects as under:

a. Geometric design measures, which ensure adequate width, curve radii, easy grades and sight distance.

b. Engineering design measures to deal with specific and exclusive conditions in hills. This includes design and proviso of good drainage system, protection like parapets, railings, snow fences, snow shelters, rolling boulder buffer (netting), etc.

c. Traffic control devices like sign, signals, pavements markings, delineators, advance public warning system etc.

d. Maintenance response and safety monitoring.

20.5 Enforcement measures: There are laws enforcing traffic and vehicle discipline to be adhered to by all road user and drivers. Strict enforcement of these by the appropriate authorities and deterrent action on violations can be enhancing safety level. Some of these are mentioned below:

a. **Condition Of the vehicle:** the vehicle must be in a mechanically fit condition to operate on hill roads.

b. **Condition of driver:** The driver should be physically and mentally capable and alert to operate in the hills and undergo rigors of climate and toughness of terrain met with. Drunken driving should be checked.

c. **Overloading**: Overloading of vehicles (load carriers and passengers) has to be strictly prohibited. The practice of passengers traveling on bus top as also on heavily loaded truck or overcrowding in driver's cabin, which has to be curbed.

20.6 Education measures: Consciousness among the users about the road condition and necessity to adopt safety measures should be imparted by appropriate awareness system like pamphlets, mass media publicity and etc. Important aspects like "DON'T MIX DRINK & DRIVING", IT

TAKES CARE FROM TWO DRIVERS TO AVOID AN ACCIDENT" and "SAFE DRIVING TECHNIQUES" etc. can be imparted by training measures by traffic control and enforcing authorities. Private sector participation for erection of such slogan boards with their advertisement as per approved pattern on the reverse of board may be considered.

20.7 Bridge Approaches: Another serious accident-prone location in hill road is existence of bridge with curved approach combined with down gradient. Such locations are common sites of topping over of vehicle over the bridge. Such sitting of bridges should be avoided and bridge structure should follow the general flow of the alignment. However, short-term measures to improve safety are to increase visibility, use of reflective cautionary signs, use of speed control measures and strong guardrails to deflect out of control vehicles.

20.8 Rock fall, shooting boulders, unstable areas etc.: A common cause of accidents in some locations in hill roads is shooting boulders or rock fall. This is basically due to unstable upper slope. Some of the measures to improve safety of such locations are listed below and may be applied selectively depending on the situation.

a. Stabilize the upper slope by improving drainage, other erosion control measure and treatment of exposed rock face.

b. Planting of upper slopes with a belt of trees to stop the boulders short of the road.

c. Providing extra wide hillside shoulders with deep drain to catch these falling debris and carry away as the water flows.

d. Provide a shelter similar to snow shelter to allow the boulder to go over the road.

e. Provide deflection walls and buffer zone to divert boulders and impound them.

f. Design a wire net screen buffer to catch the boulders and subsequently dispose them off suitably.

g. Post appropriate warning signs to caution the traffic.

Slides, flow of excessive water and slope materials on roads are a common factor endangering safety on roads in hills during rainy season. Major slides block the road and smaller slides make the roads slushy and slippery. Water overflowing drain erodes the berms, jeopardizing safety. A combination of catch-water drains, chutes, catch pits with cross drains and adequate camber can channelize the drainage and improve safety on roads.

BRIDGE

CHAPTER-21

SUB STRUCTURE

21.1 General: Q.A. for construction indicating the following shall be submitted by the contractor for approval of the Engineer, well in advance.

1. Sources of material
2. Design, erection and removal of formwork
3. Production, transportation, laying and curing of concrete
4. Personnel employed for execution and supervision
5. Tests and sampling procedures
6. Lab equipments details

Arrangements for execution under water wherever necessary, shall be included in methodology.

21.2 Piers and Abutments: Masonry, formwork, concrete and reinforcement for piers and abutments shall conform to relevant section of the specifications. In case of concrete piers, the number of horizontal construction joints shall be kept minimum. Construction joints shall be avoided in splash zones unless specifically permitted by the Engineer and provided they are treated in accordance with special provisions. No vertical construction joint shall be provided.

In case of tall piers and abutment, use of slip form shall be preferred for which the design and specifications to be provided by the contractor.

In case of solid abutments, weep holes on shown in the drawings or as directed by the Engineer and the specification briefed in the manual.

21.3 Pier Cap and Abutment Cap: The locations and levels of pier cap/abutment cap/pedestals and bolts for fixing bearings shall be checked carefully to ensure alignment of the bridge.

The surface of cap shall be finished smooth and shall have a slope for draining of water. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

The surface on which elastomeric bearings are to be placed shall be wood float finished to a plane level. The surface on which other bearings (steel bearings, pot bearings) are to be placed shall be cast about 25mm below the bottom level of bearings and as indicated on the drawings.

21.4 Dirt/Ballast wall, Return wall and Wing wall: Masonry, concrete and reinforcement shall conform to relevant previous chapter of these specifications.

In case of cantilever return walls, no construction joint shall generally be permitted.

For gravity type masonry and concrete return and wing wall, no horizontal construction joint shall be provided. Vertical expansion gap of 20mm shall be provided in return wall/wing wall at every 10 meters intervals or as directed by the Engineer.

CHAPTER-22

CONCRETE SUPERSTRUCTURE

REINFORCED CONCRETE CONSTRUCTION

22.1 Solid Slabs: Where adjacent span of slab has already been cast, the expansion joint and filler board shall be placed abutting the already cast span which shall form the shutter on that side of the new span to be cast The whole of the slab shall be cast with reinforcement embedded for the road kerb and railings.

Where wearing coat is requireto be provided, after the deck slab has been cast, the surface of the slab shall be finished rough, but true to lines and levels as shown on the drawings, before the concrete has hardened.

The top of the slab shall be covered with clean moist sand as soon as the top surface has hardened curing shall be carried out accordingly.

22.2 RCC T-Beam and Slab: Provision of construction joint shall conform to the drawings or as per directions of the Engineer. No construction joint shall be provided between the bottom bulb and the web. If not indicated on the drawing, construction joint may be provided at the junction of the web and the fillet between the web and the deck slab with the permission of the Engineer.

The portions of deck slab near expansion joints shall be cast along with reinforcements and embedments for expansion joints.

The surface finish of the deck slab shall be finished rough but true to lines and levels as shown on the drawings before the concrete has hardened.

22.3 Prestressed concrete construction:

1. **PSC Girder and Composite RCC Slab:** PSC Girder may be precast or cast-in-situ as mentioned on the drawing or as directed by the Engineer. Girders may be post-tensioned or pre-tensioned. Where precast construction is required to be adopted, selection of casting yard and details of methodology and of equipment for shifting and launching of girders shall be included in the method statement.

   In case of cast-in-situ construction, the sequence of construction including side shifting of girders, if applicable, and placing on bearings shall be in accordance with the drawings.

   The PSC girder constituting the top flange, web and the bottom flange shall be concreted in a single operation without any construction joint.

2. **Box Girder:** Box girders may be simply supported or continuous. Simply supported box girders shall have minimum construction joints as approved by the Engineer. In the case of continuous box girders the sequence of construction and location of construction joints shall strictly follow the drawings.

   The box section shall be constructed with a maximum of one construction joint located in the web below the fillet between the deck slab and web. If permitted by the Engineer, one

additional construction joint may be permitted and this construction joint shall be located in the web above the fillet between the soffit slab and web.

3. **Cantilever Construction:** Continuity of untensioned reinforcement from one segment to the next must be ensured by providing full lap length as necessary.

The design of the superstructure shall take into account the following aspects, which form an integral part of the construction operations:

a) Stability against over-turning for each statical condition, through which the assembly passes, shall be checked.

b) Stresses at each preceding segment joint with the addition of every segment or change of statical conditions shall be checked. The load of equipment as well as construction live load shall be taken into account

c) Precambering of the superstructure during construction shall be done in such a manner that the finally constructed structure under permanent load attains the final profile intended in the drawings.

22.4 TOLERANCES

1. **Precast Concrete Superstructure:**

Variation in cross-sectional dimensions		
a)	upto and including 2m	± 5 mm
	over 2m	± 5 mm
b)	Variation in length overall and length between bearings	shall not exceed ±10 mm or ±0.1 per cent of the span length, which-ever is lesser.
c)	Permissible surface irregularities when measured with a 3 m straight edge or template	5mm

2. **Cast-in-Situ Superstructure:**

a)	Variations in, thickness of top and bottom slab for box girders, top and bottom flange for T-girders or slabs	-5mm to ±10mm
b)	Variations in web thickness	-5mm to ±10mm
c)	Variations in overall depth or width	±5mm
d)	Variation in length overall and length between bearings	shall not exceed ±10mm to ±0.1 per cent of the span length, which-ever is lesser.
e)	Permissible surface irregularities when measured with a 3 m straight edge or template	5mm

CHAPTER-23

PRESTRESSING MATERIALS

All prestressing steel, sheathing, anchorages and sleeves or coupling must be protected during transportation, handling and storage. The prestressing steel, sheathing and other accessories must be stored under cover from rain or damp ground and protected from the ambient atmosphere if it is likely, to be aggressive. Storage at site must be kept to the absolute minimum.

23.1 Tendon: Wire, strand and bar from which tendons are to be fabricated shall be stored about 300mm above the ground in a suitably covered and closed space so as to avoid direct climatic influences and to protect them from splashes from any other materials and from the cutting operation of an oxy-acetylene torch or arc welding process in the vicinity. Under no circumstances, tendon material shall be subjected to' any welding operation or on site heat treatment or metallic coaling such as galvanizing. Storage facilities and the procedures for transporting material into or out of store shall be such that the material does not become kinked or notched. Wire or strand shall be stored in large diameter coils, which enable the tendons to be laid out straight. As a guide, for wires above 5mm dia, coils of about 2m dia without breaks or joints shall be obtained from manufacturer and stored. Protective wrapping for tendons shall be chemically neutral. All prestressing steel must be provided with temporary protection during storage.

23.2 Anchorage Components: The handling and storing procedures shall maintain the anchorage components in a condition in which they can subsequently perform their function to an adequate degree. Components shall be handled and stored so that mechanical damage and detrimental corrosion are prevented. The corrosion of the gripping and securing system shall be prevented. The use of correctly formulated oils and greases or of other corrosion preventing material is recommended where prolonged storage is required. Such protective material shall be guaranteed by the producer to be non-aggressive and non-degrading.

Prestressing steel shall be stored in a closed store having single door with double locking arrangements and no windows. Also the air inside the store shall be kept dry as far as possible by using various means to the satisfaction of the Engineer. Also instrument measuring the air humidity shall be installed inside the store. This is with a view to eliminating the possibility of initial rusting of prestressing steel during storage. The prestressing steel shall be coated with water solvable grease. The prestressing steel should be absolutely clean and without any signs of rust.

All prestressing steel shall be stored at least 30 cm above ground level and it shall be invariably wrapped by protective cover of tar paper or polythene or any other approved material.

The Contractor should see that prestressing steel should be used within 3 months of its manufacture. He should check out his programme in this respect precisely, so as to avoid initial corrosion before placing in position

23.3 Steel for Prestressing:

The prestressing steel shall conform to either of the following:

(a) Plain hard drawn steel wire conforming to IS: 1785 (Part I) and IS: 1785 (PartII).
(b) Cold drawn indented wire conforming to IS: 6003
(c) High tensile steel bar conforming to IS: 2090
(d) Uncoated stress relieved strands conforming to IS: 6006.

ANNEXURE-1

TESTS ON MATERIALS

Quality Control Tests For Earth Work and Sub grade

Sr.No.	Type of Construction	Test
A.	Earthwork for Embankment	1. Soil Classification as per IS:1498 I. Sieve Analysis (Wet sieve Analysis except for cohesionless soils) for determining the size of particles. II. LL, PL and PI for determining the consistency of soil related to water contents.
		2. Standard Proctor Compaction test (IS: 2720 Part 7) for determining the moisture content density relationship vis-à-vis-Max Dry Density.
		3. Free swell Index Test to determine mineral content in soil for expansion property. (IS: 2720 Part-40)
B	Earthwork for Subgrade	**1.** Tests at 1 to 3, under 'A' above. (In case the soil for embankment meets the prescribed requirements for the Subgrade, the above three tests need not be repeated.)
		2. CBR Test (IS: 2720 Part 16) soaked/ unsoaked as specified for determining the stability of soil subgrade.
		3. Placement Moisture Content (IS: 2720 Part2) Where facility for oven drying is not available, any of the following quick test Methods can be used: i) Sand bath method ii) Rapid moisture meter.
		4. Insitu Density Measurements (IS: 2720 part 28) (Each layer)
		5. Degree of compaction, surface regularity and transverse profile/ camber/ cross fall and super elevation for finished subgrade.

Quality Control Test For Sub-Base And Base Course

Sr.No.	Type of Construction	Test
A.	Granular Sub-Base	1. Soil classification as per IS: 1498. i) Wet Sieve Analysis, except for cohesion less soils for determining the size of particles. ii) Liquid and Plastic Limits to determine the consistency.

		2. Combined Grading and plasticity tests on materials from different sources, mixed in the design proportions. This shall be done when material from more than one source are combined.
		3. Proctor Compaction test (IS: 2720 Part7) for determining vis-à-vis-Max. Dry Density.
		4. Wet Aggregate Impact Value Test (IS: 5640) where soft/marginal aggregates are used e.g. Laterite, Kankar, Brick Ballast etc. for determining the toughness of aggregates.
		5. CBR test (IS:2720 Part 16) on representative sample compacted at 100% Proctor dry density for determining the stability of G.S.B. layer.
		6. Placement Moisture Content (IS: 2720 Part 2)
		7. Insitu Density Measurements.(IS 2720 Part 28)
		8. Degree of Compaction and surface regularity of finished G.S.B.
B.	**Water Bound Macadam for G_1, G_2 and G_3.**	1. Aggregate Impact Value Test (IS: 2386 Part 4) for evaluating the toughness of aggregates.
		2. Aggregate water absorption test (IS: 2386 Part 3) for determining the quantity of percentage water absorbed.
		3. L.L. and P.I. of Crushable Screening (IS: 2720 Part 5) (where Screenings are to be used from the same source as the Stone Aggregates this test is not needed).
		4. Grading of stone aggregates and screenings (IS: 2386 Part I) for determining the size of aggregates.
		5. Flakiness index of stone aggregates (IS:2386 Part I for determining percentage flaky material and percentage elongated material particles.
		6. LL AND PI of binding material when used.
C.	**Wet Mix Macadam**	1. Aggregate Impact Value test (IS: 2386 Part 4) for evaluating the toughness of aggregates.
		2. Flakiness Index Test (IS: 2386 Part I) for determining percentage flaky material and percentage elongated material particles.
		3. Water Absorption Test (IS: 2386 Part 3) for determining the quantity of percentage water absorbed.
		4. Grading Test (IS: 2386 Part I) for determining the size of aggregates.
		5. Atterberg Limits of portion of aggregate passing 425 micron sieve (IS: 2720 Part 5) for determining the clay content in soil.
		6. Proctor Compaction Test (IS: 2720 Part 7) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm

		size) alongwith Dry Density-Moisture Content Relationship for determining the moisture content density relationship vis-à-vis-Max. Dry Density.
		7. Placement Moisture Content (IS: 2720 Part 2)
		8. Density of compacted layer (IS: 2720 Part 28)

Quality Control Test For Bitumen Work

Sr.No.	Type of Construction	Test
A.	**Dense Bituminous Macadam/Semi Dense Bituminous Concrete/ Bituminous Concrete**	1. Quality of binder (Penetration, Ductility and softening point test)
		2. Aggregate impact value/ Los Angeles Abrasion value for evaluating the toughness and hardness of aggregates.
		3.Flakiness index and Elongation index for determining percentage flaky material and percentage elongated material particles.
		4.Mix grading.
		5. Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling.
		6. Control of binder content and grading of the mix.
		7. Rate of spread of mixed material.
		8. Density of compacted layer.

Quality Control Tests for Concrete Works

Sr.No.	Type of Construction	Test
A.	**Cement**	Minimum quantity (kg/m^3)
B.	**Coarse Aggregates**	1. Gradation for PCC works for determining the size of aggregates.
		2. Flakiness index (IS: 2386 Part 1) for determining percentage flaky material and percentage elongated material particles.
		3. Water absorption/ content (IS: 2386 Part 3) for determining the quantity of percentage water absorbed.
		4. Aggregate Impact value (IS: 2386 part 4) for determining the toughness of aggregates.
C.	**Fine Aggregates**	1. Moisture Content (IS: 2386 Part 3)
		2. Gradation (IS: 2386 Part I) for determining the size of aggregates.
		3. Fineness Modulus for sand.
D.	**Water**	Normally potable water is good enough for making concrete.
E.	**Concrete**	Mix Design (for each work) to be approved by EE for cement content, W/C ratio and use of

		plasticizers, if any.
		1. Workability-slump cone test (IS: 1199)
		2. Cube strength (IS: 516)
F.	**Pre-cast Concrete Block**	1. Size
		2. Cube strength of mix used for concrete block.
		3.Consistency and compressive strength of Mortar used.

Quality Control Tests for Steel Works

Sr.No.	Type of Construction	Test
A.	**Steel Reinforcement**	1. Grade, Percentage Elongation and Ultimate Tensile Strength (IS: 432 Part 1 and IS: 1786)
		2. Pitch of the ribs and Nominal Diameter (Clause 1002 of MoRI) Specifications
		3. Modulus of Elasticity

Quality Control Tests for Bricks

Sr.No.	Type of Construction	Test
A.	**Brunt Clay Brick**	1. Color and Dimension Check
		2. Minimum Compressive Strength
		3. Water absorption
		4. Efflorescence.
		5. Compressive strength of brick.
		6. Consistency and compressive strength of mortar (IS: 2250)

Quality Control Tests for Stone

Sr.No.	Type of Construction	Test
A.	**Stone**	1. Shape and dimension IS: 1597 Part-I
		2. Water absorption IS: 1124
		3. Dressing of stone. IS: 1129
		4. Compressive Strength of stone.
		5. Consistency and Compressive strength of mortar

Quality Control Tests for Structural Steel Works

1. Certification of its composition by the manufacturer I.S.O. approved.
2. Certification of its Mechanical properties by the manufacturer I.S.O. approved.

Quality Control Tests for Concrete Pipes

Sr.No.	Type of Construction	Test
A.	C.C. Hume Pipe.	1. Dimensions and grade.
		2. Tolerances (IS: 458)
		3. Three edge bearing test (IS: 3597)
		4. Laying, joining of pipes and longitudinal gradient.
		5. Cushion over pipes.

ANNEXURE-2

GUIDELINES ON SELECTION OF BITUMINOUS BINDER

Bitumen:

For surface dressing, premix carpet, mix seal surfacing, bituminous macadam, built-up spray grout and modified penetration macadam.

I. Paving grade VG-10 may be used:
   - in NE states
   - in high altitudes, snowboard areas
   - in areas where temperature variations throughout the year are more than 25^0C.

II. Paving grade VG-30 may be used:
   - in coastal regions
   - in areas with hot climate condition throughout the year.
   - in areas where the temperature variations throughout the year are less than 25^0C.

Modified Bitumen:

Certain additives or blend of additives can improve properties of bitumen. Selection criteria for these categories are given below. (Source IRC: SP53-2002).

Selection criteria for PMB, NRMB and CRMB based on Atmospheric Temperature				
Minimum Atmospheric Pressure		**Maximum atmospheric temperature**		
		<35^{0}C	**35^{0}C to 45^{0}C**	**>45^{0}C**
	<-10^{0}C	PMB/NRMB-120 CRMB-50*	PMB/NRMB-70 CRMB-55	PMB/NRMB-70 CRMB-55
	-10^{0}C to 10^{0}C	PMB/NRMB-70 CRMB-50	PMB/NRMB-70 CRMB-55	PMB/NRMB-40 CRMB-60
	>10^{0}C	PMB/NRMB-70 CRMB-55	PMB/NRMB-70 CRMB-55	PMB/NRMB-40 CRMB-60

* Note below – 15^0C

PMB – Polymer Modified Bitumen

NRMB – Natural Rubber Modified Bitumen

CRMB – Crumb Rubber Modified Bitumen

Emulsion

(i) For premix carpet, mix seal surfacing – Medium Setting (MS) type for all areas.
(ii) For surface dressing – Rapid Setting (RS) type for all areas.
(iii) For prime coat and tack coat – Slow Setting (SS) type for all areas.

Cut-Back: Cutback may be used under sub-zero temperature conditions. For surface dressing, it may be rapid curing. For prime coat, tack coat, premix carpet and mix seal surfacing, it may be medium curing.

Sampling Bitumen:

(i) Heat the bitumen inside the container or tank so that it comes to a liquid state.
(ii) Mix it with the sampling device, which has a long rod, attached to it.
(iii) Take sample from the top portion, middle portion and bottom portion in a container separately:
   a. **Top sample:** Sample taken at a level of one sixth of the depth from the top surface of the container.
   b. **Middle sample:** Sample taken at one half of the depth.
   c. **Lower sample:** Sample taken at a level of five – sixths of the depth.
(iv) For knowing the variation among these three samples, these can be collected in different containers and tested separately. A mixture of these samples can also be taken for testing.

Requirements for Paving Grade Bitumen:

Sr. No.	Characteristics	Grade VG-30	Grade VG-10
1	Penetration at 25^0C	60-70	80-100
2	Ductility	75cm min	75cm min
3	Softening Point	45^0C-55^0C	45^0C-55^0C
4	Specific Gravity at 27^0C	0.99	0.99
5	Water content	0.2%	0.2%
6	Flash point	175^0C	175^0C
7	Viscosity at 60^0C	2000±400	1000±400
8	Loss of heat	1%	1%
9	Solubility in Trichloroethylene	99%	99%
10	Wax content	4.5% max	4.5% max

Requirements for Emulsion:

Sr.No.	Characteristics	Rapid Setting (RS)	Medium Setting (MS)	Slow Setting (SS)
1	Sieve test	0.35% max	0.05% max	0.05% max
2	Stability to mixing with aggregate	Good to fair	Good to fair	Good to fair
3	**Viscosity**			
	At 25^0C	--	--	20-100
	At 50^0C	50-400	50-400	--
4	Storage stability	1% max	1% max	1% max
5	Particles charge	Positive	Positive	Positive
6	Miscibility with water	Nil	Nil	Nil
7	Stability with cement	--	--	2% max

ANNEXURE-3

EQUIPMENT FOR FIELD LABORATORY

The field laboratory should be equipped with essential equipment required for day-to-day tests for exercising quality control during construction. Further, only those test equipment, which are relevant to the project specifications, will be necessary. Where the Contractor is required to carry out the maintenance of road and structures, the field laboratory should have necessary equipment during maintenance period for exercising quality over maintenance activities.

List of Essential Equipment - For Earthwork, Granular Construction and other General Requirements:

1.	Post Hole Auger with extensions	One set
2.	Digging tools like pick axes, shovels etc.	One set
3.	IS Sieves with lid and pan (125 mm, 100 mm, 90 mm, 80 mm,75 mm, 63 mm, 53 mm, 50 mm, 45 mm, 40 mm, 31.5 mm, 26.5 mm, 25 mm, 22.4 mm 20 mm,19 mm, 16 mm, 13.2 mm, 12.5 mm, 11.2 mm, 10 mm, 9.5 mm, 6.3 mm, 5.6 mm, 4.75 mm, 3.35 mm, 2.36 mm, 2 mm, 1.18 mm, 600 micron, 425 micron, 300 micron, 180 micron, 150 micron, 90 micron and 75 micron)	One set
4.	Standard Proctor Density Test Apparatus with Rammer	One set
5.	Sand Pouring Cylinder with tray complete for field density test	One set
6.	Core Cutter (10 cm dia), 10 cm/15 cm height complete with dolly and hammer	One set
7.	Speedy moisture meter complete with chemicals	One set
8.	Straight Edges	Two nos.
9.	Liquid Limit and Plastic Limit testing apparatus	One set
10.	Gas Burner, sand bath	One set
11.	Camber Board	Two nos.
12.	Electronic/digital balance 1 kg with the least count of 0.01 g	One no.
13.	Electronic /digital balance 5 kg	One no.
14.	Pan balance with weight box, 5 kg	One no.
15.	Oven (200^{o}C), thermostatically controlled	One no.
16.	Enameled tray	Six nos.
17.	Measuring tape, spatula, spirit levels, glassware, porcelain dish, pestle mortar	One set
18.	Aggregate Impact Test Apparatus	One set
19.	Flakiness Gauge	Six nos.
20.	Essential survey equipment for checking surface levels	One set
21.	Lab CBR equipment	One set

22.	Uppal's Syringe for Plasticity Index	One set
23.	Pocket Penetrometer	One set

For other tests like Soundness of Aggregate, Deleterious Material, Sulphate Content etc. facilities at the District Laboratory will be used.

Additional Equipment for Bituminous Construction

1.	Digital Thermometers	Three nos.
2.	Water bath (ambient to 100^{o}C)	One no.
3.	Penetration apparatus (Bitumen)	One set
4.	Trays for measurement of tack coat quantity	Three nos.
5.	Bitumen extraction apparatus	One no.

For other tests like R&B Softening Point, Viscosity, Storage Stability, Ductility, Elastic Recovery and Separation Difference, facilities at the District Laboratory will be used.

Additional Equipment for Cement Concrete Works and Structures

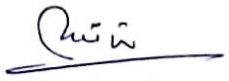
1.	Slump Cone	Two nos.
2.	Cube Moulds	Twelve nos.
3.	Core Cutting Machine	One no.

For other tests like physical and chemical tests on Cement, Alkali Aggregate Reactivity Test, Chemical Tests for Water, Compressive and Flexural Strength of Concrete etc., facilities at the District /Central Laboratory will be used.

NOTE

This Handbook has been approved as a reference by Public Works Department, Govt. of Himachal Pradesh vide letter no. PW-SE(QC&D)/EA-1/CM/QC.Cell/2020-3004-06 dated 02/12/2020. However, the provisions in the relevant manuals, CPWD Manual & relevant IS Codes with upto date amendments shall supercede the provisions in this handbook in case of any variation.

For WAPCOS Ltd.



(Sumitt Mittal)
Addl. Chief Engineer & Project Manager
Chandigarh Office

GOVERNMENT OF HIMACHAL PRADESH

HANDBOOK ON QUALITY CONTROL

Part- C

Himachal Pradesh State Electricity Board Limited

Prepared by:

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PREFACE

The Government of H.P. felt its necessity that IQCS may be constituted to have an independent quality check and positioned in CM office. The squad shall be headed by the Team Leader and ably assisted by specialist/expert having vast experience in Civil Engineering works, Mechanical, Electrical works and IPH works being executed by the various departments.

WAPCOS Ltd., A Govt. of India Undertaking, Ministry of Jal Shakti, Chandigarh office has been entrusted with the task of implementing this program for total quality management concept aimed at embedding awareness of quality in all infrastructure departments of Govt. of H.P. including but not limited to PWD, IPH, HPSEB, Urban development, Forest, Tourism, RDD and HPSIDC etc.

In this respect this handbook has been prepared which is brief, handy and instant helpful at site for field engineers. It is an effort just like to express too much in too few words. It summarizes all quality assurance, specifications and prepared on basic sources viz HPPWD specifications for building and roads, rural road manual, MORTH and handbook of quality control Vol.- 1 and Vol- 2. The IPH contents have been taken from CPEHEEO, AWWA manual, Pollution Control Board and Relevant Standard codes etc. The handbook has been prepared by in cooperating relevant extract from HPPWD specification keeping in view subsidiary departments also and prevalent practice being followed at present.

In preparing this handbook the sincere efforts have been made by the team of WAPCOS Ltd. along with the officers of Himachal Pradesh State Electricity Board Limited, Himachal Pradesh.

We dedicate this effort to the state and hope this handbook shall be very useful for all the field engineers for various departments of Govt. of HP and advised that it may always be kept with them at site as ready and instant reference. We are further hopeful that the state authorities would evolve suitable mechanism to implement the needed quality assurance plan with objective of achieving the economic and social development of the State and improving the quality of life of people.

WAPCOS Limited
A Govt. of India Undertaking
Ministry of Jal Shakti
Chandigarh Office

CONTENTS

HANDBOOK ON QUALITY CONTROL

PART- C
(HIMACHAL PRADESH STATE ELECTRICITY BOARD LIMITED)

Chapter-1

INSTALLATION OF POLES, CONDUCTORS, TRANSFORMERS FOR POWER DISTRIBUTION

1.1 General: Before going to discussion on poles, conductors, transformers, generators and all other allied equipments, electrical materials, classification of voltage is given as under:

1. Low voltage – not exceeding 250 volts
2. Medium voltage – not exceeding 650 Volts
3. High voltage – more than 650 Volts and up to 33kv
4. Extra high voltage – more than 33kv

1.2 Electric Pole: A pole or utility pole or post used to support overhead power lines and various other public utilities such as cable, fiber optic cable and related equipment such as transformers and street lights. Supports for overhead lines are mainly two types (a) Pole and (b) Tower. Up to 33kv in distribution system, poles are used and above 33 kv, towers are used. Different types of poles:

1. Wooden pole
2. PCC pole
3. RCC pole
4. Rail pole
5. Steel pole
6. Steel towers
7. Presently, steel tubular poles are being preferred for use on LT & HT lines e.g.

I. LT poles (240 V to 440 V) →8 to 10m long- depending upon site for erection w.r.t. ground clearance.
II. HT poles (11 kV to 33 kV) → 9 to 13 m long – depending upon site for erection w.r.t. ground clearance.
III. Rail poles &Girders→11 to 13m are also used on 33 KV lines and substations.
IV. For 66 kV & above voltage level, Steel Towers are used for 66 KV, 132 KV, 220 KV, 400 KV Transmission Lines and Steel Columns and Gantries are used for 66 kV, 132kV, 220kV, 400kV Substations.
V. Steel tubular poles shall confirm to IS: 2713 (Part I & III): 1980.

1.3 Conductors: Any substance which allows the electric current to flow through it is called conductor. e.g. silver, copper, aluminum, iron, steel etc. silver is the best conductor but is very costly (about Rs 40,000 to 45,000/kg now a days), copper is the 2nd best conductor but also comparatively costly about Rs 450 to 500/kg. Ultimately, aluminum is the optimal conductor because of its low resistance, light weight, cheapest in cost (Rs 130 to 150/kg now a days in the market) and good electrical properties.

- To obtain higher tensile strength in aluminum conductor, it is steel reinforced (or used together with strands of steel) so called ACSR conductor.
- ACSR conductors which are generally used in our distribution & transmission lines are called by name of animals:

1. Weasel conductor – ACSR 6/1/2.59mm – used on 230 V or 400 V lines.
2. Rabbit conductor - ACSR 6/1/3.35mm – used on 11kV lines.
3. Dog conductor - ACSR 6/1/4.72mm – used on 33kV lines.
4. Wolf conductor – ACSR 30/7/2.59mm – used on 66kV lines.
5. Panther conductor – ACSR 30/7/3.00mm – used on 132kV lines.
6. Zebra conductor – ACSR 54/7/3.18mm – used on 220 kv lines.
7. Mouse conductor – ACSR 54/7/3.53mm – used on 132 kV or 220 kV bus bars.

- Likewise AAC (All Aluminum Conductor) or AAAC (All Alloy Aluminum Conductor) are used in low, medium and high voltage lines with usually shorter spans (extensively in urban areas). Types of AAC are given as under:

1. Gnat – AAC 7/2.21mm
2. Ant – AAC 7/3.10mm
3. Wasp – AAC 7/4.39mm

   Though AAC or AAAC has very good conductivity but has very low mechanical or tensile strength.

1.4 <u>Transformers:</u> A transformer is an alternating current static machine used to step up or step down the voltage to its desired level for transmission or distribution purpose keeping the electrical power same. The transformers are rated in kVA. Transformer may be single phase or 3 phases.

- Thus a distribution transformer is used to step down high voltage (so called HT or HV) from 33kV, 22kV or 11kV to required distribution voltage level of 400V (line voltage - for industrial consumer's use) or 230 volts (Phase voltage – for domestic consumer's use) e.g. 33/0.4kv, 22/0.4kv or 11/0.4kv. The general ratings of distribution transformers may be 25 kVA,63kVA, 100kVA, 250kVA,400kVA, 500kVA, 630kVA, 1000kVA or 1 MVA etc.
- Low rating transformers 25, 63, 100, 250 kVA may be pole mounted while higher rating capacity transformers having more weight are stationed on ground followed by barbed wire/mesh fencing.
- Generally, 33/0.4 kV transformers is used as station transformer or as per voltages existing at Sub-Station.

1.5 Wiring: Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets and light fittings in a structure.

- These are different types of wiring:

1. Cleat wiring
2. Wooden casing & capping wiring
3. CTS or TRS or PVC sheathed wiring
4. Lead sheathed or metal sheathed wiring
5. Conduit wiring

The most commonly used material for electrical wires and cables is copper because copper has low resistance and twice the tensile strength of aluminum.

Electrical wiring, in the light of quality assurance, should have features such as fire retardant, low smoke, 100% copper bunching, anti-rodent, corrosion resistance, good insulation material.

- The international standard wire sizes are given in IEC-60228. In India, we use ISI marked materials.
- In a typical electrical code, some color-coding of wires is mandatory. In India, phase colors adopted for wires are red color for R-phase, yellow color for Y-phase, blue for B-phase, black color for neutral and green color for earth.
- The prescribed tests for quality assurance of wiring in an electrical installation are given as under:

1. Wiring continuity test or continuity test of wiring.
2. Insulation resistance test – should not be less than 50MOhm.
3. Earth continuity test – resistance should not be more than 1 ohm.
4. Earth resistivity test (earth resistance test).
5. Performance test and any other tests as instructed by the Supervising Engineer in conformity with IEE regulations.

ISI standards for electrical wiring are:

- IS: 732-1989 Code of practice for electrical wiring installation.
- IS: 4648-1968 Guide for electrical layout in residential buildings.
- IS: 8884-1978 Code practice for installation of electric bells and call system.
- IS: 2672-1966 Code of practice for library lighting.

1.6 Conduits: An electrical conduit is a tube used to protect and route electrical wiring in a building or structure. Mostly conduits are rigid but flexible conduits are also used for some purposes.

- These are different types of conduits used commonly in residential and commercial wiring:

1. Rigid Metal Conduit – RMC and IMC
2. Electrical Metallic Tubing – EMT
3. Electrical Non-metallic Tubing – ENT
4. Flexible Metal Conduit – FMC
5. Rigid PVC Conduit

Conduits are subjected to following tests:

- Bending Test
- Compression Test
- Collapse Test
- Impact Test

PVC conduits (DIPLAST, POLYFIT-make) and steel conduits [ISI marked (9537), Part-II, 1981 standards] are available in sizes of 20mm, 32mm, 40mm, 50mm, 63mm. These conduit pipes are available in standard length of 3 meters.

1.7 Switches: Electric switch is a device which is used for making and breaking of an electric circuit (e.g. To make ON or OFF light, other house hold appliances like induction heaters, water heaters /Geysers, electric iron, washing machine, juicer and mixer grinder, refrigerators etc.)

Testing of switches is done:

1. Tests with an ohmmeter (multimeter)
2. Tests with a test lamp
3. Pen tester

The material used for switches (i.e. Metal contacts and moulded body) should confirm to IS 3854(1997) standards with reference to quality assurance.

1.8 Preventive Maintenance Schedule for Maintenance of Important Equipments

- The proper maintenance of a electrical system not only improve the reliability but also generate revenue to the electrical utilities.
- The old concept of breakdown maintenance can be deferred by adopting periodical testing [monthly (M), quarterly (Q), half yearly (1/2Y), yearly (Y), 2 years (2Y), 3 years (3Y), SOS (as and when required) etc.] of equipments and its accessories and thus doing preventive maintenance (repair or replacement, if any) accordingly.
- The preventive maintenance is much relevant to keep the equipment continuously in service for desired output over a long period span. The preventive maintenance schedule for maintenance of important equipments installed at an electrical sub-station is to be followed as per CBIP manual as under:

Transformers:

- Without shut down activities:

  Checking of bushing oil level, oil level in conservator, oil level in OLTC conservator, oil level in oil seal of breather → Monthly

  Checking of silica gel in breather → Monthly

  Manual actuation of cooler oil pumps and fans → Monthly

With shut down activities:

- BDV, PPM of transformer oil → Yearly
- External cleaning of radiators, marshalling boxes of transformers → Yearly
- Cleaning of all bushings → Yearly
- Checking of auto starting of cooler pumps and fans → Yearly
- Checking of Buchholzrelay by oil draining → Yearly
- Tan δ measurement for bushings → Yearly
- Checking of earthing connections → Yearly
- IR measurement of winding → Two Yearly
- Tan δ measurement of windings → Two Yearly
- Checking & cleaning of diverter contacts → Two Yearly
- Checking and calibration of OTI (Oil Temperature Indicator), WTI (Winding Temperature Indicator) → Two Yearly
- Measurement of winding resistance at all top positions → Four Yearly

Circuit Breaker:

- Checking of all interlocks, pressure settings, all operation lock outs → Yearly
- Cleaning of breaker interrupter, support insulators, PIR and grading capacitors → Yearly
- Checking of pole discrepancy relay, pressure settings → Yearly
- Function checks, duty cycle operation including rapid re-closing → Yearly
- Checking of CB operating timings → Yearly

SF_6 Circuit Breakers: Now a, being used on 66kV, 132kV, 220kV, 400 kV and above voltage level sub-stations.

- Checking of oil leaks from grading capacitors → Monthly
- SF_6 gas leakage test → SOS
- Dew point of SF_6 gas → 3 Yearly
- Checking tightness of foundation bolts → Yearly
- Vacuum Circuit Breaker (VCB): (Now days, being used on 11kV, 22kV & 33 kV sub-stations.)
- Checking of vacuum interrupter → Yearly
- Replacement of vacuum interrupter → SOS
- Cleaning of control cubicle and checking for loose connection → Quarterly
- Checking of ON/OFF indicator, spring charge indicator and checking of manual and electrical operation → Half Yearly
- Checking of foundation bolts → Yearly

Current Transformers (CT's)

- Visual inspection of CT for oil leakage and cracks in insulator etc. → Monthly
- Checking of bellow expansion → Monthly
- Thermo vision scanning of CT → Yearly

- Checking of oil leakage in terminal box → Yearly
- Checking of primary connections strips (if provided externally) → Yearly
- Measurement of Tan δ and capacitance → 2Yearly

Potential transformers (PT's)/ Capacitance Voltage Transformer (CVT)/Coupling Capacitor/ Voltage Transformer (VT)

- Checking of oil leaks → Monthly
- Measurements of voltage at control room panel → Half Yearly
- Visual checking of earthing HF point (if it is not being used PLCC) → Yearly
- Cleaning of CVT capacitor stacks and tightness of terminal connections →- Yearly
- Thermo vision scanning of capacitor stacks → Yearly
- Capacitance and Tan δ measurement → 3Yearly
- Testing of oil for BDV (if oil found discolored) → SOS
- Checking for rust and painting → SOS

Disconnectors (i.e. isolators) and Earth Switches:

- Cleaning and lubrication of main contacts, pins and bearings → Yearly
- Checking of interlocks, earth connections of structure, tightness of bolts, nuts & pins, healthiness of gaskets etc → Yearly
- Check operation of isolators and earth switches → Yearly
- Check contact resistance measurement → 2 Yearly
- Check alignment of isolator blades/earth switch blades → 2 Yearly

Surge Arrestors/Lightning Arrestors

- Checking of leakage current → Yearly
- Testing of surge counters and leakage current meters → Yearly
- Cleaning of insulators → Yearly
- Checking of earth connections between surge arrestor, surge monitor and earth → Yearly
- Measurement of capacitance and Tanδ and IR of each stack → SOS

Bus-bar, Jumpers, Connectors, Clamps, Switchyard illumination etc.

- Visual inspection of insulators for cracks, cleaning of insulators → Yearly
- Removal of hot spots, De-weeding of switchyard → SOS
- Repainting, rust removal of all structures, equipments etc. → SOS
- Thermo vision scanning of all conductor joints, terminal connectors/clamps → Yearly
- Measurement of earth resistance, checking of earthing connection of all structures → Yearly

Wave traps

- Tightness and cleanliness, general inspection/cleaning of tuning unit cleaning of post insulators (if provided) → Yearly
- Thermo vision scanning of joints → Yearly
- Repair of bird guard → Yearly

Batteries and DC distribution system

- Checking of electrolyte level and topping up with distilled mineral water (if required), measurement of specific gravity and voltage of each cell → Monthly
- Checking of emergency DC lightning to control room and checking of any earth fault (if E/F relay not provided) → Monthly
- Checking of electrical connections for batteries and application of petroleum jelly on each cell terminal if required → Yearly
- Checking of electrical connections for charge panel and DC DB panels for tightness and cleanliness → Yearly
- Checking control cards of charger and measurement of test point voltage values → Yearly

LT Switch Gear, LT Transformer, LT Panel etc. LT Switchgear

- Cleaning of insulators and tightness of terminal connections of CBs, CTs, PTs, isolators etc. → Yearly
- Alignment checking of isolators → Yearly
- Functional checking (trip, close etc) of 33/11 kV CBs → Yearly
- Measurement of operating timings → 3Yearly

LT Transformers

- Testing of oil BDV, testing/checking of OTI, WTI & Buchholz (if provided) → Yearly
- IR measurement → Yearly
- Checking healthiness of Buchholz relay, pressure relief diaphragm → Yearly
- Checking tightness of earthing connections → Yearly

LT Panels

- Cleaning of panels, bus bars insulators etc. → Yearly
- Relay testing → Yearly
- Tightness of all electrical connections → Yearly
- Checking of indicating meters, spring charging of CB, operation indications in off-load condition of CB → Yearly
- Checking for change over facility, if provided → Yearly
- In addition to above, a similar deep thought needs to be given towards preventive maintenance of switchyard, lightning system, fire-fighting system, cooling system/exhaust system, PLCC system/ Telephone exchange, Air-Conditioning Plant/system, all motors & pumps installed as accessories of equipments, DG set (i.e what-so-ever installed at the sub-station) for relevant equipments healthiness, efficiency and longer life.

1.9 Recommended list of Vendors

- Different vendors manufacture and sell different class (i.e. EHV class or HV class) electrical equipments/electrical item according to their suitability and specialization in the field.
- Some vendors manufacture inventorial items and sell these items to consumers (through their marketing division) while some vendors may offer services or experience.

S. No.	Item Description	Preferred make
1.	Transformers: 220kv, 132kv, 33kv, 11kv, 6.6kv	BHEL, CGL, EMCO, AREVA, ABB, TELK, SIEMENS
2.	Circuit Breakers (CB): 220 KV, 132KV CKT BREAKERS 33kv, 22kv, 11kv, 6.6kv vacuum ckt breakers	ABB, CGL, SIEMENS, AREVA ABB, CGL, SIEMENS, AREVA, BHEL, Schneider, Jyoti (Jyoti up to 11kv only)
3.	Current Transformer (CT): 220 kv& 132kv CT 33Kv, 22Kv, 11Kv, 6.6KvCT	ABB, TELK, BHEL, CGL, AREVA ABB, Pragati, Intra Vidyut, Prayog, Insutech Industries
4.	Potential Transformers (PT): 220 kv, 132kv PT 33kv, 22kv, 11kv,6.6kv PT	ABB, TELK, BHEL, CGL, AREVA ABB, Pragati, Prayog, IntraVidyut, Jyoti
5.	Capacitance Voltage Transformer 220kv and132kv CVT	AREVA, ABB, CGL, BHEL
6.	Lightening Arrestors (LA) 220kv and 132kv (LA) 33kv, 11kv, 6.6kv (LA)	OBLUM, Elpro, AREVA, CGL OBLUM, ELPRO,SIEMENS, TOSHIBA, WS-Insulators
7.	Isolators 220kv and 132 kv Isolators 33 kv, 11kv, 6.6kv Isolators 11kv Go Switch	S&S Pondicherry, Elpro, ABB, AREVA, CGL,WS-Insulator. ABB, SIEMENS, CGL Pactil &Panchkati, Kayal& Co.
8.	Condenser Bushings 220kv& 132kv	BHEL, CGL, AREVA, TELK
9.	Capacitors 33kv, 11kv, 6.6kv	ABB,Unistar (Universal Cables), BHEL, Meher (Bangalore)
10.	Cable joining kits 33kv, 22kv, 11kv, 6.6kv	Raychem, CCI, 3M, M-Seal (M-seal for 6.6kv)
11.	BatteryCharger	Chhabi Electricals, Standard, Hi-rect, Amara Raja
12.	Lead Acid Battery	Exide, AMCO, Amara Raja

13.	Electronic Energy Meters (Trivector/KW)	SEMS, L&T, SATEC, ABB, SIEMENS, AREVA, Schneider, Dukati, CONZERVE
14.	Annunciators	Minilec, SPA, Procon, Yashmun
15.	EHT/HT Insulators i) Porcelain ii) Epoxy insulator	WS-Insulators,Jayashree, BHEL, A-bond strand, S&S, AREVA, OBLUM. A-Bond Strand, Power Com Electrical Pvt. Ltd., Baroda Bushings, S&C Electric Co. (America), RISHO-KOGYO Co. Ltd (Japan)
16.	Protection & Auxiliary Relays	ABB, SIEMENS, L&T, AREVA, Schneider
17.	Recorders (Chartless Type)	Chino,Yokogawa India Ltd., Fuji, Okhura, ABB, Tata Honeywell, Hioki
18.	HT HRC Fuses	S&S, GE Power Control, Bushmann, SIEMENS, ABB, DrescherPaniker
19.	HV/LV Bus Duct	Best & Crompton, ECC (KolKatta), Star Drive (Chennai), Empro (Chennai), Advance Power Control Advance Power Control for LV Bus Duct Only

A. (i) List of approved makes of Electrical Accessories for E.I. Works

S. No.	DESCRIPTION OF ITEMS	BRAND / MAKE
1.	Piano type switch sockets, ceiling rose and bakelite lamp holders.	ANCHOR, ESS ESS KAY POWER, KINJAL
2.	HRFR & LS Copper conductor PVC insulated wires.	HAVELL'S, L&T, PLAZA FINOLEX, ANCHOR CAP-CAB
3.	Steel conduits	ISI MARKED (9537) Part-II, 1981.
4.	PVC conduits	DIPLAST, POLYFIT
5.	Modular switch sockets	ABB, HAVELL'S, LEGRAND SSK, NORTH – WEST L&T
6.	Change-Over-switch	SCHNEIDER, L&T, ABB C & S
7.	Bus Trunking	SCHNEIDER, LEGRAND C&S, SIEMENS, G.E.,

A. (ii) CATEGORIZATION OF ELECTRICAL ITEMS

S. NO.	DESCRIPTION OF ITEMS	CATEGORY			
		CAT – A+	CAT-A	CAT-B	CAT-C
1.	Switch disconnector fuse unit with ISI marked HRC/HBC fuse in sheet steel		L&T ABB SCHNEIDER	G.E. HAVELL'S CROMPTON	STANDARD SUPERTECH AECO GECO
2.	Switch disconnector fuse units with ISI marked HRC/HBC fuse in Open execution		L&T ABB SCHNEIDER	G.E. HAVELL'S	STANDARD SUPERTECH
3.	Miniature circuit breakers 240/415 volts	ABB LEGRAND HAGER	HAVELL'S L&T G.E. C&S	STANDARD ANCHOR	GECO SIGMA
4.	Residual current circuit breakers (RCCB)	ABB LEGRAND HAGER	HAVELL'S L&T G.E. C&S	STANDARD	
5.	Water heaters (Geysers)			RECOLD BAJAJ CROMPTON GREAVES SPHEREHOT VENUS	PEARL
6.	Ceiling fans / Exhaust fans Note: The Model for specified brands to be approved by the Engineer-in-Charge			USHA BAJAJ CROMPTON HAVELL'S KHAITAN	
7.	Indoor lighting		TRILUX (through Bajaj) KESELEC SCHREDER PHILIPS	BAJAJ HAVELL'S G.E. DECON CROMPTON	
8.	Outdoor lighting		TRILUX (through Bajaj) SCHREDER PHILIPS	G.E. BAJAJ HAVELL'S	

Chapter-2

SAFETY PRECAUTIONS & INSTRUCTIONS

2.1 General Safety Precautions:

Safety Precautions are necessary to avoid the accidents and the General Safety Instructions that are required to be followed are as follows:

1. All voltages shall be considered dangerous even though it may not be high enough to produce serious shock.
2. All Electric circuits are to be treated as live and no work (maintenance, repairs, cleaning) is to be carried out on any part of electrical apparatus on circuit unless such parts are:
   a. Dead.
   b. Isolated and all practicable steps taken to lock off from live conductors.
   c. Efficiently connected to earth between such points and points of work.
   d. Permit to Work (PTW), to work on the equipments has been issued.
   e. By ensuring the equipment and conductor for its de-energized condition.
3. Working Conditions requiring more than one work man
   I. On some hazardous works it is not desirable for one man to work alone. The AE/JE shall determine when additional men are needed to protect authorized line staff against accidents or to render assistance in case of unforeseen circumstances.
   II. On especially hazardous jobs where close clearance or difficult working conditions are encountered, an observer may be required. On any job which in the opinion of the AE/JE requires an observer, the AE/JE or a man appointed by him will act as an observer. The observer should not engage in any activity that will interfere with the duty.
4. Under no circumstance shall an authorized line staff hurry or take unnecessary chances when working under hazardous conditions, neither shall he attempt to perform hazardous work when extremely tired or exhausted.
5. Authorized line staff must use the standard protective safety equipment intended for each job.
6. Only experienced/authorized line staff shall be permitted to clean around energized or moving equipment.
7. The authorized line staff working on pole or in all elevated position should not work on electrical apparatus or circuit without using a suitable safety belt or other adequate means to safe guard against falling.
8. Circuits should be tagged, marked or lettered unless clear identification by other means exists.
9. No authorized line staff should go or take any conduction objects within the distance given from any exposed live part at the voltages specified.
10. Telephone conductors and ground wires of lightning arresters, though they may be at or near ground potential are liable to develop high-induced voltage under fault conditions. Suitable precautions should be taken' when working on or near such circuits.

11. When fighting fires near exposed live parts, authorized line staff should avoid using fire-extinguishing liquids, which are not insulating. If necessary, all neighboring equipment may be disconnected or made dead.
12. After tripping of circuit breaker the isolation in air media by an air break switch or isolator should preferably be visible.
13. No signal system like waving hands, flags and whistle should be resorted to communicate or convey instructions.
14. Adequate insulation should be provided where any part of the body is likely to come in contact with live lines or equipment. .
15. Parts of equipment or apparatus, which may develop dangerous potential due to surges, arcs or insulation failure, may be grounded for safe working conditions.
16. Do not use bare fingers or hands to determine whether a circuit is live.
17. Do not depend upon insulation of cables for safe working.
18. In handling portable apparatus or lamps, first make sure that the extended metal frame is not live by contact with or leakage from live parts within. Have such portable equipment inspected at least once daily during the period of their use. Do not attempt to make any alterations or adjustments in portable equipment without cutting off supply.

2.2 SAFETY PRECAUTION FOR WORK ON OVERHEAD MAINS, SERVICE LINES.

Working on Dead line and Equipment: No authorized line staff shall work on line supports or conductors unless these are discharged and earthed as follows:

1. The circuit or conductor to be worked on shall be made dead by switching off or opening the isolator links or fuses and by locking isolator/links in the off position. A danger notice board with the words "DO NOT CLOSE', 'MEN ON LINE' should be fixed securely, below the switch or links/isolator. The operational sequence for maintenance of electrical system must be as under:

Before maintenance the operational sequence must be:

PTW → CB [Off]→ ISOLATOR [Off]→ ISOLATOR with earth blade

After maintenance the operational sequence must be:

ISOLATOR with earth blade [remove earth blade] →ISOLATOR [ON] →PTW (Cancellation) →CB [ON]

2. After switching off the supply, before touching the lines, each conductor of line shall be tested for pressure *(voltage)* by a discharge rod. The discharge wires should he kept at least two feet away from the body. The procedure is necessary in order to make sure that the line to he worked on is actually the line that has been isolated. Rubber gloves or preferably gauntlets should he used on both hands.
3. All the conductors shall then be short circuited together and adequately earthed: this shall he done at .the points on each side of the place thereby creating a safety zone where the work is carried out. Rubber gloves or gauntlets shall he used while doing this work. Poles on which work is actually to be carried out should also be earthed.

4. A working section at either end of which the conductors are earthed shall not exceed 1.5 km in length. In the case of lines meeting or crossing at any pole which forms the site of work, all the lines crossing or ending at that pole shall be earthed as stated above unless work on the one line with any or all the remaining lines alive is otherwise permissible and so specified in the permit-to-work.
5. Ensure that there is no possibility of back feed due to some emergency electrical supply such as DG sets, invertors, solar panels or other energy source installed in the system.
6. All phases shall he earthed even if work is to be carr.ied out on one phase only.
7. When work is to be carried out on lines of all insulated conductors where grounding points are not provided at point of work, temporary, grounds shall be connected at point of work to an efficient portable earth straight driven into the ground. The line shall also he grounded at the nearest line grounding point on either side of the point of work.
8. Where two or more crew of authorized line staff are working independently on the same line or equipment, each crew shall properly protect them by placing their own temporary grounds.

2.3 Working on lines and equipment adjacent to live equipment or lines

1. When working near live lines or apparatus, each man should plan his moves and take extreme care in moving from one position to another.
2. Where impractical to erect barriers between men at work and live parts within reach of their hands and objects being handled, continuous watch shall be kept by the Foreman or someone specifically designated by JE/AE incharge for that purpose.
3. When a truck is used near live parts, all workmen except the driver should stay away from the truck. Driver should see that truck is clear from live lines before leaving and entering the truck. To maintain Equip-potential, the authorized staff near the vehicle must have insulated rubber mats underneath.
4. Special care should be taken while working on T·off/4·pole or 6-pole structures under direct supervision of foreman by providing suitable lock and key arrangement.

2.4 Work on Double Circuit Overhead lines with one Circuit alive

1. To distinguish dead circuit from a live one, green flags should he fit on the tower/poles. Flags of any other color shall not be used for indicating a dead circuit.
2. Flags will be removed only after work is finished and temporary ground has been removed.
3. If the Sub-Station has source supply from one of the circuits and shut down of sub-station is required, it should be ensured that no work on *CVT,* Wave trap, coupling capacitor should be carried out. For maintenance/replacement of CVT, Wave trap, coupling capacitor PT and LA's both circuits are to be de-energized after standard shutdown procedures.

2.5 INSPECTION OF EOUIPMENT ON LIVE LINES:

1. Inspection will be carried out from ground level.
2. No man shall climb above the anti-climbing device until under observation by another at ground level.

2.6 TESTING OF INSULATORS ON LIVE LINES:

1. Special care will be taken at tension, double circuit, transposition and terminal tower, poles in view of close proximity of live crossover connections.
2. Works shall be carried out under "Caution Order" as in the case of Hot Line work.
3. Testing shall not be carried out when humidity is above normal and shall be discontinued if thunderstorm approaches.
4. One man should be stationed on ground to *see* that the man testing the insulator maintains necessary clearances.

2.7 Work on Poles and Towers

1. Before climbing an elevated structure every, authorized line staff shall first assure himself that the structure is strong enough to sustain his weight safely.
2. II poles or cross arms are apparently unsafe because of decay or unbalanced tensions of wires on them, they shall be properly braced or guyed before they are climbed.
3. In choosing the climbing side, the side at the pole where the ground wire is attached should not be used.
4. The workman should avoid using conductors, insulators, pins and so forth as hand holds and should not rest on street light fixtures or other apparatus on the poles or structures.
5. Authorized line staff shall wear their safety belts while working on the poles and towers.
6. Wire hooks shall not be attached to authorized line staff belts or safety straps.
7. Safety straps should be placed above the top cross arm when it is at the top at the pole.
8. When two or more men are ascending a pole the second man should not start climbing until the first man is in a safe position or when descending until the first man is on the ground.
9. Before climbing a pole for carrying out any work, the condition of adjacent poles should be checked and, if required, they should be guyed or reinforced. The adjacent poles should also be checked for loose or broken tie wires, broken insulators, etc.
10. On arriving at the working position, the authorized line staff should put his safety belt around the pole or some other suitable supports and make sure that the belt is properly secured. Care should be taken to prevent the straps on safety belt coming in contact with anything that may open the snap and thus release the safety belt. Safety belts should not be attached to insulator pins, span wires, guy wires etc.
11. Authorized line staff tools should be so secured that they will not fall out of the tool belts. An authorized line staff should carry only the minimum number of tools in his belt. All other tools should be kept on the ground until they are required and then raised by means of a material bag attached to a hand line.
12. Ordinarily no authorized line staff should work vertically below another authorized line staff on the same pole except under emergencies. When this condition is necessary, extreme care should be taken to prevent tools or other objects being dropped upon the man below.

13. When transferring wires and equipment from an old pole to a new pole, the old pole should either be locked to the new pole or guyed or both, as the condition may demand.

14. Before an authorized line staff cuts an overhead conductor he should make sure that it will fall clear. Where there is a possibility of the falling line coming in contact with another wire or doing other damage, it should be lowered with a rope.

15. All light equipment and tools to be used aloft should be raised and lowered by means of a hand line and canvas bucket, or other suitable container. Men on the ground should stand clear of overhead work to prevent being struck by falling objects.

16. Tools and materials should not be thrown from the ground to an authorized line staff working aloft, nor should authorized line staff throw tools and materials from working place to the ground.

17. No authorized line staff shall work in such a manner that his arms or any tools extend beyond the body of tower when working on the live side.

18. Broken insulators or other sharp edged material shall not he left in vacant lots, along the right of way or in the location where the hazard of cutting feet could be caused for men or animals.

19. When stringing wires across streets and highways, avoid interfering with traffic or causing injury to workmen or pedestrians. Danger signs should be erected on both sides of the work location and where conditions warrant, flag-men should be stationed. No stringing should be done with the force of vehicle.

20. Hand lines, materials, tools or equipment must not be scattered around streets, sidewalks, highways, etc., but must be kept in a neat and orderly manner where they will not be liable to cause accident.

21. In handling win's on a pole, they should he raised or lowered with a dry hand line and extreme care should be exercised to prevent them from coming in contact with live lines and equipment.

22. A safety belt should be used when working on overhead locations. In its absence, manila rope may he permitted round the waist of the workman and tied to cross arm or pole as an alternative to the use of safety belt, under exceptional circumstances. The ropes should be kept in good condition and scrapped when not safe. It is necessary that the rope is twisted round the pole once or twice in order that release of tension on the pole may not cause it to slip down the pole.

23. Use ladders of suitable lengths to go up the poles to replace fuses or to carry out other minor works on feeders and wherever possible or necessary, dry hickory rod should also be used.

2.9 SAFETY PRECAUTIONS FOR WORK ON UNDERGROUND MAIN/CABLES

- **Work on Live Low Voltage Mains**

  Only competent, experienced and authorized line staff may work on live low voltage mains and testing apparatus only after adhering to the entire requisite safety requirement.

• **Use of Insulating Guards**

1. No authorized line staff shall work on low voltage main with live conductors (UG Cable) alongside him until all those conductors are insulated for a distance at least 900 mm on each side of his body with tile insulating hose or mats provided for the purpose,
2. The neutral shall be regarded as a live conductor.

• **Work on Dead Low Voltage Mains:** Unless an authorized line staff is authorized to work on live low voltage mains and testing apparatus, all low voltage mains testing apparatus to be worked upon, shall be isolated from all sources of supply, proved dead, and measures shall be taken against the inadvertent energizing of the mains and apparatus.

• **Testing Low Voltage**: An authorized line staff shall not apply low voltage, for test purpose, to any mains, unless he has received a permit to work and warned all other authorized personnel working on the mains of the proposed application of low voltage for test. Where any part of the mains which will then become live is posed, the Supervisor in charge of the test shall arrange for an authorized line staff to stand by at the exposed part during the whole period of the tests.

• **Work on High Voltage Mains**

While working on High Voltage underground mains, the following shall be complied with:

1. The dead cable should first be identified by approved means.
2. Before working on underground cable, all its conductors shall be effectively discharged and earthed at both ends and the earthing switches wherever installed shall be locked up.
3. The neighboring cables, if any, should be adequately protected.

2.10 Minimum Working Distance

1. No authorized line staff shall work within the minimum working distance, which is normally, 4'/1.2 Mts. from the exposed live high voltage mains.

2. Under certain conditions, for special work and in an emergency, all authorized line staff may work within the minimum safe working distance where the work is directly and specifically sanctioned by the Foreman / JE responsible for the work and authorized line staff is fully experienced, and aware of the dangers that exist.

3. In all such cases, the authorized line staff shall be accompanied by another person that is also aware of the dangers which exist and who is cable of rendering First Aid and Artificial Respiration.

2.11 Devices for proving Dead High Voltage Mains

1. Only devices approved and issued for the purpose shall be used:

2. The High Voltage Neon Lamp contact indicator rod may be used for proving dead exposed high voltage mains. Each rod is fitted with an indicating Neon tube which should glow when the contact end of the rod is applied to exposed live high voltage mains. Each rod is clearly marked for the maximum voltage on which it may be safely used and must not, under any circumstances be used on higher voltages.

3. High Voltage contact phasing rods are provided for phasing and proving dead exposed high voltage mains. A set consists of two rods connected in series by a length of insulated cable. Both rods are fitted with contact tips and indicating tubes. When the contact tip of one rod is applied to exposed live high voltage mains and that of the other to earth or other exposed live high voltage mains and when there is a sufficient difference of potential from that to which the first rod applied, the indicating tubes should glow. Each set of rods is normally marked for the maximum voltage on which it may be used and must not, under any circumstances be used on higher voltages.

2.12 Use of High Voltage Contact Indicator and Phasing Rods: While using the high voltage contact indicator and phasing rods, the following shall be complied with:

1. Ensure that the rod is clean and dry.
2. Check the rod by applying it to known live mains of the correct voltage -the indicating tube must glow.
3. Apply the rod to each phase of the mains to be proved dead. The indicating tube must not glow. Be very careful to be in a position to see the glow in the indicating tube, if any, should appear.
4. Again, check the rod by applying it to live mains as in (2) above. Again, the indicating tube must glow.

Note: All the above operations shall be carried out at the same place and time. If no live high voltage mains or apparatus are available on the site, rods up to 11 kV may be tested by applying them to the top of ZI spark plug in running motor car engine. If the rod is in order, the indicating tube will glow each time the plug sparks. Therefore, the glow will be intermittent, but the indicating tube must glow on this test or the rod is useless as a means of proving dead. Remember to test the rod before and after use.

2.13 Work on Cubicle Type High Voltage Panels: If draw out cubicles are the ones on which work is programmed, these cubicles shall be drawn out after switching off circuit breakers, and the draw out panels effectively discharged before any work is done over the same.

2.14 General Safety Instructions

2.14.1 Housekeeping: Workmen are frequently injured by tripping, stumbling, stepping on or bumping into tools, material and other object, left lying around or by carelessly placed object falling from above.

To ensure good housekeeping the following instruction shall be followed:

i. The place of work with in the building and around the work area in switch yard should be kept neat and clean.
ii. Handling and usage of flammable liquids, oils, cleaning solvents should be carried out as per the prescribed manner so that they will not become the potential source of fire hazard.
iii. The storage area should be neatly maintained and the materials should be stored systematically and in an orderly manner to prevent their falling or spreading and to eliminate tripping and stumbling hazards.

iv. Clothing or any other types of material should never be hanged behind the space of tilt' neighborhood of substations, pole yards, buildings, oil tanks, or other structures.

v. Pathways, stairways, fire escapes surrounding area near the distribution boards control panel etc. anti all other passage ways shall be kept dear from all obstructions.

vi. Tools and materials should not be placed where they may cause tripping or stumbling hazards or where they may fall and strike anyone below.

vii. Puddles of oil and water create a slipping hazard hence should be cleaned up promptly.

viii. Nails in boards, such as those removed' from Scaffolds, forms and packing boxes, constitute OJ hazard and should be removed. The hoards should be carefully stacked or stored.

ix. Dirty and oily waste rags should be deposited in approved container and disposed off as soon as practicable to avoid fire hazard.

x. Broken light bulbs, glass, metal scrap and other sharp objects should be dumped in a specified place or containers provided specially for them.

xi. Discarded fluorescent and other gas filled tubes shall be disposed off safely.

xii. Broken insulators or other sharp edged material shall not be left in vacant lots. along the right of way or in the location where the hazard of cutting feet could be caused to men & animals.

xiii. Line materials, tools or equipment must not be scattered around street sidewalks, highways, etc. but must be kept in a neat orderly manner, where they will not be liable to cause accident.

2.14.2 Storing and piling of Materials:

i. Material stored in quantity should be arranged so that the weight is evenly distributed and not top heavy.

ii. All stacks and piles should be protected against over-turning or other movement.

iii. Barrels, drums and kegs should be stored on end or securely locked to prevent rolling.

iv. Store the material at adequate / safe distance from the live equipments.

v. No material or earth work or agricultural produce shall be dumped or stored or trees grown below or in the vicinity of bare overhead conductor lines so as to **reduce** the requisite safety clearances specified.

2.14.3 Lifting Carrying & Hoisting heavy object.

i. Any person should not attempt to lift beyond his capacity.

ii. Person should avoid twisting or excessive bending when lifting or settling down load.

iii. Pushing should be resorted to when moving a load horizontally. rather than pulling it.

iv. Gripping, Grasping, and Lifting with just the thumb or index fingers should be avoided & whole hand and all devices should be used.

v. Authorized line staff working at site should wear helmets.

vi. Manila or sisal rope sling should not be used over sharp metal corners and edges; wire ropes with padding over sharp corners and edges may be preferred.

vii. No one shall stand or pass under any suspended load being handled by a crane, derrick.

viii. Several work men, should not climb at the same time.

ix. Most lifting accidents are due to improper lifting methods rather than lifting too heavy loads. When lifting heavy objects, the back should be kept close to vertical and the lifting done with leg and arm muscles rather than with back muscles.

x. Pipe, conduits, reinforcing rods and other conducting material should not be carried on shoulder near exposed live electrical equipment or conductors.

xi. Rope tackle and slings wherever required should be checked to ascertain that they have sufficient strength to perform the work in hand.

2.14.4 Cleaning of Parts:-With inflammable solvents

i. Adequate ventilation must be available to avoid fire explosion and health hazards.

ii. Avoid breathing solvent vapors.

iii. Keep open flames and sparks away from inflammable liquids and their vapors.

iv. Metal nozzle of a hose for spraying flammable solvents shall be grounded.

v. Goggles and safety mask shall be used when blowing out dust with compressed air.

2.14.5 Supports & Scaffolds:-

i. Do not stand taking support of any structure, pole equipment in the yard.

ii. Do not use support for men, material/equipment to roles, scaffolds, Ladder, walkway or Portion of tree and any elevated structure, unless it ensures that they are firmly secure & adequate enough to take load. Do not stand by taking above support.

iii. Scaffolding should be checked before use, for its strength, rigidity.

iv. The footing and anchorage point for scaff holds shall be sound rigid, and capable of carrying the maximum load without settling or displacement.

v. Carry the scaffolds/ladders carefully in the yard.

vi. Scaffolds should not be moved before all the Material/Tools/Equipment are removed.

vii. Authorized line staff working on suspended scaffold shall be protected by an independent life line.

2.15 FIRE PROTECTION AREAS:

1. **INTRDDUCTION:** Fire is a great destructive natural force. It can destroy vital stores, equipments, accommodation and amenities. Majority of Fires, which affect properties, are due to carelessness, ignorance, arson, lack of discipline and failure to observe statutory and general regulation. A little knowledge on this subject may save loss of lives and properties.

2. **BASIC OF FIRE:** Ordinary Fire is a chemical reaction between a fuel and oxygen in presence of heat. In other words, it may be stated that three things are essential to initiate a Fire viz. OXYGEN, FUEL & HEAT which can be represented as three arms of a triangle. The triangle is known "Fire Triangle". A Fire cannot take place in absence of any one of these three factors.

   In extinguishing a Fire, all that is done is to break any of the arms of the "Fire Triangle" removal of Heat or Fuel or Oxygen from Fire.

3. **METHOD OF EXTINCTION:** Whatever may be the equipment or extinguishing media for fire fighting, the three under mentioned method are used:

   i. **Cooling Method:** The method, in which Heal of burning substance is removed, generally by using water, is known as cooling method. Water brings the heat of substance under Fire below the ignition temperature of substance. This method is normally applied till extinguishing Fire of solid combustible materials.

   This method must not be adopted for fighting live electrical Fire. This method is applied for extinguishing electrical originated Fire only after ensuring the cut-off of power supply.

   ii. **Smothering Method:** The method in which Oxygen is removed from burning substance is known as smothering method. In this method oxygen is restricted to Fire by using layers of Foam or inert gases like CO2, Nitrogen, Chlorofluoro carbon or Dry Chemical Powder or Dry sand. Sometimes this is achieved by proper blanketing of Fire using Fire blanket or Asbestos blanket or Aluminum blanket or other available non-combustible materials. This method is normally used for extinguishing Fire in Flammable liquids.

   iii. **Starvation Method:** The method in which Fuel or combustible material is removed from Fire is known as starvation method. This is achieved by removing burning substance from the scene of Fire. Fire in pipe lines, cylinders. Tankers containing flammable - liquid or gas is controlled by closing the valves. By closing valves the fuel or combustible materials are isolated from Fire and thus starvation is achieved. This method is best used for extinguishing Fire in pipelines, cylinders containing flammable liquid or gas.

4. **CLASSIFICATION OF FIRES:**

   Fires are categorized in to four different classes mentioned below:

   i. **CLASS -A:** Fires involving solid materials normally of organic nature are categorized as Class -A Fire. Fire in paper, wood, cotton, plastic. rubber etc. are the example of Class-A fires. Cooling method is normally used for extinguishing Class-A Fires.

   ii. **CLASS -B:** Fires involving flammable liquids or liquefiable solids are categorized as Class-B Fire. Fires in petrol, kerosene, diesel, oil etc. are the examples of Class -B Fires. Smothering method is normally used for extinguishing Class-B Fires.

   iii. **CLASS -C:** Gaseous Fires are categorized as Class ~ C Fire. Fires in LPG, Acetylene. natural gas etc. are the examples of Class-C Fires. Starvation method is normally used for extinguishing Class-C Fires.

   iv. **CLASS -D:** Fires in metals are categorized as Class-D Fire. Fires in Sodium. Magnesium, Potassium etc. ere the examples of C1Jss-O Fires. A special type of powder is used for fighting Class – D Fires. There is no chance of Class-D Fire in Sub-Station.

2.16 FIRE EXTINGUISHERS: It is very easy to extinguish a Fire when it is small. If Fire is not controlled in its incipient stage, then it may require lots of manpower, time and money to control. Hence, it is better to attack Fire whl'1l it is small.

To extinguish small Fire, Fire Fighting extinguishers must be kept at the strategic locations in all the Sub-Stations. This can be easily identified by its red colored and cylindrical in shape. These Fire extinguishers must be used for extinguish small Fires by an authorized line staff nearest to it. Therefore, the operational knowledge of Fire extinguishers is inevitable for each and every authorized line staff working in Sub-Station.

There are various types and capacities of Fire extinguishers provided in Sub-Stations. These Fire extinguishers should be operated on Fire according to their suitability. Before operation, it is very important to read the information given on the sticker of a particular Fire extinguisher:

i. The name of Fire extinguisher is written on bold capital letters on the sticker By name, the inside contents and discharge of Fire extinguishers can be identified. The following are the examples of names and contents of Fire Extinguishers:

S. No.	Name of Extinguisher	Contents	Discharge
1	Water Co_2 type	Water & Co_2 gas cartridge	Water
2	Co_2 type	Co_2 gas	Co_2 gas
3	Dry Chemical powder (DCP)	Powder (Normally sodium bicarbonate) and Co_2 gas cartridge Powder	Powder
4	Mechanical Foam	Water mixed with Foam compound.	Foam
5	Halon Type	Halon Gas (Normally Bromo Chloro Difinoro Methane)	Halon gas

ii. The information regarding suitability of Fire extinguishers is given ill form ojf capital letters in circle. If character 'A' is written inside the circle then it is suitable for Class-A Fires. It characters 'B' &'C' are written then it is suitable for Class-B &Class-C Fires.

iii. The method of operation of Fire extinguishers varies from type and capacities. It is, therefore, essential, to read carefully the method of operation written on the sticker of particular Fire extinguishers. A stepwise drawing for operation is also shown.

The date of checking and due date of checking must be checked before the operation of Fire Extinguisher. It must be ensured that the Fire extinguisher is well maintained and ready for use.

Chapter-3

SAFETY RULES FOR AUTHORIZED LINE STAFF

3.1 General: No authorized line staff shall start to do any hot-line maintenance work without first assuring himself that he thoroughly understood the work to be done and the method of doing it. In case there is any doubt in his mind, he shall ask the Forman / JE incharge and receive the required information from him.

1. The authorized line staff shall at all time keep parts of his body as far as possible from the tool end of the stick. On poles with vertical formation with or without tapings, where there is an abundance of hardware, rubber gloves should be used while changing out dead-end disc to eliminate the effect of static discharges.
2. Authorized line staff shall see that their safety belts are properly fastened before they start work.
3. When in doubt concerning the strength of the tool or piece of equipment, it should not lie used.
4. Hot-line maintenance tools shall not be carried up poles or towers in safety belts but tool bags or hand lines shall he used for this purpose.
5. The authorized line staff must be certain, before he attempts any work, that his companions or the pole thoroughly understand the work to be done. Conversation should be limited to the necessary remarks concerning the work. No conversation, not pertinent to the work, shall be permitted.
6. The authorized line staff shall not change the position on the structure without informing his fellow authorized line staff as to what he intends to do.
7. Under no circumstances should an authorized line staff depend upon another authorized line staff to hold a live conductor clear of him permanent anchors must he used for this purpose. When blocks are under strain, the ropes must he secured snubbed. It is not permissible to snub to a truck or to a trailer.
8. No knots of lesser security than "two half hitches" shall he used in tying off various lines. Where a line is to be subjected to a strain, a "turn-around" shall be taken around the snub and the completing knot shall be "two half hitches". When joining two lines of the same size temporarily to take strain, a square knot shall be used. If two lines are to be joined permanently, a spliced joint shall he made. When a loop is to be made in the end of the line, a bow line knot shall be used.
9. When removing tie wires, these shall be rolled into a ball or cut short as soon as they are unwound so that under no circumstances will they be long enough to reach a ground or another conductor and to endanger the authorized line staff. During the installation or the removal of tie wires, an authorized line staff shall steady the conductors on the insulator with a proper tool. Tie wires shall never be used a second time
10. When moving live conductor, the authorized line staff shall stay below the conductor that is being moved until it is thoroughly secured in a safe working position. Blocks shall be used on the end of the hot-line tools so that the conductor may be moved slowly and carefully.

11. When working on lines paralleling or crossing roads or highways, special attention shall be paid to securing adequate clearance for all moving vehicles.

12. Hot-line tools shall never be placed directly on the ground as **it** is possible that they might absorb moisture which would reduce their dielectric strength.

13. Authorized line staff must at all time take extreme carein transporting and using tools so as not to damage them.

14. All tools used on each job shall be carefully inspected before **and** after the work is done.

15. All tools, when not in use, must be kept in canvas bags or whether-proof boxes provided for that purpose. Care should be exercised to see that tools kept in these bags or boxes are stored in a dry and. if possible warm place. Wooden sticks should be inspected regularly, dried out and thoroughly maintained at intervals, depending upon the extent of use and exposure.

16. Hot-line maintenance work shall not be hurried. The job should be done safely even though it takes more time.

17. The authorized line staff should avoid wearing rings, wrist-watches, identification bracelets, etc. when engaged in hot-line work.

18. Rubber-Gloves should be worn when within reach of the live conductor.

19. Ground wire should either be covered by rubber goods or lowered down to a safe working distance; it should be ensured that it does not contact with any lines below. Rubber gloves should be worn when disconnecting and connecting ground-wire.

20. Do not throw tools or materials to or from authorized line staff on pole.

21. Ground man must maintain safe working distance from poles.

22. Safety hats should be worn by the entire authorized line staff while engaged in hot line work.

23. Suggested working clearances are as follows;

Line Voltages (kV)	Min. Clearances (In Meter)
2.2 to 6.6	0.305
11 kV	0.610
33 kV	0.71
66kV	0.91
110 kV	1.02
220 kV	1.52

The working clearance gives the minimum safe working distance from the conductors or from the hot end of Hot-Sticks to the authorized line staff. In General it is a good practice to maintain a working position so that no conductor, regardless of voltage is within the reaching distance of a authorized line staff.

24. Maintain steady pull on fall lines or hand line or set of blocks; do not jerk.

25. Never tie hand lines, fall lines, snuh lines to truck or other vehicles.

26. Do not use rope directly on conductors carrying over 5000 volts without separating the rope from the conductor by a link stick.

27. Be sure that temporary anchoring devices will handle the strain placed on them.

28. Be sure that temporary lines are tied securely to anchors and that they are placed in such a position that they will not interface with the work in progress or he accidently loosened.

3.2 Safe Working in Sub-Station:

3.2.1 General Safety Instructions:-

I. Danger signs should he displayed to warn person, the presence of high voltage equipment.

II. Gates in switchyard fences and doors to bus compartments and other enclosures containing live equipment should be kept locked at all times except when authorized line staff are working inside.

III. Unauthorized person should not be allowed inside a hazardous operation area like a bus compartment, switchyard etc. unless such person is accompanied by a responsible authorized person, who shall always be present while such person *re*mains in the area. Any person deputed to clean the floors or parts of the plant in such areas must be given clear instructions and a responsible person must be present while the mall is carrying out the work to ensure that the man does not endanger his own safety.

IV. Before doing any work on rotating equipment. it should be shut down and properly disconnected from power source.

V. Care should be taken to prevent clothing, wiping cloths, waste dusters, oil cans or tools from getting caught in the moving parts of machinery.

VI. When using compressed air on live electrical machinery, an insulating hose and nozzle should be used. Dust proof goggles and safety mask should always be used when cleaning with compressed air. Compressed air should never he used for cleaning or dusting clothes or any part of the body.

VII. If authorized line staff are working on H.T. (voltage above 650V) equipment. the area safeguarded for work shall be cordoned off by tying a white rope or cotton tape all round and danger boards shall he fixed within the safe guarded area at various location with the inscription facing the safe working area to warn the other line staff/ personnel not to cross over the area with live equipment during the progress of work.

VIII. It should be ensured that maintenance and repair works are done properly before the equipment deteriorates further and become a source of danger. It shall be also ensured that defective equipment is not retained in operation till they are rectified.

IX. It should be ensured that the appropriate and proper tools are used for maintenance and repair. These tools should be periodically checked and if defective, must be rectified before using them again or condemned, if beyond repairs.

X. Live disconnecting switches and fuses should not be opened or closed by any other means than the stick or operating gear provided for this purpose. The authorized line staff using the switch stick should ensure himself of a secure footing and proper clearance from other equipment and should wear rubber gloves of adequate insulating value for the voltage of the disconnecting switch or fuse and in good condition

3.2.2 Sub-Station layout diagram & Equipment numbering:

1. A list should be prepared and put at a prominent place in the Sub-Station Control Room showing all essential safety equipment and T&'P to be maintained.
2. The numbering and identification of sub-station equipment and bus arrangement should be standardized and used consistently. All equipments shall have number and identification according to the scheme only. The numbering in the switchyard and in the control panels should be same to avoid possibility of any misunderstanding. The single line diagram in the control room shall have same numbering arrangement and should be as per SCADA nomenclature.
3. Single line schematic diagram (SLD) of the sub-station shall be put in the control room at prominent position. The SLD should indicate tile bus and feeder arrangements with all associated equipment in the Sub-Station. The Single line diagram shall be updated for any change /addition the Sub-Station.

3.2.3 Transformers:

1. All transformer installations shall comply with the provisions of IS 1646: 1982 in addition to the following:

- As a protection against excessive damage due to occurrence of faults, transformers fitted with conservators shall be protected with Bucholz Relay.
- All transformers shall be equipped with oil temperature alarms or excess current relay protection.
- The bushings, insulators, and contacts of taps changing gears shall be kept scrupulously clean at all times.
- The level and dielectric strength of the transformer oil shall be checked at periodic intervals, and in the event of presence of a large quantity of sludge the oil shall be renewed.

2. In addition to the usual cable clamps above floor level, cables shall also be clamped immediately below floor level, each cable or group shall, where possible be protected by a pipe or cover of heat resisting material rising to a height of at least 45 cm above floor level or terminating just below cable gland, sealed at the bottom and filled with sand or small pebbles.

3. Whenever possible, all jute shavings shall be removed from cables in switch rooms, basements and tunnels.

4. Where cables rest on the floor of tunnel or basements, they shall be separated into groups by vertical barriers of tile brick, or concrete and the trenches so formed shall be filled with small pebbles. Alternatively, the cables may be separately clamped and each cable run shall be separated by a minimum clear space of 75 mm.

5. The cable shall not be routed near hot steam pipe, turbine, and pulverized coal pipe and near hot gas ducts. Wherever it is unavoidable fire resistant cables shall be used.

6. Power cables and control cables shall run in separate trenches, wherever possible.

3.2.3.1 Fire Protection of Transformer

1. No fixed fire protection equipment (such as high velocity spray) is required on transformers below 10 MVA or in the case of oil filled transformers with oil capacity of 2000 liters and below. For all other transformers high velocity water spray system, shall be provided. This system shall be separately mounted and designed to take into account the possibility of a transformer explosion. The water spray deluge valve house shall be located outside the transformer fire zones and protected from radiant heat and other fire effects. The actuation of this system shall be automatic but manual operating valves shall also be provided.
2. The high velocity spray system for the transformers should be well designed to have adequate coverage of the entire transformer unit including the conservation tanks, the bashings and the bottom area. The positioning of the nozzles should be such to protect all surfaces of the transformer and to give standard discharge rate for the system to be protected. The automatic high velocity water spray shall be of pre-active with quartzoid bulbs.
3. Fire barriers walls shall be provided between transformers where they are less than 15 m apart or where the oil capacity exceeds 2000 liters.
4. The transformer shall be so designed as in permit the safe testing of the fire protection system, with discharge of water, while on load.
5. There shall be arrangements for containment of the spilled oil. For large transformers the drainage system as well as storage pit shall be sufficient to accommodate at least the total volume of the oil and as allowable volume of fire fighting water. The drain pipes shall be provided with standard type of flame arresters.
6. The fire protection systems covering the transformers, associated oil conservator tank and cooler batteries shall be designed to meet the single risk concept so that simultaneous deluge over all the three risk zones is possible.

3.2.3.2 Maintenance work on Transformers:

- When work is to be carried out on a transformer, both the low and high tension (Primary & secondary sides) breakers and isolator shall be opened. Similarly when isolating transformers to which potential transformers are connected, such potential transformers shall be isolated and secondary P.T. fuses removed to prevent any possibility of transformer being made alive through synchronizing or voltmeter plug.
- Before commencing any work on a transformer, the transformer winding should be discharged to ground. In case the transformer is isolated from the supply by single point (jf disconnection e.g. fuse, the transformer shall be safeguarded by shorting the phase terminals together and connecting them to ground. before commencing any work.. The neutral ground of a transformer should never be treated as the grounding of phase terminals, as required above.

3.2.4 Work on Circuit Breaker:

The Following Precautions shall be taken before commencing the maintenance work in the Circuit Breakers:

1. Breaker must be open before any disconnections.
2. It is to be ensured that line and bus isolators are open and there is no back feed from potential transformers and interlocking should be ensured.
3. Main fuses at the switchboard/panel should be removed and D.C. voltage must be disconnected from breaker mechanism.
4. Tools and equipment should be in safe working condition.
5. In outdoor HV or EHV breakers work must be done from Ladders or platforms alongside the breaker. Energized overhead conductors are dangerous for workmen to stand on these breakers. Essential work may be done from the top of the breaker only if protective barriers have been installed.
6. Do not operate the breaker by solenoid or other operating mechanism without oil in the tank, as this will damage the breaker mechanism.
7. When working on the mechanism with the breaker-dosed, wire the trip latch or block the breaker closed so that it cannot be tripped accidentally. Be sure that auto reclosure feature has been by-passed during maintenance work.
8. In case of ABCB and other pneumatically operated circuit breakers the circuit breakers should be closed after opening the isolators on both sides, to prevent fall of pneumatic pressure.
9. After maintenance work is over the breaker should be operated by relay operation as test check. This ensures safety of the system for future faults.

3.2.5 Isolator Operation. Earth Switch Operation:

1. The Circuit Breaker shall be open/off.
2. The isolators should not operate (open or close) on load in any case.
3. The isolators should not be operated (open or close) on charged line / transformer in any case.

4. After opening isolator be sure that there is no pole stuck and all three poles of the isolators have been opened fully.
5. After closing isolator be sure that all three poles of the isolators have been closed.
6. The isolator should be locked with pad lock and key after opening on PTW and should be closed when PTW is returned properly.
7. When PTW is given for work on line the Earthing switch is closed after opening the isolator and both should be locked in position till returned of PTW properly.

3.2.6 Instrument Transformers Operation:-

1. The instrument transformers should he grounded.
2. One lead of the secondary circuit of the current transformers should he connected to ground at all times when the C.T. is in service.
3. Potential transformer secondary should never be shorted to ground except at star point.
4. The low voltage winding of potential transformers should always have one side permanently and defectively grounded.

3.2.7 Capacitors:-

1. Every capacitor shall be treated as 'hot' until proved otherwise. Capacitors store energy and are not necessarily dead when disconnected from the lines. Once charged, a capacitor may retain this charge for several hours even after it has been disconnected.
2. Before commencing work on the capacitors, first open all cut-outs or disconnecting devices to the capacitors and then wait for at least five minutes for the internal resistor to reduce the voltage. Next use a hot stick, short circuit and ground all terminals of the capacitor. The short circuit grounding Jumpers should be left attached while work is being done on the capacitor.
3. To place the capacitor banks in service, first remove the jumpers with hot sticks and then close the cut-outs.

3.2.8 Precaution while Maintenance of Battery:

1. While preparing electrolyte for initial filling up in the new battery always remember that the acid should be poured into water slowly and not the water into acid as it may splash acid on face or eyes.
2. Water should not 'he poured in concentrated acid as this will lead to chemical explosion.
3. If the acid is splashed in the eyes, immediately flush eyes with water, followed by Olive Oil. If irritation does not subside bathe eyes with zinc and rose water lotion in eye glass.
4. If the acid is drunk by mistake, take a drink of soap suds and baking soda in a glass of water and get medical advice as soon as possible.
5. Don't take open flam e near the battery especially while it is being charged.

3.2.9 D/C distribution:

1. D/C Distribution Board (DCDB) /Battery Charger must be cleaned regularly. Connections must be Tight / Rigid.
2. Only H.R.C. fuses of adequate and correct rating shall be used. Maintain the stock in the site store.
3. On DCDB, every DC feeder DC Cable provided for bay shall be named separately.
4. Separate Room shall be provided for DC distribution system in tile substation.
5. AC power cables & DC control cables shall be run separately in cable Trench as soon as possible.
6. Do not pull out the control cables with force & Jerk.
7. The defective cable shall be removed from Trench. Both ends of the cable must be made free first, pull the cable gently /smoothly, without disturbing other live cables.

3.2.10 Protection for EHV Sub Station:

1. The licensee/ utility/ company shall provide & maintain appropriate protective relays at 33kV and above S/Stn. including all the 33 kV & higher voltage transmission lines. The protective relays will also be provided on 11 kV outgoing feeders from the entire source S/Stns.
2. All protective relays shall be tested for their proper operations at least once every year & record of such testing will be maintained.
3. Record of mal-operations or non-operations of all protective relays shall be maintained. After every such mal-operation investigation for its causes will be carried out & remedial measures will be taken.

3.2.10.1 EHV substation shall maintain following T&P (minimum) for safe working:

1. Ten sets of discharge rods.
2. Good quality Torch (4 no) with fresh cells.
3. First Aid Box.
4. Tool Box (2nos) containing Insulation, Tape, all size ring & flat spanners, Allen key set, pliers (big, small size) Insulation cutter etc.
   a. H.R.C. fuses of various capacities.
5. Ladder (4nos.).
6. Ropes.
7. *AIC* Distribution Board with adequate wiring set.
8. Tong Tester.
9. Megger (5kV).
10. Multi meter with cords.
11. Danger Boards.
12. Good quality rubber (hand) gloves.

- For fast and effective communication (in case of accident), the following phone numbers shall be readily available

1. Police station of concerned Area
2. Ambulance service
3. Govt. Hospitals (near to 5/5)
4. Fire brigade station
5. Electrical Inspector
6. **Mobile No. of following:**

I. Substation in charge
II. Fire drill head of the substation
III. Ambulance service
IV. Fire brigade
V. Security head

Chapter-4

Safety Devices and Equipments

4.1 Safety Devices and equipments:

The following Safety Devices and equipments are required:

1. Rubber Hand Gloves, Gauntlets (11 *kV* class).
2. Safety Belts.
3. Leather Protective Gloves
4. Hand lines.
5. Ropes.
6. Helmets.
7. GOS Rods (11 *kV* Insulated).
8. Goggles.
9. Fiber Ladder.
10. Rubber Mat.
11. Telescope earthing rods.
12. **Hand Tools:-**

I. Insulated Cutting Pliers.
II. Insulated Screw Drivers.
III. LT Line Tester.
IV. Adjustable Spanner.
V. Rain Coat.
VI. Chargeable Hand Torch.

4.2 Workmen's Safety Devices:

I. Rubber gauntlets, gloves, mats, boots and galoshes, insulated platforms and stools, safety belts, hand lines, tower wagons and other special insulated devices shall be used as required by authorized line staff working on electrical apparatus. Underground mains and overhead lines as precaution against accidental electric shock.

II. Pliers and other tools insulated with brittle materials or otherwise liable to have the insulation damaged when in use, shall not be used.

III. The Supervisor in charge of the work will be responsible to test and ensure proper use of the safety equipment. supplied to the gang of workmen under him and see that it is maintained at all times in efficient condition and must immediately bring to the notice of his superior officer any equipment which is liable to be broken in use, when arrangements will be made immediately for their replacement.

4.3 Authorized line staff /lineman's, fitter's oil cable jointer's clothing

Authorized line staff while working on lines shall avoid wearing loose clothing, rings, metal chains etc., which may (contact a live portion and cause hazard. They shall use rubber gloves, safety shoes, head gear, goggles wherever available

4.4 Responsibility in using safety devices:

IT is the responsibility of the authorized lint:' staff to make use of safety devices properly.

4.5 Rubber gloves and gauntlets:

Rubber gloves should not be rough handled as to be damaged. After the work they should be cleaned and powdered with French chalk and stored in a safe place.

4.6 Testing rubber gloves and gauntlets:

Before using, the gloves should be checked for cuts, weak spots and pin holes. by an "Air Test". This is done by rolling the gloves tightly from the gauntlet end, and noticing if any air escapes. If air leaks the gloves should be discarded. If the either hand glove is found to be unserviceable the pair itself should be discarded.

4.7 Care of rubber equipment:

Rubber equipment shall be kept clean and free from oil. They should not be stored near a "source' of heat, or exposed unnecessarily to sun's heat. They are best stored in protective containers, and should not be tied by cords or thread, which may cut it.

4.8 Use of Rubber gloves should be insisted:

1. When inspecting the Transformer or its H.T. & L.T. leads.
2. When connecting wire near a live conductor equipment.
3. While removing or replacing fuses of H.T. installations.
4. A combination of glove and hickory rod or fuse pole rods should be used where the voltage exceeds 5,000 volts.
5. While opening and closing Isolators.

4.9 Care of safety belts: Safety belts should be properly handled, and periodically treated with oil to prevent its becoming hard. Care should be taken to see that sharp tools or edges do not cut dents and holes in it. Extra holes should not be punched as it weakens the belt. It is best preserved in a separate case.

4.10 Leather protecting gloves: Protective leather gloves may be worn over rubber gauntlets when wires are being spliced or when solder or hot compound are being handled when it is necessary for the authorized line staff to move about a lot during working or when line wire are being tied on to insulators or when any other work is being done which might render the gauntlet liable to tear and consequent danger to the wearer.

4.11 Eye and face protection: Necessary eye protection should be used while operating the switches on load to avoid injury to the eyes due to sparking. The eye protection should be used during handling molten solder, handling the acids and electrolyte in the battery rool11.

The eye and face protection should be inspected by Foreman / JE Incharge at frequent intervals by the user and should be replaced immediately when the first sign of damage is observed.

4.12 Head protection: Safety head gear shall be worn by the authorized line staff whenever there is a hazard of falling objects, or electrical contact or any other cause which may lead to head injury. Hair should not pose any obstruction to work and also should not lead to any accident during the work.

Head protective gear should also be subjected for inspection level very frequently and should be replaced immediately when the sign of damage or deterioration is noticed.

4.13 Hand lines: Hand lines should be twice as the height where work is being done. They should always be kept clean and dry, free from grease, solder, oil. etc., ends should be tied to prevent unraveling of the strands. Hand lines should not have metal reinforcement. When jointing the hand lines a splice should be made. No metallic clamps or wire should be used for joining. Hand line should be carried up a pole, uncoiled and attached to the body belt. The hand line must be strong enough to carry the weight of an authorized line staff. Hand lines should not be allowed to become wet, and should be dried before being stored. A spare hand line should always be available in an emergency. Hand lines should be kept away from street and vehicle traffic.

4.14 Ladders:

1. Ladders must be of strength to carry double the strain of the heaviest load that would be placed upon them.
2. Defective ladders must never be used.
3. A clearance space of not less than 12" must be provided between ladder rungs. A minimum clearance space of 36"/90 cms must be provided in front of ladders where space permits.
4. When straight, portable ladders are used on hard surfaces, they must h£:' held or firmly locked in audition, anti-slip shoes must be used where provided.
5. Ladder may not be placed against unsafe place.
6. Ladders must be kept free from dirt, grease and paint-spots.
7. Ladders must be stored upon brackets and. in sheltered locations.
8. Ladders must not be placed in front of doors opening towards the ladder or against window sashes.
9. Step-ladders must be fully opened before being used.
10. Two ladders must not be spliced together.
11. Authorized line staff must face ladders when ascending or descending over them and must have both hands free.
12. Authorized line staff must not slide down or try stunts on ladders.

13. Ladders must be periodically inspected, when found defective; they must be repaired or disposed off.
14. Straight, portable ladders must be placed at safe angle about 75 degrees with the horizontal. In other words, place the foot of a 12'/4 Mts ladder 3'/1 Mts. from the object it leans against.
15. Straight ladders shall not he climbed beyond the third step from the top.
16. Authorized line staff shall use the safety belt tied to the ladder whenever both hands must be used for the job or a possibility of the authorized line staff falling from an elevated position exists.
17. As far as possible portable metal ladders shall not be used in the vicinity of exposed energized lines and equipment.
18. Only One authorized line staff shall work from a ladder at one time. If two authorized line staff is required, a second ladder shall be used.
19. Ladders are not meant to be used as scaffolding platforms.
20. Other makeshift arrangements for the purpose of ladders like using boxes, chairs. etc., shall not be resorted to.
21. Use of step ladders above 20 feet is prohibited and the use of extension ladders above 24 feet is discouraged.
22. Step ladder legs shall be fully spread and the spreading bars locked in place.
23. Step ladders shall not be used as straight ladders.
24. When an authorized line staff is working on a step ladder more than 10 feet high the ladder shall be held by another authorized line staff.

4.15 <u>Ropes:</u>

1. Fiber ropes are made principally of manila fiber, sisal fiber and hemp. Frequent inspections are required in the use of rope as the interior fibers may be broken or ground to powder, while the exterior fibers may indicate that the rope is little worn.
2. Pure manila rope is the strongest and most reliable of fibers ropes. It is of a yellowish color with silvery or pearls luster and has a silky feel when drawn through the hand. Rope with brown or black fiber is of inferior grade.
3. Sisal rope has about 6.7% of the strength of manila rope. It is-yellowish white, sometimes with a greenish tint. The Fibers are hard and stiff. with a tendency to splinter:
4. Hemp rope is nearly as strong as manila and is slightly more resistant to atmospheric deterioration. It is of a dark grey color and is much softer than manila rope.
5. Rope must be so uncoiled as to avoid kinking, since even a moderate strain on a rope in which there is a kink may over-stress the fibers at the kink.
6. Wet rope deteriorates rapidly unless dried properly. It should be hung up in loose coils so that dry air can be circulated through them. Heat should never be applied as it dries out the oil and thus shortens the life of the rope. Wet rope has a tendency to form kinks. No load should be applied until all kinks are removed.

7. All ropes are easily damaged by acids and alkalis. Any rope known to have been exposed to acids or alkalis (sometimes indicated by discoloration or strains) should be used with caution.
8. In making a rope fast, an object with a smooth round surface should be selected. When rope is running over a sheave or pulley internal wear is caused by friction. The life of the rope is greatly prolonged by using blocks with sheaves of large diameter.
9. Fiber rope should always be cleaned before being placed in storage and shall be stored in a dry, airy place. It should never be stored in the same room with acid or caustics.

4.16 <u>Hand Tools;</u>

1. All Hand tools to be used should be of an approved type.
2. Tools shall be inspected at frequent intervals and disposed off as soon as the sign of damage is observed.
3. Using hand tools improperly, neglecting to keep them in safe working condition and carelessly leaving them around where they may endanger authorized line staff and frequent cause of accidents. Proper tools should always be used for the work.
4. All tools shall be maintained in good working conditions. Burred heads shall be promptly redressed. Broken, cracked or otherwise damaged handles shall be replaced. All tools with sharp edges should be kept in sheaths, shields, tool chests or other containers, when not in actual use.
5. A screw driver should never be used as a chisel. Screwdrivers with full length metal tong of shank through handle must not be used for electrical work. Other tools such as pliers, wrenches, etc., whether insulated or not, shall not be used without rubber gloves while working near live parts of any voltage.
6. All files shall be fitted with substantial handle; workmen should keep files cleaned as this reduces the slipping hazard and prevents skinned hands.
7. Never use metal tapes, rulers, or cloth tapes with metal strands or wood rulers with metal ferrules or joints near energized equipment.
8. Avoid use of long saws among wires as a short circuit may be caused.
9. Belt-tools must be well secured to the belt. Only pliers, hammers, wrench and connectors should be carried. All other tools should remain below until needed and then hoisted in bag/tool buckets or firmly attached to hand lines.
10. Chisels, drills, punches, ground rods and pipes shall be held with suitable holders or tongs (not with the hands) while being struck by another authorized line staff.
11. Shims shall not be used to make a wrench fit.
12. Wrenches with sprung or damaged jaws shall not be used.
13. Pipe shall not be used to extend a wrench handle for added leverage unless the wrench was designed for such use.

14. Wooden handles those are loose, cracked, or splintered shall be replaced. The handle shall not he taped or lashed with wire.
15. All cutting tools such as saws, wood chisels, drawknives, or axes shall be kept in suitable guards or in special compartments. The insulation on hand tools shall not be depended upon to protect users from electric shock.
16. When using such tools as screwdrivers and wrenches, authorized line staff should avoid using their wrists in a bent (flexed), extended or twisted position for long periods of time. Authorized line staff should maintain their wrists in a neutral (straight) position.

4.17 Portable Electric Tools:

1. All portable electric power tools such as drills, saws and grinders on requisition from authorized line staff to be issued to authorized line staff. They should have an earth conductor connected effectively with the earth when energized.
2. The power supply cord should be inspected at regular intervals.
3. They must be used to their capacity in accordance with the manufacturer's instructions.
4. Electric tools should not be used in areas where there is a flammable atmosphere.
5. All portable power supply systems like vehicle mounted generators shall he protected by an Earth Leakage protection.
6. Protective guards should be used wherever possible and provided.

Chapter-5

EARTHING

Grounding /Earthing is provided to connect some parts of electrical equipment, installation or the neutral point of power system. This provides dispersing path for fault current and lightening current in order to stabilize the potential and act as a zero potential reference point to ensure the safe operation of the power system, electrical equipment and safety of· power system operator and other persons.

Grounding is achieved by the grounding devices buried in the soil. The grounding devices of a power system can be divided into relatively simple one for transmission towers/poles such as pipe earthing or counterpoise earthing by horizontal grounding electrode or vertical electrode or by grounding grid for an S/Station power plant.

5.1 Classification Earthing can be classified as under:

i. **Working grounding/Neutral earthing**: It is done to reduce the voltage stresses due to switching and lightning surges and to control the fault currents to satisfactorily values.

ii. **Protective earthing:** When the insulation of electrical equipment fails, its enclosure becomes live and the person feels a shock if he or she contacts its enclosures. In order to guarantee the personal safety the enclosures of all the equipments are to be grounded.

iii. **Lightning protection earthing:** In order to provide safety from lightning to human beings and power system this type of earthing is done by providing Surge lightning and other lightning protection arrestors which are connected with the grounding system.

iv. **Functional earthing:** The functional earth is used for interference suppression. It is a low-impedance current path between the circuitry and earth and is only used to improve the equipment's performance and not for protective~ purposes. Functional earth should be established for the low frequency and the high frequency range. At the low frequency range the most important factors for a satisfactory functional earth are the cross section area of the earthing cable and the cable length to ensure minimum over-all cable impedance. At the high frequency range a short cable length, high outer conductor surface (skin effect) and low inductance are important.

5.2 Purpose of Earthing:

1. Reducing insulation level of Electrical Equipment
2. Ensuring safe operation of Power System.
3. Ensuring personal safety.
4. Eliminating Electrostatic accidents.
5. Detecting grounding faults.
6. Equipotential bonding.
7. Reducing electromagnetic interference.

5.3 Temporary Earthing: This section covers the detailed procedures for providing temporary earths for the protection of workmen and property while carrying out operation and maintenance works Oil the already existing lines or construction of new lines for the protection of workmen and property.

5.3.1 Temporary Earths: Temporary earths are those applied at the actual location of the work, during repair or construction of installations, for the protection of workmen and property.

Following feature of temporary earthing equipment shall be kept in view by authorized line staff using it.

Earthing devices shall be of approved types, comprising properly designed clamps attached to insulated sticks of sufficient lengths to enable the clamps to be securely clamped to the conductors being earthed without an authorized lint' staff's hand approaching closer than the minimum safe working distances, each such line clamp is to be connected by a flexible copper earthing lead or of equivalent copper section of aluminum cable to an adequate earth clamp or other device for attaching to permanent a connection or to a temporary earthing spike. The earthing should be connected to clean rust free nut bolts of tower / Earthing Electrode.

All earthing jumpers shall be of annealed hare and stranded copper equivalent aluminum conductor. Earthing leads for use at substations and lines shall have a cross section of at least 0.645 sq. cm (0.1 sq. inch) copper equivalents.

Least 1.905 cm (3/4") in diameter and 1.524mtrs. / (5ft.) in length. These shall be of conducting earthing rod electrode material and be driven to a depth of at least 0.914 meters (3ft) in a spot considered to give good earth.

Grounding cable/Earth wire used for earthing shall be examined by the authorized line staff every time before use.

5.3.2 General precautions to be taken in connection with the application of temporary earths:

1. Before doing any work on dead lines Or equipment where there is a possibility of their becoming energized from any source, such line or equipment should be grounded between the location of work and all possible sources of energy.
2. Temporary grounding cables shall be flexible standard copper/aluminum not less than No.l/0 AWG (0.590 inch) and shall he equipped with approved clamps at each end.
3. When grounding lines or equipment the connection to the ground shall be made first and that to the circuit or equipment last. In removing grounds, first remove the connection to tile circuit or apparatus and then remove the ground connection. Approved discharge rods should be used in making ground connection to the circuit or apparatus.
4. Where two or more crews of authorized line staff are working independently on same line or equipment, each crew shall properly protect themselves by placing their own temporary grounds.

5. No electric apparatus or line shall be earthed until all reasonable precautions have been taken to ensure that it has been disconnected from all sources of supply.
6. The connection for earthing of an apparatus or line shall be applied or removed only by competent authorized line staff.
7. When it is necessary to cut a line, bus bar or loop or to repair a broken conductor or damaged loop, earths shall be placed on both sides of the work. When removing earthing leads, they shall be disconnected from the line conductor first and the earth system last. The removal shall be carried out in a reverse order to that adopted for the connection of various conductors to earth.
8. All works on dead circuit shall be dune between two sets of temporary earths.
9. Y. Earths shall never be attached or removed with bare-hands, Rubber gloves, gauntlets or approved protective equipment shall always be used.
10. In so far as practicable, the authorized line staff applying the earth's connection on poles and structures shall maintain his position below the level of conductor to be earthed in order to keep the body away from any live part when the earthing device is applied.
11. No temporary earth shall be removed from the equipment while the work is in progress.
12. Authorized line staff shall not touch any conductors from which protective earths have been removed.
13. Earthing of one conductor does not render other conductors safe for work. All phases shall be earthed even if work is to be carried out only on one phase.
14. Temporary earth connections should not be connected to neutral wire, guy/stay wire or any other metal part of the structure.
15. The meaning of temporary earth is that it is done for the purpose of carrying out the specific work by creating a safety zone for the protection of working authorized line staff from electric shock.
16. The temporary earthing connection to the lines should be as close to the point of work as possible.
17. High voltage mains shall not be worked upon unless they are discharged to earth after marking them dead and are earthed and short-circuited with earthing and short-circuited with earthing and short-circuiting equipment adequate to carry possible short-circuit currents and which are specially meant for the purpose. All earthing switches wherever installed should be locked up.
18. The earthing device when used shall be first connected to an effective earth. The other end of the device shall then he connected to the conductors to be earthed.
19. Except for the purpose of testing, phasing, etc. the earthing and short-circuit device shall remain connected for the duration of the work.

i. Removing the earth connections -On completion of work-removal of the earthing and short-circuiting devices shall be carried out in the reverse order to that adopted for placing them that is, the end of the earthing device attached to the conductors of the earthed mains or apparatus

shall be removed first and the other end connected to earth shall be removed last. The conductor shall not be touched after the earthing device has been removed from it.

ii. Safety precautions of earthing -The precautions mentioned in (a) to (e) below should be adapted to the extent applicable and possible.

a) Examine earthing devices periodically and always prior to their use.
b) Use only earthing switches or any other special apparatus, where provided for earthing.
c) Verify the circuit is dead by means of discharging rod or potential indicator of approved type. The indicator itself should first be tested on a live circuit before and after verification.
d) Earthing should he done in such a manner that the authorized line staff doing the job is protected by earth connections on both sides of the working zone.
e) All the three phases should be effectively earthed and short-circuited even though work may be proceeding on one phase only.

5.4 **Earthing in Sub-Stations:** Earthing is an important aspect of every sub-station. The function of a Earthing system is to ensure the safety of authorized line staff and the public, to minimize hazard from transferred potential, to protect equipment, to provide a discharge path for lightning strikes and to provide a low-resistance path to ground. The earthing installations required at sub-station are as below:

a. The neutral points of each separate electricity system which has to be earthed at the substation.
b. Apparatus framework or cladding or other non-current carrying metalwork associated with each system, for example, transformer tanks, power cable sheaths.
c. Extraneous metalwork not associated with the power systems, for example boundary fences, sheaths of control or communication cables.

For safety, the objective of earth bonding is to ensure that, in normal or abnormal conditions, any voltage appearing on equipment to which there is access should be below a dangerous level. It is not practicable to ensure that metal parts are earthed and remain near true earth potential during the passage of earth fault currents, particularly on high voltage systems with directly earthed neutrals. The objective should, therefore, be to provide effective bonding of low impedance and adequate current-carrying capacity between parts with which anyone may be in simultaneous contact, and to arrange, as far as possible, that large fault currents do not flow between such points. To minimize risk of damage to certain auxiliary plant, the rise of potential of a station earthing installation above the potential of true or remote earth should be as low as practicable, since this potential will be applied across protective insulation of any plant with connections to earth external to the substation, for example, plant with connections to pilot or telephone cables or cable sheaths. For similar reasons, the potential difference between earthed points in the station should also be kept to a minimum. Where surge protection is provided, the connection of the protective devices to earth should be as direct as possible. The discharge of high currents with high-frequency

components requires earth connections of low resistance and reactance, that is, short connections with as few changes of direction as possible.

When' the neutral points of two electrically separate electricity systems are connected to a common earth electrode system at a site, there is a coupling of the systems in the event of an earth fault occurring on either system by virtue of the rise of earth potential due to the passage of the fault current through the earth electrode system. Similarly, if non-current carrying metalwork is bonded to the same earth electrode as the neutral point of the supply the metalwork will experience the same rise of earth potential. If complete separation of electrical systems were required, it would be essential that the neutral points of each system and its associated metal work be separately earthed. If such a method were adopted, each earthing system would require insulation from other earthing systems to withstand the maximum rise of earth potential occurring in any system by virtue of lightning currents or power system fault currents. Insulation to this level is rarely practicable.

The choice of using a common earth or separate earths for the system of different voltages at a transforming point affects:

a.	The probability of breakdown occurring in a transformer between the higher and lower voltage sides due to lighting or other surges.
b.	The safety of consumers or their property supplied by any low voltage system distributed from the station against arise of potential of the earthed neutral by a high voltage system earth fault at the station.

The former risk is reduced by use of a common earth system and the latter danger only arises if the resistance of the earth electrode system is not sufficiently low to limit the rise of earth potential to a safe value. There is advantage in using a common earth where the earth electrode resistance, including the parallel resistance of any bonded metalwork, etc to earth is 1 ohm or less, as is usual at power stations, large outdoor substations or substations supplying a network of cables whose sheaths have low impedance to earth.

The substation earth system rise of potential will not be excessive if the resistance of the earth electrode system is small compared to the total earth fault circuit impedance. Systems of higher voltage (66 kV and above) generally have the neutral directly earthed, since the increase in costs of insulation that would be required for the transformer winding would be considerable.

The requirements are, therefore, best considered separately for substations:

a. where low voltage is confined to auxiliary supplies within the substation;

b. substations that provide an external low voltage supply; and

c. power stations.

The use of neutral earthing switchgear in public supply systems is avoided, where possible, since a direct earth is simple, reliable and cheaper than a switched earth. The circumstances in which neutral earthing/switchgear may be necessary are so broad that it is not practicable to form general rules on type and application.

5.4.1 Permissible Current through a Human Body during the Fault: Humans are quite sensitive to AC currents ranging from 50-60 Hz. The effects of the AC current going through a human body depend on the magnitude, duration, and also frequency. The threshold of perception for the human body is about 1mA. Currents between 1-6 am, often called let-go currents, usually do not impair a person from controlling his muscles and releasing the energized object they were holding. Higher currents ranging from 9-25 mA can cause pain and affect the muscle control so that the energized object is hard if not impossible to release. Still higher currents between 25-75 mA can affect breathing and may cause fatality. If current is even higher, it could result in ventricular fibrillation of the heart, which if not treated quickly, can result in death. When currents reach 100 mA and higher, above the ventricular fibrillation level, it can cause burns, heart paralysis and inhibition of breathing.

Chapter-6
CONSTRUCTION AND TRANSPORTATION

6.1CONSTRUCTION: We should use only good quality and materials as per BIS/ISS specifications, having more than adequate mechanical strength and the desired factor of safety for the supports and conductors as mentioned in the Safety Regulations, for construction of transmission lines and substations.

Using these practices would automatically avoid danger to the public and ensure Safety in the Construction.

Regulation 12 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: 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 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 being, 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 regulations and in the event of any inconsistency, the provision of these regulations shall prevail.
3. The material and apparatus used shall conform to the relevant specification of the Bureau of Indian Standards or International Electro-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 Municipal 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 seepage or leakage or logging of water in the basement.

6.2 OVER-HEAD EHV/EHT & HT/LT LINES, UNDERGROUND CABLES & SUB STATIONS/CEA REGULATIONS PROVISION:

1. **Material and strength, Regulation 55 of CEA(measures relating to Safety and Electric Supply) Regulation,2010**
   i. All conductors of overhead lines other than those specified in regulation 68 shall have a breaking strength of not less than 350l<g.
   ii. Where the voltage does not exceed 250 V and the span is of less than fifteen meters and is drawn through the owners or consumer premises, a conductor having an actual breaking strength of not less than 150 Kg may be used.

2. **Joints, Regulation 56 of CEA (measures relating to Safety and Electric Supply) Regulation, 2010.**

   i. 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.

   ii. The ultimate strength and the electrical conductivity of the joint shall be as [ler relevant Indian standards.

3. **Maximum stresses, factors of safety, Regulation 57 of CEA(measures relating to Safety and Electric Supply) Regulation,2010**

   i. The load and permissible stresses un the structural members, conductors and ground wire of self supporting steel lattice tower for overhead transmission lines shall be in accordance with specifications laid down, from time to time, by the Bureau of Indian Standards.

   ii. 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, molded concrete supports	2.5
iv.	For wood supports	3.0

4. **Clearance between conductors and trolley wires, Regulation 59 of CEA (measures relating to Safety and Electric Supply) Regulation, 2010.**

   1. No conductor of an overhead line crossing a tramway or trolley-bus route using trolley wire shall have less than the following clearance above any trolley wire.

i.	Lines of voltage not exceeding 650 volts	1.2 meters

Provided that where an insulated conductor suspended from a bearer wire crosses over a trolley wire, the minimum c1earimce for such insulated conductor shall he 0.6 meter.

ii.	Lines of voltage exceeding 650 volts up to and including 11,000 volts	1.8 meters
iii.	Lines of voltage exceeding 11,000 volts but not exceeding 33,000 Volts	2.5 meters
iv.	Lines of voltage exceeding 33 kV	3.0 meters

   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 lines and the line which will be crossed in accordance with the provisions of 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.

5. **Conductors at different voltages on same supports" Regulation 62 of CEA (measures relating to Safety and Electric Supply) Regulation, 2010.**

   Where conductors forming parts of systems at different voltage levels are erected on the same support. 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.

6. **Routes -proximity to aerodromes, Regulation 66 of (EA (measures relating to Safety and Electric Supply) Regulation,20l0**

   Over-headlines 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.

7. **Maximum intervals between supports, Regulation 67 of CEA (measures relating to Safety and Electric Supply) Regulation, 20l0.**

   All conductors shall be attached to supports ,n intervals not exceeding the sale 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 over-headlines 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 meters.

8. **Condition to apply where telecommunication lines and 'Power lines are carried on same supports, Regulation 68 of CEA (measures relating to Safety and Electric Supply) Regulation, 20l0.**

   i. 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.

   ii. Every telephone used on a telecommunication line erected on supports carrying a power line shall be suitably guarded against lightning and shall be provided by cut-outs.

   iii. 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.

9. Lines crossing or approaching each other and tines crossing street and road, Regulation 69 of CEA (measures relating to Safety and Electric Supply) Regulation, 2010.

Where an over-head line crosses or is in proximity to any telecommunication line. The owner of either the over-head line or the telecommunication line, whoever lays his line later, shall arrange to provide protective devices or guarding arrangement and shall observe the following provisions, namely:

i. When it is intended to erect a telecommunication 'line or an over-head line which will cross or be in proximity to an over-head line or a telecommunication line, as the case may be, the person proposing to erect such line shall give one month 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 over-head line crosses or is in proximity to another overheads line, guarding arrangement shall he provided so as to guard against the possibility of their cOll1ing into contact with each other.

iv. Where an over-head line crosses another over-head line, clearances shall he as under:

(Minimum clearance in metres between lines crossing each other)

S. No.	Nominal System voltage (A.C.)	11-66 (A.C.) kV	110-132 (A.C.) kV	220 (A.C.) kV	400 (A.C.) kV	800 (A.C.) 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	4.58	5.49	7.94
6	800 kV	7.94	7.94	4.58	5.49	7.94

Provided that no guarding are required when an extra high voltage line crosses over another extra-high voltage, high voltage, medium or low voltage line or a road or a tram subject to the condition that adequate clearances are provided between the lowest conductor of the extra-high voltage line and the top most conductor of the overhead line crossing underneath the extra-high voltage line and the clearances as stipulated in rule && from the topmost surface of the road is maintained.

v. A person erecting or proposing to erect a line which may cross or be inn proximity with an existing line, may normally provide guarding arrangements on his own line or require the owner of the other overhead line to provide guarding arrangements.

vi. 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 maintenance.

vii. All work required to be done by or under this rule shall be carried out to the satisfaction of the inspector.

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 lines as practicable and the support of the lower line shall not erected below the upper line.

Chapter -7

TOOLS & PLANT

7.1 The List of T & P to be maintained:

List of T & P to be maintained by Line man:

S. No.	Material Name	Unit	Quantity
1	GOS Rod(ll kV insulated)	No.	1
2	Rubber Hand Gloves(11 kV Class) Good quality suitable to work on live wire	Pair	1
3	Insulated Cutting Pliers 12"	No.	1
4	Screw Driver (Each) Size 6” Size 12”	No.	1
5	LT line Tester	No.	1
6	Helmet	No.	1
7	Safety Belt	No.	1
8	Adjustable screw spanner	No.	1
9	Rain Coat (light Weight)	No.	1
10	Chargeable Hand Torch	No.	1
11	Goggles	No.	1

List of T & P to be maintained by J.E. and A.E/A.E.E:

Sr. No	Material Name	Unit	Quantity
1	Telescopic Earthing Rod	Sets / Nos.	2 (6 Nos.)
2	Fiber Ladder	Nos.	2
3	Chargeable Hand Torch	No.	1
4	Rubber Hand Gloves (11 kV Class)	No.	1
5	11 kV Line Tester	Nos.	4
6	Helmet	No.	1
7	Rain Coat (light Weight)	No.	1
8	Rubber Mat Size 2’ X 3’	Nos.	2

7.2 INSPECTION OF SAFETY EQUIPMENT

All safety equipment shall be thoroughly inspected:

1. Monthly, by the T&P holder.
2. Quarterly, by the Assistant Engineer/Assistant Executive Engineer,
3. Once in six mOl1lhs, by the ASE/Sr. Xen Officer for its being in good condition.

CHAPTEB-8

FIRST- AID

8.1 Treatment for Electric Shock Asphyxiation (Suffocation) and Drowning

In most of the cases of electric shock and collapse, it is the lungs and the diaphragm (the thin sheet of muscles which lies below the lungs) that have stopped working and there is a very good chance of revival by applying artificial respiration quickly.

In case of severe shock, respiration is seldom established less than one hour while three to four hours or more might be found necessary to restore normal breathing. It is therefore essential that in all cases of electric shock where the condition of the patient is doubtful or the patient is unconscious or not breathing, artificial resuscitation should be continued until the patient breathes normally or until the doctor has pronounced life extinct.

8.2 Resuscitation Drill: Every authorized line staff shall qualify himself by practical study and drill in the treatment for electrical shock according to the instructions contained in this Chapter.

8.3 Removal of Contract: If the authorized line staff is still in contact with the apparatus that has given the shock, switch off the electric circuit at once if there is a switch, fuse or circuit breaker close at hand, if not, lose no time from proceeding to remove the body from contact with the live conductor.

Do not touch the victim's body with bare-hands, but if rubber gloves are not in hands pull the victim off the line conductor by his coat, shirt etc., if they are not wet or fold your coat or some dry article such as news paper to three or more folds/thickness and using this as a pad, take hold of the body and pull it away from the circuit. An operating rod or a broom handle may be used to raise the body or to detach the wires from it. Layers of thick news paper or bundle of dry sacking and remove the victim away from the live apparatus. Dried wooden sticks or rods can be used without any risk or shock.

If the victim is at height, efforts must be made to prevent him from falling or to make him fall safe

If the casualty is unconscious but is breathing loosen the clothing around neck chest and waist and place the casualty in the recovery position.

Extinguish any sparks if the patient’s clothes smoldering. Send for bringing a doctor while simultaneously keeping watch on the victim on his breathing and heart beat. If apparently not breathing proceeds as per detail there here under:

In case of severe bleeding especially wrist, hand or fingers. It must be considered and should he given serious attention.

i. Make the victim to lie down and rest.
ii. If possible raise the injured part above the level of the body / heart and apply pressure to the wound.
iii. Call for medical Assistance.

8.4 Immediate Action to Recover the Patient:

When a man has received severe electric shock or been subjected to poisonous gases, or has been removed from the water in a drowning condition, his breathing is usually stopped. In accidents of this kind, speed may save the injured man's life; hence do not waste a second. Send for a doctor at once but do not neglect the patient in doing so.

The first thing to do is to get the injured man to a suitable place where you can work on him. This may necessitate lowering from a pole or raising him from a manhole. This work usually involves considerable danger to the rescuer, because a manhole may be full of poisonous gases, or the injured man may be in contact with the dangerous circuit on the pole. You must, therefore, work very carefully.

Avoid so placing the patient as to bring pressure on the burns he has sustained, if any. Do not expose the patient to cold. Stimulants should not be administered unless recommended by a doctor. Cold water may be given in small quantities in cases of electric fire or asphyxiation cases and smelling salts may also be administered in moderation.

Continue artificial respiration without interruption until breathing is restored. Cases of success are on record after resorting for artificial respiration for more than 3 hours. Ordinary tests for death are inconclusive in cases of electric shocks and-Doctor's pointed attention must be drawn to this when necessary.

Resuscitation should be carried on at the nearest possible place where the patient received his injuries. He should not be removed from this place until he is found breathing normally and then also should be moved only in lying position. Should it be necessary due to extreme weather conditions, etc. to move the patient before the victim starts breathing normally, he should be kept in a prone position and placed on the hard surface (door or shutter) or on the floor of a conveyance, resuscitation being carried on during the time that he is being removed.

A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently, the patient, after a temporary recovery of respiration stops breathing again. The patient must be watched and if normal breathing stops, artificial respiration should be resumed at once.

8.5 Upon Recovery: When the victim revives, he should be kept lying down and not allowed to get up or be raised under any circumstances, unless on the advice of a doctor. If the Doctor has not arrived by the time the victim has revived, he .should be given some stimulant, or a drink of hot ginger tea or coffee. The victim should then have any other injuries attended to and be kept warm, being placed in the most comfortable position.

8.6 First Care of Burns: Burns, if serious, should be treated with a proper dressing. A raw or blistered surface should be protected from the air. I f clothing sticks, do not peel it off but cut around it. The adherent cloth or a dressing of cotton or other soft material applied to burnt surface should be saturated with picric acid (0.5%). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of Hour and water, or it may be protected with Vaseline, carron oil, olive oil, castor oil or machine oil. if clean, cover the

dressing with cotton gauze, linen, clean waste, handkerchief. or other soft cloth, held tightly in place by bandage. The same coverings should be tightly bandaged over a dry, charred burn, but without wetting the burnt region or by applying oil to it. Do not open blister.

8.7 Treatment for electric Burn:

If, as result of electric shock the victim is suffering from burns, the following treatment should be given without hindrance to artificial respiration:

i. Remove clothing locally to enable the burn to be treated but do not break blisters.
ii. Saturate burns with warm solution of one dessert spoonful of bicarbonate of soda to a pint of warm water or a teaspoonful of salt to a pint of warm water.
iii. Cover twit lint soaked in a similar solution and bandage (lightly if blisters have formed).
iv. If the above solutions are not available, cover with sterile dressing.
v. Warm, weak sweet tea may be given when the patient is able to swallow.

8.7 Artificial Respiration

8.7.1 Nelson's Arm lift back pressure method: Place the victim prone face down with his arms folded with the palms one over the other and the head resting on his check over the palm. Kneel on one or both knees near the victim's hand. Place your hands in the victims back beyond the line of the armpits, with your fingers spread outwards thumbs just touching each others.

Gently rock forward keeping the arms straight until they are nearly vertical and thus steadily pressing the victim's back to force the air out of the victim's lung.

Synchronizing the above movement rock backwards, slide your hands downwards along the victim's arms and grasp his upper arm just above the elbows as shown.

As you rock hack, gently raise and pull the victim s arms towards you until you feel tension in his shoulders. To complete the cycle, lower the victim's arms and move your hands up to initial position. This method should not be used if there are injuries on the chest and belly of the victims.

8.7.2 Schafer's method: Lay the victim on his belly, with one arm extended directly forward and the other arm bent at the elbow and with the face turned sideward and resting on the hand or fore arm.

Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned.

With the arms held straight swing forward slowly so that the weight of your body is I gradually brought to bear upon the ribs of the victim to force the air out of victim's lungs.

Now swing backward immediately removing all the pressure from the victim's body.

After two seconds, swing forward again and repeat the cycle for twelve to fifteen times a minute. However, this method cannot be adopted if there are injuries on the chest and belly of the victim.

8.7.3 Direct Artificial Respiration: Direct artificial respiration is the method whereby a authorized line staff ventilates the lungs of an unconscious non-breathing victim by blowing his own breath directly in to the mouth or nose of the victim.

Expired air is not dead air. It has been proved more than adequate for artificial respiration. The atmosphere contains 21 % oxygen while expired air contains 14-18 % oxygen.

It has been clearly established that direct artificial respiration is superiors to indirect artificial respiration (manual method), in all age groups and in all situations.

Indirect manual methods of artificial respiration cannot be applied in many situations when emergency resuscitation is urgently required.

For example, in case of severe chest and spinal injuries, indirect manual methods cannot be used. Furthermore, a victim may be partially buried in a cave or trapped behind a steering wheel or located in cramped quarters as would be the case in small craft aero planes and other places.

In all these instances, the victim's survival will depend upon direct artificial respiration.

The procedure for Direct Artificial Respiration (mouth to mouth method) is as follow:

i. Place the victim on back immediately.
ii. Clear throat of water, mucus, coins, or food.
iii. Tilt head back as far as possible.
iv. Lift jaw up to keep tongue out of air passage.
v. Pinch nostrils to prevent air leakage when you blow.
vi. Blow until you see the chest rise.
vii. Listen for snoring and gurgling signs of throat obstruction.
viii. Repent blowing 10-20 times a minute.

In case of infants and small children tilt the head fully back, surround the mouth and nose completely with your mouth. Blow with only enough force to produce a visible rise in the victim's chest and no more. Repeat every 3 seconds. Continue direct artificial respiration until victim breathes for himself or until expert help is obtained. The method is fully described hereunder:

Step 1: Lay the victim flat on his / her bark and place a roll of clothing under the shoulders to ensure that his head is thrown well back. Tilt the victim's head back so that the chin points straight upward.

Step 2: Grasp the victim's jaw, and raise it upward until the lower teeth are higher than the upper teeth; or place finger on both sides of the jaw, near the ear lobes, and pull upward. Maintain jaw position throughout artificial respiration to prevent the tongue from blocking the air Passage.

Step 3: Take a deep breath and place your mouth over the victim's mouth. Making airtight contact. Pinch the victim's nose shut with thumb and forefinger. If you dislike direct contact, place a porous cloth between you and the victim's mouth. For an infant, place your mouth over his/her mouth and nose.

Step 4: Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth, & release the hold on his nose, to let him exhale, turning your head to hear the out-rush of air. The first eight to ten breaths should be as rapid as the victim responds. Thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

8.7.4 <u>Mouth to nose method:</u>

If the victim's mouth will not open or has a blockage which cannot be cleared , use the fingers of one hand to keep the victim's lips firmly shut and seal your lips round the victims nostrils and breathe in to him check to see if the victim's chest is rising and falling.

Note:

1. If air cannot he blown in, check the position of the victim's head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise, turn the victim's face down and strike his back sharplv to dislodge obstructions.
2. Sometimes air enters the victim's stomach, as evidenced by a swelling stomach. Expel air by gently pressing the stomach during the exhalation period.

In any case where external cardiac compression and artificial respiration are being administered Pressure - Cycling mechanical resuscitators shall not be used in lieu of mouth-to-mouth or other approval artificial respiration, because they may not be effective in adequately ventilating the lungs with air (oxygen).

Medical research has shown that properly administered mouth to mouth resuscitation is at least as effective as mechanical resuscitator: also. MMR can be performed effectively without the use of airways of any kind. The time delay in waiting for a mechanical resuscitator or an airway to be made available and place in operation could materially reduce or preclude the victim's chance of recovery.

Care for the unconscious:

i. Oxygen is the element most vital for survival. Permanent brain damage or death may result within a few minutes from lack of air or oxygen. Therefore a victim's breathing requirements must receive your first attention.

ii. The case of unconsciousness may be obvious, as in the case of drowning, electric shock, smoke or gas inhalation, strangulation, severe injuries, etc.

iii. The cause of unconsciousness may be obscure, as in the case of poisoning, overdose of drugs, alcoholism, heart disease, brain disease, diabetes, uremia, epilepsy etc.

iv. An unconscious authorized line staff may be breathing or not breathing.

v. In either case an open air passage to tilt' lungs must be maintained. The human tongue is as large as a quarter pound beefsteak. The muscles of the tongue relax with loss of consciousness. In certain positions the tongue fall back, obstructing the throat and cutting off the air passage.

8.8 The unconscious authorized line staff who is breathing: Many accident victims, especially those sustaining head injuries (common in home and traffic accidents), suffer tempor3ry shock and loss of consciousness. This may lead to death by suffocation.

Accidental death may be avoided in such cases by first taking a simple precaution:

i. Place the victim on his side or abdomen with his head turned to one side and tilted back.

ii. In this position there is less danger of obstruction by the tongue or aspiration of vomits into the lungs.

8.9 The unconscious authorized line staff who is not breathing:

In such cases the unconscious victim requires immediate artificial respiration. Direct artificial respiration is the most positive and efficient means of ventilating his lungs.

The indirect or manual chest compression methods of artificial respiration (Holger Neilsen, Schafer., etc.,) depend on negative pressure, and are unsatisfactory unless provision has been made to establish and maintain an open air passage to the lungs.

8.10 The Unconscious authorized line staff whose breathing is very slow or shallow:

The victim may be assisted by direct artificial respiration, timing the air inflation with the patient's breathing efforts.

8.11 SPECIAL CARE SITUATIONS:

8.11.1 Drowning:

i. Direct artificial respiration must be started it victim's head can be kept above the water.

ii. Do not waste valuable time waiting to bring the victim ashore or by attempting to drain the stomach or throat beforehand. This may be done after artificial respiration has been started.

iii. If the stomach is distended, lower and turn the victim's head to the side and then apply moderate pressure with the palm of the hand over the distended stomach. Any air or water ill the stomach will be then belched up.

8.11.2 Inhalation of foreign bodies: If the victim is a child, turn him over your knees in the "spanking position", with his head lower than his hips; slap him between shoulder blades ill all attempt to dislodge the foreign body by causing him to cough it out. If the object is not dislodged and the child is in distress, quickly clean the throat with the fingers and begin direct artificial respiration.

8.11.3 Infant and child victims: The technique of direct artificial respiration is essentially the same in cases involving children and adults. However, in the case of infants and children:

i. Only a small volume of air is required to inflate the lungs. Over-inflation may produce damage. Short puffs of air are all that are required, sufficient to produce a noticeable rise in the infant's chest with each inflation.

ii. The inflation rate should be at least every 3 seconds, twenty times per minute.

iii. An over-distended stomach in infants interferes with ventilation as well as normal heart action. This may be reduced by applying pressure over the infant's abdomen, care being taken to avoid aspiration of the fluid brought up in this manner by turning the head to one side.

8.12 FIRSTAID BOX:

i. A First Aid Box is an essential medical unit in any habitual premises. It ensures tiding over the crisis by avoiding last minute hunts. It should he kept at accessible place, and bare essentials stored in it. Each item must be replaced, as soon as it gets used up.

ii. The essential items to be preserved in the First Aid Box are given below:

8.12.1 Contents of First Aid Box

S. No.	Contents	Quantity
1.	Wound dressing (sterilized)	6Nos.
2.	Burn dressing (sterilized) Large	3 Nos.
3.	Adhesive plastering ((for fastening dressing). 2 cm x 1 mtrs.)	1 No.
4.	Washable Bandage	6 Nos.
5.	Triangular Bandage (for fractures) - large	1 No
6.	Safety pins (for fastening bandages)	1 Bunch
7.	Scissors (of fastening bandages)	1 Pair
8.	Scissors (of stainless steel) 8 cm plank	1 Pair
9.	Absorbent cotton wool for cleaning wound)	100 Grams
10.	i. Potassium Permanganate B.P. ii. Tincture iodine B.P. (for all wound) iii. Dettol or Savlon iv. Hydrogen peroxide (Antiseptic and bleeding stopper)	1 Bottle 1 Bottle 1 Bottle 1 Bottle
11.	Snake bite lancet	1No.
12.	Burn Ointment (for burns. cuts & insect bites) e.g. Burnol or Badiohnat	1 Tube
13.	Tourniquet (for stopping bleeding)	1 Set
14.	i. Soda-bi-carp. BP For acid burns) ii. vinegar (for Alkali burns]	1 Bottle 1 Bottle
15.	Eye Drop sterilized eye pads (separate by seal)	1 Bottle 6 Nos.
16.	Anti Allergy tablet (avil or pyrigesic)	50 Nos.
17.	Analgesic tablet (crocin or pyrigesic)	100 Nos.
18.	i. Spirit of Sal volatile ii. smelling salts	1 Bottle l00 Grams
19.	First Aid Leaflet	1 Copy

CHAPTER -9

SAFETY BINDINGS ON CONTRACTORS

Regulation 7 of Central Electricity Authority (Safety requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines), Regulations 2011

9.1 Safety Provisions relating to contractor:

1. The Owner shall incorporate the safety provisions in the contract document which are required to be compiled by the contractor's employees during execution of the contract to facilitate safe working during execution of the work.
2. The Contractor shall observe the safety requirements as laid down in the contract and in case of sub-contract. it shall be responsibility of main contractor that all the safety requirements are followed by the employees and staff of the sub-contractor.
3. The Contractor employing two hundred employees or more, including contract workers. shall have a safety coordinator in order to ensure the implementation of safety requirements 01 the contract and a contractor with lesser number of employees, including contract workers, shall nominate one of his employees to act as safety coordinator who shall liaise with the safety officer on matters relating to safety and his name shall he displayed on the notice board at a prominent place at the work site.
4. The Contractor shall be responsible for non-compliance of the safety measures, implication, injuries, fatalities and compensation arising out of such situations or incidents.
5. In case of any accident, the contractor shall immediately submit a statement of the same to the owner and the safety officer containing the details of the accident, any injury or causalities, extent of property damage and remedial action taken to prevent recurrence and in addition, the contractor shall submit a monthly statement of the accidents to the Owner at the end of each month.

9.2 Safety aspects during Civil Work.

1. In exercise of the Power Conferred by clause (el) of sub-section 2 of section 176 of I.E. Act, 2003. An Electricity plan prepared under the provision sub-section 4 of section 3 of the Act shall be published in the Govt. gazette and at least two daily vernacular Language Newspapers.
2. The plan layout of the Sub-Station for method of Construction & Route of line must be got approved from Electrical inspector.
3. After approval of Electrical plan layout of switchyard, a civil foundation plan layout is to he prepared & got approved from competent authority then only the Civil Work is taken in hand.
4. Land Leveling:

i. The leveling of the land is done to make available a plain land for switchyard development.
ii. There shall not be water logging during the rain season/rainy water must drain away.
iii. The level of the cable trench should be maintained so that water will be drained away immediately.

5. Construction quality has long term effect on safety; hence ensure excellent quality of work during every stage of the project construction.
6. The Record of the Civil Quality test taken at all stages of construction must be documented / preserved.
7. Seasonal & Trained young workers must be engaged for civil work, preferably with Knowledge of the site.
8. Workers protective equipments like helmet, safety belt, boots hand lamps etc. must invariably be used while working in the yard.
9. Child Labor -It is criminal to employ child labor.

9.3 <u>Unsafe conditions in Civil work.</u>

S. No.	Unsafe Conditions	Prevention
1.	Risk of fall of worker during installation due to i. Open pit of Civil foundation. ii. Open Cable Trench. iii. Unguarded opening from First / Second floor in slabs.	i. The foundation pit must be barricaded by the Rope & danger signs. ii. Put Cable Trench covers. iii. Put barricade around the opening and place danger / warning signs as necessary.
2.	Mistake in Civil Layout i. Insufficient clearance. ii. Insufficient clearances for Movement.	The plan of the layout must be got approved from competent authority and take necessary corrective steps during construction in consultation with competent authority.
3.	Uneven foundation i. Inclined superstructure. ii. Inclined equipment.	The level of the foundation must be maintained & level to be taken by dumpy level must be taken before casting the foundation.
4.	Accident during transportation / material handling i. Road not Ready. ii. Inadequate strength width / curvature.	Good quality internal Road must be ready with adequate width & curvature before actual transportation of material is started.
5.	Uneven Roof level	Arrangement must be made to drain out the rainy water so that the water leakage eliminated.
6.	Snakes in the cable trench	Use poisonous gas sprays at regular interval.

7.	Inadequate water arrangement & its storage	Before start of work the water arrangement must be made for i. Drinking ii. Civil work For the initial stage of civil work, Temporary water arrangement must be done for drinking & other works.
8.	Open water pipe line.	The pipe line must be laid under ground.
9.	Roof leakage During rains and water spray through window.	Water proofing of Roof-top parapet wall above window should be done.

9.4 <u>Unsafe Act.</u>

S. No.	Unsafe Act.	Prevention
1.	Digging in the switch yard without know sledge of underground wiring/cable/ water pipe line.	Work must be taken under the supervision of authorized staff with adequate knowledge of the site.
2.	Putting lot of debris & garbage in the yard.	Put the yard clean, keep out unwanted equipment / material outside the yard as soon as the work is over.
3.	Large heap of soil from excavation.	Put danger signs and barrier fencing round the uncompleted work.
4.	Running around in the yard with Rush of work.	Plan the work & be calm on the worksite.
5.	Survey in the substation by Iron Ranging Rod.	Use Bamboo in Place of Iron Rod.

Identification of the name of equipment & Demarcation of work hazardous / dangerous Area in view of Safety.

(Measures relating to safety and electric supply)

i. Regulation 18 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: Danger notices:-

The owner of every installation of voltage exceeding 250 V shall permanently in a conspicuous position a danger notice in Hindi or English and the local language of the District, with a sign of skull & bones of a design as per IS-2551:-

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 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 there to 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.

ii. Regulation 24 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: Distinction of different circuits:-

The owner of every generating station, Sub-station, junction-box or pillar in which there are many 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.

iii. Regulation 25 Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: Distinction of the installation 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.

iv. Regulation 73 Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: Safety and Protective devices:

- Every overhead line which is not being suspended from 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 guarding for rendering the line harmless in case it breaks.
- **Anti-climbing devices:**

  The owner of every HV/EHV O/H line shall make adequate arrangements to the satisfaction of inspector to prevent unauthorized line staff/ unauthorized persons from ascending any pole of such line, which can be easily climbed upon without the help of a ladder or special appliances.

9.5 <u>Identification:</u>

i. It will be easy to identify when the Location line when:

- The Each Tower of the line with Location Number.
- Each equipment is marked with code Number & bay Name.
- For easy identification Each Room is marked with Room name plate in the building

ii. Affix permanently, with Bold Letters, on visible Position-.

1. **Identification labels on the line:**

- Location Number Plate.
- Phase plate (Indication R-Y-B Phase).
- Circuit Name plate in case of Double Circuit line.
- Anti climbing device with Danger Notice.

Indicating plate cum Notice Board must be fixed on the Tower Line which will help in avoiding accident and lead to safety.

2. **<u>Sub-Station switch yard:</u>** Each bay in the switch yard shall be painted permanently with bay name

   Each equipment/control box shall be painted with their code name/ SCADA nomenclature.

- Power Transformer.
- Auxiliary Transformer.
- Breaker.
- Isolator with Earth Blade and Without Earth Blade

a. Auxiliary.
b. Mainbus-1.
c. Main bus-II.

- C.T/PT/LA/CC/CVT with colour code (R,Y,B).
- Control Box.

1. Isolator Control Box.
2. CT/PT/CVT Control Box.

3. **Building:-**

- Control Room -Name of bay on control & relay panel. All Control & Relay.
- Panel must be painted with respective Name of bay as per SCADA nomenclature.
- Battery Room.
- Battery Charger Room.
- PLCC Room/Carrier Room/Broad Band.
- AC supply Room (Name of the feeders).

- Air conditioning plant Room.
- Compressor Room.
- Office of the Incharge.
- Store Room.
- Laboratory.

By painting the Name on the equipment/Room

1. It will be easy for identification of equipment on which work has to be carried out.
2. Demarcation of working Area is easy.
3. Identification of work spot from long distance is easily visible.

9.6 <u>Demarcation:</u> Before any work is to be started / carried out in or adjacent to a charged (live) area the work area to be clearly demarcated.

1. **WARNING BOARDS:** Warning boards shall be placed by the authorized line staff-in-char., on all switchgear before men are permitted to work and should only be removed by the authorized line staff who has placed them. It is desirable that the authorized line staff issuing the permit shall place one warning board on the switch energizing the mains for each permit issued so that he can be sure that all the permits-to-work are returned when he has to charge the mains.
2. **<u>VISITORS AND UNAUTHORIZED PERSON</u>:** Visitors and unauthorized person shall not be allowed to proceed to the Vicinity of live mains and apparatus, unless accompanied by an authorized line staff that will be responsible to ensure that his instructions regarding safety are strictly complied with.
3. **<u>WARNING THE PUBLIC</u>:** When, either accidentally or otherwise, live mains and apparatus pose a danger to authorized line staff in a public place, a authorized line staff shall be directed to stand at such locations for authorized line staff warning the public until the danger has been removed/cleared.

   Equipment on which work is to be carried out must be readily identifiable. Where necessary a means of identification must he fixed to it, which shall remain effective throughout the course of the work.
4. **<u>DANGERS:</u>** The main **Danger** to authorized line staff working in substation.

- The possibility of mistaking **Equipment** on which it is unsafe to work.
- Inadvertently infringing **Safety Clearances.**
- Other induced voltage on the **Equipment from adjacent/nearby live equipment/line.**
- Failure to make proper use of authorized line staff protective equipments.

i. Where work is to be carried out near to **Equipment** which may be **Live,** then the limits of the work area must be defined as per the **Safety Clearance.**

ii. Boundary mark must be clearly identifiable and easy to see. They must only be fixed or removed only by the maintenance authorized line staff under the **Supervision** of the **Maintenance Engineer / Shift Engineer.**

9.7 <u>Boundary marking should</u>

- Be independently supported.
- Not be attached to any structure supporting any Equipment.
- Not carry any notice.

i. The boundary of the work area must be identified using plastic tape or nylon rope of about 8/10 mm diameter.

ii. Where the work is separated from adjoining areas by fixed screens, the work must be identified by green cones placed within the safe area and visible from the outside at each point of access. The fixed screens must remain in position during the course of the work.

CHAPTER-10

DO'S AND DO NOT'S

10.1 General Safety Measures that should be followed while performing any operation:-

S. No.	Do's	Do Not's
1.	Before replacing a lamp or handling a fan, make sure that the supply is switched off.	Do not connected single pole switch or fuse in a neutral circuit, but always connect in the live or phase wire
2.	Place Safety Tagging or other warning boards on main switch before commencing work	Do not close any switch, unless you are familiar with the circuit which it controls and know the reason for its being open
3.	Before working on any circuit or apparatus, make sure that the controlling switches are open and locked.	Do not touch or tamper with any electrical gear or conductor, unless you have made sure that it is dead and earthed. High voltage apparatus may give leakage shock or flash over even without touching
4.	Always treat circuit as live until you have proved them to be dead, the insulation of the conductor may be defective.	Do not work on live circuit without the orders of the authorized Engineer/person. Make certain that all safety precautions have been taken
5.	Cultivate the habit or turning your face away whenever the flash or an arc may occur	Do not disconnect earthing connection or render it ineffective of the safety gadgets installed on mains and apparatus
6.	Guard against arcs as well as high voltage; remember that burns from arc are very severe	Do not tamper with the meter board and cut-outs, unless you are authorized to do so
7.	See that all the splices and connections are securely made	Do not expose your eyes to an electrical arc. Painful injury may result even with short exposure
8.	Use extreme care when breaking an inductive circuit as dangerously high voltage is likely to result	Do not close or open a switch slowly or hesitatingly. Do it quickly and positively
9.	Thoroughly discharge to earth all cables before working on cores	Do not place any part of your body in circuit either to ground or across the terminal when making a connection or doing operation

10.	Test rubber gloves periodically	Do not touch an electrical circuit when your hands are wet, bleeding from a cut or have an abrasion
11.	Place rubber mats in front of electrical switchboard	Do not work on energized circuit without taking extra precautions, such as the use of rubber gloves. Do not use metal case flash light around apparatus which is energized
12.	Preach and practice safety at all the time. Good work can be spoiled by an accident	Do not wear loose clothing, metal, watch straps, bangles or finger rings while working on appliances. Do not hand clothes and such other things on electric fittings. Do not touch the circuit with bare fingers or hand or other makeshift devices to determine whether or not it is live
13.	Work deliberately and carefully Haste causes many accidents. Be sure of what you are doing	Do not work on pole or any elevated position if there is a live partion it, without the safety belt and rubber gloves and unless the authorized line staff stands on the ground nearby to direct operation and give warning
14.	Always obey the safety instructions given by the staff in-charge	Do not use a ladder without a lashing rope, otherwise the ladder should be held firmly by another authorized time staff. Do not remove Safety Tags or other signs or interface with safety barriers or go beyond them
15.	Always report immediately to the authorized line staff in-charge or to any other proper authority of any dangerous condition or a practice, which you may observe	Do not bring naked light near battery Smoking in the battery room is probhited. Do not allow visitors and un authorized personnal to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus
16.	Ensure that all portable appliances are provided with 3 pin plug and socket connections. Also the metal work of the apparatus is effectively earthed	Do not use a lamp in a metal holder fixed to the end of a loose flexible wire as a portable hand lamp. Do not disconnect a plug by pulling the flexible cable or when the switch is on

CHAPTER-11

SAFETY AND DISASTER MANAGEMENT

11.1 General: Himachal Pradesh is prone to many natural hazards such as Earthquakes. Landslides, flash floods, snowstorms Lind avalanches etc.

The state is also evident to the hazards which are manmade such as forest fires, accident road, Industrial and hazardous m chemicals. Earthquakes, however is the most prominent danger in the state, as 80 earthquakes have been experienced in the state. As per the BIS seismic zoning map five districts of the State, namely Chamba (53.2%) Hamirpur (90.9%), Kangra (98.6%), Kullu (53.1 %), Mandi (97.4%) have 53 to 98.6 percent of their area liable to the severest design intensity of MSK IX or more, the remaining area of these districts being liable to the next severe intensity VIII. Two districts, Bilaspur (25.3%) and Una (37.0%) also have substantial area in MSK IX and rest in MSK VIII. The remaining districts also are liable to intensity VIII.

Landslides are the other common disaster in the state which causes the immense loss of life and property. The Safety precautions required to be followed in the disasters are as follows:

11.2 EARTHQUAKE SAFETY PROCEDURES: It is not possible to prevent earthquakes or change the Likelihood of an earthquake occurring. However, we can greatly increase our chances of safety, and survival, by being aware and prepared. Since knowledge and preparation Lire keys to our survival during and after an earthquake, we should take steps to become informed.

11.3 Dangers Associated with Earthquakes: The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from falling objects and debris or collapsing structures. Injuries are commonly caused by:

a. Partial building collapse, falling masonry, collapsing walls, falling ceiling plaster, etc.
b. Flying glass from broken windows.
c. Overturned bookcases, cabinets, fixtures, furniture, office machines and appliances.
d. Fires, broken gas lines. These dangers may be aggravated by lack of water due to broken mains.
e. Fallen power lines.
f. Inappropriate actions resulting from panic.

11.4 Earthquake Safety Guidelines

i. Remain Calm. Sound usually precedes earthquake motion by a split second. If you have developed the correct earthquake responses in your mind before a quake, this split second is enough time to activate your automatic reactions. If you stay calm, you will be better able to assess your situation. The rolling and roaring may terrify you, but unless something falls on you, the sensations probably won't hurt you. Try talking yourself through the violent motion phase. This will release stress and others may take courage and follow your reasoned restraint. Think through the consequences of any action you plan to take.

ii. If you are indoors, stay there. If you are in danger:
- Get under a study table, desk or bed.
- Brace yourself in an inside corner away from windows. Move to an inner wall or corridor. (A door frame or the structural frame or inner core of the building are its strongest points and least likely to collapse. They will also break the impact of any falling objects).
- In an apartment building the safest place is by the central reinforced core of the building, which is usually located by the elevator well.
- Choose shelter which will provide an airspace if it collapses. If your furniture shelter moves, stay under it and follow it around the apartment.
- Watch for falling objects – plaster, bricks, light fixtures, pots and pails, etc
- Stay away from tall shelves, china cabinets and other furniture, which might slide or topple over.
- Stay away from windows, sliding glass doors, mirrors.
- Grab anything handy (blanket. pillow, tablecloth, newspapers, box, etc.) to shield your head, and face from falling debris and splinting glass.
- Don’t be alarmed if the fire alarm or sprinklers go off.

iii. Do Not Rush Outside. Stay on the same floor that you are on. Stairways may he broken and exits jammed with people. Do not use elevators as the power for elevators may go out and leave you trapped. The greatest danger from falling debris is Just outside door-ways and close to outer walls. If for safety reasons you must leave the building, choose your exits as carefully as possible.

iv. If you are outside, stay there. Move away from the building, garage, walls, power poles and lampposts. Electric power lines are a serious hazard, stay away from fallen lines. If possible, proceed cautiously to an open area.

v. If you are in a moving car, stop. Stop as quickly as safety permits in the best available space. Stay in your car. Don't stop where buildings can topple down on top of you. A car is an excellent shock absorber and will shake a lot on its springs during an earthquake, but it's a fairly safe shelter from which to assess your situation.

vi. Avoid Fallen Power Lines. The possibility of encountering fallen live wires is great during and after an earthquake. If you are on foot, make a wide path around the wires. If you are in the car and live wires have fallen across the car, remain where you are. Your car is usually well insulated and will protect you from electric shock. Never assume that downed power lines are dead.

11.5 After an Earthquake:

11.5.1 Within the First Several Minutes:

i. Remain Calm. Don't Panic. Try to calm and reassure others. Stop and taken time to think.
ii. Wait until all motion has stopped. Do not run down stairs or outdoors. Be prepared for additional shockwaves.
iii. Do not light matches, cigarettes or turn on electrical switches. Flashlights are one of the best light sources after a damaging earthquake. Proceed with extreme caution.
iv. Protect hands and feet from broken glass or debris. Keep head and face protected (hard-hat, blanket, tablecloth, etc.).
v. Make a quick check for injuries or trapped people. Provide emergency first aid if needed.
vi. Do not try to move seriously injured persons unless they are in immediate danger from further injury
vii. Turn off all appliances and office machines. Extinguish all open flames. Check power lines and cords. If problems exist in electrical lines or gas lines the mains should be shut off.
viii. It may be necessary to draw a moderate amount of cold water in bathtubs and sinks and other containers, in case service should be disrupted.

11.5.2 During the Next Several Hours:

i. Do not operate electrical switches, appliances or open-flame equipment if gas leaks are suspected. Sparks or flames can ignite gas from broken lines causing an explosion.
ii. Tend further to injured or trapped persons. Try to get help if necessary. If a person is trapped and you can free him without injury [0 yourself, remove debris piece-by piece starting with the top of the pile.
iii. Be prepared for aftershocks· they are weaker than the main shock but can cause additional damage and psychological trauma. Watch out for other possible dangers, which may follow an earthquake, such as fire, flood, and landslide.
iv. Turn on a battery radio to receive disaster instructions. Use telephones only to report extreme emergency situations.
v. Inspect your work area carefully for structural damage. Carefully open exit doors they sometimes jam. The initial quake may damage the structure and an aftershock could knock down weakened walls. Use extreme caution when moving around in damaged areas they may collapse without warning. Check to see that sewage lines are intact before flushing toilets.
vi. One should not try to get home until government authorities say it is safe, which will be when the worst fires are under control and the streets have been cleared. This may happen quickly or it may take longer (perhaps 72 hours or more). You should advise your family that in the event of a major earthquake you may be re trained at work. When possible notify your family about your well being.
vii. Don't go outside Sightseeing. Keep streets clear for passage of emergency vehicles. Your presence might hamper rescue and other emergency operation.

11.6 Landslides: The fragile nature of the rocks framing the mountains along with climatic conditions and various anthropogenic activities has made the state vulnerable to the vagaries of nature. Beside earthquake, landslides are the other geological hazards that are common and peculiar to the state.

Landslides are the downslide movement of soil, debris or rock resulting from natural causes vibrations, overburden of rock material removal of lateral supports, change in the water content of rock or soil bodies, block drainage etc. In Himachal Pradesh the mass movement varies in magnitude from soil creep to landslides, Solifluction (A form of creep in which snow or water saturated rocks move down the slope) is another type of mass movement that is common in the higher snow covered ranges of the state.

Immediate steps for imminent Landslide:

i. Contact your local Fire. Police or Public Works Department.
ii. Inform affected neighbours
iii. Leave the area quickly

Actions to be taken before Intense Rainfall:

i. Become familiar with the land around you. Slopes, where landslides or debris flows have occurred in the past, are likely to experience them in the future.
ii. Buildings should be located away from known landslides, debris flows, steep slopes, streams and rivers, intermittent-stream channels, and the mouths of mountain channels.
iii. Observe the patterns of storm-water drainage on slopes near your home, and watch especially the places were runoff water converges, increasing flow over soil covered slopes. Observe the hillsides around your home for any signs of land movement, such as small landslides or debris flows or progressively tilting trees.
iv. Contact your local authorities to learn about the disaster management response and develop your own emergency plans for your family and business.

During Intense Rainfall:

i. Be observant. Many landslide and debris now casualties occur when people are sleeping. Listen to radio for warnings of intense rainfall. Intense short bursts of rain may be particularly dangerous. especially after longer periods of heavy rainfall and damp weather.
ii. Unusual sounds might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger landslides. Be alert for any sudden increase or decrease in water now in streams or ch.1ilnels. Such changes l1lay indicate landslide activity upstream, so be prepared to move quickly.
iii. If you live in .1reas susceptible to landslides and debris flows, consider leaving if it is safe to do so. If you remain at home, move to a part of the house farthest away from the source of the landslide or debris flows, such as an upper floor, but keep an escape route open should it become necessary to leave the house.

iv. Be alert when on the roads. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible landslides or debris flows. Be observant. Many landslide and debris flow casualties occur when people are sleeping. Listen to radio for warnings of intense rainfall. Intense short bursts of rain may he particularly dangerous, especially after longer periods of heavy rainfall and damp weather.

v. Unusual sounds might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger landslides. Be alert for any sudden increase or decrease In water now in streams or cilJnn0ls. Such changes may indicate landslide activity upstream, so be prepared to move quickly.

vi. If you live in areas susceptible to landslides and debris flows, consider leaving if it is safe to do so. II you remain at home, move to a part of the house farthest away from the source of the landslide or debris flows, such as an upper floor, but keep an escape route open should it become necessary to leave the house.

vii. Be alert when on the roads. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible landslides or debris flows.

After Intense Rainfall: Be alert for signs indicating land movement. Landslides can occur weeks or months after intense storms.

Things to Remember

i. Mudflows tend to flow in channels, but will often spread out over a floodplain. They generally occur in places where they have occurred before

ii. Landslides and mudflows usually strike without much appreciable warning. The force of rocks, soil, or other debris moving down a slope can devastate anything in its path. Take the following steps to be ready:

   a. Plant ground cover on slopes and build retaining walls.
   b. In mudflow areas, build channels or deflection walls to direct the flow around buildings.
   c. Remember: If you build walls to divert debris flow land the flow lands on a neighbour's property, you may be liable for damages.

Precautions to be taken during landslides

If inside a building:

i. Stay inside.

ii. Take cover under a desk, table, or other piece of sturdy furniture.

If outdoors:

i. Try and get out of the path of the landslide or mudflow.
ii. Run to the nearest high ground in a direction away from the path.
iii. If rocks and other debris are approaching, run for the nearest shelter such as a group of tress or a building.
iv. If escape is not possible, curl into a tight ball and protect your head.

After Landslide

i. Stay away from the slide area. There may be danger of additional slides.
ii. Check for injured and trapped persons near the slide area. Give first aid if trained.
iii. Remember to help your neighbors who may require special assistance—infants, elderly people, and people with disabilities.
iv. Listen to a radio or television for the latest emergency information.
v. Stay away from the slide area. There may be danger of additional slides.
vi. Check for damaged utility lines. Report any damage to the utility company.
vii. Check the building foundation, chimney, and surrounding land for damage.
viii. Replant damaged ground as soon as possible since erosion caused by loss of ground cover can lead to flash flooding.

CHAPTER-12
CONSTRUCTION UNDERNEATH OVERHEAD LINES

Construction (Temporary or Permanent) under over head EHV.HT /LT line is not safe for the people and can further hinder the performance of electric lines, the construction under overhead lines may be allowed as per relevant regulations of the Central Electricity Authority(Measures relating to Safety and Electric Supply). Regulations2010 and provisions of the Electricity Act.2003 and it shall be ensured that construction under overhead lines shall comply with Standard Regulations, the standard procedure as under:-

Regulation 63 of Central Electricity Authority (Measures relating to Safety, and Electric Supply), Regulations2010.

Erection of or alternation to 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 food 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 of flood bank or road, any permanent or temporary addition or alternation, he and the contractor whom he employs to carry out the erection. addition or alteration, shall give information 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 or any addition or alteration and scaffolding thereof required during the construction.
2. On receipt of such information, the supplier or owner shall examine:
   i. whether the line under reference was laid in accordance with the provisions of these regulations and any other law;
   ii. whether it meets the requirement of Right of Way(ROW);
   iii. 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 oasis, 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 clause (ii); and charges incurred by the supplier 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 dispute of such estimated cost to the supplier or owner.
6. No work upon such building, structure, flood bank, road and addition or alternation thereto shall be commenced or continued until the Electrical inspector has certified that the provisions of regulation 58.60 or 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, on receipt of such deposit, after the overhead line in such a way that it does not contravene the provisions of regulations 58, 60 or 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.

Regulation 58 of Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations2010:-

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 be at a height of less than
   i. for lines voltage not exceeding 650 volts: 5.8 metres
   ii. for line voltage exceeding 650 volts but: 6.1metres
   not exceet1ing 33 kV
2. No conductor of an overhead line, including service lines, erected along any street shall at any part thereof be at d height less than
   i. for lines of voltage not exceeding 650 Volts: 5.5 metres
   ii. for lines exceeding 650 volts not exceeding: 5.8 metres
   33 kV
3. No conductor of in 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 up to and including : 4.6 metres
   and including 11,000 volts, if bare
   ii. for lines of voltage up to and including: 4.0 metres
   11,000 volts, if insulated
   iii. for lines voltage exceeding 11.000 volts: 5.2 metres
   But not exceeding 33 kV

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.

Regulation 60 of Central Electricity Authority(Measures relating to Safety and Electric Supply), Regulations2010 :-

Clearances 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 maxim urn sag, shall be observed, namely:
   - **i.** For any flat roof, open balcony, verandah roof and lean-to-roof-
     - **a.** When the line passes above the building a vertical clearance or 2.5 metres from the highest point.
     - **b.** When the line passes adjacent to the building a horizontal clearance or 1.2 metres from the nearest point.
   - **ii.** For pitched roof-
     - **a.** When the line passes above the building a vertical clearance of 2.5 metres immediately under the lines.
     - **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.

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

Regulation 61 of Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010:-

Clearances from buildings of lines of voltage 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 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 voltage exceeding 6S0 Volts up to and including 33,000 volts : 3.7 metres

ii. For lines of voltage 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 voltage exceeding 6S0 V upto and including 11,000 volts: 1.2 metres

ii. for lines of voltage exceeding 11,000 V and upto including 33,UOO volts: 2.0 metres

iii. for lines of voltage exceeding 33 kV : : 2.0 metres plus 0.3 metre for every additional 33,000 volts for part thereof.

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

The Construction of Structure shall comply with the above rules otherwise the construction shall be treated as unauthorized construction and rule 68(5) of Electricity Act, 2003 states as under:

Where any tree standing or lying near an overhead line or where any structure or other object which has been placed or has fallen near all overhead line subsequent to the placing of such line, interrupts or interferes with, or is likely to interrupt or interfere with, the conveyance or transmission of electricity or the accessibility of any works, an Executive Magistrate or authority specified by the Appropriate Government may, on the application of the licensee, cause the tree, structure or object to be removed or otherwise dealt with as he or it thinks fit.

In addition to above clearances over river, tree clearance, clearance from supporting structures of another line are also given as under:

Clearance over the rivers: Minimum 10' (3.048 meters) over highest flood level for rivers, which are not navigable. For navigable rivers, clearance to be fixed in relation to the tallest mast in consultation with the concerned navigation authorities.

Tree clearance:

I. For E.H.V.T. lines all tall tree within 40' (12.19 meters) on either side of the line and all trees which are falling or would fall. To be cut.

II. All bust growth 20' (6.095m) on either side to be completely cleared grafted fruit trees, which will not grow tall, may be left out.

III. Al branches or leaves, which are within 3' (0.914m) from the conductors, neutral and earth wires in case of L.T. line, should be cut.

Clearance between supporting structures of another line:

The vertical clearance between the guard wire and any conductor under maximum sag shall be as under:

I.	L.T. voltages	1.219m
II.	High Voltage upto 33kv	1.219m

Every guard wire shall be securely bound to earth at each where its electrical continuity is broken. Guard wires shall have an actual breaking load of not less than 1400 lbs (635 kgs) and shall be galvanized.

Chapter-13

CAPACITOR KVAR AT DIFFERENT MOTOR RATINGS AND SPEEDS

HP	750rpm	1000rpm	1500rpm
3	**2**	**1.5**	**1.0**
5	3.5	2.5	2.5
7.5	5	4	3
10	6	5	4
15	8.5	6.5	5.5
20	11	9	7
25	13.5	11	9
30	15.5	13.5	10.5
40	20.5	17	14.5
50	25.5	20	18
60	29.5	24	21.5
75	33.5	28.5	25.5
90	40	34	30.5
100	44.5	36	34
120	53.5	43	40.5
130	58	46.5	44
150	66.5	53.5	50.5
160	71	57	54

Reference Table amps per MVA						
MVA	**11KV**	**33KV**	**66KV**	**132KV**	**220KV**	**400KV**
1	52.5	17	8.7	4.3	2.62	1.4
2	105	35	17.5	8.7	4.4	2.9
3	157.5	52	26.2	13.0	6.6	4.8
4	209.9	70	35.0	17.5	8.7	5.7
5	262.4	87	43.7	21.9	10.9	7.2
6	314.9	105	52.5	26.2	13.1	8.7
7	367.4	122	61.2	30.6	15.3	10.8
8	419.9	140	70.0	35.0	17.5	11.5
9	472.4	157	78.7	39.4	19.7	13.0
10	524.9	175	87.0	43.7	21.9	14.4
11	577.4	192	96	48.1	24.0	15.9
12	629.8	210	105	52.5	26.2	13.3
13	682.3	227	114	56.9	28.4	18.8

14	734.8	245	122	61.2	30.6	20.2
15	787.3	262	131	65.6	32.8	21.6
16	839.8	280	140	70.0	35.0	23.8
17	892.3	297	149	74.3	37.1	24.5
18	944.8	315	157	78.7	39.4	26.0
19	997.0	332	166	83.1	41.5	27.4
20	1050.0	350	175	87.5	43.7	28.9
25	1312	437	219	109	54.7	36.8
30	1575	525	262	131	65.6	43.3
35	1837	612	306	153	76.5	50.5
40	2099	700	350	175	87.5	57.7
45	2362	787	394	197	98.4	65.0
50	2624	875	437	218	109.3	72.2
60	3149	1050	525	262	131.2	86.6
70	3674	1225	612	306	153	101
80	4199	1400	700	350	175	115
90	4724	1575	787	394	197	130

Loading on the Basis of Ambient Temperatures

Type of Cooling	**Percentage of rated KVA**	
	Decrease load for Each degree C higher Temp.	Increase load for Each degree C lower Temp.
Self cooled	1.5	1.0
Water cooled	1.5	1.0
Forced air	1.0	0.75
Forced oil cooled	1.0	0.75

Current Ratings and Fuse wire (Tinned Copper)

Sizes of Sub Station

Capacity of	Current rating	Fuse wire	Current L.T.	Fuse wire
T/F in KVA	11KV side	SWG	Side	SWG
25	3 Amps	33	30 Amps	21
50	5 Amps	35	50 Amps	18
75	5 Amps	30	106 Amps	2 of 18
100	10.5 Amps	30	120 Amps	2 of 18

Horn Gap Fuses (H.T. side of TFs)

	33KV (Gap 385mm)		11KF(Gap 205mm)	
3MVA	18SWG 500	KVA 20	SWG 100	KVA 33SWG
2MVA	19SWG 300	KVA 23	SWG 63	KVA 35SWG
1MVA	22SWG 200	KVA 24	SWG 25	KVA 38SWG
0.5MVA	26SWG			

Min safe IR Value of Megaohms at different temperature of power T/F windings (Use 1000V megger)

Rate Voltage of the windings	30^0C	45^0C	50^0C	60^0C
66KV & above	800	300	150	75
33KV	600	250	125	65
66KV & 11KV	400	200	100	50
Below 6.6KV	200	100	50	25

HV/LV Ampere ratings of T/Fs

Power	LV-Amps	HV-Amps for rated KV of		
T/F KVA	11KV	33KV	66KV	132KV
500	26.25	8.75	4.4	2.2
1000	52.50	17.50	8.75	4.37
1500	78.75	26.25	13.12	6.56
2000	105.00	35.00	17.50	8.75
3000	157.50	52.50	26.75	13.37
5000	262.50	87.50	43.75	21.87
10000	525.00	175.00	87.50	43.75

Weight of Copper Conductor

Size	Wt/km	M/kg	Size	Wt/km	M/kg
No.9SWG	472.9kg	2.11	No.8SWG	115.00kg	8.67 km
2SWG	343.2kg	2.91	10	73.71 kg	13.55
4	242.4kg	4.13	7/0.074	122.7kg	8.15
6	166.6kg	6.02	(Standard)		

Conductor Characteristics Based on I.S. 398/1961

Electrical Characteristics					Mechanical Characteristics			
Code	Equiv.		Resisat	App. A	Strands	Conductor		
	Cut wire	Cu/Alu are in	20 COH M/KM	Carrying cap at	Al/St Dia in	Total Dia mm	Wt. inkg.km	Appro Ultimate
	SWG	Sq.inch		40^0C 45^0C	mm			Tensile strength kg

All Aluminimum Conductor

ROSE	8	0.02/20.0	1.361	116	108	7/1.96	5.88	58	362
GNAT	7	0.25/26.56	1.071	133	123	7/2.21	6.63	73	485
IRIS	6	0.030/33.0	0.850	150	138	7/2.48	7.44	92	582
PANSY	4	0.040/42.0	0.677	178	165	7/2.78	8.34	116	730
ANT	3	0.05/52.00	0.544	204	189	7/3.10	9.30	144	892
ASTER	2	0.065/66.96	0.423	239	196	7/3.51	10.53	184	1157

A.C.S.R. Conductors

SQrl	0.02	8.13/20.7	1.374	115	107	6/1/2.11	6.33	85	771
Weasel	0.03	620/31.2	0.911	150	139	6/1/2.59	7.77	128	1136
Ferret	0.04	4.525/41.8	0.679	181	168	6/1/3.0	9.00	171	1503
Mink	0.6	240/62.3	0.456	234	217	6/1/4.09	12.27	255	2107
RANCO	0.075	48/7780	0.365	270	250	6/1/4.09	12.27	318	2746
Dog 0.1	2.0	65/103.6	0.275	325	300	6/1/4.09	12.27	318	2746
Tiger 0.125	3.0	80/128.0	0.222	382	354	30/7/2.36	16.62	604	5758
Wolf 0.15	5.0	95/154.3	0.184	430	398	30/7/2.59	18.13	727	6880
LYNX 0.175	6.0	110/179.0	0.158	475	440	30/7/2.79	19.53	844	7950
Panther 0.2	-	130/207.0	0.137	520	482	30/7/3.0	21.00	976	9127
Lion 0.225	-	140/232.5	0.122	555	515	30/7/3.18	22.26	1097	10210
Goat 0.3	-	185/316.5	0.089	680	630	30/7/3.71	25.97	1492	13780
Gofer	-	0.5449							
Zebra	-	360/416	0.068	795	736	54/7/3.18	28.62	1623	
Moose	-	325/517.7	0.05517	900	736	54/7/3.53	31.77	-	-

Number of units in the tension string of normal lines

System Voltage	No. of discs	Dry f.o.v.KV	Wet f.o.v.KV	Impulse f.o.v.KV	1*50ms+ ve wave
11	1	78	45	120	
22	2	135	75	230	
66	5/6	285/335	180/210	460/535	
132	7	380	240	610	
132	9/10	470/515	310/345	750/825	
220	14/15	690/720	465/495	1100/1175	

Spares allowable on the basis of ground clearance as per I.E. rules

Height of pole in M	Type of formation with AAC 8/6/4 SWG	No. of Wires	Across the road	Span in m along the road	Elsewhere than along or Across the road
8	Vertical	5	-	-	60.96 (200)
		4	-	30.48 (100)	68.58 (225)
		3	30.48 (100)	45.72 (150)	68.58 (225)
8	Horizontal	5	30.48 (100)	45.72 (150)	68.58
		3	45.72 (150)	60.96 (200)	68.58 (225)
9	Vertical	5	45.72 (150)	60.96 (200)	As it would not be advantageous
		4	45.72 (150)	60.96 (200)	To use 9 meter poles in cross country, the spans are not given
		3	60.96 (200)	67.056 (220)	
9	Horizontal	5	67.056 (220) 67.056 (220)	67.056 (220) 67.056 (220)	It would not be advisable to employ a span more than 225ft.
		4			

Note: The spans along or across a road are restricted to 220 only as per I.E. Rule 85.

Limits of earth Resistance

Large Power Stations 0.5 Ohm

Major Sub Stations 1.0 Ohm

Small Stations 2.0 Ohm

Tower Footing Station 15.0 Ohm

Distribution 10.0 Ohm

Number of Damper per Span

1. Span up to 450 mts used 2 stocks Bridge Damper per span.
2. Span between 450 mtrs& 900 mts. Used 4 stock Bridge Damper per span.
3. Span above 900 mts used 6 stocks Bridge Damper per span.

CHAPTER- 14

FIELD QUALITY PLAN FOR TRANSMISSION LINE

TABLE OF CONTENTS

OVER HEAD POWER TRANSMISSION LINE CONSTRUCTION

S. No.	Activity Description	Reference Document
1.	Quality Control	Standard Field Quality Plan (Containing Quality Control Parameters from Preliminary Survey to Commissioning of Transmission Line)
2.	Site Registers	Site Order Book
		Hindrance Register
3.	Survey	Topographical Sheets for route alignment
		Tower Spotting Data & Route Alignment for Detail Survey
		Detail Survey Report for Check Survey
4.	Foundation	Check List of Pit Marking
		Check List of Stub Setting
		Check List of Construction Material
		Check List of Reinforcement & Form Boxes
		Pour Card
		Check List of Placing, Mixing & Compaction of Concrete
		Joint Measurement Certificate
5.	Tower Erection	Check List of Tower Erection Works
		Joint Measurement Certificate
6.	Stringing	Check List Cum Joint Measurement of Earthing Works
		Checklist of Stringing Works
		Detail of Conductor & OPGW/Earth Wire
		Detail of MSJ & Repair Sleeves
		Record of Insulators
		Sag Measurement for Conductor & OPGW / Earth Wire
		Detail of Suspension & Tension Clamps for EW/OPGW
		Record of Vibration Dampers for OPGW & Earth Wire
7.	Final Checking	Punch List of Remarks / Observations
8.	Testing & Commissioning	Conductor Continuity Test & Test Charge

STANDARD FIELD QUALITY PLAN FOR TRANSMISSION LINE

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
1.	Preliminary / Detail Survey	a) Route alignment	Optimization of route length	a) Preliminary survey b) Topographical maps c) Tower spotting data	Contractor	PIC	PEA/Client
		b) Route profiling & tower spotting	1. Ground clearance 2. Cold weight span 3. Hot weight span 4. Wind Span 5. Angle of Deviation 6. Suitability of tower spotting in hilly area 7. Unequal leg Extensions	a) Sag template b) Tower spotting data c) Route alignment	Contractor	PIC	PEA/Client
2.	Check Survey	Tower location & Final length	1. Alignment 2. Final length 3. Angle of deviation & pit marking	a) Route alignment b) Tower schedule c) Profile	Contractor	PIC	PEA/Client

3.	Detail Soil Investigation	a) Bore log	1. Depth of borelog 2. SPT test 3. Collection of samples	As per technical specification	Contractor	PIC	PEA/Client
		b) Tests on samples	As per technical specification	As per technical specification	Contractor	PIC	PEA/Client
		c) Special foundations	As per technical specification	As per technical specification	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
4.	Revetment	RR Masonry	a) Size of stone	CPWD Specifications	Contractor	PIC	PEA/Client
			b) Water absorption	-Do-	Contractor	PIC	PEA/Client
			c) Cement: Sand ratio in mortar	As per technical specification	Contractor	PIC	PEA/Client
5.	Benching	Checking of reduced level	Reduced level	As per approved drawings.	Contractor	PIC	PEA/Client
6.	Tower Foundation				Contractor	PIC	PEA/Client
		A) Material 1. Cement	1. Brand approval	As per list of approved brands of HPSEBL	Contractor	PIC	PEA/Client
			2. Physical Test	As per annexure-I of SFQP	Contractor	PIC	PEA/Client
			3. Chemical Tests	As per annexure-I of SFQP	Contractor	PIC	PEA/Client
		2. Reinforcement Steel	Source Approval	May be procured either from main producers directly or through authorised dealer who can produce MTC from main producer s with traceability	Contractor	PIC	PEA/Client
			2. Physical & Chemical analysis tests	As per annexure-2 ofthis SFQP	Contractor	PIC	PEA/Client
		3. Coarse Aggregate	1. Source approval	As per approved list ofHPSEBL	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
			2. Physical Tests	As per annexure-3 of this FQP	Contractor	PIC	PEA/Client
		4. Fine Aggregate	1. Source approval	As per approved list of HPSEBL	Contractor	PIC	PEA/Client
			2. Physical Test	As per annexure-4 of this FQP	Contractor	PIC	PEA/Client
		5. Water	1. Cleanliness	As per technical specification	Contractor	PIC	PEA/Client
			2. Ph Value	-Do-	Contractor	PIC	PEA/Client
		B) Foundation Classification	1. Visual observations of soil strata	1. Bore log data 2. Soil Investigation Report 3. Technical specifications	Contractor	PIC	PEA/Client
			2. Ground water level		Contractor	PIC	PEA/Client
			3. History of water table in nearby area/ surface water		Contractor	PIC	PEA/Client
			4. Fissured rock / hard rock		Contractor	PIC	PEA/Client
	C) Concrete Works						
	1.Before Concreting	1. Bottom of excavated earth	Depth of foundation	Approved construction drawings	Contractor	PIC	PEA/Client
		2. PCC Grade, thickness & size	Completeness	IS:456, technical spec. and approved drawings	Contractor	PIC	PEA/Client

		3. Stub setting	1. Centre line 2. Diagonals 3. Level of stubs 4. Back to back	Approved construction drawings	Contractor	PIC	PEA/Client
		4. Reinforcement Steel	Bar bending schedule	Approved construction drawings	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
	2. During Concreting	1. Workability	Slump test	Annexure-5 of SFQP	Contractor	PIC	PEA/Client
		2. Concrete Strength	Cubes compressive strength	Annexure-5 of SFQP	Contractor	PIC	PEA/Client
		3. Chimney Concrete	Top level of chimney w.r.t GL	Approved Drawings	Contractor	PIC	PEA/Client
	3. After Concreting	Backfilling, compaction and levelling	Completeness	As per specifications	Contractor	PIC	PEA/Client
7.	Tower Erection	1. Material of tower parts/bolt-nuts, washers & accessories.	Visual checking for 1. Stacking 2. Cleanliness 3. Galvanizing 4. Damages	Approved Drgs./ Bill of Material & Technical Specification	Contractor	PIC	PEA/Client
		2. Erection of superstructures	1. Sequence oferection	As per approved drawings & specifications	Contractor	PIC	PEA/Client
			2. Checking for completenes s	As per approved drawings **&** specifications	Contractor	PIC	PEA/Client
			3. Tightening of nutand bolts	As per approved drawings **&** specifications	Contractor	PIC	PEA/Client

			4. Checking forverticality	As per approved drawings & specifications.	Contractor	PIC	PEA/Client
			5. Tack welding for nut & bolts	As per specification.	Contractor	PIC	PEA/Client
		3. Tower Footing Resistance (TFR)	TFR at locations before and afterverticality	As per specifications.	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
8.	Earthiing	Pipe Type	Salt & Charcoal	As per approved drawings	Contractor	PIC	PEA/Client
		Counterpoise Type	Length & depth of earth electrode	As per approved drawings	Contractor	PIC	PEA/Client
9.	Stringing	**1. Material**			Contractor	PIC	PEA/Client
		a) Insulators	1. Visual check for damage, cracks, chipping, cleanliness / glazing/cracks/and white spots.	As per specifications	Contractor	PIC	PEA/Client
			2. Insulation Resistance Value	Minimum accepted value 2000 Mega-Ohms	Contractor	PIC	PEA/Client
			3. Traceability (Make/batch no./Loc. No.)	Packing list/CIP	Contractor	PIC	PEA/Client

		b) Conductor	1. Visual check of drums.	Packing list/CIP	Contractor	PIC	PEA/Client
			2. Check for seals	-do-	Contractor	PIC	PEA/Client
			3. Check depth from top of flange to the top of the outer most layer	-do-	Contractor	PIC	PEA/Client
		c) Earth wire / OPGW	Check for seals at both ends.	Packing list/CIP	Contractor	PIC	PEA/Client
		2. Field activity			Contractor	PIC	PEA/Client
		a) Before stringing	Readiness for stringing works	Stringing procedure as per specifications	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
		b) During stringing	(Conductor/ Earth wire/OPGW)				
			1. Scratch / cut check (Visual)	Approved drawings/specifications	Contractor	PIC	PEA/Client
			2. Repair sleeve	-Do-	Contractor	PIC	PEA/Client
			3. Mid span joints	-Do-	Contractor	PIC	PEA/Client
			4. Guying (in case of tower not designed for one side stringing)	As per specification	Contractor	PIC	PEA/Client
		c) After stringing	Check for				
			1. Sag/tension	Stringing chart/tower spotting data	Contractor	PIC	PEA/Client
			2. Electrical clearances	As per specifications	Contractor	PIC	PEA/Client
			a) Ground & live metal clearances	-Do-	Contractor	PIC	PEA/Client
			3. Jumpering	-Do-	Contractor	PIC	PEA/Client
			4. Copper Bond	As per approved	Contractor	PIC	PEA/Client
			5 Placement of vibration dampers	As per specifications/drawings	Contractor	PIC	PEA/Client
			6. Mid span joints	As per specifications	Contractor	PIC	PEA/Client
			7. Placement if arcing horns	As per specifications	Contractor	PIC	PEA/Client

			8. Tightening of nut- bolts as per manufacturer's recommendation	As per specifications	Contractor	PIC	PEA/Client
10.	Final checking of line	Foundation/Tower/ Stringing works	Rectification of defects	As per punch list	Contractor	PIC	PEA/Client

S. No.	Description of Activity	Items to be checked	Tests/Checks to be done	Ref. Documents	Action Required		
					To be checked	To be reviewed	To be approved
11.	Final testing a) Pre-commissioning	Readiness of lines for pre-commissioning	1. Completeness of line. 2. Megger testing of line 3. Conductor continuity test	As per pre-commissioning procedures	Contractor	PIC	PEA/Client
12.	Commissioning of lines	Readiness of lines for commissioning	Digital photograph of each tower to ascertain the completeness of tower	1. As per latest pre-commissioning procedures 2. Pre-commissioning report 3. CEA clearance	Contractor	PIC	PEA/Client

ANNEXURE- I OF SFQP
ACCEPTANCE CRITERIA AND PERMISSIBLE LIMIT FOR CEMENT

ORDINARY PORTLAND CEMENT [OPC]

S. No.	Name of the Test	OPC Grade 33 Grade as per IS 269	OPC Grade 43 as per IS 8112	OPC 53 Grade as perIS 12269	Remarks
A) Physical Tests					**To be done only in approved lab**
1.	Fineness	Specific surface area shall not be less than 225 sq.m per Kg.	Specific surface area shall not be less than 225 sq.m per Kg.	Specific surface area shall not be less than 225 sq.m per Kg.	Blaine's air permeability method as per IS 4031 (Part-2)/Sieve analysis as per IS 4031 (Part-3)
2.	Compressiv eStrength	72 ± 1 hour: Not less than16 Mpa (16 N/mm²) 168 ± 2 hour: Not less than22 Mpa (22 N/mm²) 672 ± 4hour: Not less than33 Mpa (33 N/mm²)	72 ± 1 hour: Not less than23 Mpa (23 N/mm²) 168 ± 2 hour: Not less than33 Mpa (33 N/mm²) 672 ± 4hour: Not less than43 Mpa (43 N/mm²)	72 ± 1 hour: Not less than 27 Mpa (27 N/mm²) 168 ± 2 hour: Not less than37 Mpa (37 N/mm²) 672 ± 4hour: Not less than53 Mpa (53 N/mm²)	As per IS 4031 (Part-6)
3.	Initial & Final setting time	Initial setting time: Not lessthan 30 minutes Final setting time: Not less than 600 minutes	Initial setting time: Not lessthan 30 minutes Final setting time: Not less than 600 minutes	Initial setting time: Not lessthan 30 minutes Final setting time: Not less than 600 minutes	As per IS 4031 (Part-5)
4.	Soundness	Unaerated cement shall not have an expansion of more than 10 mm when tested by Le Chatlier and 0.8% by Autoclave test	Unaerated cement shall not have an expansion of more than 10 mm when tested by Le Chatlier and 0.8% by Autoclave test	Unaerated cement shall not have an expansion of more than 10 mm when tested by Le Chatlier and 0.8% by Autoclave test	Le Chatlier and Autoclave test asper IS 4031 (Part-3)

Note: All physical tests are required to be performed in approved lab, Review of 100 % MTC and testing of one sample for every batch number of manufacturer of a particular brand.

S. No.	Name of the Test	OPC Grade 33 Grade as per IS 269	OPC Grade 43 as per IS 8112	OPC 53 Grade as perIS 12269	Remarks
B Chemical Composition Tests					**Review of MTC only**
1.		Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02 %	Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02 %	Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02 %	
2.		Ration of percentage of alumina to that of iron oxide minimum 0.66 %	Ration of percentage of alumina to that of iron oxide minimum 0.66 %	Ration of percentage of alumina to that of iron oxideminimum 0.66 %	
3.		Insoluble residue percentage by mass Max. 4.00%	Insoluble residue percentage by mass Max. 2.00%	Insoluble residue percentage by mass Max. 2.00%	
4.		Magnesia percentage by mass 6% (Maximum)	Magnesia percentage by mass 6% (Maximum)	Magnesia percentage by mass 6% (Maximum)	
5.		Total sulphur content calculated as sulphuric anhydride (SO3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percentage by mass is 5 or less and greater than 5 respectively	Total sulphur content calculated as sulphuric anhydride (SO3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percentage by mass is 5 or less and greater than 5 respectively	Total sulphur content calculated as sulphuric anhydride (SO3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percentage by mass is 5 or less and greater than 5 respectively	
6.		Total loss on ignition shall not be more than 5 %	Total loss on ignition shall not be more than 5 %	Total loss on ignition shall not be more than 5 %	

Note: Chemical composition tests of cement are not required to perform in lab, only review of Manufacturer's Test Certificate (MTC) is to be done.

PORTLAND POZZOLANA CEMENT [PPC] AS PER IS 1489/2005

S. No.	Name of test	Acceptance Criteria	Remarks
	Physical Tests		
1.	Fineness	Specific surface area shall not be less than 300 sq.m per Kg. or 3000 Cm^2/gm	
2.	Compressive Strength	a) 72 ± 1 hour: Not less than 16 Mpa (16 N/mm^2) b) 168 ± 2 hour: Not less than 22 Mpa (22 N/mm^2) c) 672 ± 4 hour: Not less than 33 Mpa (33 N/mm^2)	**All physical tests to be done inapproved lab only**
3.	Initial & Final setting time	Initial setting time: Not less than 30 minutes Final setting time: Not more than 600 minutes	
4.	Soundness	Unaerated cement shall not have an expansion of more than 10 mm Le Chatlier test and) 0.8 % by automotive test as per IS 4031 (Part-3)	
	Chemical Composition Tests		
1.	Magnesia percentage by mass max. 6%		Review of Manufacture's TestCertificate (MTC) only
2.	Insoluble material percentage by mass + 4 (100-x)/100, where x is the declared % of pozzolana in the PPC		
3.	Total sulphur content as sulphuric anhydride (SO3), percentage by mass not more than 3.o		
4.	Total loss on ignition shall not be more than 5 %		

ANNEXURE- II OF SFQP

Acceptance Criteria and Permissible Limit for Reinforcement Steel as per IS 1786-1985 Edition-4.3 (2004-2012)

S. No.	Name of Test	Fe 415	Fe 500
1.	**Physical Tests**		
a)	Tensile strength minimum	10 % more than actual 0.2 % proof stress but not less than 485 N/mm²	8 % more than actual 0.2 % proof stress but not less than 545 N/mm²
b)	0.2 % of proof stress / Yield stress minimum, N/mm²	415	500
c)	Elongation percentage minimum	14.5	12
2.	**Bend & Re-bend Test**	Pass	Pass
3.	**Chemical Analysis Tests**		
a)	Carbon	0.30 % Maximum	0.30 % Maximum
b)	Sulphur	0.060 % Maximum	0.055 % Maximum
c)	Phosphorous	0.060 % Maximum	0.055 % Maximum
d)	Sulphur & Phosphorus	0.11 % Maximum	0.105 % Maximum

Note: All physical & bend re-bend tests are to be performed in approved lab, Review of MTC and testing of one sample of 10 mm steel & above size per 500 MT and unit weight of three samples for each size of steel shall be witnessed.

ANNEXURE-III OF SFQP

Acceptance Criteria and Permissible Limit for Coarse Aggregate as per IS 383

Physical Tests

S. No.	Physical Tests										
1.	Determination of Particle Size	IS Sieve Designation	Percentage Passing for Single Sized Aggregate of Nominal Size					Percentage Passing for Graded Aggregate ofNominal Size			
			40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
		63 mm	100	--	--	--	--	--	--	--	--
		40 mm	85 to 100	100	--	--	--	95 to 100	100	--	--
		20 mm	0 to 20	85 to 100	100	--	--	30 to 70	95 to 100	100	100
		16 mm	--	--	85 to 100	100	--	--	--	90-100	--
		12.5 mm	--	--	--	85 to 100	100	--	--	--	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
		4.75 mm	--	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	--	--	--	--	0 to 5	--	--	--	--
2.	Flakiness Index		Not to exceed 25 %								
3.	Crushing Value		Not to exceed 45 %								
4.	Presence of deleterious material		Not to exceed 5%								
5.	Hardness		Abrasion value not more than 50 %, Impact value not more than 45 %								
6.	Soundness test (for concrete work subject to frost action)		Not to exceed 12 % when tested with sodium sulphate & 18 % with magnesium sulphate								

Note: All physical tests shall be carried out at approved lab, one sample per 500 Cubic Meter or part thereof per source shall be tested.

ANNEXURE- IV OF SFQP

Acceptance Criteria and Permissible Limit for Fine Aggregate as per IS 383

Physical Tests

S. No.	Name of Tests	IS Sieve Designation	Percentage Criteria		
1.	Determination of particle size		**Fine Aggregate Zone-I**	**Fine Aggregate Zone-II**	**Fine Aggregate Zone-III**
		10 mm	100 mm	100 mm	100 mm
		4.75 mmm	90 - 100 mm	90 - 100 mm	90 - 100 mm
		2.36 mm	60 - 95 mm	75 - 100 mm	85 - 100 mm
		1.18 mm	30 - 70 mm	55 - 90 mm	75 - 100 mm
		600 microns	15 - 34 mm	35 - 59 mm	60 - 79 mm
		300 microns	5 - 20 mm	8 - 30 mm	12 - 40 mm
		150 microns	0 - 10 mm	0 - 10 mm	0 - 10 mm
2.	Silt Content		Not to exceed 8%	Not to exceed 8%	Not to exceed 8%
3.	Presence of deleterious material	Total presence of deleterious material not to exceed 5 %			
4.	Soundness applicable to concrete work subject to frost action	12 % when tested with sodium sulphate and 15 % when tested with magnesium sulphate			

Note: All physical tests shall be carried out at approved lab, one sample per 500 Cubic Meter or part thereof per source shall be tested.

ANNEXURE-V OF SFQP

Acceptance Criteria and Permissible Limit for Concrete Work

Concrete	a) Workability	Slump shall be recorded by slump cone and it must be in range of 25-55 mm
	b) Compressive Strength	For nominal (volumetric) concrete mixes compressive strength for M20, 1:1.5:3 (Cement: Fine Aggregate: Coarse Aggregate) concrete 28 days strength shall be min 265 Kg/cm² and for M15, 1:2:4 (Cement: Fine Aggregate: Coarse Aggregate) nominal mix concrete 28 days strength shall be min 210 Kg/cm². **Concrete Cube Sampling per Day of Concreting** One sample consisting of three cubes at each location shall be taken if all legs are being casted continuously without interruption otherwise three additional cubes shall be taken for every subsequent continuous casting or in alternate as per IS-456 one cube per five cubic meter of concreting to be taken.

Notes:

1. On the basis of mandatory lab test results, in case of actual average compressive strength being less than specified strength but up to 70% of specified value, concrete may be accepted and rate payable shall be in the same proportion as the actual average compressive strength bears to specified compressive strength, however, in case cube strength of any one leg on any location is found to be in between 70 % to 100 % of specified value, all four legs of the respective location shall be analysed. Root cause analysis has to be carried out with NDT [Non Destructive Testing] by REBOUND HAMMER TEST to verify the quality and strength of foundation. If results are not satisfactory acceptable penalty such as re-doing of complete foundation/legs, cost towards supervision charges shall be levied from contractor towards the sub-standard works, with the approval of client/HPSEBL.

2. If the actual strength of accepted sample is less than 70 % of specified strength, PIC/PEA may reject the defective portion of work represent by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor.

3. Cement for concrete work needs to be used in the order of its receipt at store [FIFO-First in First out] basis, it should not be more than 6 weeks old from the date of manufacture, in case the cement remains in the storage for more than three months, the cement needs to be retested to find its suitability for further use for concrete works, if it fails to conform to any of requirement given in the Indian Standard it needs to be discarded for further use.

ANNEXURE-VI OF SFQP

Engineering Guidelines and Acceptance Criteria for Soil Investigation Work

Normal Foundation

1. The soil investigation report should be carried out in line with technical specification, it needs to be signed by the soil investigating agency, contractor and reviewed by PIC and approved by PEA/Client.
2. Soil investigation report should contain the bore log sheet indicating the variation of different soil strata.
3. The Bearing capacity, Bulk capacity, Sub-merged density, Angle of repose in dry & wet conditions, Angle of internal friction for different soil layersincluding at 3 meters depth shall be indicated in the soil investigation report.
4. Present water table and history of variation of water table at the tower locations shall be indicated in the report.
5. Classification of foundation should be indicated based on the water table, Bearing capacity, Swelling Index, Soil type and the value of the angle of repose in line with parameters indicated in the standard foundation drawings.

River Crossings / Special Foundations

1. A sketch indicating profile of river crossing locations with borehole positions shall be indicated in the soil investigation report.
2. Maximum discharge, Maximum velocity and Highest Flood Level (HFL) data of the river shall be enclosed in the soil investigation report.
3. Comprehensive Bore log sheet indicating the depth of different soil strata, soil type, SPT Value & Water table for each bore hole is to be indicated in the soil investigation report.
4. Natural Ground Level (NGL) for all locations are to be indicated, note that the NGL & HFL should be w.r.t same reference level.
5. Whether the river is navigable or not is to be indicated in the report.
6. Silt factor calculation based on the laboratory test results of weight mean diameter of soil for different layers to be furnished in the report.

7. Bulk density, Submerged Density, Value of Cohesion (c) and Angle of internal friction, for different soil layers based on laboratory test results shall be indicated in the soil investigation report.

8. If rock encountered prior to termination of bore hole (40 meters below existing ground level), core drilling should be done, the detail of core recovery (Run wise) and calculation of Rock Quality Designation (RQD) with photograph of core sample properly placed in a core box are to be enclosed in the soil investigation report.

9. If the refusal is not obtained or the type of soil encountered at the depth below existing ground level is very poor like loose clay, organic deposit etc. further boring should be furnished in the soil investigation report as detailed above.

SITE ORDER

S. No.	Date	Instruction Issued on Inspection of Works with Signature and Designation (To be Filled in By PIC/PEA/Inspecting Body)	Contractor's Acknowledgment with Name, Signature and Date	Compliance Report By Contractor with Name, Signature and Date	Final Remarks of Inspecting Officer/ Engineer with Name, Signature and Designation (To Be Filled in By PIC/PEA/Inspecting Body).

HINDRANCE

S. No.	Nature of Hindrance	Date of Occurrence	Date of Clearance	Hindrance Period	Overlapping Period if Any	Net effect Days of Hindrance	Remarks & References	Sign. Of PIC	Sign. Of HPSEBL	Sign. Of Contractor

PIT MARKING

Name of Line / Site:

Location No……. Tower Type……

1. Approved Drawing No.
……
……

2. Reference Level
……
……

3. Alignment of location w.r.t previous and next Location
……

4. Centre of location / position of various landmarks
……..
are matching with profile.

5. Any new object on ground w.r.t profile necessitating re-alignment /shifting of location features or due to any other reasons — YES / NO

6. Span on both sides of Location — As per profile / As per Actual (Mtrs)

a) Preceding Span (Loc. No.) …….. / ……

b) Succeeding Span (Loc. No.) …….. / ……

7. Angle of deviation and bisection (for Angle tower locations) As per profile / As per Actual

a) Angle of Deviation …….. / ……..

b) Bisection Details …….. / ……..

8. Position of cross pegs in transverse direction — O.K / Not O.K

9. Position of all four pits are as per profile / safe — Yes / No

10. Dimension of pits are as per drawings — Yes / No

11. Whether Benching / Revetment required if yes

a) If contour maps / approved revetment drawings available /prepared — Yes / No

b) Possibly calculated volume .....Cu. M

Certified that location is cleared and safe for excavation

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

STUB SETTING

Name of Line / Site:
……..

Location …… No. Tower …… Type.

1. Approved Drg. No. ……
……

2. Pit Dimensions

a) Depth of Pits	From Ref. Level	Ground Level
PIT A	----------	----------
PIT B	----------	----------
PIT C	----------	----------
PITD	----------	----------

b) Pit dimensions are as per approved foundation classification Yes / No

c) Excavated soil is kept minimum 2 meter away from pit edge Yes / No

d) Under cutting is done in case of fissured rock as per approved drawing Yes / No

e) Minimum working space of 50 - 80 mm is kept for ease of reinforcement / form work Except in case of fissured rock foundation Yes / No

3. Whether make use of Template or Prop for casting of foundation ----------

In case of template

a) Alignment of template

Tangent tower (in the direction of line) Yes / No

b) Angle tower

Angle of Deviation ----------

Alignment of template on bisection Ok / Not Ok

4. Diagonal of Template

AC .....

BD .....

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

CONSTRUCTION MATERIAL

Name of Line / Site:
……

Location No…… Tower Type…….
Classification……..

1. Quality & Quantity of Coarse Aggregate and Fine Aggregate

Material Detail	Qty. Required	Qty. Available	Approved Source	Quality
Fine Aggregate				
20 mm CA				
40 mm CA				

2. Dimension of Measurement Boxes (30 cm x 30 cm x 39 cm) OK / Not OK
3. Proportion of Nominal Mix

Grade of Concrete	Qty. of Cement	Qty. of Fine Aggregate	Qty. of Coarse Aggregate	Qty. of Water
M10				
M20				

4. Quality & Quantity as per specification
5. Reinforcement Steel

Dia of Bar	Qty. Required (MT)	Qty. Available (MT)	Approved Source	Quality (OK/Not OK)
6 mm				
8 mm				
12 mm				
16 mm				
20 mm				
25 mm				

6. Form Boxes
a) Dimensions are as per approved drawings OK/Not OK
b) Oiling of inner walls of Form Boxes OK/Not OK
7. T&P and Man power as per requirement are available at site OK/Not OK
8. Lean Concreting/PCC-M10
a) Pits are free from are foreign material Yes/No
b) Pits are free from standing water (Dewatering continued in advance Yes/ No Pumps / Buckets)
c) Mix ratio 1:3:6 with 20 mm coarse aggregate Yes/No
d) Concrete mixture by mixer as per specification OK/Not OK
e) Mixture running time (minimum 2 minutes) OK/Not OK
f) De-Watering done Yes / No / Not Required
g) Lean concreting is done up to specified level and area in all the four pits Yes / No
h) No of cement bags consumed As per design /Actual
i) In case of excess excavation filling is done by lean concrete & no loose soil is permitted for filling volume of excess lean concrete

Certified that pits are cleared for installation of reinforcement steel & form boxes

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

INSTALLATION OF REINFORCEMENT STEEL & FORM BOXES

Name of Line / Site……

Location No……Tower Type…….. Type of Foundation…….

Approved Drawing No……

SL	Description	Acceptability
1	**Reinforcement Steel**	
a)	Pits are free from stagnant water	Yes / No
b)	De-watering arrangements are available	Yes / No
c)	Bending & Placing is done as per approved drawings and specifications	Yes / No
d)	Required number of chair rods are being used (Min-12 mm dia)	Yes / No
e)	Binding is done as per specification and BBS	Yes / No
f)	Any undue stress or bending of steel bars	Yes / No
g)	Steel being used for reinforcement is of approved make	Yes / No
h)	Steel is clean and free from any rust or foreign material	Yes / No
i)	Position of bars w.r.t stub is as per approved drawing	Yes / No
2	**Form Boxes**	
a)	Dimensions of form boxes are as per approved drawing	Yes / No
b)	Bolts and Nuts are water tightened	Yes / No
c)	Shuttering oil / Mobil oil is applied to inner faces of form boxes	Yes / No
d)	Form boxes are placed w.r.t stub as per approved drawing	Yes / No
3	Clear cover of 50 mm or as per drawing is available	Yes / No
4	Earthing Strip is fixed as per approved drawings	Yes / No
		Yes / No

Certify that installation of reinforcement steel is ready for casting / concreting.

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

POUR CARD

Name of Line /
Site…….

Pour Card No…….. Date…….

Location No……

Reference Drawing
No……..

S. No.	Items	Status / Remarks
1	Mix proportion as per specifications	
2	Quantity of concreting as per approved drawing	
3	Level of stub & chimney concreting	
4	Checking for shuttering & shoring	
5	Reinforcement as per BBS & specifications	
6	Slope of stub as per approved drawing	
7	Checking for stub nut-bolts, cleat-plates etc.	
8	Cement Brand & Week No	
9	Quantity of cement	
10	a) As per design	
11	b) As per actual	
12	Water cement ratio	
13	Slump value	
14	Identification of Cubes	

Certified that prepared mix / concrete is as per specifications and ready to pour

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

MIXING, PLACING AND COMPACTION OF CONCRETE

Name of Line / Site……

Location No……..Type of Tower …… Classification of Foundation……..

Approved Drawing No……..

S. No.	Description		Acceptability
1	**Mix Ratio**		
a)	For Frustum & step boxes with M20 (1:1.5:3), use of 40 mm coarse aggregate		Yes / No
b)	For Chimney with M20 (1:1.5:3), use of 20 mm coarse aggregate		Yes / No
c)	Water cement ratio as per specification		Yes / No
2	**Mixing method**		
a)	Concrete mixer machine (minimum running time: 2 Minutes)		Yes / No
b)	Hand Mixing (use of 10 % extra cement) , only for inaccessible location		Yes / No
c)	Hand mixing done on either GI sheet or pucca floor		Yes / No
3	Use of poking rod for compaction of concrete		Yes / No
4	Use of vibrator for compaction of concrete		Yes / No
5	Casting of frustum & chimney in continuity		Yes / No
6	Quantity of cement as per specification		Yes / No
7	Coping is done as per approved drawing		Yes / No
8	**Detail of Cube Preparation**		
	Tower Legs	**Date of Casting**	**No. of Cubes Taken**
	A		
	B		
	C		
	D		
9	Removal of shuttering after 24 hours of concreting		Yes / No
10	Layer wise backfilling of soil along with water for curing		Yes / No
11	Curing is done for minimum 10 days		Yes / No
12	Use of wet gunny bags for curing of chimneys		Yes / No
13	Availability of water pump & storage arrangement for curing		Yes / No
14	Backfilling & levelling of foundation as per specification		Yes / No
15	Removal of surplus material from site		Yes / No
16	Cubes are kept in water for curing (28 Days)		Yes / No

Certificate: Foundation is cleared for tower erection subject to fulfilment of part-I before erection and part-II indue course of time and planning.

Part-I: Setting period (28 days) is allowed as per specification

Part-II: a) Revetment / Benching proposal if any
……

b) Revetment / Benching likely execution
……..

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

JOINT MEASUREMENT CERTIFICATE (FOUNDATION WORKS)

Name of line / site		
Tender No. & Date		
Contractor's Name		
JMC No.		Date:
Location No.		Type of Tower:
Foundation Drawing No.		Depth of water Level:
Stub Drawing No.		Foundation Classification:

1. Excavation Detail
a) Area of Pit **Length =** **Breadth =** **Area =**

PIT DETAIL	Type of Soil & Depth Detail in Meters					
	Dry	Wet	PS	DFR	WFR	Hard Rock
PIT A						
PIT B						
PIT C						
PIT D						
Average Depth (D)						
Volume = AXD						
Under Cut Volume in FR						
Total Volume						

2. DETAIL OF BENCHING (If any)

a) Proposal of benching submitted Yes / No
b) Approval of contour drawings & benching proposal Yes / No
c) Volume of benching done.....Cubic Meter

3. DETAIL OF DE-WATERING (If any)

a) Whether de-watering is done during concreting works Yes / No If done then mode of de-watering
b) Manual.....Man Days
c) Mechanical Pump.....Hours
d) Power Driven Pump .....Hours

4. CHECKING OF CASTING

a) Alignment of location & template Found Ok / Not Ok
b) Diagonal (In Meters) AC = , BD =
c) Level of stub & template Found Ok / Not Ok
d) Quality of
i) Coarse Aggregate Found Ok / Not Ok, (Source Name .....)
ii) Fine Aggregate Found Ok / Not Ok, (Source Name .....)
iii) Cement Found Ok / Not Ok, (Make / Type .....)
iv) Reinforcement Steel Found in order / Not in order, (Make…..)
v) Water Clean & Potable Water / Not Ok, (Source Name .....

5. DETAIL OF CONCRETING WORKS

a) Volume of Concrete (1:1.5:3, M20) .....Cubic Meter
b) Volume of Concrete (1:3:6, M10) .....Cubic Meter
c) Quantity of cement bags consumed in M20 concrete .....Nos
d) Quantity of cement bays consumed in M10 Concrete .....Nos
e) Total cement bags consumed in entire casting of foundation (M10 + M20) ..Nos
f) Quantity of Reinforcement placed as per drawing Yes / No

Reinforcement Steel			Sub Detail		
Size of Bar	**Quantity**	**Unit**	**Item of Stub**	**Quantity**	**Unit**
06 mm		Kg	Mild Steel		Kg
08 mm		Kg	HT Steel		Kg
10 mm		Kg	Bolt & Nut including washers		Kg
12 mm		Kg			
16 mm		Kg			
20 mm		Kg			
25 mm		Kg			
Total Weight		Kg	Total Weight		Kg

6. Detail of Revetment / Protection Wall (If any)

a) Proposal of Revetment Submitted along with drawing & justification Yes / No
b) Approval of Revetment Proposal Yes / No
c) Volume of excavation..... Cubic Meters
d) Cement Concrete, 1:4:8 (If Any) .....Cubic Meters
e) Plain Cement Concrete, 1:3:6 (If any) ..... Cubic Meters
d) RCC & Coping with M15 .....Cubic Meter

f) RR Masonry Works (1:6) .....Cubic Meters
g) Steel for Reinforcement ..... Kg
h) Dry Stone Masonry (If any) .....Cubic Meter
i) Stone Packing in Weep Holes..... Cubic Meter

7. Detail of Cubes

a) No. of cubes prepared along with dates ……
b) Current status of cubes whether under curing or sent to lab for testing or tested ……
c) Copy of cube test report from approved lab (if tested) Yes / No Certify that work has been carried out as per specifications & approved design/drawings. **Representative of Contractor**

Representative of Consultant ……

Representative of HPSEBL ……

CHECK LIST OF TOWER ERECTION WORKS

Name of Site / Line……

Location No……. Tower Type……..

S. No.	ITEM DESCRIPTION	STATUS	OBSERVATION
1	Backfilling, compaction and levelling of foundation is as per specification and location is ready for tower erection works	YES / NO	
2	Setting period of foundation is allowed for at least 14 days as per specification.		
3	All tested tools, plants and safety equipments are in working conditions.		
4	Revetment / protection wall if any is completed if not then program of completion.		
5	Shut down of power lines if required is arranged.		
6	PPE's Safety shoes, Helmets, Safety Belts are being used.		
7	Double lanyard full body harness is being used.		
8	First section of tower is braced and all plan diagonals are placed in proper position.		
9	Guying of tower provided as per approved drawings and norms, guying of tower to be terminated on firm ground.		
10	All nut-bolts, flat / spring washers are provided as per approved drawings.		
11	All vertical bolts to be kept downward and horizontal to be kept outside the tower.		
12	Subsequent sections of tower are erected only after complete erection and bracing of previous section.		
13	Any undue stress, bending or damaged of member during erection noticed.		
14	Any filling of holes or cutting of members during erection works		
15	Any heavy hammering of bolt causing damage of threads noticed.		
16	Any substitute of tower members erected, if yes member nos.		
17	Tightening is done progressively from top to bottom.		
18	All bolts at same level are tightened simultaneously		
19	Slipping /running over nut bolts are replaced by new ones		
20	Threaded portion of bolts projected outside of nut is not less than 3 mm.		
21	Punching of threads projected outside is done at three positions on diameter.		
22	All blank holes are filled with correct size of bolt-nut.		
23	Verticality of tower is checked with help of theodolite for both longitudinal and transverse directions, this is within specified limit.		

S. No.	ITEM DESCRIPTION	STATUS	OBSERVATION
24	Detail of missing members, nut-bolts.	YES / NO	
25	Tack welding is done as per specification using standard quality of welding rods.		
26	Zinc rich paint applied on tack welding.	Yes/ No	
27	**Earthing**		
a)	Tower footing resistance (Value in Ohms)		
b)	Soil Resistivity (Value in Ohm-M)		
	Type of Earthing Done	Pipe Type / Counter poise earthing type	
A	Pipe Type Earthing		
1	Earthing provided on leg A	Yes/ No	
2	G.S Pipe, flat tightened with nut & bolts and placed as per approved drawings	Yes/ No	
3	There is no sharp damage or bent in earthing strips /flat	Yes/ No	
4	Finely broken coke and salt in ratio of 10:1 is filled in earth pits (Alternate Layers)	Yes/ No	
5	Backfilling done properly	Yes/ No	
B	Counter Poise Earthing		
1	Excavation is done up to required depth of 1 meter and length of 15/30 meters in four radial direction	Yes/ No	
2	GS wire placed in excavation and lugs firmly tightened with nut-bolts.	Yes/ No	
3	Backfilling is done as per specification	Yes/ No	
C	Value of tower footing resistance after earthing in dry season (Permissible limit of 10 Ohms)	---------- Ohms	

Certificate: Certify that erection of tower is completed in all respect and footing resistance is within permissible limit.

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

JOINT MEASUREMENT CERTIFICATE

(Tower Erection)

Name of Line / Site:
……

Location No……. Tower Type…….

Date of Completion……

Tower Type	**Summary of Weight in MT**				
	H T	MS (Incl. PW & Accessories)	Hex. Bolts & Accessories	Total	BOM Ref. No.

Status of Tack welding …….

Status of application of anti-corrosive paint…….

Status of fixation of tower accessories……..

Certificate: Work is executed as per specification and approved drawing

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

JOINT MEASUREMENT CERTIFICATE CUM CHECK LIST
(Earthing Works)

Name of Site / Line						
LOA No. & Date						
JMC No. & Date						
Approved Drawing Nos.						
S. No.	**Loc. No.**	**Foundation Classification**	**Type of Earthing**	**Completion Date**	**Value of TFR (Ohms)**	**Observations (If any)**

Certificate: Certify that work is carried out as per approved drawings / technical specification andfollowing conditions are met.

1. Quality and quantity of salt & coke is as per approved drawings in case of pipe earthing. (Yes / No)
2. Nut-Bolts / Washers are properly tightened .....(Yes / No)
3. Specification & Size of Bore Pipe and MS Flats are per approved drawings……. (Yes/No)
4. Depth of bore pipe is 3 meters.....(Yes/ No), If no specify the reason in observation column
5. Length & depth of counter poise wire to be mentioned in observation column.
6. Value of soil resistivity to be mentioned in observation column in case of counter poise earthing.
7. Specification & Size of GS wire, MS lugs, nut-bolts & washers are as per approved drawing in case

of Counter poise earthing..... (Yes/No).

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

JOINT MEASUREMENT CERTIFICATE

(Stringing Works)

Name of Site / Line
……

Tender No. & Date
……

S. No.	Section Detail			Observations if any
	From (Tower. No.)	To (Tower No.)	Section Length (Mtrs.)	
Total length of sections in Km				

Certified that stringing is done as per approved sag chart/ specifications and following conditions aremet during stringing works.

1. Stringing is carried out in above mentioned sections as per approved stringing chart, drawings andtechnical specifications.
2. Work has been completed in all respect including Final sagging, Installation of OPGW/Earthwire, Jumpers, Pilot Strings, Spacers, Vibration Dampers, MSJ, CC Rings, Copper Bonds, Junction boxes etc.
3. All safety rules and regulations are being followed at site such as use of PPEs, proper earthing, shut down of feeders / power lines (if required), prohibition of unauthorised person and general public in corridor, correct methodology of pulling/lifting/ paying out / sagging etc.
4. Periodic & proper maintenance and overhauling of tools, plants, machineries etc.
5. All sections and locations are made clean & free from any kind of scrap, debris which may causepotential impact on environment etc.
6. No damaged conductor, earth wire, insulator, hardware fittings and accessories are being used inany span / section being billed.
7. Workmanship and quality of execution as per relevant specification and methodology.

Representative of Contractor **…….**
Representative of Consultant **…….**

Representative of HPSEBL **…….**

CHECK LIST FOR STRINGING WORK

Name of Site / Line

……

Section Length…….From AP. No. ……..To AP. No. ……..

	ITEM CHECKED/RESULT	OBSERVATION,IF ANY
A)	**Pre- Stringing Checks**:	
1)	Back filling of soil and revetment/ Benching Wherever required is done.	Yes/ No
2)	Towers are tightened properly and all the Members, Nut/Bolts are provided.	Yes/ No
3)	Trees in the corridor removed to facilitate Smooth stringing.	Yes/ No
4)	All line materials, tested T&P, safety equipments and relevant drawings available for stringing.	Yes/ No
5)	Shutdown of Power line/Railway block if Required, is arranged.	Yes/ No
6)	Necessary protection/ Scaffolding/warning Signals provided for Railway/Power line/P&T Line/Road Crossings.	Yes/ No
7)	Towers vulnerable for one side load are guyed Properly.	Yes/ No
8)	Tower footing resistance is within permissible Limit of 10 ohms.	Yes/ No
B)	**Paying out of OPGW / Earthwire: -**	
1)	Work is being carried out in full safety measures as per guide line.	Yes/ No
2)	Traveling rounds are provided.	Yes/ No
3)	Paying out is carried out as per approved Drum schedule.	Yes/ No
4)	All pulleys fixed on towers for paying out are moving freely.	Yes/ No
5)	Effective communication exists through walkie-talkie and through persons on towers.	Yes/ No
6)	Earthwire /OPGW is being constantly checked as it is unwound, damaged portion, if any, is removed	Yes/ No
7)	Necessary arrangements have been provided to avoid rubbing of Earthwire / OPGW against hard ground / surface	Yes/ No
8)	Necessary details of OPGW/Earthwire, M.S. Joints Junction boxes recorded as per Annexure CF-I & CF-II.	Yes/ No

C)	**Paying out of conductor**	
1)	Work is being carried out with full safety measures as per guideline.	Yes/ No
2)	Tensioner/ Puller/Winch Machine are properly placed, Firmly anchored and earthed.	Yes/ No
3)	Conductor drums are placed properly to avoid bird caging.	Yes/ No
4)	Sequence of paying out is such that to avoid unbalancing of load on tower.	Yes/ No
5)	Details of insulators and fitting are recorded as per Annexure CF-III & CF-IV.	Yes/ No
6)	Paying out is carried out as per approved drum schedule.	Yes/ No
7)	Travelers fixed on towers are moving freely	Yes/ No
8)	Effective communication exists through Walkie-talkie and through persons standing at towers for smooth and safe paying out.	Yes/ No
9)	Conductor is checked continuously as it is unwound from drum, damaged portion, If any, is removed/ repaired.	Yes/ No
10)	Proper arrangements made to avoid rubbing Of conductor on ground/hard surfaces.	Yes/ No
11)	Details of conductor and MSJ/Repair Sleeve is recorded as per Annexxure CF-I & CF-II.	Yes/ No
D)	Final Sagging and Tensioning of Earth Wire / OPGW and Conductor	
1)	Sag board is fixed correctly after taking into account length of suspension clamp/fittings	Yes/ No
2)	No. of sag boards fixed in a section is as per technical specification.	Yes/ No
3)	Sag is measured correctly at prevailing Temperature, details recorded as per Annexure CF-V.	Yes/ No
4)	Sag mismatch is within permissible limits and checked with theodolite	Yes/ No
5)	After measuring sag, marking/cutting of Earthwire/conductor is done correctly to fix tension clamps/ fittings.	Yes/ No
6)	Details of tension clamps/fittings are recorded as per annexure CF-VI, CF-III & CF-IV.	Yes/ No
E)	**Clipping of Earthwire / OPGW and Conductor**	
1)	For Clipping, the marking is done correctly so That suspension clamp/fitting hangs exactly vertical.	Yes/ No
2)	Before clipping of conductor, proper earthing is provided.	Yes/ No
3)	Following line material provided as per Specification, details recorded as shown below. a) Suspension clamp of Earthwire/ OPGW and Conductor as per annexure CF-IV & CF-VI.	Yes/ No

	b) Vibration dampers for Earthwire/ OPGW and Conductor as per annexure CF-VII. c) Spacer/Spacer damper/ jumper spacer as per annexure CF-VIII. d) Jumper for Earthwire / OPGW/ conductor as per annexure CF-IV & CF-VI e) Pilot fitting, wherever necessary as per annexure CF-III & CF-IV.	
4)	Sag/tension again measured after clipping and found OK. Details recorded as per annexure CF-V.	Yes/ No
5)	Transportation done as per specification. details of line material recorded properly.	Yes/ No
6)	All line materials provided as per specification and approved drawings, all necessary details are recorded for traceability.	Yes/ No
7)	Jumpers are tightened properly, live metal clearances are as per specification.	Yes/ No
8)	Minimum ground clearance, clearance over Power line/railway line/ river crossing are as per Specification.	Yes/ No

Certificate: Stringing is completed as per relevant specifications in all respect.

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……

ANNEXURE CF - I
DETAILS OF CONDUCTOR & EARTHWIRE / OPGW

1. Make ……
2. Batch No ……
3. Quantity and Location……

S. No.	Drum No.	Length marked on Drum	Length Paid	Paid Between		Phase no.	Wire No.
				From Loc No.	To Loc No.		

4. There is no damage to Earthwire/ conductor before or during stringing. Strands are in perfect position.

Representative of Contractor ……

Representative of Consultant ……

Representative of HPSEBL ……..

ANNEXURE CF - II

Details of M.S. Joint for Earthwire/ OPGW/ Conductor &Repair Sleeve for Conductor

1. Make ……..
2. Batch ……..
3. Quantity and Location ……

S. No.	Between Loc. No.	Phase No.	Wire No.

4. Dimension-Recorded as per Annexure CF –IX
5. M.S. Joint has been provided at least 30 meters away from tower.
6. There is no M.S. Joint over Railway/River/Main Road crossings.
7. Not more than one M.S. Joint provided in one span for each Earthwire/ conductor.
8. Repair sleeve shall be used if number of damaged strands is not more than 1/6th of the total strands in outer layer. If damage is more then the damaged portion shall be removed and M.S. Joint provided.
9. Bores in the sleeves are perfectly clean
10. The following may be checked as per approved drawing.
    a. Marking and Cutting.
    b. Correct size of dies.
    c. Centering & fixing of sleeves.
    d. Fixing of all the components i.e. Aluminum and pipes, hole plugs etc.
    e. Compression of sleeves at specified pressure.
    f. Application of filler paste (Zinc chromate).
11. All the sharp edges have been filled after compression.
12. There is no crack, bend or any damages to joint after compression.

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

ANNEXURE CF - III
RECORDS OF INSULATORS

1. Type ……..
2. Make ……
3. Batch No ……
4. Electro Mechanical Strength ……..
5. Quantity and Location ……

S. No.	Loc. No	Qty. as per Specification	RHS	LHS	Remarks

6. Insulators are completely cleaned with soft cloth, glazing is proper, there is no crack, scratch orwhite spot on its surface.
7. 'R' clips in insulator are fitted properly.
8. While hoisting, no damage caused to insulator.

Representative of Contractor **…….**

Representative of Consultant **…….**

Representative of HPSEBL **…….**

ANNEXURE CF - IV
DETAILS OF HARDWARE FITTINGS

1. Make ……..
2. Batch No ……..
3. Type of fitting …….
4. Quantity and Location …….

S. No.	Loc No.	Hardware Fittings		Remarks
		RHS	LHS	

5. All nuts/ Bolts properly tightened.
6. All components of fittings have been provided as per approved drawings. Dimensions and galvanizing are OK. Fitting is cleaned and there is no damage to anycomponent.
7. All split /cotter pins properly provided.
8. In case of Tension fittings, dimensions before and after compression recorded as per AnnexureCF-IX.

Representative of Contractor……

Representative of Consultant……

Representative of HPSEBL……

ANNEXURE CF - V

SAG MEASUREMENT FOR EARTHWIRE /OPGW AND CONDUCTOR

1. Sag board fixed between ……..……..……
2. Temperature..... ^{0}C
3. Measurement of Sag/Tension

Item	RHS /LHS PHASE	As per Sag/ Tension Chart	Actual
Sag			
Tension			

4. During paying out/ rough sagging, tension in conductor/Earthwire/OPGW was as per technicalspecification.
5. For final sagging, initial stringing chart for conductor and final stringing chart for earth wire/OPGW are used.

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……..**

ANNEXURE CF - VI
SUSPENSION & TENSION CLAMPS FOR EARTHWIRE /OPGW

1. Make ……
2. Batch No ……..
3. Quantity and Location No ……

S. No.	Phase No. / Wire No.	Loc No.	Remarks

4. All components of clamps have been provided as per approved drawings, dimensions andgalvanizing is OK, clamp is cleaned and there is no damage to any component.

5. All nuts & bolts have been properly tightened.

6. Split / cotter pins have been properly fixed.

7. In case of tension clamp, dimensions before and after compression recorded as per AnnexureCF- IX.

Representative of Contractor **……**

Representative of Consultant **……**

Representative of HPSEBL **……**

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Annexure CF - VII
RECORDS OF V.D. FOR EARTHWIRE / OPGW

1. Make ……..
2. Batch No …….
3. Quantity and Location No …….

S. No.	Fixed on Loc. No.	Fixed towards Loc. No.	Phase / wire No.	No. of V.D.

4. All components of V.D. have been provided as per approved drawings, dimensions and galvanizing are OK. V.D. is cleaned and there is no damage to any component.

5. All nuts & bolts have been properly tightened.

6. V.D. fixed as per approved placement chart.

Representative of Contractor **…….**

Representative of Consultant **…….**

Representative of HPSEBL **……..**

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Annexure CF - VIII
RECORDS OF LINE SPACER / SPACER DAMPER

1. Make ……
2. Batch No ……
3. Quantity and Location No ……

S. No.	Span/Loc No.	Pole No.	No. of Spacer

4. All components of spacer have been provided as per approved drawings, dimensions and galvanizing are OK. Spacer is cleaned and there is no damage to any component.

5. All nuts & bolts have been properly tightened.

6. Spacer/ Spacer damper fixed as per approved placement chart.

Representative of Contractor **…….**

Representative of Consultant **…….**

Representative of HPSEBL **……..**

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CHAPTER- 15: FIELD QUALITY PLAN SUB STATION

STANDARD FIELD QUALITY PLAN FOR POWER TRANSFORMER

						Responsible agencies			
S.No.	CHARACTERISTICS/ ITEMS	INSTRUMENT	TYPE OF CHECK	QUANTUM / FREQUENCY OF CHECK	REF. DOC & ACCEPTANCE STANDARD	Contractor	Employer	FORMAT OF RECORDS	REMARK
1	**RECEIPT AND STORAGE**								
1.1	**RECEIPT OF MATERIALS**								
1.11	Check for Manufacturer's name as per Purchase Order, Name Plate details / Delivery Challan.		Visual	100%	Delivery Challan & Packing List / Transformer Name Plate	Verify	Verify		
1.12	Review Reports (Completeness of documents etc.)		Visual	100%		Verify	Verify		
1.13	Check supply of accessories / Loose supply items (if any)		Visual	100%	Packing List / BOQ	Verify	Verify		If short supplied Yes, Report immediately to Project Manager
1.14	Visual examination for damage / oil Leakage		Visual	100%	With out damages & leakages	Verify	Verify		If Yes, Report immediately to Project Manager

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1.2	**STORAGE OF MATERIALS**								
1.21	Ensure that different accessories / loose supply material are stored separately section and size wise labeled and tagged for easy identification		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
1.22	Ensure that all hardware are tagged & kept separately in racks/Bags size-wise for easy identification		Visual	do	do	Verify			
1.23	Ensure Gasket shell be stored in room.					Verify			
1.24	Ensure Tarpaulin covers have been provided.		Visual	do	do	Verify			
1.25	Ensure that area where the transformer oil drums are stored is free from fire hazards.		Visual	100%	do	Verify			
1.26	Ensure crates should not be stacked one over the other.		Visual	do	do	Verify			
1.27	Ensure surrounding area of storage is not polluted and water does not accumulate in the storage area.		Visual	do	do	Verify			
1.28	Ensure that the material is stored in vertical position or vertically raised wooden platform/ Planks to avoid direct contact with ground / Moisture .		Visual	do	do	Verify			
1.29	Ensure that the material is stored in systematic manner rating wise for easy removal/ Usage.		Visual	do	do	Verify			
1.3	Ensure sufficient space is provided underneath for free flow of air and also for lifting, jacking etc..		Visual	do	do	Verify			

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1.31	Ensure in case of gas filled storage the dry nitrogen gas cylinder shall be available of manufacturer specification.		Visual	do	do	Verify			
1.32	Ensure if the pressure of gas inside the tank in case of gas filled storage drops due to leakage, the leakage point should be detected by using soap water. The matter shall be reported to the manufacturer for immediate action.		Visual	do	do	Verify			Report immediately to Project Manager
1.33	Ensure that, if the oil leakage is present in transformer tank while received and it is not possible to rectify the leak immediately , the transformer must be made as water tight as possible by putting a tarpaulin sheet over the whole tank until remedial measures can be carried out.		Visual	do	do	Verify			Report immediately to Project Manager
2.00	**PRE-INSTALLATION**								
2.01	Check name plate details of the transformer with drawing.		Visual	do	GA Drawing	Verify			
2.02	Check size & type of hardware / accessories required as per the drawing / BOQ.		Visual	do	GA Drawing/ Packing List	Verify	Witness		
2.03	Ensure that no physical damage to trafo body / bushing etc. is observed.		Visual	do	No damages	Verify	Witness		
2.04	Ensure that no oil leakage is observed, oil level is OK and drain / sampling valves is tightly dosed.		Visual	do	No leakages	Verify	Witness		
2.05	Check Matching of rails / wheels of trafo, and mounting foundation.		Visual	do	GA Drawing	Verify	Witness		

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2.06	Handling Tools: crane Capacit 5 to 10T sling and shackles for lifting ,Pulling Winches/Pulleys, Hydraullic / Mechanical Screw Jacks with locking facility ,Wooden Sleepers, Measuring Tape, Spirit Level/Level tube(Plastic).Oil storage tank of sufficient capacity,Oil Purifier, Flexible hoses, Water profv\ sheets,Venyl Hose, Hose Nipple, CTC,Rag cotton cloth, Unstarched Mill Cloth, Knife etc. Electrical Tools: Megger 5KV,2KV,500V,Multimeter,Electric Hand Lamp, Oil testing equipment etc.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
2.07	Ensure that foundation for mounting the transformer has been rigidly constructed with wheel stopper etc.		Visual	do	Foundation civil drg.	Verify	Witness		
2.08	Ensure the dragging passage and movement area of transformer tank is clear from any free movement obstructions.		Visual	do	_	Verify			
3.00	INSTALLATION								
3.01	Ensure while unloading from the Trailer/ Waggon lift the main body of the transformer with Jacks, slipper and winches. Each Jacks capacity may be rated for approximately 50% weight of transformer with oil. DO NOT APPLY ANY DIRECT HORIZONTAL PUSHING LOAD TO TRANSFORMER TANK.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.02	Ensure unloading must be done without any jerking movements or dropping.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.03	Ensure use only slinging hooks/ bollards for lifting.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			

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3.04	Ensure if the foundation of the transformer is not ready and if the transformer is to be unloaded temporarily, it should be done on a leveled hard surface/ wooden slippers preferably , under base of the transformer, should not rest on the ground.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.05	Ensure that 300 to 400 mm wooden sleepers to facilitate jacking.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify	Witness		
3.06	Ensure when jacking (e.g. to remove steel plates), position the jacks under specified jacking pads only. When jacking, ensure that all four jacks are operated simultaneously.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.07	Ensure if the transformer is not provided with rollers and if it is to be erected on its skid base, the transformer must be slid to its final position using greased steel plates.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.08	Ensure before lowering, clean all grease dirt etc. from the under base of the transformer.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.09	Check that transformer rests securely on foundation and wheels are anchored and welding of stoppers to rails.		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.10	Check and ensure that level of all the foundations for cooler support are in the same level as that of the top surface of rails. Level difference should be compensated by putting shims if the level is lower and chipping the concrete foundation if the level is higher.		Measurement	do	Manufacturer Manual/Drawing	Verify			

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3.11	Ensure cooler Assembly should be carried out referring to "GENERAL ARRANGEMENT" and "PART MARKING DRAWING" of the transformer.		Visual	do	Manufacturer Manual /Drawing	Verify			
3.12	Ensure all items of pipe work are match marked.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.13	Ensure that all accessories belong to the same unit. Indent No., Unit No. and Serial number		Visual	do	Manufacturer Manual/Drawing	Verify			
3.14	Ensure all joints are to be assembled with gasket only and without using compound or grease.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.15	Check Top and bottom butterfly valves of each radiator should be in the same vertical line. This should be confirmed by a plumb.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.16	Check and ensure while mounting oil pump and oil flow indicators, care should be taken to ensure that arrows indicating oil flow direction are towards the transformer tank.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.17	Check and ensure the mounting of the conservator as shown in G.A. drawing.		Visual	do	G.A. Drawing	Verify			
3.18	Check and ensure the mounting of all valves as shown in GA drawing on the conservator		Visual	do	G.A. Drawing	Verify			
3.19	Check and mount the Air cell in conservator as per Manufacturer Manual instruction.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.20	Ensure direction of Buchholz Relay by the direction of arrow on Buchholz Relay towards conservator.		Visual	do	G.A. Drawing	Verify			

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3.21	Ensure the mounting of silica gel breathers for main and OLTC conservators.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.22	Check and Mount PRD as per manufacturers leaflet and also the G.A. drawing of Transformer.		Visual	do	G.A. Drawing	Verify			
3.23	Ensure turret installation (w.r.t match mark & orientation) prior to bushing installation.		Visual	do	G.A. Drawing/Matching Mark.	Verify			
3.24	Ensure before starting the erection work of Condenser Bushing, lift the Bushing from its crate and keep it vertical and check the oil level. Confirm that oil level is upto the centre of oil sight window of Bushing		Visual	do	Manufacturer Manual/Drawing	Verify			
3.25	Ensure if weather is bad (rain, snow or fog) the tank should not be opened unless adequate shelter is provided.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.26	Ensure for details of connections from winding to the bushing refer to the specific drawing and suppliers catalogue given in the instruction manual.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.27	Ensure that a fresh gasket is used while mounting the bushing		Visual	do	Manufacturer Manual/Drawing	Verify			
3.28	Ensure that the air release pipe connections are oriented towards the correct directions, as shown in the GA and part marking drawings.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.29	Ensure while mounting the bushings, ensure that the oil level gauge is oriented away from the transformer.		Visual	do	Manufacturer Manual/Drawing	Verify			

3.30	Check and ensure that secondary terminals of turret mounted C.T. if any, are connected to the proper terminals on the terminal board.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.31	Check before mounting the thermal sensing bulbs, inside of the pocket should be cleaned thoroughly and filled with transformer oil upto a depth of half the pocket.		Visual	do	G.A. Drawing	Verify			
3.32	Ensure Capillary tubes should be clamped properly.		Visual	do	G.A. Drawing	Verify			
3.33	Ensure that a minimum capacity of oil filltartion machine should be of 6000 litres per hour .		Visual	do	Standard engg. Practice/Supplier Recommendation	Verify			
3.34	Before oil filtration that Check and ensure bottom filter valve shall be attached to inlet point of filter machine and top filter valve of transformer shall be attached to outlet of vacuum filter machine.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.35	Ensure quality of transformer oil must be checked before it is filled into the transformer.		Visual	do	Sepcs / IS.	Verify			
3.36	Ensure Oil samples should be taken from 5 drums at random. Samples should be collected from the bottom of the drums.		Visual	do	Sepcs/ IS.	Verify	Witness		
3.37	Check Oil should be tested for breakdown voltage .		Measurement	do	Sepcs/ IS.	Verify			
3.38	Ensure if oil does not meet the specified criteria, oil should be filtered and stored in the oil storage tank before filling in to the transformer.		Visual	do	Manufacturer Manual/Drawing	Verify			

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3.39	Ensure the bottom filter valve is open on the transformer and top air release valve is open on the oil storage tank.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.40	Ensure the filter outlet temperature should be limited to 60-70 °C.		Visual	do	Manufacturer Manual	Verify			
3.41	Ensure Oil level shall be continuously monitored during oil filling.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.42	Ensure results of oil tests and insulation resistance together with the temperatures at the time of measurement should also be recorded in the log sheet.		Visual	do	Specs/Standard engineering practice	Verify			
3.43	Check all air release plugs shall be loosened and closed after releasing trapped air if any.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.44	Check for mechanical stops of OLTC at extreme positions by manually operating with the handle.		Visual	do	Manufacturer Manual/Drawing	Verify	Witness		
3.45	Check raise/lower operations, if direction is correct, check electrical end stops at extreme positions.		Operational	do	Manufacturer Manual/Drawing	Verify	Witness		
3.46	Ensure coupling up of drive mechanism and OLTC bevel gear shall be done only after ensuring that the DM and the tap changer are at the same tap position.		Visual	do	G.A. Drawing	Verify			
3.47	Check and confirm that for each impulse given in both raise and lower directions, diverter switch operation sound is heard before the motor stops.		Operational	do	Manufacturer Manual/Drawing	Verify			
3.48	Ensure that before commencing the test it should be ensured that the secondary terminals of all current transformers are		Visual	do	Standard engineering practice	Verify			

	kept short-circuited. After test these shorting connections shall be removed.								
3.49	Check and confirm tightness of all fasteners.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.50	Check and confirm that valves are either open or closed as indicated the valve schedule plate.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.51	Check all bolted gasket joints and confirm that there is no oil leak.		Visual	do	Standard engineering practice	Verify			
3.52	Check all blanking plates and spares including spare gasket should be stored carefully for future use.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.53	Check all cable terminations and ensure that cables are properly connected and cable numbering ferrules are provided.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.54	Check and ensure that all protective covers like valve guards, LV bushing protection covers etc. are removed.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.55	Check and confirm that all bushing porcelain are cleaned thoroughly and are without damage.		Visual	do	Standard engineering practice	Verify			
3.56	Ensure removal of the cap provided at the bottom of silicagel breather for the transportation purpose.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.57	Check arcing horns if provided are set to the specified gap		Visual	do	Specs/Standard engineering practice	Verify			
3.58	Check all earthing connections are tightened properly.		Visual	do	Specs/Standard engineering practice	Verify			

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3.59	Check anti condensation heaters are functioning correctly.		Visual	do	Manufacturer Manual/Drawing	Verify			
3.60	Ensure Rating and connection diagram plates and other marking labels are fitted properly.		Visual	do	Manufacturer Manual/Drawing	Verify			
4.00	**TESTING**								
4.01	Check and record insulation resistance between pair of windings and windings and earth using 5 kV megger and record.	Megger	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.02	Check and record the Ratio tests.	Ratio meter /Multimeter	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.03	Check and record the Vector group tests.	Multimeter	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.04	Check and record the Magnetic balance test.	Multimeter	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.05	Check and record the Magnetising current test.	Multimeter	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.06	Check and record the Winding resistance test.	Micro ohm Meter	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.07	Check and record the Operation checks of pumps and fans,flow indicators ,circuits for pump.		Visual	do	Factory Test Report/Specs	Verify	Witness		
4.08	Check and record the Operational test Tap changer Equipment,Cooling Equipment	Multimeter	Visual	do	Factory Test Report/Specs	Verify	Witness		
4.09	Check and record the Oil BDV .	BDV Tester/Certified Lab	Measurement	do	Factory Test Report/Specs	Verify	Witness		

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4.10	Check and record the CT test of bushing and neutral CT		Current Injection kit	Measurement	do	Factory Test Report/Specs	Verify	Witness		
4.11	Ensure after the inspection and precommissioning tests are successfully completed the transformer can be energized at no load for 24 hrs.			Visual	do	Standard engg. Practice/Supplier Recommendation	Verify	Witness		
4.12	Ensure that after watching the operation of the transformer at no load for 24 hours and confirming that everything is normal the transformer shall be put on load.			Visual	do	Standard engg. Practice/Supplier Recommendation	Verify	Witness		
4.13	Ensure that a joint inspection has been conducted by Client/ contractor / site engineer and a protocol jointly signed by both the parties.			–	do	–	Verify	Witness		
4.14	Ensure that complete site as built drawings / documents along with test reports & reconciliation report have been handed over to Client/Projects/engineering & receipt obtained.			–	do	–	Verify	Witness		
4.15	All test will be done as per technical specification/IS						Verify	Witness		
S.NO.	**Revision**	**Date**	**Legend**	**Contractor**		**Employer**				
1										
2										

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STANDARD FIELD QUALITY PLAN FOR PT-CVT										
S.NO	TITLE	CHARACTERISTICS/ ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPOSIBE AGENCIES		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
1	**RECEIPT**									
	Transportation documents	Gate pass, Excise duty,MDCC,LA	Visual	100%	Delivery Challan & Spec	Tender specification	Verify	Verify		
	Check the Technical Documents	Check the Availability of Factory test report , catalogues and operation manual	Visual	100%	Delivery Challan & Spec	Tender specification	Verify			
	Physical inspection of material	Check for any physical damage.	Visual	100%			Verify	witness		
		Check name plate details as per P.O	Visual	100%	Purchase order		Verify			
		Verify the case no. as per L.R.	Visual	100%	Manual Standard engg. Practice	Visual	Verify			
2	**Qualification of Manpower**	Hydra operator should have license	Visual	100%	Certificate	Visual	Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate	Visual	Verify			
3	**Unloding and storage**	Extra care to prevent damage on porcelain parts while unloading.	Visual	100%	No damage	Visual	Verify			
		Ensure that equipment is not	Visual	100%	Manual Standard	Visual	verify			

		lifted or handled using primary terminals			engg. Practice						
		Ensure that the material is stored on raised wooden platform/ Planks to avoid direct contact with ground/ Moisture	Visual	Once in a month.	Manual Standard engg. Practice	Visual	verify	Witness			
		Ensure that the material is stored in systematic manner for easy removal / Usage.	Visual	do	do	Visual	verify				
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	do	do	Visual	verify				
		Ensure that all hardware are tagged & kept separately in racks/ in Bags size-wise for easy identification	Visual	do	do	Visual	verify				
		When stored in unpacked condition, store in such a way	Visual	do	do	Visual	verify				

		that the gauge glass is prevented from possible damage								
4	**Pre installation**	Check name plate details of the PT-CVT with drawing.	Visual	100%	Drawing / BOQ	Visual	verify			
		Check size & type of hardware / accessories required as per the drawing / BOQ	Visual	do	do	Visual	verify			
		Ensure that no physical damage to PT-CVT body / bushing etc. is observed.	Visual	do	do	Visual	verify	Witnes s		
		Ensure that no oil leakage is observed, oil level is OK and drain / sampling valves is tightly Closed.	Visual	do		Visual	verify			
		Check Matching of structure / PCD hole on PT-CVT, and mounting foundation	Visual	do	GA Drawings	Visual	verify			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of In. transformer etc.	Visual	do	Manual Standard engg. Practice	Visual	verify			

		Ensure that foundation for mounting the PT/CVT has been rigidly constructed.	Visual	do	Civil foundation Drg.	Visual	verify	Witness		
5	**Installation**	Ensure that In.Transformer is always lifted using lifting hooks only and not from bushings etc.	Visual	do	Instruction Manual	Instruction Manual	verify			
		Ensure that the PT/CVT is not tilted during lifting.	Visual	do	do		verify			
		Ensure the orientation of primary and secondary terminals (P1&P2) & secondary terminals.	Visual	do	Manual Standard engg. Practice	Manual Standard engg. Practice	verify			
		Check fixing nuts & bolts are properly tigthed immediately after placement on the structure.	Visual	do	do		verify			
		Check that sender line/vertical line of PT/CVT is correct.	Visual	do	do		verify			
		Ensure fixing of accessories / loose supplied / Terminal Connector items if any.	Visual	do	Packing List		Verify			

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		Ensure secondary terminations and earthing connection to earth are done using correct size of lugs / glands / stips/Connectors.	Visual	do	Specs		verify			
		Ensure oil level maintained as recommended.	Visual	do	Manufactures Manual		verify			
		Check verticality / alignment of PT/CVT.	Visual	do	GA Drawing.		verify			
6	**Testing**	General Checks as mention in check list	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	verify	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	verify	Witness		

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S.No.	Revision	Date	Legend	**Contractor**		**Employer**					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR CURRENT TRANSFORMER(CT)										
S. NO.	TITLE	CHARACTERISTICS/ ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPONSIBLE AGENCIES		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
	RECEIPT									
1	**Check the transportation documents**	Gate pass, Excise duty ,MDCC,LR	Visual	100%	Delivery Challan & Packing List	Availability	Verify	Verify		
	Check the technical documents	Check the availability of Factory test report ,catalogues and operation manual	Visual	100%	Packing List / BOQ	Availability	Verify			
	Physical inspection of material	Check for any physical damage.	Visual	100%			Verify	Witness		
		Check name plate details as per P.O	Visual	100%			Verify			
		Verify the case no. as per L.R.	Visual	100%	No damages & No leakage	No damage	Verify			
2	**Qualification of Manpower**	Hydra operator should have valid license.	Visual	100%	Certificate		Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate		Verify			
3	**Unloading and storage**	Ensure extra care to prevent damage on porcelain parts while unloading	Visual	100%	do		Verify			

		Ensure that equipment is not lifted or handled using primary terminals	Visual	100%	do		Verify			
		Ensure that the material is stored on raised wooden platform/ Planks to avoid direct contact with ground / Moisture.	Visual	Once in a month	Packing List / BOQ	Packing List / BOQ	Verify			
		Ensure that the material is stored in systematic manner for easy removal / Usage.	Visual	100%	do		Verify			
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	100%	do		Verify			
		Ensure that all hardware are tagged & kept separately in racks/ in Bags size-wise for easy identification	Visual	100%	do		Verify			
		Ensure Tarpaulin covers have been provided if required .	Visual	100%	do		Verify			
		When stored in unpacked condition, store in such a way that the gauge glass is prevented from possible damage	Visual	100%	do		Verify			

		Check Matching of structure / PCD hole on CT, and mounting foundation	Visual	do	GA Drawings		Verify			
		Ensure that foundation for mounting the CT has been rigidly constructed.	Visual	do	Civil foundation Drg.		Verify			
		Check size & type of hardware / accessories required as per the drawing / BOQ	Visual	do	do		Verify			
4	**Pre Installation**	Ensure that no physical damage to CT body / bushing/bellows etc. is observed.	Visual	do	No Damages.		Witness	Witness		
		Ensure that no oil leakage is observed, oil level is OK and drain / sampling valves is tightly Closed.	Visual	do	Manufacture s Manual		Witness			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of In. transformer etc.	Visual	do	Manufacture s Manual		Verify			
		Ensure that Current Transformer is always lifted using lifting hooks only and not from bushings etc.	Visual	do	Instruction Manual		Verify			
5	**Installation**	Ensure that the CT is not tilted during lifting.	Visual	do	do		Verify			

		Ensure the orientation of primary and secondary terminals (P1&P2) & secondary terminals.	Visual	do	Erection Drawing		Verify			
		Check fixing nuts & bolts are properly tigthed immediately after placement on the structure.	Visual	do	Manufacture s Manual		Verify			
		Check that center line/vertical line of CT is correct.	Visual	do	do		Verify			
		Ensure fixing of accessories / loose supplied / Terminal Connector items if any.	Visual	do	Packing List		Verify			
		Ensure secondary terminations and earthing connection to earth are done using correct size of lugs / glands / stips/Connectors.	Visual	do	Specs		Verify			
		Ensure that touch up paint has been applied where ever peeled off.	Visual	do			Verify			
		Ensure oil level maintained as recommended.	Visual	do	Manufacture s Manual		Verify			
		Ensure unused secondary cores, if any, have been shorted.	Visual	do	Manufacture s Manual		Verify			

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6	**Testing**	General Checks as per STR	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Witness	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Witness	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Witness	Witness		

S.No	**Revision**	**Date**	Legend	Sub Contractor		Client				
1										
2										

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STANDARD FIELD QUALITY PLAN FOR ISOLATOR											
Standard Field Quality Plan for ISOLATOR											
S.NO	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPONSBILE AGENCY			FORMAT OF RECORDS	REMARKS
							Contractor	Consultant	Employer		
1	**RECEIPT**										
	Check the transportation documents	Gate pass, Excise duty doc ,MDCC,LR etc.	Visual	100%	Delivery Challan & MDCC	Delivery Challan & MDCC	Verify	Witness	Verify		
	Verify the technical Documents	Check the availability of Factory test report ,catalogues and operation manual.	Visual	100%	Delivery Challan & MDCC	Delivery Challan & MDCC	Verify	Witness			
	Physical inspection of material;	Check supply of accessories like tandem pipes / Insulators / Mechanism box / fixing hardware / any connectors etc. as applicable.	Visual	100%	Packing list/BOQ	Packing list/BOQ	Verify	Witness			
		Visual examination for damage.	Visual	100%	No Damages	No Damages	Verify	Witness	Witness		
2	**Qualification of Man power**	Hydra operator should have license.	100%	100%	Certificate		Verify	Verify			
		Fitter and Technician should be have relevant experience.	100%	100%	Certificate		Verify	Verify			

3	**Unloading and Storage**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Manual / Standard engg. Practice	Instruction Manual / Standard engg. Practice	Verify	Witness			
		Ensure that the material is stored in a systematic manner rating wise for easy removal & Tarpaullin cover is to be provided when kept exposed if required .	Visual	100%	do	do	Verify	Witness			
		Ensure that different accessories / loose supply material are stored separately , section and size wise labelled and tagged for easy identification	Visual	do	do	do	Verify				
		When stored in unpack condition care shall be taken to ensure match pole and mechanism are together.	Visual	do	do	do	Verify				
4	**Pre installation**	Check material is complete as per the BOQ / drawing	Visual	100%	Packing list/BOQ	Packing list/BOQ	Verify				
		Check size & type of hardware as per the drawing / BOQ.	Visual	100%	Packing list/BOQ	Packing list/BOQ	Verify				

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		Check the overall dimensions/ Lay Out with foundations.	Visual	100%	GA Drawing	GA Drawing	Verify				
		Check Matching of foundation bolts / holes.	Visual	100%	Civil foundation drawings		Verify				
		Check all bearings are smooth & no contact jaw springs are loose.	Visual	100%	Instruction Manual		Verify				
		Ensured that lifting facility of suitable capacity is available.	Visual	100%	Instruction Manual	Instruction Manual	Verify				
		Ensured that proper tools and tackles are available.	Visual	100%	Instruction Manual	Instruction Manual	Verify				
		Check the verticality/Alignment of support structure.	Visual	100%	Instruction Manual	Instruction Manual	Verify	Witness			
5	**Installation**	Check mounting levels are correct.	Visual	do	As per instruction Manual	As per instruction Manual	Verify	Verify			
		Check the Vertical & Horizontal alignment of base frame before erection.	Visual	do	GA Drawing	GA Drawing	Verify	Witness			
		Check the proper installation & alignment	Visual	do	do	do	Verify				

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		of MOM box.									
		Check the functioning of operating lever system and adjustment of drive coupling .	Visual	do	As per instruction Manual		Verify				
		Check the contact engagement and its synchronization.	Visual	do	do		Verify				
		Check Proper operation of Limit & auxiliary switch, mechanical interlock between Isolator & earth switch.	Measure ment	do	do		Verify				
		Check glanding & tightness of the cables in the marshalling box.	Visual	do	do		Verify				
		Check Phase to phase and phase to earth clearance of poles.	Visual	do	GA Drawing		Verify				
		Check Earthing of Isolators as per Drawing .	Visual	do	do		Verify	Witness			
		Check direction of earth switch.	Visual	do	Erection Drawing.		Verify				
		Proper tightening of insulator fixing bolts and provision for washer at	Visual	do	As per instruction Manual		Verify				

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		all places.									
		Cleanliness of insulator surface	Visual	do			Verify				
		Check Provision of cable /core Identification tags & ferrules.	Visual	do	Cable Schedule		Verify				
		Check Cable termination and tightness & sealing of unused holes.	Visual	do	As per instruction Manual		Verify	Verify			
6	**Testing**	General Checks as per STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness			
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness			

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S.No	**Revision**	**Date**	**Legend**	**Contractor**		**Employer**						
1												
2												

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STANDARD FIELD QUALITY PLAN FOR HT/LT WORKS											
					Issued on :						
Name of document :- FQP FOR HT/LT BUSDUCT WORKS					**Rev :**						
Name of Employer:-					**FQP ref. No. FQP/ELECTRICAL/HT-LT-BUSDUCT/06**						
Name of project:-					**Doc No:**						
Name of contractor:-											
Standard Field Quality Plan for HT/LT BUSDUCT											
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**			**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Consultant**	**Employer**		
	RECEIPT										
1	**Check the transportation documents**	Gate pass, Excise duty,MDCC, LR.	Visual	100%	Delivery Challan & MDCC	Availability	Verify	Verify	Verify		
	Verify the technical Documents	Check the scheme drawing /GA drawing	Visual	100%	Packing list	Tender specification	Verify	Verify			
	Physical inspection of material	Visual examination for damage	Visual	Random	Manual	No Damage	Verify	Verify	Witness		

2	**Qualification of Manpower**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify	Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate	Availability	Verify	Verify			
3	**Unloading and Storage**	Ensure that the material is stored on raised wooden platform / Plank to avoid direct contact with ground / Moisture	Visual	100%	Instruction manual /Standard Engg. Practice	Availability	Verify	Verify	Verify		
		Ensure that the material is stored in systematic manner rating wise for easy removal	Visual	100%	Manual	Availability	Verify				
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	100%	do		Verify	Verify			
		Keep the Bus Duct indoor and avoid any kind of wet condition in the premises.	Visual				Verify				
		Ensure that all hardware are tagged & kept separately in racks size-wise for easy identification	Visual	100%	do		Verify				
4	**Pre Installation**	Check for inspection agency stamp	Visual				Verify	Verify			
		Ensure the bus duct entry with civil drawing	Visual				Verify				

		Ensure that the contact surface of busbar, busbar bolts and nuts shall be thoroughly cleaned with petrol and wiped petroleum jelly.	Visual				Verify				
		check the levelling and verticality of the bus duct	Visual				Verify	Verify			
		Check the busbar, flexiable Connector , hardware as per drawing etc.	Visual	100%	Drawing/Boq		Verify	Verify			
		Check size & type of hardware / accessories required as per the drawing / BOQ	Visual	100%	do		Verify				
		Ensure that no physical damage to HT/LT BUSDUCT body /insulator etc. is observed.	Visual	100%	No Damages.		Verify	Verify	Witness		
		Check the allocated bus duct position and dimesion are correct and the access toward the HT/LT busduct free from blockage	Visual	100%	GA drawing		Verify				
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of HT/LT busduct etc.	Visual	100%			Verify				

		Check work area clean and safe	Visual				Verify				
5	**Installation**	Ensure that opening in the wall where the busducts enter the switch gear room shall be completely sealed to avoid rain water entry.	Visual				Verify				
		check the colour coding of the busbar	Visual				Verify				
		Ensure the tightness of the bolts and nuts.	Visual				Verify				
		Carry out the final check on the correct positon of the HT/LT bus duct support frame and anchor it to the celing / wall with the aid of the anchore fastener	Visual	do	GA DRAWING	GA DRAWING	Verify				
		Erect the different section of the HT/LT busduct with the rope / chain pully system	Visual	do	GA DRAWING	GA DRAWING	Verify				
		Ensure the jointing of different section of HT/LT bus duct in the specified sequence as per drawing. .	Visual	do	GA DRAWING	GA DRAWING	Verify				

		Check the alingment and couple the section of bus duct as per drawing.	Visual	do	GA DRAWING	GA DRAWING	Verify				
		Ensure the cleanliness of bus bar and insulator after erection	Visual	do	As per Instruction Mannual		Verify	Witness	Witness		
6	**Testing**	Routine Tests are as per Technical specification.	Visual	100%	specification		Verify	Witness	Witness		
		General Checks as mention in check list	Visual	100%	As per Instruction Manual	As per Instruction Manual	Verify	Witness	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness	Witness		

S.No.	Revision	Date	Legend	Contract	Consultant	Employer						
1												
2												

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STANDARD FIELD QUALITY PLAN FOR EARTHING WORKS									
Standard Field Quality Plan for Earthing Works									
S.NO.	**CHARACTERISTICS/ITEM**	**INSTRUMENT**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**Responsible Agencies**		**FORMAT OF RECORDS**	**REMARKS**
						Contractor	**Employer**		
1	**RECEIPT AND STORAGE**								
1.1	**RECEIPT OF MATERIALS**								
1.11	Check for manufacturer's name as per Purchase Order identification punch mark/Detail as per the test certificates/Delivery Challan.		Visual	100%	Delivery Challan & Packing List	Verify	Verify		
1.12	Check for MDCC issued by Customer/Consultant/AREVA.		Visual	do	MDCC	Verify	Verify		
1.13	Check for visual damage/Cracks in earth electrodes/pipe/flats/shiled wire etc.		Visual	do	No Damages	Verify	Verify		
1.14	Check for dimensions and class/duty of earth electrodes/pipe/flat/hardware/shield wire etc.		Measurement	do	Spec/BOQ	Verify	Verify		
1.15	Check for proper galvanisation and finishing of all parts of earthing system including hardware.		Visual	do	do	Verify	Verify		

1.2	**STORAGE OF MATERIALS**								
1.21	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground/moisture		Visual	Once in 3 months	Instruction Manual/standard engg. Practice	Verify	Verify		
1.22	Ensure that the material is stored in systematic manner for easy removal		Visual	Once in 3 months	do	Verify			
1.23	Ensure that different members of material are stored separately section and size wise labelled and tagged for easy identification		Visual	Once in 3 months	do	Verify			
1.24	Ensure that all hard ware kept separately in racks size-wise for easy identification		Visual	Once in 3 months	do	Verify			
2	**INSTALLATION**								
2.01	Excavation of earth pits upto required depth and the number of pits		Visual	100%	Drgs./Spec/IS	Verify			
2.02	Check for proper salt and charcoal layering in case of treated earth pit.		Visual	100%	do	Verify			
2.03	Check for quality of masonary, brickworks and cover plate for the earth chamber.		Visual	100%	do	Verify			
2.04	Check for burial depth of Electrodes.		Visual	do	do	Verify			

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2.05	Check for burial depth of earthman.		Visual	do	do	Verify			
2.06	Check for size, overlap, welding quality of the earth riser.		Visual	do	do	Verify			
2.07	Check for ovarlap of joints		Visual	do	do	Verify			
2.08	Check for Usage of proper electrodes for welding		Visual	do	do	Verify			
2.09	Ensure that all earth strips are cut & drilled using proper tools like Hexsaw/drill machine etc and not by welding machine.		Visual	do	do	Verify			
2.10	Check for Proper application of protective bituminous tape /paint		Visual	do	do	Verify			
2.11	Check for Earth pits are properly prepared for electrodes		Visual	do	do	Verify			
2.12	Check for Earthing of structure/Poles		Visual	do	do	Verify			
2.13	Check for Clamping/support of earth flats		Visual	do	do	Verify			
2.14	Check for Earthing of cable supports		Visual	do	do	Verify			
2.16	Check for Earthing of fence and gates (at every 10 mtrs.		Visual	do	do	Verify			

2.17	Check for Earthing of all equipment structure		Visual	do	do	Verify			
2.18	Ensure that all outdopr HT & LT equipment like transformer, circuit breaker,CTs,PTs,isolator (with or w/o earth switch),LAs,cable trays etc. have been provided with double earthing.		Visual	do	do	Verify	Verify		
2.19	Ensure that all indoor HT & LT equipment like Swithgear panels, ACDBs, DCDBs, battery racks,if Applicable charger panels, capacitor panel, cable trays etc. have been provided with double earthing.		Visual	do	do	Verify			
2.20	Ensure that shield wire of the grid has been properly earthed at every tower.		Visual	do	do	Verify			
3	**TESTING**								
3.01	General inspection		Visual	do	SPEC/Drg/IS	Verify	Witness		
3.02	Individual Earth electrode Resistance Measurement	Earth Megger	Measurement	do	do	Verify	Witness		

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3.03	Total Earth Grid resistance measurement	Earth Megger	Measurement	do	do	Verify	Witness		
3.04	All tests will be done as per technical specification			do	specification	Verify	Witness		
3.05	Final document review		Visual	do		Verify	Witness		

STANDARD FIELD QUALITY PLAN FOR HT PANELS

Standard Field Quality Plan for HT Panel.

S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	Acceptance Norms	Responsible Agencies			FORMAT OF RECORDS	REMARKS
							Contractor	Consultant	Employer		
1	**RECEIPT**										
	Check the transportation documents	Gate pass, Excise duty doc,MDCC,LR etc.	Visual	100%	Packing List / BOQ	Availability	Verify	Verify	Verify		
	Verify the technical Documents	Check the Availability cataloguesand operation manual	Visual	100%	Packing List / BOQ	Tender specification	Verify	Verify			
		Check the Factory test report,scheme Drawings /GA drawing	Visual	100%	Schematic drawing.		Verify				
	Physical inspection of material	Verify the no. of unit.,name plate	Visual	100%	Delivery Challan & MDCC		Verify				
		Verify any kind of damage ,scratch and	Visual	100%	Packing List / BOQ	No damage	Verify	Verify	Verify		

		unavailability of gasket.									
		verify the physical condition of selector switch ,toggel switch ,heater ,indication lamp etc.	Visual	100%	Invoice/Packing list/BOQ	Availability	Verify				
	Verify the technical specification Name plate	Verify the rating of BREAKER, CT ,BUSBAR,PT etc.	Visual	100%	Technical specification	conformance	Verify				
		Verify the size and length of BUSBAR	Visual	100%	Approved drg	conformance	Verify				
		Make sure that the Relay mounted on the panels are according to the designed protection scheme.	Visual	100%	Technical specification	conformance	Verify				
		Verify the range of meters.	Visual	100%	Technical specification	conformance	Verify				
		verify the range of auxiliary AC and DC supply	Visual	100%	Scheme Drawing Technical specification	conformance	Verify				
	Check the Availability of accessories	verify the availability of inter panel control wiring cable.	Visual	100%	Technical specification	conformance	Verify				
		verify the availability of CB rack in rack out and spring charge Handle	Visual	100%	Approved drg	Availability	Verify				

		verify the availability of grouting nut and bolt.	Visual	100%	Approved drg	Availability	Verify				
2	**Qualification of Man power**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify				
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate	Availability	Verify				
3	**Unloading and storage**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture	Visual	Once in a month	Instruction Manual/ Standard engg. Practice		Verify				
		Ensure that the material is stored in systematic manner for easy removal.	Visual	do	do	Proper Safety	Verify				
		Ensure that different accessories / loose supply material are stored separate section and size wise labelled and tagged for easy identification	Visual	do	do	Proper Safety	Verify				
		Ensure all the safty procaution at the time unloading of panels and Cubical and man.	Visual	do	do	Proper Safety	Verify				

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4	**Pre installation**	Visual inspection shall be done after unpacking	Visual				Verify				
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of HT Panel etc.	Visual	100%	Drawing	Availability	Verify				
		Check Matching of hole on HT Panel, and mounting foundation with layout plan.	Visual	100%	GA Drawing / BOQ	Availability	Verify				
		Ensure that avialbility of proper foundation / floor cut outs.	Visual	do	do	Availability	Verify				
		Ensure that no physical damage in Panel body /insulator etc. is observed.	Visual	do		Availability	Verify				
5	**Installation**	Check for inspection agency stamp	**Visual**			Availability	Verify				
		Lay out marking	**Visual**	100%	Floor level should be matched	As per drawing	Verify				

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		Fixing of Base Channel	**Visual**	do	Specification	As per drawing	Verify				
		Shifting the panel to location by the using Hydra Or manualy.	**Visual**	do	Drawing / BOQ	Availability	Verify				
		Grouting of panel to the base frame .	**Visual**	do	Specification	As per drawing	Verify				
		Fixing of Bus bar.	**Visual**	do	Alignment.	As per drawing	Verify				
		Assembling the panel components	**Visual**	do	Schematic drawing.	As per drawing	Verify				
		Cleanliness of the joint surface	**Visual**	do	Ensure	Cleanliness	Verify				
		Ensure that panel free from any kind of foreign particle	**Visual**	do	Standard engg. Practice	No foreign material	Verify	Verify			
		Tightness of Bus Bar Nut Bolt	**Visual**	do	IS Specification	Availability	Verify				
		NO live parts inside panel	**Visual**	do	Instruction Manual / Standard engg. Practice	Availability	Verify				

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		Earth connection to the panel Earth Bus	**Visual**	do	Standard engg. Practice	As per drawing	Verify				
		Sealing of any kind of unnecessary Hole and opening	**Visual**	do	Standard engg. Practice	No extra hole	Verify				
6	**Testing**	General Checks as STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness	Witness		
S.No	**Revison**	**Date**	**Legend**	**Contractor**		**Employer**					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR CIRCUIT BREAKER										
S.NO.	TITLE	CHARACTERISTICS / ITEMS	TYPE OF CHECK	QUANTUM / FREQUENCY OF CHECK	REF. DOC & ACCEPTANCE STANDARD	Acceptance Norms	Responsible Agencies		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
	RECEIPT OF MATERIALS									
1	**Check the transportation documents**	Gate pass, Excise duty, MDCC,LR etc.	Visual	100%	Delivery Challan & Packing List	Availability	Verify	Verify		
	Check the technical documents	Check the availability of Factory test report ,catalogues and operation manual.	Visual	100%	Packing List / BOQ	Availability	Verify			
	Physical inspection of material	Check for any physical damage.	Visual	100%	No damages		Verify	Verify		
		Check name plate details as per P.O	Visual	100%	Purchase order		Verify			
		Verify the case no. as per L.R.	Visual	100%	do		Verify			
2	**Qualification of Man power**	Hydra operator should have valid license.	Visual	100%	Certificate		Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate		Verify			

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		Each Crate/case has to be unloaded one by one only.	Visual	100%			Verify			
		Ensure hydra/Crane can be used for the unloading purpose and using marks provided on case.	Visual	100%			Verify			
		Ensure that the material is stored on raised wooden platform/ Planks to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Manual / Standard engg. Practice		Verify	Verify		
3	**Unloading & Storage**	Ensure that the material is stored in a systematic manner rating wise for easy removal / usage.	Visual	do	do		Verify			
		Ensure that different accessories / loose supply material are stored separately ,section and size wise labelled and tagged for easy identification.	Visual	do	do		Verify			
		Ensure that all hardware are tagged & kept separately in racks / in bags,size-wise for easy identification.	Visual	do	do		Verify			
		Ensure the SF6 gas cylinders shall be stored in Cap intact condition(provided for valve	Visual	do	do		Verify			

		protection) with valve fully closed and free from explosive environment.								
		Ensure Tarpaulin covers have been provided if required .	Visual	do	do		Verify			
		Ensure while in storage , on no account water shall enter the equipment.	Visual	do	do		Verify			
		Ensure Cu tube and ferrule, nipple, and fitting etc. to be stored together inside the room.	Visual	do			Verify			
		Check when stored in unpack condition care shall be taken to Ensure match pole and mechanism are togeather.	Visual	do	do		Verify			
4	**Pre Installation**	Ensure that the foundation for mounting CB cleared from civil works .	Visual	100%	Civil Construction clearance		Verify			
		Check size & type of hardware / Busbar coupling accessories required as per the drawing / BOQ	Visual	do	do		Verify			
		Ensure that no physical damage to CB body	Visual	do	NO Damages		Verify	Witness		

		/insulator etc.								
		Visual inspection shall be done after unpacking .	Visual	do			Verify	Witness		
		Ensure availbility of proper foundation and structure.	Visual	do	GA Drawing		Verify			
		Check Matching of structure / Holes on CB, and mounting foundation bolts	Visual	do	GA Drawing		Verify			
		Ensure availability of necessary tools &, tackles, crane/Hydra , sling for lifting of CB, Sealer Anabond, Circlip plier, Bolts&nuts, derrick pipes, support, wire brush, emer sheet etc.	Visual	do	As per instruction Manual		Verify			
		Ensure the placement position of the phases and orientation of breaker on foundation.	Visual	do	Erection Drawings		Verify			
		Check for inspection agency stamp/punch.	visual	do			Verify			
		Ensure the availability of drawings.	Visual	do	Erection key diagram, scchematic diagram.		Verify			

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5	**Installation**	Ensure the CB shall be gas filled & checked by manufacturer.	Visual	100%	As per instruction Manual/ Test report	As per instruction Manual/ Test report	Verify			
		Ensure that CB is always lifted using lifting hooks only and not from bushings etc.	Visual	100%	As per instruction Manual/ Test report	As per instruction Manual/ Test report	Verify			
		Ensure that the CB is not tilted during lifting.	Visual	do	do		Verify			
		Ensure to avoid giving jerk and the side seal does not hit anywhere	Visual	do	do		Verify			
		Check proper tightness of foundation nuts & bolts immediately after placement on the structure .	Visual	do	do		Verify			
		Check that center line and verticality of CB is correct and horizontal leveling.	Visual	do	do		Verify			
		Ensure once the links are attached, shall be tighten firmly with nuts and lock clips.	Visual	do	do		Verify			
		Ensure not to temper with the valve at any stage.	Visual	do	do		Verify			

		Check for mechanical indication to show open & close position.	Visual	do	do		Verify			
		Ensure fixing of accessories / loose supplied items if any.	Visual	do	do		Verify			
		Ensure top & bottom terminations and earthing connection to earth are done using correct size of lugs /strips / Connectors.	Visual	do	do		Verify			
		Ensure that touch up paint has been applied where ever peeled off.	Visual	do	do		Verify			
		Check the wiring diagram make the required connections	Visual	do	do		Verify			
		Check for any loose connections	Visual	do	do		Verify			
		Ensure to clean the joint surfaces of the the terminal adaptor with wire brush or emery sheet.	Visual	do	do		Verify			
6	**Testing**	General checks as per STR.	Visual	100%	As per instruction Manual	Availability	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		

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			Ensure that complete site as built drawings/ documents alongwith test reports, reconciliation report, MTC, MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		`
S.No.	Revision	Date	Legend	Contractor		Employer					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR CR PANEL										
S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPONSIBLE AGENCIES		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
1	**RECEIPT**									
	Check the transportation documents	Gate pass, Excise duty,MDCC,LR.	Visual	100%	Packing List / BOQ	Availability	Verify	Verify		
	Check the technical Documents	Check the availability of Factory test report,catalogues and operation manual.	Visual	100%	Packing List / BOQ	Availability	Verify			
		Check the scheme Drawings /GA Drawing	Visual	100%	Schematic drawing.	Availability	Verify			
		Keep the panels indoor and avoid any kind of wet condition in the premises.	Visual	100%			Verify			
	Physical inspection of material	Verify the no of unit	Visual	100%	Delivery Challan & MDCC		Verify			
		Verify the any kind of damage, scratch and availability of gasket	Visual	100%	Packing List / BOQ	No damage	Verify	Verify		
		verify the physical condition of selector switch, toggel switch, heater, indication lamp etc.	Visual	100%	Invoice/ Packing List/ BOQ	Availability	Verify			

	Verify the technical specification Name plate	Verify the rating of BREAKER, CT, BUSBAR, PT etc.	Visual	100%	Technical specification	conformance	Verify			
		Verify the size and length of BUSBAR	Visual	100%	Technical specification	conformance	Verify			
		Verify the proper insulation of BUS BAR	Visual	100%	Technical specification	conformance	Verify			
		Make sure the that Relay mount on the panels are according the designed protection scheme .	Visual	100%	Technical specification	conformance	Verify			
		Verify the Range of Auxiliary AC and DC supply.	Visual	100%	Technical specification	conformance	Verify			
		Verify the range of meters.	Visual	100%	Technical specification	conformance	Verify			
	Check the Availability of accessories	Verify the availability of inter panel control wiring cable.	Visual	100%	Technical specification	conformance	Verify			
		Verify the availability of CB rack in rack out and spring charge Handle	Visual	100%	Approved drg	Availability	Verify			
		Verify the availability of grouting nut and bolt.	Visual	100%	Approved drg	Availability	Verify			
2	**Qualification of Man power**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate	Availability	Verify			
3	**Quality of tools**	Crane/Hydra	Visual	100%		Availability	Verify			
		Chain Pulley	Visual	100%		Availability	Verify			

		Breaker Trolley	Visual	100%		Availability	Verify			
		Mobile Scaffold	Visual	100%		Availability	Verify			
		Welding machine.	Visual	100%			Verify			
4	**Unloading & Storage**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture	Visual	Once in a month	Instruction Manual / Standard engg. Practice	Instruction Manual / Standard engg. Practice	Verify	Verify		
		Ensure that the material is stored in systematic manner rating wise for easy removal	Visual	100%	do	Instruction Manual / Standard engg. Practice	Verify			
		Panels to be stored inside	Visual	100%			Verify			
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	do	do	Instruction Manual / Standard engg. Practice	Verify			
		Ensure that all hardware are tagged & kept separately in racks size-wise for easy identification	Visual	do	do		Verify			
5	**Pre Installation**	Check for inspection agency stamp/punch.	Visual	100%			Verify			
		Check size & type of hardware / accessories required as per the drawing / BOQ	Visual	100%	do		Verify			

		Ensure that availability of proper foundation and floor.	Visual	do	Civil Drawing		Verify			
		Check Matching of Hole on C&R Panel, and mounting foundation.	Visual	do	GA Drawings		Verify			
		Visual inspection shal be done after unpacking.	Visual	do			Verify			
		Check for indicating instruments mounted on panel.	visual	do			Verify			
		Check for inspection agency stamp/punch.	Visual	do			Verify			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of C&R Panel etc.	Visual	do	Instruction Manual / Standard engg. Practice		Verify			
		Ensure the availability of schemetic drawing of C & R panel.	Visual	do	Schematic Drawings		Verify			
6	**Installation**	check that panels are erected as per layout drawing.	Visual	100%	Layout drawing.					
		Check verticality of equipment on support structure & Leveling.	Visual	100%	Instruction Manual / Standard engg. Practice		Verify			
		Check the earth bus connection.	Visual	do	GA Drawings		Verify			
		Check for painting of base frame.	Visual	do			Verify			
		Check the completeness of supply.	Visual	do	Schematic Drawings	Schematic Drawings	Verify			

		Check the inter panel wiring.	Visual	do	Schematic Drawings		Verify			
		Ensure the proper dressing of panel wiring.	Visual	do	Properly Dressed		Verify			
		Ensure the glanding of external cables	Visual	do	Properly Glanding		Verify			
		Ensure the blanking of unused cable entry holes	Visual	do	GA Drawings		Verify			
		Ensure the proper sealing and locking arrangement of panel door.	Visual	do	GA Drawings		Verify			
7	**Testing**	General Checks as per STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		
S.No	**Revision**	**Date**	Legend	Contractor		Employer	Employer				

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STANDARD FIELD QUALITY PLAN FOR ACDB Panels										
S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPONSIBLE AGENCIES		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
1	**RECEIPT**									
	Check the transportation documents	Gate pass, Excise, MDCC, LR.	Visual	100%	Delivery Challan & MDCC	Availability	Verify	Verify		
	Check the technical documents	Check the availability catalogues, operation manual, Factory test report .	Visual	100%	Packing List / BOQ	Availability	Verify			
		Check the scheme Drawings/ GA Drawing	Visual	100%	Schematic drawing.	Availability	Verify			
	Physical inspection of material	Verify the No of unit			Packing List / BOQ		Verify			
		Check the quality of Paint and Sheet material of panel body	Visual	100%	Packing List / BOQ	Availability	Verify			
		Verify any kind of physical damage, scratch and availability of Gasket	Visual	100%	No damage	No damage	Verify	Verify		
		Verify the physical condition of the Selector Switch, Toggle Switch,	Visual	100%			Verify			

		Indication Lamp, Inspection Lamp etc.								
		Check the availability of Space heater, bakelite sheet and Inspection light	Visual	100%	GA drawing	GA drawing	Verify			
		Verify the size of the panel (Length and Breath)	Visual	100%	Packing List / BOQ		Verify			
	Verify the technical specification Name plate	Verify the ratings of Breaker ,Bus Bar, CTs, PTs Etc with the specification	Visual	100%	Technical specification	Availability	Verify			
		Verify the size of the Bus Bar with its current Ratings and short circuit Ratings and availability of Sleeve/ Epoxy paint	Visual	100%	Technical specification	As per drawing	Verify			
		Verify the proper insulation of Bus Bar	Visual	100%	Technical specification	As per drawing	Verify			
		Ensure that Relays mounted on the panels are according to designed protection Scheme	Visual	100%	GA drawing	GA drawing	Verify			
		Verify the Range of Meters	Visual	100%	Technical specification		Verify			

		Verify the Range of Auxiliary AC and DC supply	Visual	100%			Verify			
		Verify the availability of inter Panel control wiring Cable	Visual	100%	Schematic drawing.		Verify			
		Verify the availability of breaker Rack in Rack out and spring Charge Handle	Visual	100%			Verify			
2	**Qualification of Manpower**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should have relevant experience	Visual	100%	Certificate	Availability	Verify			
3	**Quality of Tools**	Crane/Hydra	Visual	100%		Availability	Verify			
		Chain Pulley	Visual	100%		Availability	Verify			-
		Breaker Trolley	Visual	100%		Availability	Verify			
		Mobile Scaffold	Visual	100%		Availability	Verify			
		Welding machine.	Visual	100%		Availability	Verify			

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4	**Unloding and Storage**	Ensure all the safety precautions at the time unloading of panels and Cubicle(Both man and material).	Visual	Once in a month	Instruction manual/ Standard engg. Practice	conformance	Verify			
		Use sling of proper size and quality during process of unloading.	Visual	100%	do	conformance	Verify			
		Keep the panels indoor and avoid any kind of wet condition in the premises.	Visual	100%	do	conformance	Verify			
5	**Pre installation**	Check for inspection agency stamp.	Visual				Verify			
		Check the availability of site.	Visual	100%	Drawing / BOQ	Availability	Verify			
		Verify the foundation of panel.	Visual	do	do	Availability	Verify			
		Ensure Proper Tools and Procedure for shifting and installation of panel.	Visual	do		Availability	Verify			
		Ensure all precautionary measure for man and material.	Visual	do		Availability	Verify			
		Verify the availability of all the accessories like Grouting Nut Bolt, Bus	Visual	do	Packing List	Availability	Verify			

		Bar ,connecting Nut Bolt,Founadtion Gasket.								
6	**Installation**	Check the lay out marking.	Visual	do	GA drawing	conformance	Verify			
		Ensure the fixing of Base Channel.	Visual	do	do	conformance	Verify			
		Ensure the shifting of panel to the location by using Hydra or Trailer with safety and precaution.	Visual	do	Manufacturer instruction manual	conformance	Verify			
		Ensure the grouting of panel to the base frame.	Visual	do	Manufacturer instruction manual	conformance	Verify			
		Check the assembling of panel components.	Visual	do	do	conformance	Verify			
		Ensure the fixing of Bus Bar.	Visual	do	Schematic drawing.	conformance	Verify			
		Ensure cleanliness of the joint surfaces .	Visual	do	Manufacturer instruction manual	conformance	Verify			
		Ensure that panel is free from any kind of foreign particle.	Visual		do	conformance	Verify			
		Check the tightness of Bus Bar nut bolt.	Visual		do	conformance	Verify			

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		Ensure the firm earth connection to the panel Earth Bus.	Visual	do	Earthing drg	conformance	Verify			
		check for any sctaches and apply touch up paint.	Visual				Verify			
		Ensure the sealing of any kind of unnecessary Holes and openings.	Visual	do		conformance	Verify			
7	**Testing**	General checks as per STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	As built drg/Schematic drawing.	Availability	Verify	Witness		

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S.No.	Revision	Date	Legend	Contract	Consultant	Employer					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR DCDB Panels										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
1	**RECEIPT**									
	Check the Transportation documents	Gate pass, Excise duty doc, MDCC,LR,etc.								
	Verify the technical Documents	Check the availability of Factory test report, catalogues and operation manual	Visual	100%	Delivery Challan & MDCC	Delivery Challan & MDCC	Verify	Verify		
		Check the scheme Drawings/ GA Drawing	Visual	100%	Packing List / BOQ	Delivery Challan & MDCC	Verify			
	Physical inspection of material	Verify the any kind of damage ,scratch and availability of gasket	Visual	100%	Delivery Challan & MDCC	Availability	Verify			
		verify the physical condition of selector switch ,toggel switch ,heater ,indication lamp etc.	Visual	100%	Packing List / BOQ	Availability	Verify	Verify		
2	**Qualification of manpower**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should have relevant experience	Visual	100%	Certificate	Availability	Verify			
3	**Unloading and storage**	Keep the panels indoor and avoid any kind of wet condition in the premises	Visual	100%			Verify			

		Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture	Visual	Once in a month	Instruction manual Standard engg. Practice	Availability	Verify	Verify		
		Ensure that the material is stored in systematic manner rating wise for easy removal	Visual	100%	do		Verify			
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	do	do		Verify			
4	**Pre installation**	Check for inspection agency stamp/punch.	Visual	100%			Verify			
		Check name plate details of the DCDB Panel with drawing / BOQ	Visual	100%	GA Drawing / BOQ	GA Drawing / BOQ	Verify			
		Ensure that availability of proper foundation and floor.	Visual	do	Civil layout drawing		Verify			
		Check matching of floor / Hole on DCDB Panel, and mounting foundation.	Visual	do	GA Drawings	GA Drawings	Verify			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of DCDB Panel etc.	Visual	do	Instruction manual/ Standard engg. Practice		Verify			

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5	**Installation**	Ensure that base channels shall be grouted	Visual	do	layout drawing		Verify			
		Bolt tightness checking of panel with base frame in case of bottom entry of cables	Visual				Verify			
		Check the lubrication of moving part	Visual				Verify			
		Check the Earth bus connection at two different point	Visual	do	Schematic drawing.	Availability	Verify			
		Ensure that power and control cables are terminated with proper ferruling	Visual	Random	do	Availability	Verify			
		Ensure correct sizes of cable are used and properly tagged.	Visual	do	do	Availability	Verify			
		Check healthiness of fuses, links, MCBS, Switches, indication lamps, push buttons, space heater & illumination circuit.	Visual	do	Instruction manual/ Standard engg. Practice	Availability	Verify			
		Check the wires are dressed & routed properly.	Visual	Random	_	Availability	Verify			
		Check the metering circuit.	Measurement	do	do		Verify			
		Check the polarity of shunt, ammeter, voltmeter etc.	Measurement	do	do		Verify			
		Check space heater for continuity .	Measurement	do	do		Verify			
		Check indicating lamps' rating and their circuits and ensure their colours are in order.	Visual	do	do		Verify			
		Check door alignment.	Visual	do	do		Verify			

			Check door lock facility.	Visual	do	_		Verify			
			Check cleanliness of the board.	Visual	do	_		Verify			
			Check function of all switch fuse units.	Visual	do	_		Verify			
			Checked for broken glass, switch handle, lamp cover elc.	Visual	do	_		Verify			
			Ensure blanking of unused cable entry holes.	Visual	do	GA Drawing		Verify			
			Ensure proper sealing and locking arrangement of panel door.	Visual	do	GA Drawing		Verify			
			Check that the relays and meters are flush mounted on the front of the panels.	Visual	do	GA Drawing		Verify			
6	**Testing**		General Checks as per STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
			Routine Tests are as per Technical specification.	Testing	100%	Technical Specification	Availability	Verify	Witness		
			Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		
S. No.	**Revision**	**Date**	**Legend**	**Contractor**		**Employer**	**Client**				
1											
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STANDARD FIELD QUALITY PLAN FOR AL BATTERY CHARGER										
Standard Field Quality Plan for Battery Charger Panel.										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
	RECEIPT									
1	**Transportation Documents**	Gate pass, Excise duty, MDCC,LR.	Visual	100%	Delivery Challan & MDCC	Availability	Verify			
		Check for Manufacturer's name as per Delivery Challan.	Visual	100%	Delivery Challan & MDCC	Tender specification	Verify			
	Technical documents	Check the Factory test report ,scheme drawing /GA drawing .	Visual	100%	Packing List / BOQ	Availability	Verify			
	Physical inspection of material	Check supply of accessories / Loose supply items (if any).	Visual	100%	Packing List / BOQ	Availability	Verify			
		Visual examination for damage.	Visual	100%	NO Damages	NO Damages	Verify			
2	**Qualification of Man power**	Hydra operator should have license.	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should have relevant experience .	Visual	100%	Certificate	Availability	Verify			

3	**Unloading and Storage**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Manual/ Standard engg. Practice	Availability	Verify			
		Ensure that different accessories / loose supply material are stored separate section and size wise labelled and tagged for easy identification.	Visual	100%	do		Verify			
		Ensure that all hardware are tagged & kept separately in racks, size-wise for easy identification	Visual	100%	do		Verify			
4	**Pre installation**	Check for proper ventilation and illumination in working condition.	Visual	100%			Verify			
		Check name plate details of the Bat. Charger Panel with drawing / BOQ	Visual	100%	GA Drawing / BOQ	Availability	Verify			
		Check size & type of hardware/ accessories required as per the drawing / BOQ.	Visual	do	Packing List / BOQ	Availability	Verify			
		Ensure that no physical damage to Bat. Charger Panel body /insulator etc. is observed.	Visual	do	No damage		Verify	Verify		

		Ensure that availability of proper foundation and floor cut out.	Visual	do	Civil cut out drawing		Verify			
		Check Matching of floor cut out / Hole on Bat. Charger Panel, and mounting foundation.	Visual	do	GA Drawings	GA Drawings	Verify			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of Bat. Charger Panel etc.	Visual	do	Instruction Manual/ Standard engg. Practice	Standard engg. Practice	Verify			
5	**Installation**	Check the Verticality of Charger on support structure & Leveling.	Visual	100%			Verify			
		Check for broken glass, switch handle, lamp cover etc.	Visual	do	No Damages	Availability	Verify			
		Check all nuts, bolts, clamps, connectors and terminals are tightened correctly.	Visual	do	Drawing / BOQ	Availability	Verify			
		Check the panel clearance from any equipment and wall.	Visual	do	Specification	Availability	Verify			
		Ensure that power and control cables are terminated with proper ferruling.	Visual	do	Schematic drawing.	Availability	Verify			
		Check for proper connection and tightness of all wires.	Visual	do	Standard engg. Practice		Verify			

		Check for completion of wiring as per schematic drawing.	Visual	do	Schematic drawing.		Verify			
		Check healthiness of fuses, links, MCBs, Switches, indication lamps and space heater & illumination circuit.	Visual	do	Instruction Manual / Standard engg. Practice		Verify			
		Check cables are supported properly.	Visual	do	Standard engg. Practice		Verify			
		Check mounting arrangement of relays, PCBs, chokes and transformer visually.	Visual	do	GA drawing.	GA drawing.	Verify			
		Check tightness against proper mounting of SCRs and Diodes on their heat sinks.	Visual	do	GA drawing.		Verify			
		Check Polarity of meters shunts and relays.	Visual	do	Schematic drawing.		Verify			
		Ensure proper glanding of external cables	Visual	do	GA Drawing		Verify			
		Ensure blanking of unused cable entry holes.	Visual	do	GA Drawing		Verify			
		Check for earthing of the panel at 2 places grounded individually to different grounding pads.	Visual	do	Earthing Drg		Verify			

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6	**Testing**		General Checks as per STR.	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
			Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
			Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report, MTC, MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		
S.No.	**Revision**	**Date**	**Legend**	**Contract**		**Employer**					
1											
2											
3											

STANDARD FIELD QUALITY PLAN FOR AL BATTERY BANKS WORKS										
Standard Field Quality Plan for Battery Bank.										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
1	**RECEIPT**									
	Check the Transportation documents	Gate pass, Excise duty MDCC, LR.	Visual	100%	Invoice/ packing list	Availability	Verify	Verify		
	Check the technical documents	Check the Factory test report, scheme drawing /GA drawing.	Visual	100%	Invoice/ packing list	Availability	Verify			
		Check supply of accessories/ Loose supply items (if any).	Visual	100%	Packing List/ BOQ	Availability	Verify			
		Verify the AH Rating of Battery	Visual	100%	Packing List/ BOQ	Availability	Verify			
		Verify the Voltage and Frequency	Visual	100%	Packing List/ BOQ	Availability	Verify			
		Check the availability of Catalogues and operation manual	Visual	100%	Packing List / BOQ	Availability	Verify			
	Check the physical inspection	Check for any physical damage.	Visual	100%	Packing List / BOQ	Availability	Verify	Verify		
		Check name plate details as per P.O	Visual	100%	Invoice /packing list	Availability	Verify			
		Verify the case no. as per L.R.	Visual	100%		No Damages	Verify			

	Verify the Technical specification(Name Plate Details)	Verify the AH rating of Battery.	Visual	100%	Technical specification/BOQ	Conformance	Verify	Witness		
		Verify the Voltage Rating.	Visual	100%	Technical specification/BOQ	Conformance	Verify	Witness		
		Verify Input Voltage and Frequency.	Visual	100%	Technical specification/BOQ	Conformance	Verify	Witness		
2	**Qualification of Man power**	Hydra operator have license.	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician is having relevant experience .	Visual	100%	Certificate	Availability	Verify			
3	**Quality of Tools**	Trolley	Visual	100%		Availability	Verify			
4	**Unloading and Storage**	Ensure that the material is stored inside on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction manual/ Standard engg. Practice	Conformance	Verify	Verify		
		Ensure proper unloading & storage of battery.	Visual	100%	do	Availability	Verify			
		Battery shall be kept in Dust free indoor area.	Visual	do	do	Availability	Verify			
5	**Pre installation**	Verify the location for installation of battery	Visual	100%	Drawing		Verify			
		Ensure proper tools and planning for Shifting and Installation of battery bank	Visual	100%	GA Drawing / BOQ		Verify			
		Verify the availability of all accessories like connecting lead.	Visual	do	do		Verify			

6	**Installation**	Cleaning of terminals	Visual				Verify			
		cleaning of premises	Visual				Verify			
		tap cell connection shall be made at 80% of battery bank	Visual	100%		conformance	Verify			
		Anchored the stand for the battery .	Visual	100%	Floor level should be matched		Verify			
		Battery shall be handled carefully.	Visual	do	No Damages		Verify			
		Check all nuts, bolts, clamps, connectors and terminals are tightened correctly.	Visual	do	Drawing / BOQ		Verify			
		Batteries shall be arranged in such a way that positive and negative terminals of adjacent batteries are nearby.	Visual	do	Specification		Verify			
		Connect positive terminals of one battery to the negative terminal of other battery.	Visual	do	No Misalignment.		Verify			
		Ensure correct sizes of cable are used and properly tagged.	Visual	do	Schematic drawing.		Verify			
		Ensure sufficient torque for tightening of terminals.	Visual	do	Standard engg. Practice		Verify			
		Apply petroleum jelly at battery terminal.	Visual	do	Instruction manual / Standard engg. Practice		Verify			
		Numerical nomenclature of the battery bank.	Visual	do	Standard engg. Practice		Verify			

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7	**Testing**	General checks as per STR.	Visual	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports & reconciliation report have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		
S.No	**Revision**	**Date**	**Legend**	**Sub Contractor**			**Client**			
1										
2										
3										

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STANDARD FIELD QUALITY PLAN FOR AL BUS BAR WORKS										
Standard Field Quality Plan for Al. BUS BAR										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
1	**RECEIPT**									
	Check the transportation documents	Gate pass, Excise duty, MDCC,LR	Visual	100%	Delivery Challan & MDCC	Availability	Verify	Verify		
		Check for Manufacturer's name as per Delivery Challan.	Visual	100%	Delivery Challan & MDCC	Availability	Verify			
	Check the technical document	Check the Factory test report,GA drawing.	Visual		Delivery Challan & MDCC	Availability	Verify			
	Physical inspection of material	Check for Quantity and size of AL tube.	Visual	100%	Packing List / BOQ	Availability	Verify			
		Verify the size and thickness of Bus BAR.	Visual	100%	Packing List / BOQ	Packing List / BOQ	Verify			
		Verify the any kind of damage .	Visual	100%	Packing List / BOQ	No damage	Verify			
2	**Qualification of Man power**	Hydra operator should have license.	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should be have relevant experience.	Visual	100%	Certificate	Availability	Verify			

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3	**Unloading and storage of materials**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction manual /Standard engg. Practice	Availability	Verify	Verify		
		Ensure that the material is stored inside in systematic manner rating wise for easy removal.	Visual	100%	do	Availability	Verify			
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification.	Visual	100%	do	Availability	Verify			
4	**Pre installation**	Check the busbar hardware as per drawing.	Visual	100%	GA Hardware drawing	GA Hardware drawing	Verify			
		Ensure that the bus bar free from cut and othe damage.	Visual	100%	No Damages.		Verify			
		Check the length and bends of Bus Bar as per drawing.	Visual	100%	GA Hardware drawing		Verify			

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		Ensure availability of necessary tools &, tackles and insulator for lifting of Bus Bar.	Visual	100%	Instruction manual/ Standard engg. Practice	Instruction manual	Verify			
5	**Installation**	Ensure the Shifting of Bus Bar from lorry/ manually .	Visual	do	GA DRAWING		Verify			
		Ensure the Installation the Bus Bar with the help of hydra Or manually	Visual	do	GA DRAWING		Verify			
		Ensure the colour sleeve (R,Y,B) shall be used in Bus Bar.	Visual	do	GA DRAWING		Verify			
		Ensure the proper size of Bus Bar on the insulator or other equipment as per approved drawing .	Visual	do	GA DRAWING		Verify			
		Ensure the Bus Bar shall be properly tightened with the clamp and connector.	Visual	do	As per Instruction Manual		Verify			
6	**Testing**	General Checks as per SIR	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per	Testing	100%	specification		Verify	Witness		

			Technical specification.								
			Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		
S. NO.	**Revision**	**Date**	**Legend**	**Contractor**		**Employer**					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR APFC PANEL										
Standard Field Quality Plan for APFC PANELS										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
1	**RECEIPT**									
	Transportation Documents	Gate pass, Excise duty, MDCC, LR	Visual	100%	Packing list	Packing list	Verify			
		Check for Manufacturer's name as per Delivery Challan	Visual	100%	Packing list	Packing list	Verify			
	Technical documents	Check the Factory test report, scheme drawing and GA drawing	Visual	100%	MDCC/Delivery Challan	MDCC/Delivery Challan	Verify			
	Physical inspection of material	Check supply of accessories / Loose supply items (if any)	Visual	do	Packing List	Availability	Verify			
		Visual examination for damage and Availability of gasket.	Visual	do	No Damage	Availability	Verify			
2	**Qualification of Man power**	Hydra operator should have license.	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should be have relevant experience.	Visual	100%	Certificate	Availability	Verify			

3	**Unloading and Storage**	Ensure that the material is stored inside on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Manual/ Standard engg. Practice	Availability	Verify			
		Ensure that the material is stored in systematic manner for easy removal.	Visual	do	do	Availability	Verify			
		Ensure that different accessories / loose supply material are stored separate section and size wise labelled and tagged for easy identification.	Visual	do	do	Availability	Verify			
		Ensure that all hardware are tagged & kept separately in racks,size-wise for easy identification	Visual	do	do		Verify			
4	**Pre Installation**	Ensure that the foundation for mounting for APFC panels have been rigidly constructed & cleared from civil end.	Visual	100%	GA Drawing/Civil drawing		Verify			
		Check the proper foundation/floor cut outs as per GA drawing.	Visual	100%	GA Drawing/Civil drawing for floor cut outs.		Verify			

		Ensure the availability of necessary tools & tackles, crane/Hydra & sling for lifting of APFC panels.	Visual	100%			Verify			
		Ensure that there is no physical damage to the APFC panels while shifting for erection.	Visual	100%			Verify			
5	**Installation**	Ensure that the capacitor units are correctly positioned in the rack.	Visual	100%	GA drawing		Verify			
		Ensure that there is no damage to the capacitor body during erection.	Visual	100%	GA drawing		Verify			
		Ensure that no capacitor shall be interchanged between bank to bank.	Visual	100%	Manufacturer Erection manual/ Drawing.		Verify			
		After complete installation of the racks, Ensure that the post insulators, bus bars/jumpers & clamps are properly connected.	Visual	100%	Manufacturer Erection manual/ Drawing.		Verify			

		Ensure that the bushings are not over-tighted while connecting jumpers.	Visual				Verify			
		Ensure proper connections of the CT and PT with respect to polarity .	Visual	100%	Connection Diagram		Verify			
		Check the operations of all electrical inter-locks if any.	Visual	100%	Circuit Diagram		Verify			
		Check the earthing connections.	Visual	100%	GA drawing		Verify			
		Check the settings of the protection circuits & protective relay's operation.	Visual	100%	Manufacturer Instruction manual/ Relay setting data		Verify			
6	**Testing**	General Checks as per STR	Testing	100%	Instruction manual	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
		Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report, MTC,MIR have been handed over to	Visual	100%	Schematic drawing.	Availability	Verify	Witness		

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			projects/ engineering & receipt obtained.								
S.No.	**Revision**	**Date**	**Legend**	**Contract**		**Employer**					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR CABLE TRAYS										
Standard Field Quality Plan for HT Panel.										
S.NO.	**TITLE**	**CHARACTERISTICS/ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**		**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Employer**		
	RECEIPT									
	Check the transportation documents	Gate pass, Excise duty, MDCC, LR.	Visual	100%	Delivery Challan & MDCC	Tender specification	Verify	Verify		
1	**Physical inspection of material**	Make sure that material junk free.	Visual	100%	Delivery Challan & MDCC	Delivery Challan & MDCC	Verify			
		Verify the size and thickness of trays and tag them.	Visual	100%	Packing List / BOQ	No damage	Verify			
		Verify any kind of damage	Visual	100%	Packing List / BOQ	No damage	Verify	Verify		
	Check the Availability of accessories	Verify the availability of Coupling plate and bolts	Visual	100%	Technical specification	conformance	Verify			
2	**Qualification of Man power**	Hydra operator should have license	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate	Availability	Verify			

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3	**Unloading and Storage**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture	Visual	Random	Instruction Manual/ Standard engg. Practice		Verify	Verify		
		Ensure that the material is stored in systematic manner for easy removal.	Visual	Random	do	Proper Safety	Verify			
4	**Pre installation**	Ensure availability of approved Drawing /Documents for cable trays /routing	Visual	100%	Drawing	Availability	Verify			
		Completeness of all accessories like Coupler clamp and hardware	Visual	100%	GA Drawing / BOQ	Availability	Verify			
		Ensure that there is no physical damage during storage	Visual	do	do	Availability	Verify	Witnes s		
5	**Installation**	Availability of site front and finialize the size of cable tray according the approved drawing of trench and check that no piping /ducting in the route.	Visual	100%	Approved drg	As per drawing	Verify			

		Route marking	Visual			As per drawing	Verify			
		Verify the support arrangment	Visual	do	Approved drg	As per drawing	Verify			
		Ensure that cable trays are not cut by using elctric arc welding	Visual				Verify			
		Verification of readymade cable trays and cleaning of cable tray length.	Visual	do	Drawing / BOQ	Availability	Verify			
		Verification of jointing of cable trays	Visual	do	Specification	As per drawing	Verify			
		Ensure the alignment of cable trays both vertical and horizontal	Visual	do	Approved drg	As per drawing	Verify			
		Earthing of the cable tray	Visual	do	Approved drg	As per drawing	Verify			
		Collection and disposal of garbage	Visual	do	Approved drg	As per drawing	Verify			
6	**Testing**	NA								

S.No	**Revision**	**Date**	**Legend**	**Contractor**		**Employer**	**Client**				

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STANDARD FIELD QUALITY PLAN FOR CONTROL CABLE LAYING

Standard Field Quality Plan for HT/LT/CONTROL Cable Laying

S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS		RESPONSIBLE AGENCIES	FORMAT OF RECORDS
						Contractor	Employer		
1	**MATERIAL RECEIPT**								
1.01	Check the Type, Make, Quantity, Name plate detail of cables received from Vendor.		Visual	100%	Packing List, Challan, MTC, MIR	Verify			In case any of these is not OK, Project Manager must be informed.
1.02	Check damages to cable drums/ outer/ turns of the cables.		Witness	do	NO Damages	Verify	Verify		
1.03	Check cable ends are sealed properly		Witness	do	Packing List,Challan	Verify			
1.04	Check cable details are clearly visible on make, PO details the drums seqential marking.		Witness	do	do	Verify			
1.05	Check the megger value of Cable on receipt.	Megger 500V/5KV	Measurement	do	Material inspection record	Verify			
1.06	Check unloading facility is suitable and adequate.		Visual	do		Verify			

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2	**STORAGE**								
2.01	Ensure that while moving the drums by rolling them on ground, it should always be rolled in the direction of arrow marked on the drum.		Visual	Once in a Month	Work Instruction / Manual	Verify			
2.01	Check if the storage area is level and dry.		Visual	do	do	Verify	Witness		
2.01	Check if all drums are properly placed with stoppers so that any accidental rolling is avoided.		Visual	do	do	Verify			
2.01	Ensure the storage in manner that Identification of drums should be easy to avoid frequent movements unnecessarily		Visual	do	do	Verify			
2.01	Ensure tightness of cable drum bolts of flanges before transportation to work site		Visual	do		Verify			
3	**PRE ERECTION**								
3.01	Ensure that route is clearly defined as per drg. & necessary approvals are taken from for roads crossing, traffic movement etc. as applicable			100%	Cable route darwing	Verify			

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3.02	Preplan cut length schedule to minimize wastege,as per the approval drawings/cables route.	Measuring tape	Measurement	do	Cable Schedule	Verify			
3.03	Check if the drums are placed properly at site.		Visual	do		Verify			
3.04	Check adequate no. of rollers are all placed on the cable route.		Visual	do		Verify			
3.05	Check if all rollers movements are free and do not have sharp edges,		Visual	do		Verify			
3.06	Check proper size of the cable is being laid as per the cable schedule.		Visual	do		Verify			
3.07	Check the IR and continuity of cable before laying.	Megger	Measurement	do	As per IS	Verify			Cable ends for HT cables to be kept sealed.
3.08	Pre plan availbilty of adequate qty. of sand /bricks/pre cast slabs /route markers for protection & cushioning of cables.			do	As per typical arrangement drgs.	Verify			
3.09	Check the availabilty of Jointing kit/Termination kit/tools and taclles.			do	Standard engg prctice.	Verify			
3.10	Ensure the qualification of Cable jointer.		Witness	do	Approved Jointer	Verify			

3.11	Ensure that cable support structures are fabricated / painted strictly as per the approved drawing .		Visual	do	Typical arrangement drgs.	Verify			
4	**ERECTION**								
4.01	Ensure that proper cable jacks & shafts are used.		Visual	100%	Work Instruction / Manual	Verify			
4.02	Ensure that all conduits and ducts are free from sharp edges or foreign material.		Visual	do	do	Verify			
4.03	Ensure that proper method is adopted for cables being pulled through conduits and ducts.		Visual	do	do	Verify			
4.04	Check Depth / Width of trench and clearances..	Measuring tape	Measurement	Random	Approved Drawing	Verify			
4.05	Ensure that no. of bricks, stone slabs and sand etc. are filled as per the specifications.	do	do	do	Specification	Verify			
4.06	Ensure that proper horizontal I vertical spacings are maintained as per the approved drawings.	do	do	do	Approved Drawing	Verify			
4.07	Ensure the adequate loop is left while jointing as per specification.		Visual	100%	Specification	Verify			

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4.08	Cable Glanding, dressing of cores of Cable & Tightness of Cable terminations		Visual	Random		Verify			
4.09	Sealing of Gland plates & cable entries to Building		Visual	do		Verify			
4.10	Clamping/ Supporting of Conduits & sealing of ends after Cable laying		Visual	do	Approved Drawing	Verify			
4.11	Cleaning of cable trench after cabling & providing the Cable trench covers		Visual	do		Verify			
4.12	Ensure that before backfilling of trenches, a joint inspection is done & protocol is signed by both contractor & project engineer.		Visual	do	Approved Drawing	Verify	Verify		
4.13	Ensure that cable identification tags are provided at proper places.		Visual	100%	Approved Drawing/ specification	Verify			
4.14	Ensure that cable joints markers are provided at all joints and route markers at regular intervals / warning tapes along the route as per specification.		Visual	do	Drgs & Specification	Verify			
4.15	Ensure that cable end of left out cable are. properly sealed to prevent ingress of moisture.		Visual	do		Verify			

4.16	Check dimension of tray and its galvanizing quality before laying the cable		Visual			Verify			
4.17	Ensure that the spare pipe ducts are sealed with end cap and provided with GI wire for future pulling purpose.		Visual	do	Drgs & Specification	Verify			
5	**PRE-COMMISSIONING**								
5.01	Ensure that cable identification tags are provided at proper places.		Visual	100%	Approved Drawing/ specification	Verify			
5.03	Ensure that cables are properly clamped at regular intervals on trays		Visual	do	do	Verify			
5.04	Ensure that suitable sleeves are provided for wall crossing etc., for cables		Visual	do	do	Verify			
5.05	Ensure that cable of higher voltage grade are laid on top tier and lower voltage grade on bottom tier while laying cables.		Visual	do	Instruction manual/ specification	Verify			
5.06	Ensure that proper spacing and layers are maintained for laying of cables		Visual	do	do	Verify			

5.07	Ensure that cable markers and bricks slabs are provided for directly buried cables.		Visual	do	do	Verify			
6	**Testing**								
6.01	Check the insulation resistance of the CC/ LT/ HT cables.	500/1000 V Megger	Witness	do	Specification	Verify	Witness		
6.02	Ensure that continuity test is conducted on conductor, Shield, Armour of H.T./LT Cables and cable tray earthing.	Megger/ Multimeter	Witness	do		Verify	Witness		
6.03	Ensure that high pot (HV) test is conducted on H.T. Cables.	HI Pot Test KIT	Witness	do	Specification	Verify	Witness		
6.04	Ensure that As built drawings, Cable schedule & test reports have been submitted to Client, projects team.				Cable Schedule, Test report as built drawing	Verify	Witness		
6.05	All testswill be done as per Technical specification.		Witness		specification	Verify	Witness		

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STANDARD FIELD QUALITY PLAN FOR GALVANISED STRUCTURE

Documents, Records identified with "Y" mark shall be included by supplier in QA documentation, A- Check by CIL Quality, P-Perform, V-Verify, W-Witness, H-Hold Point, S-Surveillance, IR-Inspection Report, TC-Test Certificate, RW-Representative Witness

Sl.No	Component & Operation	Characteristic	Classification	Type of Check	Quantum of Check		Reference Documents	Acceptance norm	Record		Agency			Remarks
									Format	Doc				
RECEIPT OF MATERIALS														
1	Check for manufacturer's name as per purchase order identification punch mark/details as per Test Report/ Delivery Challan	Compliance to purchase order specification	B	Visual	100%	100%	Delivery Challan	BOQ/ Packing List			Perform	Witness	Verify	
2	Check for CRN issued by Costomer/Construction/ALS TOM	Acceptance of Material	B	Visual	100%	100%	CRN	Document No to be Mentioned			Perform	Verify	Verify	
3	Check for Visual Damage/Cracks in Structure Materials etc	Transit Damage	B	Visual	100%	100%	No Damages	Contract Specification /approved drawing /Delivery challan		Y	Perform	Witness	Verify	
4	Check for Quality Size and Section of Member, Hardware, Nut & Bolts (MS/GI)etc	Quality Size and Section	B	Measurement	100%	100%	Drawing	List in Drawing & BOQ		Y	Perform	Witness	Witness	

5	Check for Structure Member as per Drawing	Compliance to Drawing	B	Measure ment	100%	100%	Drawing	BOQ/ Packing List		Y	Perform	Verify	Verify	
6	Check for Damage of Galvanisation	Damage to Galvanized Coating& Finishing	A	Visual	100%	100%	Drawing	Smooth,unif orm galvinised surface		Y	Perform	Witness	Witness	
STORAGE OF MATERIALS														
1	Check for Structurals stored on raised Platform to avoid direct contact with Ground/Moisture	Stored on raised Platform	B	Visual	Once in a Week	Once in a Week	Manufacturers Storage Instruction	As per Storage Procedure		Y	Perform	Witness	S	
2	Ensure that different members of materials are stored seperatly Size and Sectionwise labelled & taged for easy identification with proper whether protection	Stacking/ Storing method, fixing of identification tags. Record keeping	B	Visual	Once in a Week	Once in a Week	Manufacturers Storage Instruction	As per Storage Procedure		Y	Perform	Witness	S	
INSTALATION														
1	Check for structure members of various length and section, hardware, Nut & Bolts	Length and Section	B	Measure ment	100%	100%	Erection Layout and Drawing	Contract Specification		Y	Perform	Witness	Verify	
2	Check for structure members Provided with Proper Match making	Structure Identification Numbers	A	Visual	100%	100%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Witness	Witness	
3	Checks for Centrelines and spacing of holes/clamps/hocks provided as per layout/Foundation/structural drawing	Centrelines and spacing	B	Visual	100%	100%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Verify	Verify	
4	Checks for size of nut bolts clamps & connectors and their level provided as per the drawing	Size & Level	B	Measure ment	100%	100%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Verify	Verify	
5	Check for height of the equipment mounted/electrical clearances maintained as per the approved drawing	Elevation /electrical clearance	A	Measure ment	100%	100%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Witness	Witness	

6	Checking of foundations & Foundation bolts structural members	Elevation foundation coordinates /spacing	A	Measure ment	100%	100%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Witness	Witness	
7	Bolts in Foundation	Bolt Height Pitch and diagonal	A	Measure ment	100%	10%	Erection Layout and Drawing	Specified/Res pective Standard drawings		Y	Perform	Witness	Witness	
8	Checking Approved Grouting Material	Compliance to Approval	B	Visual	100%	10%	Approved list	Approved list		Y	Perform	Verify	Verify	
Erection														
1	Check for various members of structures assembled and joined with proper bolts, nuts as per approved drawing	Completion of work	B	Visual	100%	100%	Erection Layout and Drawing	IS:800 & IS:802		Y	Perform	Witness	Witness	
2	Check all the bolts are fixed with spring washer	Provision of spring washers	B	Visual	100%	10%	Drawing	Respective Standard		Y	Perform	Witness	RW	
3	Check for the bolts Properly tightened/grouted with quick setting cement after alignment of the structure	Tightness & Grouting	B	Physical verificati on by Torque wrench	100%	10%	Testing Procedure	CIL Approved Specification		Y	Perform	Witness	RW	
4	Check for double earthing of all equipment structure/ pole	Complete	A	Visual	100%	10%	Drawing	Respective Standard		Y	Perform	Witness	Witness	
5	Check for general arrangement and physical appearance of the structure, beams and columns	Elevation verticality twist completion & correctness	A	Visual	100%	100%	Drawing	±5mm, 1mm/m height or 15mm whichever less, 2mm/m or 6 mm whichever less. IS.802		Y	Perform	Witness	Witness	

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6	Check for all shear edges of the parts from bolt centre with required clearance	Clearance	B	Measure ment	100%	100%	Drawing	Standard drawings		Y	Perform	Witness	Witness	
7	Compare as built drawing with approved drawing	Deviation	A	Visual	100%	100%	Drawing	Drawing & Standard		Y	Perform	Witness	Verify	
Documents, Records identified with "Y" mark shall be included by supplier in QA documentation, A- Check by CIL Quality, H-Hold Point, S-Surveillance, IR-Inspection Report, TC-Test Certificate, RW-Representative Witness														
				Checked By	**Approved By**	**Checked By**					**Received By**		**Approved By**	

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STANDARD FIELD QUALITY PLAN FOR STRINING WAVE TRAPE (WT)										
S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	ACCEPTANCE NORMS	RESPONSIBLE AGENCIES		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
	RECEIPT									
1	**Check the transportation documents**	Gate pass, Excise duty ,MDCC,LR	Visual	100%	Delivery Challan & Packing List	Availability	Verify	Verify		
	Check the technical documents	Check the Availability of Factory test report, catalogues and operation manual	Visual	100%	Packing List / BOQ	Availability	Verify			
	Physical inspection of material	Check for any physical damage.	Visual	100%			Verify	Verify		
		Check name plate details as per P.O	Visual	100%			Verify			
		Verify the case no. as per L.R.	Visual	100%	No damages & No leakage	No damage	Verify			
2	**Qualification of Manpower**	Hydra operator should have valid license.	Visual	100%	Certificate		Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate		Verify			

		Ensure extra care to prevent damage on porcelain parts while unloading	Visual	100%	do		Verify			
		Ensure that equipment is not lifted or handled using primary terminals	Visual	100%	do		Verify			
		Ensure that the material is stored on raised wooden platform/ Planks to avoid direct contact with ground / Moisture .	Visual	Once in a month	Packing List / BOQ	Packing List / BOQ	Verify			
		Ensure that the material is stored in systematic manner for easy removal / Usage.	Visual	100%	do		Verify			
3	**Unloding and storage**	Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification	Visual	100%	do		Verify			
		Ensure that all hardware are tagged & kept separately in racks/ in Bags size-wise for easy identification	Visual	100%	do		Verify			
		Ensure Tarpaulin covers have been provided if required .	Visual	100%	do		Verify			
		When stored in unpacked condition, store in such a way that the gauge glass is prevented from possible damage	Visual	100%	do		Verify			

4	**Pre Installation**	Check Matching of structure / PCD hole on WT, and mounting foundation	Visual	do	GA Drawings		Verify			
		Ensure that foundation for mounting the WT has been rigidly constructed.	Visual	do	Civil foundation Drg.		Verify			
		Check size & type of hardware / accessories required as per the drawing / BOQ	Visual	do	do		Verify			
		Ensure that no physical damage to WT body etc. is observed.	Visual	do	No Damages.		Witness			
		Ensure availability of necessary tools &, tackles, crane & sling for lifting of In. transformer etc.	Visual	do	Manufacturers Manual		Verify			
5	**Installation**	Ensure that WT is always lifted using lifting hooks only etc.	Visual	do	Instruction Manual		Verify			
		Ensure that the WT is not tilted during lifting.	Visual	do	do		Verify			
		Ensure the orientation of primary and secondary terminals.	Visual	do	Erection Drawing		Verify			
		Check fixing nuts & bolts are properly tigthed immediately after placement on the structure.	Visual	do	Manufacturers Manual		Verify			

		Check that center line/vertical line of WT is correct.	Visual	do	do		Verify			
		Ensure fixing of accessories / loose supplied / Terminal Connector items if any.	Visual	do	Packing List		Verify			
		Ensure that touch up paint has been applied where ever peeled off.	Visual	do			Verify			
6	**Testing**	General Checks as per STR	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness		
		Ensure that complete site as built drawings/ documents alongwith test reports, reconciliation report, MTC, MIR have been handed over to projects/ engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		

S.No.	Revision	Date	Legend	Contractor		Employer					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR STRINING WORK

Standard Field Quality Plan for Al. CONDUCTOR

S.NO.	TITLE	CHARACTERISTICS/ITEM	TYPE OF CHECK	QUANTUM/ FREQUENCY OF CHECK	REF. DOC. & ACCEPTANCE STANDARD	Acceptance norms	Resposible Agencies		FORMAT OF RECORDS	REMARKS
							Contractor	Employer		
1	**RECEIPT**									
	Check the transpotation documents	Gate pass, Excise duty, MDCC,LR	Visual	100%	Delivery Challan & MDCC	Availability	Verify	Verify		
		Check for Manufacturer's name as per Delivery Challan.	Visual	100%	Delivery Challan & MDCC	Availability	Verify			
	Check the technical document	Check the Factory test report,GA drawing.	Visual		Delivery Challan & MDCC	Availability	Verify			
	Physical inspection of material	Check for Quantity and size of AL Conductor	Visual	100%	Packing List / BOQ	Availability	Verify			
		Verify the size and thickness of Conductor	Visual	100%	Packing List / BOQ	Packing List / BOQ	Verify			
		Verify the any kind of damage .	Visual	100%	Packing List / BOQ	No damage	Verify			
2	**Qualification of Man power**	Hydra operator should have license.	Visual	100%	Certificate	Availability	Verify			
		Fitter and Technician should be have relevant experience .	Visual	100%	Certificate	Availability	Verify			

3	**Unloading and storage of materials**	Ensure that the material is stored on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction manual /Standard engg. Practice	Availability	Verify	Verify		
		Ensure that the material is stored inside in systematic manner rating wise for easy removal.	Visual	100%	do	Availability	Verify			
		Ensure that different accessories / loose supply material are stored separately section and size wise labelled and tagged for easy identification.	Visual	100%	do	Availability	Verify			
4	**Pre installation**	Check the Stringing hardware as per drawing.	Visual	100%	GA Hardware drawing	GA Hardware drawing	Verify			
		Ensure that the Conductor free from cut and othe damage.	Visual	100%	No Damages.		Verify			
		Check the length and bends of Conductor as per drawing .	Visual	100%	GA Hardware drawing		Verify			
		Ensure availability of necessary tools &, tackles and insulator for lifting of Conductor.	Visual	100%	Instruction manual/ Standard engg. Practice	Instruction manual	Verify			
5	**Installation**	Ensure the Shifting of Conductor from lorry/ manually .	Visual	do	GA DRAWING		Verify			
		Ensure the Installation the Conductor with the help of Man Lift Or manually	Visual	do	GA DRAWING		Verify			

		Ensure the colour sleeve (R,Y,B) shall be used in Conductor.	Visual	do	GA DRAWING		Verify			
		Ensure the proper size of Conductor on the insulator or other equipment as per approved drawing .	Visual	do	GA DRAWING		Verify			
		Ensure the Conductor shall be properly tightened with the clamp and connector.	Visual	do	As per Instruction Manual		Verify			
6	**Testing**	General Checks as per SIR	Testing	100%	Instruction manual/ Standard engg. Practice	As per drawing	Verify	Witness		
		Routine Tests are as per Technical specification.	Testing	100%	specification		Verify	Witness		
		Ensure that complete site as built drawings/ documents alongwith test reports, reconciliation report, MTC, MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness		

S.No	Revision	Date	Legend	Contractor		Employer					
1											
2											
3											

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STANDARD FIELD QUALITY PLAN FOR GIS

				Issued on :								
Name of document :- FQP GIS WORKS				**Rev :**								
Name of Client:-				**Reference no:**								
Name of project:-				**Doc No:**								
Name of Sub-contractor:-												

Standard Field Quality Plan for GIS

S.NO.	TITLE	CHARACTERISTICS / ITEMS	TYPE OF CHECK	QUANTUM / FREQUENCY OF CHECK	REF. DOC & ACCEPTANCE STANDARD	Acceptance Norms	Responsible Agencies			FORMAT OF RECORDS	REMARKS
							Contractor	Consultant	Employer		
	RECEIPT OF MATERIALS										
1	**Check the transportation documents**	Gate pass, Excise duty,MDCC,LR etc.	Visual	100%	Delivery Challan & Packing List	Availability	Verify	Verify	Verify		
	Check the technical documents	Check the Availability of Factory test report ,catalogues and operation manual.	Visual	100%	Packing List / BOQ	Availability	Verify	Verify			
	Physical inspection of material	Check for any physical damage.	Visual	100%	No damages		Verify	Verify			
		Check name plate details as per P.O	Visual	100%	Purchase order		Verify	Verify			
		Verify the case no. as per L.R.	Visual	100%	do		Verify	Verify			

2	**Qualification of Man power**	Hydra operator should have valid license.	Visual	100%	Certificate		Verify	Verify			
		Fitter and Technician should be have relevant experience	Visual	100%	Certificate		Verify	Verify			
3	**Unloading and Storage**	Each Crate/case has to be unloaded one by one only.	Visual	100%			Verify	Verify			
		Ensure hydra/Crane can be used for the unloading purpose and using marks provided on case.	Visual	100%			Verify	Verify			
		Ensure that the material is stored on raised wooden platform/ Planks to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Mannaul / Standard engg. Practice		Verify	Verify			
		Ensure that the material is stored in a systematic manner rating wise for easy removal / usage.	Visual	do	do		Verify	Verify			
		Ensure that different accessories / loose supply material are stored separately ,section and size wise labelled and tagged for easy identification.	Visual	do	do		Verify	Verify			
		Ensure that all hardware are tagged & kept separately in racks / in bags,size-wise for easy identification.	Visual	do	do		Verify				
		Ensure the SF6 gas cylinders shall be stored in Cap intact condition(	Visual	do	do		Verify				

		provided for valve protection) with valve fully closed and free from explosive environment.									
		Ensure Tarpaulin covers have been provided if required .	Visual	do	do		Verify	Verify			
		Ensure while in storage , on no account water shall enter the equipment.	Visual	do	do		Verify	Verify			
		Ensure Cu tube and ferrule, nipple, and fitting etc. to be stored together inside the room.	Visual	do			Verify				
		Check when stored in unpack condition care shall be taken to Ensure match pole and mechanism are togeather.	Visual	do	do		Verify				
4	**Pre Installation**	Ensure that the foundation for mounting GIS cleared from civil works .	Visual	100%	Civil Construction clearence		Verify				
		Check size & type of hardware / Busbar coupling accessories required as per the drawing / BOQ	Visual	do	do		Verify				
		Ensure that no physical damage to GIS (CB,With & Without Earth Disconnectors, CT, PT and BUS BAR Enclosers) & GIB body etc.	Visual	do	NO Damages		Verify	Witness	Witness		

		Visual inspection shall be done after unpacking .	Visual	do			Verify	Witness			
		Ensure availbility of proper foundation and structure.	Visual	do	GA Drawing		Verify				
		Check Matching of structure / Holes on GIS &GIB, and mounting foundation bolts	Visual	do	GA Drawing		Verify				
		Ensure availability of necessary tools &, tackles, crane/Hydra , sling for lifting of GIS & GIB,Sealer Anabond,Circlip plier,Bolts&nuts, derrick pipes, support, wire brush, emer sheet etc.	Visual	do	As per instruction Manual		Verify				
		Ensure the placement position of the phases and orientation of breaker on foundation.	Visual	do	Erection Drawings		Verify	Witness			
		Check for inspection agency stamp/punch.	visual	do			Verify				
		Ensure the availability of drawings.	Visual	do	Erection key diagram,scche matic diagram.		Verify				
5	**Installation**	Ensure the GIS shall be menimum pressure gas filled & checked by manufacturer.	Visual	100%	As per instruction Manual/ Test report	As per instruction Manual/ Test report	Verify	Verify	Witness		
		Ensure that GIS & GIB is always lifted using lifting hooks only and not from bushings etc.	Visual	100%	As per instruction Manual/ Test report	As per instruction Manual/ Test	Verify				

						report						
		Ensure that the GIS & GIB is not tilted during lifting.	Visual	do	do		Verify					
		Ensure to avoid giving jerk and the side seal does not hit anywhere	Visual	do	do		Verify					
		Check proper tigthness of foundation nuts & bolts immediately after placement on the structure .	Visual	do	do		Verify	Witness				
		Check that center line and verticality of GIS & GIB is correct and horizontal leveling.	Visual	do	do		Verify	Witness				
		Ensure once the links are attached, shall be tightten firmly with nuts and lock clips.	Visual	do	do		Verify					
		Ensure not to temper with the valve at any stage.	Visual	do	do		Verify					
		Check for mechnical indication to show open & close position .	Visual	do	do		Verify					
		Ensure fixing of accessories / loose supplied items if any.	Visual	do	do		Verify					
		Ensure top & bottom terminations and earthing connection to earth are done using correct size of lugs /strips / Connectors.	Visual	do	do		Verify					
		Ensure that touch up paint has been applied where ever peeled off.	Visual	do	do		Verify					
		Check the wiring diagram make the required connections	Visual	do	do		Verify	Witness				
		Check for any loose connections	Visual	do	do		Verify					
		Ensure to clean the joint surfaces of the the terminal adaptor with wire brush or emery sheet.	Visual	do	do		Verify					

6	Testing		General checks as per STR.	Visual	100%	As per instruction Manual	Availability	Verify	Witness	Witness		
			Routine Tests are as per IEC/BIS/Technical specification.	Testing	100%	Specification	Availability	Verify	Witness	Witness		
			Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report,MTC,MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness	Witness		`
S.No.	**Revision**	**Date**	**Legend**	**Contractor**	**Consultant**	**Employer**	**Client**					
1												
2												
3												

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STANDARD FIELD QUALITY PLAN FOR NIFPS (Nitrogen injection fire protection system)											
Name of Client:- HPSEBL											
SL.NO.	**TITLE**	**CHARACTERISTICS /ITEM**	**TYPE OF CHECK**	**QUANTUM/ FREQUENCY OF CHECK**	**REF. DOC. & ACCEPTANCE STANDARD**	**ACCEPTANCE NORMS**	**RESPONSIBLE AGENCIES**			**FORMAT OF RECORDS**	**REMARKS**
							Contractor	**Consultant**	**Employer**		
1	**RECEIPT**										
	Transpotation Documents	Gate pass, Excise duty ,DI,LR.	Visual	100%	Packing list	Packing list	Verify	Verify	Verify		
		Check for Manufacturer's name as per Delivery Challan	Visual	100%	Packing list	Packing list	Verify				
	Technical documents	Check the Factory test report,scheme drawing and GA drawing	Visual	100%	DI/Delivery Challan	DI/Delivery Challan	Verify				
	Physical inspection of material	Check supply of accessories / Loose supply items (if any)	Visual	do	Packing List	Availability	Verify				
		Visual examination for damage and Availability of gasket.	Visual	do	No Damage	Availability	Verify	Verify	Verify		

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2	**Qualification of Man power**	Hydra operator should have license.	Visual	100%	Certificate	Availability	Verify				
		Fitter and Technician should be have relevant experience.	Visual	100%	Certificate	Availability	Verify				
3	**Unloading and Storage**	Ensure that the material is stored inside on raised wooden platform to avoid direct contact with ground / Moisture .	Visual	Once in a month	Instruction Mannaul/ Standard engg. Practice	Availability	Verify	Verify	Verify		
		Unloading and Storage of materials Should be done as per Supplier Manual and Instruction.	Visual	do	Instruction Mannaul / Standard engg. Practice	Instruction Mannaul / Standard engg. Practice	Verify	Verify			
		Ensure that the material is stored in systematic manner for easy removal.	Visual	do	do	Availability	Verify				
		Ensure that different accessories / loose supply material are stored separate section and size wise labelled and tagged for easy identification.	Visual	do	do	Availability	Verify				
		Ensure that all hardware are tagged & kept separately in racks,size-wise for easy identification	Visual	do	do		Verify				

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4	**Pre Installation**	Ensure that the foundation for mounting for NIFPS Panels have been rigidly constructed & cleared from civil end.	Visual	100%	GA Drawing/Civil drawing		Verify				
		Check the proper foundation/floor cut outs as per GA drawing.	Visual	100%	GA Drawing/Civil drawing for floor cut outs.		Verify				
		Ensure the availability of necessary tools & tackles, crane/Hydra & sling for lifting of NIFPS panels.	Visual	100%			Verify				
		Ensure that there is no physical damage to the NIFPS panels while shifting for erection.	Visual	100%			Verify	Verify	Verify		
5	**Installation**	Ensure that the NIFPS Materials are correctly positioned in the rack.	Visual	100%	GA drawing		Verify				
		Ensure that there is no damage to the NIFPS Materials Body during erection.	Visual	100%	GA drawing		Verify	Witness			
		Ensure that all the Connecting Pipes from NIFPS panel to Transformer Body which are fitted or not.	Visual	100%	Manufacturer Erection manual/ Drawing.		Verify				
		After complete installation of the Pipes, Pipe Supports,	Visual	100%	Manufacturer Erection manual/		Verify				

			Valves, Expansion Belows are properly connected.			Drawing.						
			Check the operations of all electrical inter-locks if any.	Visual	100%	Circuit Diagram		Verify				
			Check the earthing connections.	Visual	100%	GA drawing		Verify	Witness			
			Check the settings of the protection circuits & protective relay's operation.	Visual	100%	Manufacturer Instruction manual/ Relay setting data		Verify				
6	**Testing**		General Checks as per STR	Testing	100%	Instruction manual	As per drawing	Verify	Witness	Witness		
			Routine Tests are as per Technical specification.	Testing	100%	Specification	Availability	Verify	Witness	Witness		
			Ensure that complete site as built drawings / documents alongwith test reports, reconciliation report, MTC, MIR have been handed over to projects / engineering & receipt obtained.	Visual	100%	Schematic drawing.	Availability	Verify	Witness	Witness		
S. NO.	**Revision**	**Date**	**Legend**	**Contractor**	**Consultant**	**Employer**						
1												
2												
3												

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CHAPTER- 16

FIELD QUALITY PLAN / GUIDE LINES FOR CONSTRUCTION OF OVER HEAD HT/ LT LINES

Main Points should be look after for Overhead Line Installation:

Overhead lines:

- The general precautions during storage and handling of shall be taken in accordance with relevant IS code.
- While laying the conductor shall be taken from top of the drum and the repeated in the direction of arrow on it.. Care shall be taken to avoid contact with steel works, fence, etc by giving soft wood protection, using wooden rollers.
- Proper tools shall be used during stringing work. During stringing operation standard sag table or chart shall be followed and care shall be taken to ensure that there are no kinks in the conductor. Joints in conductors shall be staggered. Mid span joints in conductors shall be avoided.
- After stringing the conductor, it shall be clamped permanently with shackle or strain clamps. An angle or section shall be selected while pulling up conductors.

Jumpers:

- While stringing, sufficient length shall of conductors be kept at shackle terminations for making jumpers. Jumpers shall be neat and as far as possible symmetrical to run of conductors. These shall be made to prevent occurrence of faults due to wind or birds. PG clamps may be preferred to binding of conductors at jumper location or service taps.

Cross Arms :

- The cross arms shall be made of MS Structural steel. The length of cross arms shall be suitable for accommodating the number of insulators on them with spacing of conductor. A gap of minimum 50 mm shall be left from the center of pin hole to end of cross arm on either side. The cross arm shall be complete with pole clamp made of MS flat of size not less than 50 x 6 mm with necessary nuts, bolts, washers, etc. The length of cross arm for carrying guard wires shall always run not less than 300 mm beyond outer most bare conductor of configuration.
- Cross arms shall be properly clamped to the support taking into consideration the orientation of lines.

Porcelain insulators and fittings:

- The porcelain insulators shall be confirming to IS 731 – 1971 for overhead lines. This shall be glazed, crack / burr free.
- The insulator shall have adequate mechanical strength, high degree of resistance to electrical puncture and resistance to climatic and atmospheric attack.

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- All iron parts shall be hot dip galvanized & all joints shall be airtight. Pin insulators / shackle insulators / disc insulators shall be erected on cross arms and 'D' iron clamp shall be used or as specified by Engineer-in-charge. Shackle insulators shall be used in conjunction with 'D' iron clamps when configuration of conductor is vertical.
- These shall also be erected on cross arm at intermediate support in case of long lines, deviation from straight lines. Care shall be taken that insulators are not damaged during erection.

Binding material:

- Binding of conductor with the insulator shall be done with soft aluminum wire / conductor. The binding of conductor to insulator shall be sufficiently firm and tight to ensure that no intermittent contact develops. The end of binding wire shall be tightly twisted in close spaced spiral around the conductor to ensure good electrical contact and strengthen the conductor.
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Supports and spacing of poles:

- Support of overhead line shall be of adequate strength confirming in all respects to rules 76 of Indian electricity rules.
- Pole spacing and clearance between lowest conductor above the ground level across / along the street shall be in accordance with rule 85 of Indian electricity rules. Suitable foundation shall be provided for erection of poles.
- The foundation shall include excavation in all types of soil and rocks and back filling, RCC, reinforcement, formwork.
- Excavation for foundations for poles / stay / strut : After the location of supports / stay are pegged accurately, the excavation work shall be taken up and care should be taken while excavating that pits are not oversized.
- The pit should be excavated in the direction of the line. The depth and size of pit shall be such that normally 1/6th of the length of pole is buried in the ground and suitable for foundation of support.
- For stay the position of pit shall normally be such stay makes as large an angle as possible with the support and it shall be in the range of 40 to 60 degrees.
- The length of stay rod shall project 450 mm above the ground level. The pit for strut shall be located at a distance not less than 1.8M from the pole.
- The depth of pit shall be such that at least 1.2M of the strut is buried in the ground.

Stay / strut:

- Stay set shall consist of stay rod, anchor plate, bow tightened / turn buckle, thimbles, stay wire and stain insulators.
- The stay rod shall be with stay grip in case of turn buckle is used instead of bow tightened. The entire stay set assembly shall be galvanized. The stay wire shall be either 7/4.0 mm diameter or 7/3.15 mm diameter GI having tensile strength of not less than 70 kgf/sq mm and confirming to IS 2141. T
- The anchor plate shall be of MS galvanized and not less than 300 mm x 300 mm x 6.4 mm thick. The stay rod / buckle rods shall be minimum 16/19 mm diameter galvanized steel rod having tensile strength not less than 42 kgf/sq mm. Minimum length of stay rod and buckle shall be 1800 mm and 450 mm respectively.

Erection stay sets:

- The anchor plate shall be galvanized MS plate. The stay rod with anchor plate shall be embedded in cement concrete 1:3:6. A stay shall be provided at all angle and terminal poles. Double stay shall be provided at all dead ends and in such case, these shall be as far as possible to be set parallel to each other.

Cage guard:

- All metal supports of overhead lines and metallic fitting attached shall be permanently and effectively earthed. Cage guard / cradle guard shall be made of 6 SWG GI wire confirming to IS 2633 including netting, stretching and jointing of cage and lacing by 10/12 SWG GI wire, binding by 14/16 SWG GI wire.

Danger boards:

- All supports carrying HV lines shall be fitted with danger plates confirming to IS 2551 at height of 3 M from ground indicating the voltage of line. The script shall be both in ‘English/Hindi’.

Anti climbing devices:

- Necessary arrangement for preventing unauthorized persons from ascending any of the supports and structure carrying HV lines without the aid of ladder or special appliance shall be made.
- Unless otherwise specified barbed wire confirming to IS 278 having four points barbed spaced 75 +/- 12 mm apart shall be wrapped helically with a pitch of 75 mm around the limb of support and firmly commencing from the height of 3.5 M and up to 5 or 6 M as directed by the engineer.

Lightning arrestor:

- Lightning arrestor suitable for HT lines shall be installed one unit per phase at terminations, transformer stations, etc.
- The devices shall be connected ahead of fuse provided if any. Independent earth electrode shall be provided for LA.

- The earth lead from earth electrode to LA shall be continuous. The LA shall confirm to IS 3070 and shall be non linear distribution class.
- The LA shall be non-linear type, distribution class, outdoor type suitable for effectively earthed system. The LA shall consist of line terminal stud, earth terminal stud, number of spark gaps in series with non-linear resistor, the whole assembly housed inside a hermetically sealed porcelain bushing.
- Neoprene rubber gasket shall be provided between metal caps and porcelain bushing. Non-linear resistor shall be silicon carbide blocks metalized at both ends to ensure good electrical contact between terminals, non-linear resistor & spark gaps.
- Mounting bracket shall be hot dip galvanized suitable for mounting LA on structure.

Cable Laying Direct in Ground:

- The method shall be adopted where the cable route is through open country, along road / lanes, etc and where no frequent excavations are encountered and re excavation is possible without affecting other work.

Width of trenches:

- The width of trench for laying single cable shall be 35 cm Where more than one cable are to be laid in the same trench in horizontal formation, width of trench shall be increased such that the inter-axial spacing between the cables for 415 volts shall be 20 cm and for 11 shall be 35 cm.

Depth of trenches:

- Where cables are laid in single formation, the total depth of trench shall not be less than 75 cm for cable up to 1.1 KV grade and shall not be less than 120 cm for cable above 1.1 KV grade. Wherever more than one tier formation is unavoidable and vertical formation is adopted, the depth of trench shall be increased by 30 cm for each additional tier to be formed.

Protective covering:

- Cable laid in trenches shall have covering of clean dry sand not less than 170 mm above the base cushion of sand before the protective cover is laid.
- The cables shall be protected by B class/second class brick of not less than 20 cm x 10 cm x 10 cm or protective cover placed on top of the sand and both sides of cable for full length of the cable to the satisfaction of Engineer-in-charge.

Back filling:

- The trenches shall be back filled wit excavated earth free from stones or other scrap edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm unless otherwise specified.

Route marker:

- Route marker shall be provided along straight runs of cables and at points of change in direction as approved by Engineer-in-charge and in general at intervals not exceeding 100 meters in straight run. Route marker shall be made out of 100 mm x 100 mm x 5 mm GI/Al plate bolted or welded on 35 mm x 35 mm x 6 mm MS angle iron of 600 mm long.
- Such route markers shall be mounted and grouted parallel to and 0.5 meter away from the side of trench. The work “cable” with voltage grading and size of cable shall be inscribed on the marker.

FIELD QUALITY PLAN- CONDUCTOR, EARTH WIRE & AB CABLE ERECTION (HT & LT)

Item: CONDUCTOR, EARTH WIRE & AB CABLE (HT & LT)

SYSTEM: CONDUCTOR, EARTH WIRE & AB CABLE

SUB-SYSTEM: 1 CONDUCTOR(AAAC,AAC,ACSR) ERECTION

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OFCHECK Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
1	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL CHECK	100%	DELIVERY CHLLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHLLAN/MDCC DESCRIPTIONS	STORES REGISTER	COMPONENETS WHICH ARE INSPECTED AND CLEARED BY PIA (Project Implementation Agency) SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL CHECK	100%		DRUMS FOUND DAMAGED DURING TRANSIT ARE STACKED SEPARATELY	STORES REGISTER	
		3) STORAGE	C	VISUAL CHECK	100%	STANDARD PRACTICE	DRUMS ARE STORED ON HARD SURFACE AREA	STORES REGISTER	
2	**ERECTION OF CON-DUCTOR**	1) HAN- DLING OF THE CON-DUCTOR	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	CONDUCTOR SHOULD NOT BE DRAGGED ON THE GROUND		SCRATCHES OR DAMAGES TO THE STRANDS WOULD OCCUR IF NOT HANDLED PROP- ERLY
		2) SE- QUENCE OF CONDUC-TOR EREC-TION	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	SEQUENCE OF RUNNING OUT SHALL BE FROM TOP TO BOTTOM, i.e.. THE TOP CONDUCTOR SHALL RUN OUT FIRST, FOLLOWED BY THE SIDE CONDUCTORS		

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		3) STRING- ING OF THE CONDUC-TORS	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	ANY DAMAGES TO THE STRANDS SHALL BE RE- PAIRED WITH REPAIR SLEEVES		
		4) MID SPAN JOINTING	B	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	COMPRESSION TYPE NOT MORE ONE JOINT PER SUB CONDUCTOR PER SPAN		ALL JOINTS AND SPLICES SHOULD BE 15 METERS AWAY FROM THE POLE
		5) BIND-ING THE CONDUC-TOR TO THE INSULATOR	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	AS PER THE REC SPECIFICA-TIONS		
		6) EREC- TION AT ROAD CROSSINGS	B	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	GUARDING SHALL BE PRO- VIDED AT MAJOR CROSS- INGS		THE GROUND CLEARANCES AT ROAD CROSS- INGS SHALL BE AS PER RELAVENT IE RULES
		7) ANTI-CLIMBLING DEVICES	B	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	APPROVED DRAWINGS		

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OFCHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		8) DANGER BOARDS	B	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	APPROVED DRAWINGS		
3	**TENSIO N- ING AND SAGGIN G**	1) MEA-SUREMENT OF SAG- GING	B	VISUAL	100%	AS PER SAG-TENSION CHARTS	AS PER IE NORMS		TENSIONING AND SAGGNG OPERA- TIONS ARE CARRIED IN CALM WEATHER, WHEN RAPID CHANG- ES IN TEMPERATURE ARE NOT LIKELY TO OCCUR
4	**CLIPPING**	1) CLIPPING THE CON-DUCTOR IN POSITION	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	MANUFACTURER'S RECOMMENDATION		
		2) JUMP-ERING AT SECTION AND ANGLE TOWERS	C	VISUAL	100%	UTILITY SPEC-IFICATION or AS PER ACCEPTANCE NORMS	JUMPERS FORMED TO PARABOLIC SHAPE		TO ENSURE MAXI- MUM CLEARANCE TO EQUIPMENT

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER- ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
4	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHLLAN/ MDCC	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHLLAN/ MDCC DESCRIPTIONS	STORES REGISTER	COMPONENETS WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%		DRUMS FOUND DAM- AGED DURING TRANSIT ARE STACKED SEPA- RATELY	STORES REGISTER	
		3) STORAGE	C	VISUAL	100%	STANDARD PRACTICE	DRUMS ARE STORED ON HARD SURFACEAREA	STORES REGISTER	
5	**FIXING OF EYE HOOK AND SUS-PENSION / DEAD END CLAMPS**	A) EYE HOOK WITH POLE THROUGH BOLT							
		1) CHECK THE THREAD-INGS OVER THE THROUGH BOLT	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGIS- TER	
		2) FIX THE THROUGH BOLT INTO THEPOLE	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	APPROVED DRAWING	SITE REGIS- TER	

S.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OFCHECK - Engineer-in-Charge	REFER- ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		3) CHECK THE ALIGN-MENT OF BOLT WITH THE POLE	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGIS- TER	
		B) EYE HOOK WITH EYE HOOK CLAMP							
		1) CHECK THE DIMEN- SIONS OF THE CLAMP AND FIX THE CLAMP TO THE POLE	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGIS- TER	
		2) CHECK THE ALIGN-MENT OF CLAMP WITH THE POLE	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGIS- TER	THE CLAMP SHOULD BE EXACTLY PERPENDICU- LAR TO POLE
		C) CHECK THE ALIGN-MENT OF THE EYE HOOKS ALONG THE LINE	C	VISUAL	100%	STANDARD PRACTICE	HOOKS SHALL BE ERECTED AT SAME ELEVATION	SITE REGIS- TER	WHERE EVER HOOKS ARE MISALIGNED THERE SHOULD BE REPLACED BEFORE CONDUCT RING

S.NO	MAIN ACTIVITY& OPERATION	CHARAC- TERISTICS/ INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OFCHECK - Engineer- in-Charge	REFER- ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		D) FIXING OF SUS- PENSION CLAMS / DEAD END CLAMPS	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGIS- TER	
6	**ERECTION OF CABLE**	1) HAN- DLING OF THE CABLE	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	CABLE SHOULD be care- fully handled to avoid any damage		CABLE SURFACE SHALL BE FREE FROM FAULTS, FLAWS e.t.c
		2) SE- QUENCE OF CABLE ERECTION	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	SEQUENCE OF RUN- NING OUT SHALL BE FROM TOP TO BOTTOM, i.e.. THE TOP CABLE SHALL RUN OUT FIRST, FOLLOWED BY THE SIDE CABLES		
		3) FIX THE MESSEN- GER WIRE OF AB CABLE TO CLAMPS (SUSPEN- SION/ DEAD END CLAMP)	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	PIA SPECIFICATION/ AS PER APPROVED DRAW- ING		
		4) CHECK THE TIGHT- NESS OF CABLE WITH CLAMPS	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	AS PER THE STANDARD PRACTICE		

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OFCHECK Engineer-in-Charge	REFER- ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		5) CHECK THE GROUND CLEARANC- ES AFTER ERECTION OF THE AB CABLE	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	AS PER IE RULES		THE MINIMUM GROUND CLEARANCES SHOULD BE MAINTAINED
7	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL CHECK	100%	DELIVERY CHLLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHLLAN	STORES REGISTER	COMPONENETS WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL CHECK	100%		THE SURFACE OF EARTH WIRE SHOULD BE FREE FROM FLAWS AND DUST	STORES REGISTER	
		3) STORAGE	C	VISUAL CHECK	100%	STANDARD PRACTICE	EARTH WIRE SHOULD BE STORED IN DRY AREAS	STORES REGISTER	
8	**ERECTIO N OF EARTH WIRE**	1) HAN- DLING OF THE EARTH WIRE	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Earth Wire should be care- fully handled to avoid any damage		SCRATCHES OR DAM- AGES TO THE SURFACE WOULD OCCUR IF NOT HANDLED PROPERLY

SL.NO	MAIN ACTIVITY& OPERATION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER- ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		2) EREC- TION OF EARTH KNOB	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	SEQUENCE OF RUNNING OUT SHALL BE FROM TOP TO BOTTOM,i.e. THE TOP EARTH WIRE SHALL RUN OUT FIRST, FOLLOWED BY THE SIDE EARTH WIRES		CHECK THE CLEARANCE BETWEEN EARTH KNOB AND PIN INSULATORS AND THE COMPONENTS SHALL BE ERECTED AS PER DRAWING AND AS PER SPEC
		3) STRING- ING OF THE EARTH WIRES	C	VISUAL	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	ALL JOINTS SHALL BE COMPRESSION TYPE		GROUND CLEARANCES SHOULD BE MAINTAINED

CLASS OF CHECK:
A -- CRITICAL B -- MAJOR
C-- MINOR

	Cables							
Sr. No.	**CHARACTERISTICES / ITEMS**	**Type of Check**	**Instru-ments**	**Class**	**QUANTUM OF CHECK - Site Incharge**	**Reference Documents & Acceptance Standard**	**"Format Of Records"**	**Remarks**
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Completeness of documents, test certificates, etc.)	V	-	B	100%	Delivery Challan	MRC	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination	V	-	B	100%	Packing list / Instruction Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual/ IS: 1255	-	
1.5	End Sealing (Cable ends are sealed by PVC cap to avoid ingress of moisture)	V	_	B	100%	IS: 1255	Site Record	
2	**PRE INSTALLATION**							
2.1	Unloading of Drums							
A	Check for drum mounting - cable wheel/ jack	V	-	B	100%	IS: 1255	Site Record	
B	Check for cable unwinding - cable wheel/ jack	V	-	B	100%	IS: 1255	Site Record	
C	Check for proper unrolling - Cable Wheel/ Jack	V	-	B	100%	IS: 1255	Site Record	
D	Check for cable end sealing	V	-	B	100%	IS: 1255	Site Record	
2.2	Availability of bricks at site for buried cables	V	-	C	100%		Site Record	
2.3	Excavation of trench for U/G cable laying	V	-	C	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instru-ments	Class	QUANTUM OF CHECK - Site Incharge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
2.4	Sand Cushioning for buried cables	V	-	C	100%		Site Record	
2.5	Ascertaining cable route and length	V	-	B	100%	Cable Route	Site Record	
2.6	Conformity with cable schedule	V	-	B	100%	Cable Schedule	Site Record	
2.7	Insulation resistance checking - Meggar (500 V for LT & 1000V for Cables upto 11kV)	Electrical	Meggar	A	100%	IS: 1255	Site Record	
2.8	Proper route maintaining during cable laying	V	-	B	100%	Cable Route	Site Record	
2.9	identification and dressing of cables	V	-	B	100%	standard Practice	Site Record	
2.10	Use of trefoil clamps for single core cables	V	-	B	100%	standard Practice	Site Record	
2.11	Proper verticality of multicore cables	V	-	B	100%	standard Practice	Site Record	
3	**INSTALLATION**							
3.1	Removal of wooden planks from cable drum	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	-	
3.2	Check cable is not dragged on hard ground	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	-	
3.3	Check size of cable & cutting of cable length	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	-	
3.4	Check the separation between different types of cables laid nearby.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC-CEPTANCE NORMS	-	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instru - ment s	Class	QUANTUM OFCHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.5	Check the laying of cables as per cable schedule.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.6	Check the cable tray are earthed as per the drawing.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.7	Check the cable glands, lugs, ferrules, cable tag/ marker are provided as per requirement.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.8	Check the cable cable drum/ cable to be laid for any external damage.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.9	Check the availability and functionality of the rollers.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.10	Check there are no damage / twisting of cables during laying.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.11	Check that cables are protected from the sharp bends while laying.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.12	Check that the power cables are separated from the control cables.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	
3.13	Check the phase matching at both end after each joint.	V	-	B	100%	UTILITY SPECIFICA- TION or AS PER AC- CEPTANCE NORMS	-	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instru - ment s	Class	QUANTUM OFCHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.14	Check cable tags are provided at required intervals/required places and both end as per cable schedule.	V	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	-	
3.15	Check the cables are dressed, clamped and supported properly as per the drawing.	V	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	-	
3.16	Insulation Resistance Check	Electrical	Meggar	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	
3.17	Check whether some extra length (1.5 mtr.) is kept in each cable run for future use	Physical	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	
3.18	Check that all wall openings/ pipes/ sleeves are sealed to avoid seepage of water	Physical	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	
3.19	check that buried cables are covered with sand layers and by protective bricks	Physical	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	
3.20	Ensure that the location of underground cable joints are identified.	Physical	-	B	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	Site Record	

S.No.	Activity and Operation	Characteristics/ instru-ments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu-ment	Acceptance Norms	Format of Records	Remarks
1	2	3	4	5	6	7	8	9	10
1.00	**RECEIPT**								
1.01	Main Unit	a) Physical damage & Oil leakage from valves/ flanges & other part of body	B	Visual	100%	No Physical damage & Leakage from valves/ flanges and other parts of main unit.			
1.02		b) Unloading with the help of lifting lugs & hydra on foun- dation or at suiatble location in absecnce of foundation.	B	Physical	100%				
		c) Check S.No. & rating	B	Verify	100%	BBU No.			
1.03	Accessories/ Loose Items	a) Physical damage	B	Visual	100%	No Physical damage			
		b) Unloading of Marshalling Box, radiator, Conservator tank, Bucholz Relay, current transformer, MOG, PRD, Breather, Silica gel, terminal Connector & boxes.	B	Visual	100%				
		c) Leakage of oil from drums	B	Visual	100%	No leakage	Log Record		
1.04	Accessories/ Loose Items	d) All Packing cases are sealed/ packed with packing list	C	Visual	100% once	No opening/ break- ing of seal/ packing	Log Record		
		e) Verification of items as per packing list	C	Verify	100% once	No shortage	Log Record		
2.00	**STORAGE**								

S.No.	Activity and Operation	Characteristics/ instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ment	Acceptance Norms	Format of Records	Remarks
1	2	3	4	5	6	7	8	9	10
2.01		a) Oil drums are placed at protected area & not stored on their side faces.	C	Physical	100% once	No leakage	Log Record		Surveilance check by NE-SCL Erection.
		b) All components/ equipment are stored at suitable location till they are used for erection.	C	Visual	100% once	….	Log Record		Surveilance check by NE-SCL Erection.
		c) Fitting of breather on main unit in case of long storage period.	C	Visual	100% once	….	Log Record		Surveilance check by NE-SCL Erection.
		d) All instruments such as MOG, PRD, silica gel, Marshalling Box, Breather, terminal connector, bucholz Relay, WTI, OTI, CT are stored indoor.	C	Physical	100% once	….	Log Record		Marshalling box are stored vertical in their respective cases.
		e) Flushing of radiators & pipes for missing blanks with oil and blanking of pipes and radiator ends.	B	Physical	100% once	No dirt should remain inside the pipe & radiators and blanking of pipe after cleaning/ flushing.			
		f) Radiators, Pipes and con-servator tanks are stored at raised platform to avoid direct contact with water.	B	Physical	100% once	….			
3.00	**ERECTION**	Transformers							
3.01		a) Availability of tools and tackles	B	Visual	100%	….			
		b) Availability of transformer foundation as per drawing.	B	Visual	100%	….			

S.No.	Activity and Operation	Characteristics/ instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Document	Acceptance Norms	Format of Records	Remarks
1	2	3	4	5	6	7	8	9	10
		c) Fixing and greasing of rollers with transformer for smooth shifting of main unit from stor- age area to site of erection.	B	Physical	100%	....			
		d) Shifting/ haulage of main unit from storage area upto founda- tion site with the help of hydra, ropes, pulleys etc.	B	Physical	100%	....			
		e) Installation of Transformer on its foundation	B	Visual	100%	....			
		f) Ensure radiators were in flushed condition before erec- tion with main unit.	B	Visual	100%	....			
		g) mounting of pipes, radia- tors, explosion vent, cable box, earthing flat as per drawing.	B	Visual	100%	....			
		h) Availability of required capac- ity filteration machine and its healthiness.	B	Visual	100%	....			
		I) Prior to start of vacuum test, breakdown voltage of oil sample taken from separate tank in which oil is stored for filtration.	B	Test	100%	....			
		j) Drying out of transformer with complete assembly with help of machine.	B	Visual	100%	....			

S.No.	Activity and Operation	Characteristics/ instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Document	Acceptance Norms	Format of Records	Remarks
1	2	3	4	5	6	7	8	9	10
		k) Oil filling in transformer under vacuum through filtration machine.	B	Test	100%	....			
		l) Testing of oil after completion of filtration.	B	Test	100%	....			
		m) Oil level & leakage in transformer tank, radiators.	B	Test	100%	....			
		n) Wiring and termination of cable from instrument, Bucholz Relay, OTI/WTI, MOG.	B	Physical	100%	....			
		o) Tap switch position	B	Physical	100%	....			
		p) Polarity and connection of CTs with leads, otherwise CTs secondary to be shorted.	B	Physical	100%	....			
		q) IR value between terminal and flange bushing.	B	Physical	100%	....			
		r) Earthing of Transformer as per drawing and IE rules.	B	Physical	100%	As per drawing			
		s) General appearance for paint condition.(Retouching of paint if required.)	B	Physical	100%	....			
		t) Whole assembly for tightness and general appearance.	B	Physical	100%	....			

FIELD QUALITY PLAN FOR CIVIL WORKS

1	**DOCUMENTS AND DRAWING**								
1.1	Check that the instruction manuals for all equipments have been received.		B	Physical	100%	Bill of Material		Office record	
1.2	Check that the approved civil foundation plan of equipment are available.		B	Physical	100%	Bill of Material		Office record	
2									
2.1	**Earth Work**								
2.1.1	**Before excavation**								
2.1.1.1	Check the pegs conditions as per line and alignment w.r.t. existing structure	Measure Tape	B	Visual	100%	As per site EIC	As per site EIC	Office record	
2.1.1.2	Checking of pit marking as per drawing.	Measure Tape	B	Visual	100%	Foundation plan	Foundation plan		
2.1.2									
2.1.2.1	Checking of pit marking / loca-tion	Measure Tape	B	Physical	100%	Foundation Plan	Foundation Plan	Site record	
2.1.2.2	Check the dimension of pit at bottom (Lx Bx D)	Measure Tape	B	Physical	100%	Foundation Plan	Foundation Plan	Site record	
2.1.2.3	Check the type of soil, if BC soil is confirmed follow the instruc- tion on drawing for stone soling	Measure Tape	B	Physical/ Hammer-ing crobar	100%	Foundation Plan	Foundation Plan	Site record	

Sr. No.	ACTIVITY AND OPERATION	Characteristics / Instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents	Acceptance Norms	"Format Of Records"	Remarks
2.1.2.4	Check the type of soil, if Non BC soil is confirmed follow the drawing.	Measure Tape	B	Physical/ Hammer-ing crobar	100%	Foundation Plan	Foundation Plan	Site record	
2.3	**Shuttering**								
2.3.1	Check the shuttering board which are made to shape with steel tape including cleaning & proper surface preparation .	Measure tape	B	Visual	100%	Foundation Plan	Foundation Plan	Site record	
2.3.2	Placment of shuttering boards including supports, tie rod etc.	Tackiling equip-ment	B	Visual	100%	Foundation Plan	Foundation Plan	Site record	Required as per site condition
2.3.3	Measurement, line and level with steel tape & water level.	Steel tape & water level	B	Visual	100%	Foundation Plan	Foundation Plan	Site record	
2.3.4	Check placement, alignment & embedment of anchor bolts, Check no oil on inserts (For foundation bolts)	Measure tape	B	Visual	100%	Foundation Plan	Foundation Plan	Site record	
2.3.5	Check bolt setting with tem-plates.	Measure tape	B	Visual	100%	Foundation Plan	Foundation Plan	Site record	
2.4	**Cement**								
2.4.1	Cement - Received from Sup- plier	Review of TC/ As per IS	A	Visual	One of con-signment	IS: 11269	Manufacturer's Test Certificate	Site Record	
2.4.2	Setting Time & Compressive strength	Review of TC/ As per IS	A	Visual	One of con-signment	IS: 11269	Manufacturer's Test Certificate	Site Record	
2.5	**Reinforced Steel**								
2.5.1	Visual Examination to ensure free from cracks, surface flaws, imperfect edges and dimen- sional checks		B	Visual	100%	IS: 1786 & Approved Drawings	Approved Draw-ings	Site Record	

Sr. No.	ACTIVITY AND OPERATION	Characteristics / Instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents	Acceptance Norms	"Format Of Records"	Remarks
2.5.2	Cutting, Bending, placing of reinforced steel bars & lapping	Tackling Equip-ment	B	Visual	100%	Approved Drawings	Approved Draw-ings	Site Record	
2.6	**Concreting**								
2.6.1	Mixing of cement (OPC, 53 Grade, ISI mark), sand & coarse aggregate as per ratio 1:4:8/1:2:4/1:5:8/ 1:1.5:3	Tackling equip-ment	B	Visual	100%	As per instructions of manufactur- er's	As per instructions of manufacturer's	Site record	
2.6.2	Check workability of concrete	Tackling equip-ment	B	Visual	100%	As per instructions of manufactur- er's	As per instructions of manufacturer's	Site record	
2.6.3	Placing concrete, poking and compacting.	Tackling equip-ment	B	Visual	100%	As per instructions of manufactur- er's	As per instructions of manufacturer's	Site record	
2.6.4	Testing of concrete cubes for compression strength. 7 Days or 28 Days.	Compression machine	A	Third party lab test	One set per substation	IS 456, IS 516	IS 456, IS 516	Site record	
2.6.5	Check whether curing period of the foundation is completed.		C	Visual	100%	Visual check for min 7 days	Visual check for min 7 days	Site record	
2.6.6	Check the backfilling and compaction is completed upto ground level.	Tackling equip-ment	A	Visual	100%	Foundation Plan	Foundation Plan	Site record	
2.7	**Masonary work**								
2.7.1	Check the proportion, mixing & placement of mortar.	Tackling equip-ment	B	Visual	Random	Foundation Plan	Foundation Plan	Site record	
2.7.2	Plumb & alignment	Tackling equip-ment	B	Visual	Random	Foundation Plan	Foundation Plan		
2.7.3	Curing		B	Visual	100%	Visual check for min 7 days	Visual check for min 7 days	Site record	

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Sr. No.	ACTIVITY AND OPERATION	Characteristics / Instruments	Class of Check	Type of Check	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents	Acceptance Norms	"Format Of Records"	Remarks
2.7.4	Control brick height " In day work"	Measure tape	B	Visual	100%	Foundation Plan	Foundation Plan		
2.8	**Plastering work**								
2.8.1	Plastering thickness and even- ness		B	Visual	Random	Visual check	Visual check		
2.8.2	Mortar mix / proportion	Tackling equip- ment	B	Visual	Random	Foundation Plan	Foundation Plan	Site record	
2.8.3	Check the placement, thickness of plaster, line & level of plaster	Tackling equip- ment	B	Visual	Random	Foundation Plan	Foundation Plan	Site record	
2.8.4	Curing		B	Visual	100%	Visual check for min 7 days	Visual check for min 7 days	Site record	

Legends :
"CLASS OF CHECK:
A -- CRITICAL -- TO BE WITNESSED BY PIA SITE AND SURVEILLANCE BY PIA, CC. B -- MAJOR -- TO BE WITNESSED BY CONTRACTOR AND PIA SITE
C-- MINOR -- TO BE WITNESSED BY CONTRACTOR AND ENGINEER IN CHARGE"

TC : Test Certificate
V : Verify
W : Witness
EIC : Engineer In Charge

FIELD QUALITY PLAN-- PSC POLES (11KV& LT), POLE EARTHING AND GUY ERECTION									
Item: PSCC Poles(11KV& LT)									
Sub-system: POLE ERECTION ,EARTHING, GUY ERECTION									
								PAGE:	
SL.NO	MAIN ACTIV-ITY& OPERA-TION	CHARAC-TERISTICS / INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMEN T	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
1	**RECEIPT AND STORAGE**	1) RECEIPT AT STORES	C	VISUAL	100%	SUPPLIER TC	CORRELATION OF THE LOT RECEIVED WITH THE TC	SUPPLIER TC	POLES WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE AC-CEPTED ON RECEIPT
		2) VISUAL INSPECTIO N	C	VISUAL	100%		BROKEN, DAMAGED POLES SHALL BE STACKED SEPA-RATELY	SITE REGISTER	
		3) PROPER STORAGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	"1)POLES SHALL BE STACKED IN SUCH A MANNER THAT BROAD SIDE IS VERTICAL. 2)EACH TIER IN THE STACK IS SUPPORT- ED ON WOODEN SLEEPERS LOCAT- ED AT 1.2Mtr APART, WOODEN SUP-PORTS ALIGNED IN VERTICAL LINE."	SITE REGISTER	

SL.NO	MAIN ACTIV-ITY& OPERA-TION	CHARAC-TERISTICS / INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
2	TRANSPOR-TATION OF POLES	TRANSPOR-TATION	C	VISUAL	100%	UTILITY SPECIFICA-TION or AS PER AC-CEPTANCE NORMS	"1)POLES SHALL BE TRANSPORTED WITH BROAD FACES PLACED VERTICALLY 2)SUPPORTS ARE LO- CATED AT 1.2Mtr APART THROUGH OUT THE LENGTH OF THE POLE"		
3	PRE INSTAL-LATION	AVAIL- ABILITY OF APPROVED DRAWINGS ALL CON- STRUCTION-AL MATE- RIAL.	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	"1)ENSURE APPROVED DRAWINGS FOR INSTAL-LATION OF THE POLES ARE AVAILABLE AT WORK PLACE 2)ENSURE ALL CON-STRUCTION MATERIAL LIKE BOULDERS, SAND , CEMENT , STONE CHIPS ARE ALSO AVAILABLE AT WORK PLACE "	SITE REGISTER	
		AVAILABILITY OF ROUTE SURVEY MAP AT WORK PLACE	C	VISUAL	100%	ROUTE SURVEY REPORT		SITE REGISTER	
	4.INSALATION OF POLES								
4.1	EXCAVATION OF PIT	4.1.1) MANUAL EXCAVATION / CON- TROLLED BLASTING	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	PIT LONGITUDINAL AXIS SHOULD BE IN THE DI- RECTION OF THE LINE	SITE REGISTER	"CONTROLLED BLASTING IS PERMITTED IN CASE OF HARD OR ROCKY SOILS (IN CASE OF INHABITED LOCA- TION DRILLING/ CHIPPING TO BE RESORTED TO)"

SL.NO	MAIN ACTIV-ITY& OPERA-TION	CHARAC-TERISTICS / INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		4.1.2)SIZE OF PIT	C	DIMEN-SIONAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	0.6M X 1.2M (OR) 0.6Dia X 1.5M Depth	SITE REGISTER	IN HARD ROCK LOCA-TIONS ONE Mtr. DEEP HOLE AND Dia OF 1.2 TIMES THE BOTTOM DIMENSION OF THE POLE.
		4.1.3) PLANT- ING DEPTH IN GROUND	C	DIMEN-SIONAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	1.5 m ABOVE PRE- CAST SLAB	SITE REGISTER	IN CASE OF BLACK COTTON & WET SOILS PLANTING DEPTH INCREASED BY 0.2 Mtr
4.2	**BASE FOUN-DATION**	BASE CON-CRETE	C	MEA-SURE-MENT	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	M-15 GRADE SIZE 0.45M X 0.45M X 0.075 m	SITE REGISTER	EQUIVALENT SIZE STONE PLATE CAN ALSO BE USED WHERE EVER FOUND ECONOMICAL
4.3	**POLE EREC-TION**	4.3.1) POLE ERECTION	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	"1)POLES SHALL BE LIFTED TO THE PIT WITH THE HELP OF WOODEN SUP- PORTS 2)THE POLE SHALL BE KEPT IN VERTI- CAL POSITION WITH THE HELP 25mm MANILA ROPES."		
		4.3.2) ALIGN-MENT & VERTICAL- ITY IN BOTH DIRECTIONS	C	SPIRIT LEVEL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS		SITE REGISTER	

SL.NO	MAIN ACTIVITY& OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		4.3.3) BACK FILLING	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	WITH BRICK BATS AND COMPACTED IN LAYERS	SITE REGISTER	TEMPORARY ANCHORS SHALL BE REMOVED ONLY AFTER THE POLE IS SET IN THE FOUNDA-TION AFTER COMPACT- ING THE SOIL.
		4.3.4) CONCRETING OF FOUNDATIONS	C	"MEA-SURE EMENT"	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS		SITE REGISTER	AT ALL TAPPING POINTS, DEAD END POLES, AT DT LOCATIONS, AT ALL POINTS AS PER REC CONSTRUCTION DRAWING AT 1 km OF LAST JAMA FILLED STRUCTURE, BOTH SIDE POLES OF NALLA CROSSINGS, ROAD CROSSING, RAILWAY CROSSINGS, AT DP , 4P STRUCTURE.
		5.1) COIL TYPE EARTHING	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REC CON- STRUCTION STANDARD J-1	SITE REGISTER	
6	**COIL TYPE EARTHING INSTALLA-TION**	a) EXCAVATION OF PIT SIZE (DIA-600 X1500 mm)	C	VISUAL/ DIMEN-SIONAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REF: REC CONSTRUC-TION STAN- DARD -J-1	SITE REGISTER	
		b)INSTALEARTHING SPIRAL	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS			ENSURE THE SPIRAL WIRE IS 4mm GI WIRE

SL.NO	MAIN ACTIVITY& OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RE-CORD	RE MARKS
		c) FILL THE PIT WITH ALTERNATE LAYERS OF 300mm WITH CHARCOAL AND SALT UPTO 1.2 Mtr.OF DEPTH FROM BOTTOM OF THE PIT.	B	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			
		d) CONNECTION BETWEEN THE SPI-RAL WIRE AND POLE EARTH WIRE	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			
		6.1) PIPE/ROD TYPE EARTHING	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD J-2	SITE REGISTER	AT BOTH SIDES OF RAILWAY, ROAD, DRAIN, TELECOM, RIVER CROSSINGS
7	**PIPE TYPE EARTHING INSTALLA-TION**	a) EXCAVATION OF PIT SIZE BY 0.6M Dia X 2.7M DEPTH	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REF: REC CON-STRUCTION STANDARD- J-2	SITE REGISTER	
		b) INSTALL 40 Dia GI PIPE WITH 12 Dia HOLES IN THE PIT.	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			

		c) FILL THE PIT WITH ALTERNATE LAYERS OF 300mm CHAR COAL AND SALT.	B	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			

SL.NO	MAIN ACTIVITY& OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		d) CONNECTION BETWEEN THE PIPE AND POLE WITH 8mm SWG WIRE	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP- TANCE NORMS			
8	**STAY / GUY ERECTION**	8.1) LOCATION FOR THE GUY SETS	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			THE GUY SETS ARE ERECTED AT ANGLE LOCATIONS ,DEAD END LOCATIONS , T -Off POINTS , STEEP GRADIENT LOCA-TIONS, DOUBLE POLE STRUCTURES.
		8.2) EXCAVATION OF PIT SIZE0.5MX0.5M X 1.6M	C	DIMEN-SIONAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD G-1		
		8.3)SIZING OF AN-CHOR PLATE	C	DIMEN-SIONAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD K-1		
		8.4)GROUTING OF ANCHOR PLATE AND ANCHORRODWITH EARTH FILLING	C	DIMEN-SIONAL	100%	UTILITY /REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS			IF GUY WIRE IS FOUND HAZARD-OUSITSHOULDBE PROTECTED WITH ASBESTOS PIPE FILL WITH CONCRETE
		8.5)ANGLE BE-TWEENSTAYWIRE AND POLE	B	"MEA-SUREMENT"	100%	UTILITY /REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD G-1		

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SL.NO	MAIN ACTIVITY& OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		8.6)ERECTION OF GUY INSULATOR	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD G-1		GUY INSULATORS ARE ERECTED AT HEIGHT OF 3050 mm FROM THE GROUND.
		8.7) ERECTION TURNBUCKLE	C	VISUAL	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEP-TANCE NORMS	REC CON-STRUCTION STANDARD G-1		TURN BUCKLE ARE MOUNTED HALF WAY IN THE WORKING PO-SITION , THUS GIVING THE Max. MOVEMENT FOR TIGHTENING AND LOOSENING

CLASS OF CHECK: A -- CRITICAL
B -- MAJOR C-- MINOR

NAME/ SIGNATURE OF THE -CONTRACTOR/ ERECTION AGENCY

FIELD QUALITY PLAN--ERECTION OF 11KV POLE ACCESSORIES

Item: ERECTION OF 11KV POLE ACCESSORIES

Sub-system: G.I COMPONENTS, INSULATORS, HARDWARE FIT- TINGS, DANGER BOARDS, ANTI-CLIMBING DEVICES, GUARDING

MS GALVANIZED COMPONENTS

SL.NO	MAIN ACTIV-ITY& OPERA-TION	CHARAC-TERISTICS/ INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
1	**RECEIPT AND STORAGE**	1) RECEIPT AT STORES	C	VISUAL CHECK	100%		CORRELATION OF THE LOT RECEIVED WITH TC	STORES REG-ISTER	COMPONENTS WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE AC-CEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL CHECK	100%		DAMAGED AND GALVANIZATION DEFECTIVE COMPONENTS ARE TO BE STACKED SEPA-RATELY	STORES REG-ISTER	
		3) PROPER STORAGE	0	VISUAL CHECK	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEPTANCE NORMS	ALL G.I. COMPO-NENTS SHOULD BE STACKED ON WOODEN SLEEPERS AND THE STORAGE AREA SHALL BE FREE FROM WA-TER LOGGING	STORES REG-ISTER	

SL.NO	MAIN ACTIV-ITY& OPERA-TION	CHARAC-TERISTICS/ INSTRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
2	**FIXING OF MS COMPONENTS**	1) V- CROSS ARM WITH CROSS ARM BACK CLAMP	C	VISUAL CHECK	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEPTANCE NORMS	AS PER AP-PROVED DRAW-ING	SITE REGIS-TER	CROSS ARMS ARE TO BE FIXED AT THE MARKINGS PROVIDED ON THE POLES
		2) HORIZON-TAL ALIGN-MENT OF CROSS ARMS WITH POLE	C	WATER LEVEL	100%	APPROVED DRAWING	APPROVED DRAWING		
		3) TOP CLEAT WITH BACK CLAMP	C	VISUAL CHECK	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEPTANCE NORMS	AS PER AP-PROVED DRAW-ING	SITE REGIS-TER	TOP CLEATS ARE TO BE FIXED AT THE MARKINGS PROVIDED ON THE TOP OIF THE POLE
		4) VERTICAL ALIGNMENT OF TOP CLEAT WITH POLE	C	WATER LEVEL	100%	APPROVED DRAWING	APPROVED DRAWING		
		5) TIGHT-ENING MS COMPONENTS WITH NUTS, BOLTS AND WASHERS	C	ERECTION CHECK	100%	APPROVED DRAWING	THE COMPO-NENTS SHOULD BE FIXED RIGID ENOUGH TO WITH STAND ALL THE FORCES	SITE REGIS-TER	

INSULATORS WITH PINS									
3	**RECEIPT AND STORAGE**	1) RECEIPT AT STORES	C	VISUAL CHECK	100%	UTILITY / REC SPECIFICA-TION or AS PER ACCEPTANCE NORMS	CORRELATION OF THE LOT RECEIVED WITH THE CHP DE-SCRIPTIONS	SITE REGIS-TER	COMPONENTS WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE ACCEPTED ON RECEIPT

L.NO	MAIN ACTIV- ITY& OPERA- TION	CHARACTERIS- TICS/ INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		2) VISUAL INSPECTION	C	VISUAL CHECK	100%		THE SURFACE OF THE INSULA- TORS ARE TO BE THOROUGH- LY CHECKED AND CLEANED , THREADING OF THE INSULATOR THIMBLE TO BE CHECKED	STORES REG- ISTER	DAMAGED IN- SULAOTRS ARE TO BE STACKED SEPARATELY
		3) PROPER STORAGE	C	VISUAL CHECK	100%	STANDARD PRACTICE		STORES REG- ISTER	
4	**FIXING OF INSULATORS**	1) CHECK THREADING OVER THE PINS AND INSULA- TOR THIMBLES AND CHECK THE ALIGN- MENT OF PIN WITH INSULA- TOR	C	VISUAL CHECK	100%	UTILITY / REC SPECIFICA- TION or AS PER ACCEPTANCE NORMS	AS PER AP- PROVED DRAW- ING	SITE REGIS- TER	AT GROUND LEVEL THIS PREASSEMBLY CHECK IS DONE FOR PROPER AS- SEMBLY
		2) ASSEMBLING THE GI PIN AND INSULATORS	C	VISUAL	100%	APPROVED DRAWING	APPROVED DRAWING		
		3) FIXING THE PIN INSULA- TOR TO THE CROSSARMS AND POLE TOP BRACKET	C	VISUAL CHECK	100%	UTILITY / REC SPECIFICA- TION or AS PER ACCEPTANCE NORMS	AS PER AP- PROVED DRAW- ING	SITE REGIS- TER	ON ALL THE POLES IN THE STRAIGHT LINE PIN INSULATORS SHALL BE USED. DISC INSULATORS ARE USED AT DEAD END AND ANGLE LOCA- TIONS

S.NO.	MAIN ACTIV-ITY& OPERA-TION	CHARACTERIS-TICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		4) CHECK THE CLEARANCES BETWEEN THE INSULATORS	B	DIMEN-SIONAL	RANDOM	UTILITY / REC SPECIFICA-TION or AS PER ACCEPTANCE NORMS	APPROVED DRAWING		FOR CHECKING THE CLEARANCES SUITABLE TEM- PLATE/ JIGS ARE TO BE USED

CLASS OF CHECK:
A -- CRITICAL
B -- MAJOR C-- MINOR

NAME/SIGNATURE OF THE CONTRACTOR/ERECTION AGENCY

FIELD QUALITY PLAN FOR ISOLATOR, AB

ITEM: ERECTION WORK

SUB SYSTEM: ISO/ AB SWITCH/ DOFUSE SWITCH/ DO FUSE

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Completeness of documents, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan	MRC	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination for damage & defects	V	-	B	100%	Packing list / Instruc- tion Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of approved drawing / Instruction Manuals	-	
2.2	Availability of all materials	V	-	B	100%	Packing list, Approved drawing & Bill Of Material	-	
2.3	Foundation (If required)	V	-	B	100%	Civil foundation drawing	-	
2.4	Verticality of support structure	V	-	B	100%	GA/ Structural draw- ing	-	
3	**INSTALLATION**							
3.1	Rating plate details	V	-	B	100%	instruction manual	Site record	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
3.2	Check for proper slinging & lifting	V	-	B	100%	Instruction Manual	-	
3.3	Check for the tightness of base bolts & other bolted joints preferably by torque wrench.	V	-	B	100%	Instruction Manual	-	
3.4	Check level & alignment of the base, housing as- sembly and flanges.	V	-	B	100%	Instruction Manual	-	
3.5	Ensure proper erection of poles, main blade & drive assembly as per approved drgs.	V	-	B	100%	Instruction Manual	Site record	
3.6	Check for the alignment of isolator and verticality of isolator / AB switch / DO Fuse.	V	-	B	100%	Instruction Manual	Site record	
3.7	Check for the clearance between live part to earth.	V	-	B	100%	As per IS 10118	-	
3.8	Check for no vibration or rotation of contacts of insulators during isolator operation. (Electrical & Mechanical)	V	-	B	100%	Instruction Manual	-	
3.9	Check for the provision of earthing and earth con- nection.	V	-	B	100%	Instruction Manual	-	
3.10	Check operation of the isolator by rotating one of the insulator stack manu- ally and adjust the length of the crossed tandem as- sembly to ensure proper engagement of contacts during closing.	V	-	B	100%	Instruction Manual	-	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
4	**PRE COMMOSSIONING**							
4.1	Check for visual damage to any parts including porcelain isolator.	V	-	B	100%	Instruction Manual	TC	
4.2	Check manual / operation and inter locks.	V	-	B	100%	Instruction Manual	TC	
4.3	IR Value	Test	Megger	B	100%	Instruction Manual	TC	
	a. Between each pole to earth.							
4.4	Ground connections	V	-	B	100%	Instruction Manual	TC	
4.5	Check continuity	Electrical	Multimeter	B	100%	Instruction Manual	Site Record	
CONTRACTOR'S SIGNATURE						NAME & SIGN OF APPROVING AUTHORITY		

Legends :
CLASS OF CHECK:
A -- CRITICAL B -- MAJOR C-- MINOR
TC: TestCertificate EIC : Engineer In Charge
MRC : Material Reciept Certificate
V : Visual

FIELD QUALITY PLAN FOR LA **ITEM : ERECTION WORK**

SUB SYSTEM : Lightening Arrestor

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Accep- tance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Completeness of documents, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan	MRC	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination for damage & defects	V	-	B	100%	Packing list / Instruction Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of approved drawing / Instruc- tion Manuals	-	
2.2	Availability of all materi- als	V	-	B	100%	Packing list, Ap- proved drawing & Bill Of Material	-	
2.3	Verticality of support structure	V	-	B	100%	GA/ Structural drawing	-	
3	**INSTALLATION**							
3.1	Rating plate details	V	-	B	100%	instruction manual	Site record	
3.2	Check cleanliness of surfaces of the arrester and check Megger value.	Test	Meggar	B	100%	Instruction manual	-	
3.3	Check base of the surge arrestor.	V	-	B	100%	Instruction manual	-	

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Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.4	Check the tightness of equipment base with structure.	V	-	B	100%	Instruction manual	-	
3.5	Ensure that the explo- sion vent of the LA is away from adjacent critical equipment.	V	-	B	100%	Instruction manual	-	
3.6	Check earthing provision and connection tight- ness.	V	-	B	100%	Instruction manual	-	
3.7	Check clearance be- tween live part to earth part.	V	-	B	100%	Instruction manual	-	
3.8	Check overall alignment of LA.	V	-	B	100%	Instruction manual	-	
3.9	Mounting height of LA	Measure	-	B	100%	Instruction manual	Site record	
4	**PRE COMMISSIONING**							
4.1	IR Value test	Test	Meggar	A	100%	Instruction manual	TC	
4.2	Check for resistance of ground connection.	Test	-	B	100%	Instruction manual	TC	
4.3	Earth continuity test	Test	Earth Megger	B	100%	Instruction manual	TC	
4.4	Final Document review	V	-	B	100%	instruction manual / final document list	TC	

CONTRACTOR'S SIGNATURE NAME & SIGN OF APPROVING AUTHORITY

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FIELD QUALITY PLAN FOR PAINTING

IITEM : ERECTION WORK

SUB SYSTEM: PAINTING

Sr. No.	CHARACTERIS-TICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep-tance Standard	"Format Of Records"	Remarks
1	2	3	4	5		7	8	9
1	**RECEIPT & STOR- AGE**							
1.1	Recveiving inspection	V		C	100%	Delivery Challan & Specification	MRC	
1.2	Proper storage	V		C	100%	5%	Site Records	
2	**PAINTING**							
2.1	De rusting from struc-tutres & other rusted part of the equipment	V	Wire Brush, emery paper	B	100%	As per EIC	-	
2.2	Red oxide zinc chromate paint on steel structures - Two Coats	V	Paint brush	B	100%	As per EIC / IS 2074	Site Records	
2.3	Synthetic enamel paint - Two Coats or more coats	V	Paint brush	B	100%	As per EIC / IS 2932	Site Records	
2.4	Aluminimum Paint - Two Coats or more coats	V	Paint brush	B	100%	As per EIC / IS 2339	Site Records	
2.5	Final document review	-	-	B	100%	Final document list	Site Records	

CONTRACTOR'S SIGNATURE NAME & SIGN OF APPROVING AUTHORITY

FIELD QUALITY PLAN

Item: ERECTION OF BPL CONNECTION

Sub-system:

SL. NO	MAIN ACTIVITY& OPERATION	CHARACTERIS - TICS / INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
SECTION 1 : BOUGHT OUT ITEMS OF BPL CONNECTION									
1	**RECEIPT AND STOR- AGE**	1) RECEIPT AT STORES	C	VISUAL CHECK	100%	APPROVED BOM AND APPROVED DRAWING	APPROVED MAKE OF THE ITEM	STORES REGISTER	
		2) VISUAL IN- SPECTION	C	VISUAL CHECK	100%		DAMAGED AND DE- FECTIVE COMPO- NENTS ARE TO BE REPLACED WITH GOOD ONE	STORES REGISTER	THE METER BOARD SHALL BE OF TEAK WOOD QUALITY OR HARD WOOD
		3) PROPER STORAGE	C	VISUAL CHECK	100%	STANDARD PRACTICE	STANDARD PRAC- TICE	STORES REGISTER	
SECTION : 2 FIXING OF BOARDS AND ACCESSORIES									
2	**FIXING OF BOARDS AND AC- CESSORIES**	1) IDENTIFYING AND MARKING THE POSITIONS WHERE THE COMPONENTS ARE TO BE ERECTED	C	VISUAL CHECK	100%	AS PER SPECIFICA- TION	AS PER APPROVED DRAWING	SITE REGIS- TER	CLEARANCE SHALL BE MAINTAINED AS PER APPROVED DRAWING AND AS PER SPECIFI- CATION
		2) FIXING THE SERVICE SUP- PORTS AND GUYS	C	VISUAL CHECK	100%	AS PER SPECIFICA- TION	AS PER APPROVED DRAWING	SITE REGIS- TER	THE SURFACE OF ALL SUP- PORTS SHOULD BE CLEANED.

S.NO	MAIN ACTIVITY& OPERATION	CHARACTERIS-TICS / INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		"3) FIXING OF THE WOODEN BOARDS (METER BOARD AND SWITCH BOARD)"	C	DIMEN-SIONAL	100%	AS PER SPECIFICA-TION	AS PER APPROVED DRAWING	SITE REGIS-TER	
		4) FIXING OF ALL OTHER ACCES-SORIES	C	VISUAL CHECK	100%	AS PER SPECIFICA-TION	AS PER APPROVED DRAWING	SITE REGIS-TER	
SECTION : 3 STRINGING OF SERVICE CABLE									
3	**STRINGING OF SERVICE CABLE**	1) HANDLING OF THE CABLE	C	VISUAL CHECK	100%	AS PER SPECIFICA-TION	CABLE SHOULD NOT BE DRAGGED ON THE GROUND	SITE REGIS-TER	CABLE SURFACE SHALL BE FREE FROM FAULTS, FLAWS e.t.c
		2) SEQUENCE OF CABLE EREC- TION	C	VISUAL CHECK	100%	AS PER SPECIFICA-TION	SEQUENCE OF RUNNING OUT SHALL BE FROM TOP TO BOTTOM, i.e.. THE TOP CABLE SHALL RUN OUT FIRST, FOLLOWED BY THE SIDE CABLES	SITE REGIS-TER	
		3) FIX THE G.I WIRE OF SER-VICE CABLE TO CLAMPS	C	VISUAL CHECK	100%	AS PER SPECIFICA-TION	SPECIFICATION / AS PER APPROVED DRAWING	SITE REGIS-TER	
		4) CHECK THE TIGHTNESS OF SERVICE CABLE WITH CLAMPS	C	VISUAL CHECK	100%	AS PER SPECIFICA-TION	AS PER THE STAN-DARD PRACTICE	SITE REGIS-TER	

S.NO	MAIN ACTIVITY& OPERATION	CHARACTERIS-TICS / INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		5) CHECK THE GROUND CLEARANCES AFTER EREC-TION OF THE SERVICE CABLE	C	VISUAL CHECK	100%	AS PER THE REC SPECIFI-CATIONS	AS PER IE RULES	SITE REGIS-TER	THE MINIMUM GROUND CLEAR- ANCES SHOULD BE MAINTAINED
SECTION : 4 EARTHING ARRANGEMENT									
4	**EARTHING ARRANGE-MENT**	1) LOCAL EARTHING OF BPL HOUSE HOLD	C	VISUAL CHECK	100%	STANDARD PRACTICE / IS 3043	IS 3043	SITE REGIS-TER	
		2) EARTHING OF GI SUPPORT WIRE	C	VISUAL CHECK	100%	STANDARD PRACTICE / IS 3043	IS 3043	SITE REGIS-TER	
SECTION : 5 CHARGING OF BPL CONNECTION									
4	**CHARGING OF BPL CONNEC-TION**	1) CHECK THE CONTINUITY OF CONNECTION	C	TEST	100%	STANDARD PRACTICE	STANDARD PRAC-TICE	SITE REGIS-TER	
		2) CONNECTION OF SERVICE LINE TO THE POLE	C	VISUAL CHECK	100%	STANDARD PRACTICE	STANDARD PRAC-TICE	SITE REGIS-TER	TAKE LINE CLEAR ON POLE FROM WHICH SERVICE LINE TO BE TAPPED
		3) CHARGING OF SERVICE CON-NECTION	C	VISUAL CHECK	100%	STANDARD PRACTICE	STANDARD PRAC-TICE	SITE REGIS-TER	CHECK FOR ANY ABNORMALITIES AT THE BOARD

FIELD QUALITY PLAN FOR VCB

Sr. No.	CHARACTERISTICS / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep- tance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Complete-ness of documents, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan	MRC	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination for damage and defects	V	-	B	100%	Packing list / Instruc-tion Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of Approved drawing/ Instruction Manual	-	
2.2	Availability of all materials	V	-	B	100%	Packing list ,Ap-proved drawing & Bill of Material	-	
2.3	VCB foundation	V	-	B	100%	Civil foundation drawing	-	
2.4	VCB Support structure (Level & Verticality)	V	-	B	100%	GA/ Structural draw-ing	-	
3	**INSTALLATION**							
3.1	Before erection check adequacy of lifting device.	V	-	B	100%	instruction manual	-	

Sr. No.	CHARACTERISTICS / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep- tance Standard	"Format Of Records "	Remarks
3.2	Ensure that breaker are erected with proper handling equipment, check slings, dereck/tripod & rope .	V	-	B	100%	instruction manual	-	
3.3	Ensure erection has been done as per approved drawing and manual.	V	-	B	100%	GA / equipment detai drawing	-	
3.4	Check for Individual pole and CB alignment.	V	-	B	100%	instruction manual	-	
3.5	Check for the tightness of pole base bolt with structure.	V	-	B	100%	instruction manual	-	
3.6	Check for the checknut tight- ness of tie rod. (if applicable)	V	-	B	100%	instruction manual	-	
3.7	Check for cable termination, ferrules and cable tags are provided (with proper lugs and glands)	V	-	B	100%	instruction manual	-	
3.8	Lubricate all the moving parts of the CB.	V	-	B	100%	instruction manual	-	
3.9	Earthing of support structure & VCB frame.	V	-	B	100%	instruction manual	-	
4	**PRE-COMMISSIONING**							
4.1	Check correct installation of circuit breaker & operating mechanism as per instruction manual.	V	-	B	100%	instruction manual	-	
4.2	Insulation resistance of each pole	Test	Megger	A	100%	instruction manual	TC	
4.3	Insulation resistance of control circuits, motor etc.	Test	Megger	A	100%	instruction manual	TC	

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Sr. No.	CHARACTERISTICS / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep- tance Standard	"Format Of Records"	Remarks
4.4	Resistance of closing & trip-ping coils.	Test	Multimeter	A	100%	instruction manual	TC	
4.5	Minimum pick up volts of coils	Test	Multimeter	A	100%	instruction manual	TC	
4.6	Contact resistance	Test	Multimeter	A	100%	instruction manual	TC	
4.7	Breaker closing & tripping time	V	-	A	100%	instruction manual	TC	
4.8	Functional checking of all ac-cessories.	Test	Multimeter	B	100%	instruction manual	TC	
4.9	Functional checking of control circuits, tripping through pro-tective relays and auto reclose operation.	Test	Multimeter	B	100%	instruction manual	TC	
4.10	Final document review	V	-	B	100%	instruction manual/fi-nal document list	TC	

CONTRACTOR'S SIGNATURE		NAME & SIGN OF APPROVING AUTHORITY

Legends :
CLASS OF CHECK:
A -- CRITICAL B -- MAJOR
C-- MINOR
TC : Test Certificate
MRC : Material Reciept Certificate
V : Visual
EIC : Engineer In Charge

FIELD QUALITY PLAN

Item: DTR STRUCTURE AND COMPONENTS

Sub-system: ERECTION TRANSFORMER STRUCTURE

SECTION - I : MS GALVANIZED COMPONENTS

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
1	RECEIPT AND STOR-AGE	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL- LAN / MDCC DESCRIP- TIONS	SITE REGISTER	COMPONENTS WHICH ARE INSPECTED AND CLEARED SHALL ONLY BE ACCEPTED
		2) VISUAL INSPECTION	C	VISUAL	100%		DAMAGED AND GALVA-NISATION DEFECTIVE COMPONENTS ARE TO BE STACKED SEPA- RATELY	STORES REGIS-TER	
		3) PROPER STORAGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	ALL G.I. COMPONENTS SHOULD BE STACKED ON WOODEN SLEEP- ERS AND THE STOR- AGE AREA SHALL BE FREE FROM WATER LOGGING	STORES REGIS-TER	
2	FIXING OF MS COM-PONENTS	1) CHECK THE ALIGN MENT OF TWO POLES	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	BOTH THE POLES SHOULD BE PARALLEL TO EACH OTHER AND SHOULD BE PLANTED AT SAME DEPTH
		2) FIX THE TOP CHAN-NEL	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	CHECK THE ALIGNMENT OF THE TOP CHANNEL WITH THE POLE

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		3) FIX THE FISH PLATE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	THESE FISH PLATE SHOULD BE PLACED RIGIDLY AND HOLES ARE TO BE CHECKED
		3) FIX THE BELTING ANGLES WITH BELT-ING ANGLE BACK CLAMP	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	ANGLES SHOULD BE FIXED FROM SPECIFIED FROM GROUND
		4) HORIZON-TAL ALIGN-MENT OF THE BELT-ING ANGLE WITH POLES	C	DIMEN-SIONAL	100%	APPROVED DRAWING	APPROVED DRAWING	SITE REGISTER	
		5) FIX THE BRACING ANGLES WITH BRAC-ING ANGLE CLAMP	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	THE BOLTS AND NUTS SHALL BE TIGHT ENOUGH TO HOLD THE BRACING TO THE POLE
		6) ALIGN-MENT OF THE BRAC-ING ANGLE WITH BELT-ING ANGLES	C	DIMEN-SIONAL	100%	APPROVED DRAWING	APPROVED DRAWING	SITE REGISTER	THE ANGLE BETWEEN THE TWO BRACING SHOULD BE 900 AND SHOULD BE RIGID ENOUGH TO BEAR THE FORCES

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S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
3	**STAY / GUY ERECTI ON**	8.1) LOCA-TION FOR THE GUY SETS	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS		SITE REGISTER	AS PER APPROVED DRAWING THE NUMBER OF STAYS ARE TO BE ERECTED
		8.2) EXCA-VATION OF PIT SIZE 0.5M X 0.5M X 1.6M	C	DIMEN - SIONA L	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REC CONSTRUCTION STANDARD G-1	SITE REGISTER	
		8.3)SIZING OF ANCHOR PLATE	C	DIMEN - SIONA L	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REC CONSTRUCTION STANDARD K-1	SITE REGISTER	
		8.4)GROUT-ING OF ANCHOR PLATE AND ANCHOR ROD WITH EARTH	C	DIMEN - SIONA L	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS		SITE REGISTER	IF GUY WIRE IS FOUND HAZARDOUS IT SHOULD BE PROTECT- ED WITH ASBESTOS PIPE FILL WITH CON- CRETE

		FILL- ING							
		8.5)ANGLE BETWEEN STAY WIRE AND POLE	B	“MEA-SUREEMENT”	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REC CONSTRUCTION STANDARD G-1	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		8.7) EREC-TION TURN-BUCKLE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	REC CONSTRUCTION STANDARD G-1	SITE REGISTER	TURN BUCKLE ARE MOUNTED HALF WAY IN THE WORKING POSI-TION , THUS GIVING THE Max. MOVEMENT FOR TIGHTENING AND LOOSENING
		8.8) EN-SURE THE RIGIDNESS OF THE STRUC-TURE	C	VISUAL	100%	STANDARD PRACTICE	APPROVED DRAWING	SITE REGISTER	
SECTION - II : FIXING OF INSULATORS									
4	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL-LAN / MDCC DESCRIP-TIONS	SITE REGISTER	COMPONENTS WHICH ARE INSPECTED AND CLEARED BY PIA SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%		THE SURFACE OF THE INSULATOR IS TO BE THROUGHLY CHECKED AND CLEANED, THE THREADING OF THE INSULATOR IS TO BE CHECKED	STORES REGIS-TER	DAMAGED INSULATORS ARE TO BE STACKED SEPARATELY
		3) PROPER STORAGE	C	VISUAL	100%	STANDARD PRACTICE		STORES REGIS-TER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC- TERISTICS/ INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
5	**FIXING OF INSULA-TORS**	1) CHECK THREADING OVER THE PINS AND INSULA- TORS AND CHECK THE ALIGNMENT OF PIN WITH INSU- LATOR	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	
		2) ASSEM- BLING THE GI PIN AND INSULA-TORS	C	VISUAL	100%	APPROVED DRAWING	APPROVED DRAWING		
		3) FIX THE PIN INSULA- TOR OVER THE FISH PLATES	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	PIN INSULATORS SHALL BE TIGHTENED RIGIDLY TO WITH STAND THE LOAD.
		4) CHECK THE CLEAR-ANCES BETWEEN THE INSU- LATORS	B	DIMEN-SIONAL	RANDOM	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	APPROVED DRAWING		FOR CHECKING THE CLEARANCES SUITABLE TEMPLATE/ JIGS ARE TO BE USED
		5) NOW FIX THE RE-SPECTIVE DISC IN-SULATORS WITH DISC INSULATOR CLAMPS	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	AS PER APPROVED DRAWING	SITE REGISTER	DEPENDING ON TYPE OF LOCATION T&C OR B&S ARE TO BE USED AS PER APPROVED DRAWING

S. NO	MAIN ACTIVITY& OPERA-TION	CHARACTERIS-TICS/INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		6) CHECK THE CLEARANCES BETWEEN THE INSULATORS	B	DIMEN-SIONAL	RANDOM	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	APPROVED DRAWING		FOR CHECKING THE CLEARANCES SUIT- ABLE TEMPLATE/ JIGS ARE TO BE USED
SECTION - III : FIXING OF 11KV HG FUSE									
6	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL-LAN	STORES REGIS-TER	COMPONENTS WHICH ARE IN-SPECTED AND CLEARED SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%		DAMAGED AND DEFEC-TIVE EQUIPMENT SHALL BE STACKED SEPARATELY	STORES REGIS-TER	MAJOR DAMAGED MATERIAL SHALL BE DISCARDED.
		3) PROPER STORAGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	THE HG FUSE COM-PONENTS SHALL BE STORED ON WOODEN PLATFORM OF 300mm DEPTH	STORES REGIS-TER	
7	**FIXING OF HG FUSE SET**	1) RATING PLATE DETAILS	C	VISUAL	100%	STANDARD PRACTICE	APPROVED DRAWINGS	STORES REGIS-TER	
		2) CHECK LEVEL & ALIGN-MENT OF THE BASE, HOUS-ING ASSEMBLY & FLANGS	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	
		3) CHECK FOR THE CLEARANCE BETWEEN LIVE PART TO EARTH	B	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
SECTION - IV : ERECTION AND COMMISSIONING OF LINE SECTIONALIZER / AB SWITCH									
8	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL- LAN	STORES REGIS-TER	COMPONENTS WHICH ARE INSPECTED AND CLEARED SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%		DAMAGED AND DEFEC- TIVE EQUIPMENT SHALL BE STACKED SEPARATELY	STORES REGIS-TER	MAJOR DAMAGED MATERIAL SHALL BE DISCARDED.
		3) PROPER STORAGE	C	VISUAL	100%	STANDARD PRACTICE	THE AB SWITCH COM-PONENTS SHALL BE STORED ON WOODEN PLATFORM OF 300mm DEPTH	STORES REGIS-TER	
9	**FIXING OF LINE SECTION-ALIZER/ AB SWITCH**	A) INSTAL-LATION							
		1) RAT- ING PLATE DETAILS	C	VISUAL	100%	STANDARD PRACTICE	APPROVED DRAWING	SITE REGISTER	
		2) CHECK FOR PROPER SLING AND LIFTING	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	
		3) CHECK TIGHTNESS OF BASE BOLTS AND OTHER BOLTED JOINTS BY TORQUE WRENCH	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		4) CHECK LEVEL & ALIGN-MENT OF THE BASE, HOUSING ASSEMBLY & FLANGES	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	
		5) ENSURE PROPER ERECTION OF POLES, MAIN BLADE & DRIVE ASSEMBLY AS PER APPROVED DRAWINGS	C	VISUAL	100%	STANDARD PRACTICE	APPROVED DRAWING	SITE REGISTER	
		6) CHECK FOR THE ALIGNMENT AND VERTI-CALITY OF SECTIONAL-IZER	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
		7) CHECK FOR THE CLEARANCE BETWEEN LIVE PART TO EARTH	B	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARACTER-ISTICS/IN-STRUMENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		9) CHECK FOR NO VI-BRATION OR ROTATION OF CONTACTS INSULATORS DURING ISOLATOR OPERATION	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	
		10) CHECK FOR THE PROVISION OF EARTHING AND EARTH CONNECTION	C	VISUAL	100%	STANDARD PRACTICE	APPROVED DRAWING	SITE REGISTER	
		11) CHECK OPERATION OF THE ISOLATOR BY ROTAT-ING ONE OF THE INSULA-TOR STACK MANUALLY AND ADJUST THE LENGTH OF THE CROSSED TANDEM ASSEMBLY TO ENSURE PROPER ENGAGE-MENT OF CONTACTS DURING CLOSING.	B	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAW-ING\	SITE REGISTER	ENSURE THE ENTIRE STRUCTURE SHOULD BE RIGID AND CHECK THE RIGIDNESS BY OERATING THE AB SWITCHES

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
10	**PRE COM-MISSIO N- ING**	1) CHECK FOR VISUAL DAMAGE TO ANY PARTS INCLUDING PORCELAIN ISOLATOR	C	VISUAL	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
		2) CHECK MANUAL / OPERTION AND INTER LOCKS	B	VISUAL CHECK	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
		3) IR VALUE BETWEEN EARTH TO POLE	B	VISUAL CHECK	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
		4) GROUND CONNEC-TIONS	C	VISUAL CHECK	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
		5) CHECK CONTINUITY	B	VISUAL CHECK	100%	STANDARD PRACTICE	INSTRUCTION MANUAL / APPROVED DRAWING\	SITE REGISTER	
SECTION - V : ERECTION & COMMISSIONING OF DTRS									
11	**RECEIPT AND STOR-AGE**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL-LAN / MDCC DESCRIP-TIONS	STORES REGIS-TER	TRANSFORMERS AND ACCESSORIES IN- CLUDING LAs WHICH ARE INSPECTED AND CLEARED SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%	APPROVED DRAWING	DAMAGED COMPO-NENTS SHALL BE STAGED SEPARATELY	STORES REGIS-TER	MAJOR DAMAGED MATERIAL SHALL BE DISCARDED.

S. NO	MAIN ACTIVITY& OPERA-TION	CHARACTERIS-TICS/INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RE-CORD	REMARKS
		3) PROPER STOR- AGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	THE TRANSFORMERS AND THE ACCES-SORIES SHALL BE STACKED ON DRY LEVELLED AND RAISED PLATFORM. ALL PIPE WORK CONSERVA- TORS, RADIATORS SHOULD BE STORED WITH THEIR BLANKING PLATES IN POSITION HEATERS IN THE MARSHELLING BOX SHOULD BE KEPT ENERZIZED TO AVOID CONDENSATION	STORES REGISTER	
12	**ERECTI ON OF TRANS-FORME RS**	1) ENSURE THE REGIDNESS OF THE STRUCTURE OVER WHICH TRANFORMER IS TO BE ERECTED	C	VISUAL	100%	STANDAR D PRACTICE	AS PER APPROVED DRAWING	SITE REGISTER	

		2) LIFTING OF THE TRANFORM-ERS	C	VISUAL	100%	AS PER MANUFAC - TURER IN-STRUCTIO N MANUAL	"VERTICALITY OF THE TRANFORMERS SHALL BE MAINTAINED HV / LV ORIENTATION OF THE TRANFORMER SHALL BE CHECKED"	SITE REGISTER	
		3) ENSURE PRO- POER SITTING OF THE TRANS-FORMER OVER THE STRUCTURE	C	VISUAL	100%	STANDAR D PRACTICE	THERE SHOULD NOT BE ANY MOVEMENT OF THE TRANFORMER AND TRANSFORMER SHALL BE FIXED RIG- IDLY TO THE STRUC- TURE	SITE REGISTER	THE BOLTS AND NUTS SHALL BE TIGHT ENOUGH TO HOLD THE TRANSFORMER WITHOUT ANY SHAKE

S. NO	MAIN ACTIVITY& OPERA-TION	CHARACTERIS-TICS/INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFER-ENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		4) HV / LV POSI-TION	C	VISUAL	100%	AS PER MANUFAC-TURER IN-STRUCTION MANUAL	AS PER APPROVED DRAWING	SITE REGISTER	AIR CLEARANCE SHOULD BE AS PER APPROVED DRAW- ING
		5) OTHER ACCES-SORIES LIKE LAs, BUSHINGS, CON-NECTORS ETC. ARE ERECTED	C	VISUAL	100%	AS PER MANUFAC-TURER IN-STRUCTION MANUAL	AS PER APPROVED DRAWING	SITE REGISTER	AIR CLEARANCES SHOULD BE AS PER APPROVED DRAW- ING
13	**PRE COMMIS-SIONING CHECKS**	1) INSULATION RESISTANCE	A	TEST	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS		SITE REGISTER	A 5 KV MEGGER PREFERABLY MO- TOR OPERATED SHOULD BE USED FOR MEASURING HIGHER VALUES. BUSHINGS ARE THROUGHLY CLEANED BE- FORE TAKING IR VALUES. IR VALUES BETWEEN WINDINGS AND BETWEEN WIND- INGS TO EARTH ARE CHECKED. WHILE CHECKING THESE VALUES, NO EXTERNAL LINES or LIGHTNING AR-RESTERS SHOULD BE IN CIRCUIT.
		2) OIL DIEELEC-TRIC STRENTH TEST	A	TEST	100%	AS PER IN-STRUCTION MANUAL	IS : 335 SAMPLES FROM TOP AND BOT-TOM OF TRANFORMER ARE TESTED, IF REQUIRED	SITE REGISTER	

S. No.	MAIN ACTIVITY& OPERA-TION	CHARAC- TERISTICS/ INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		3) GENERALCHECKS							
		a) ALL OIL VALVES ARE IN CORRECT POSITION, CLOSED OR OPENED AS REQUIRED	C	VISUAL	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	
		b) ALL AIR POCK-ETS ARE CLEARED	C	TEST	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	
		c) THER-MOMETER POCKETS ARE FILLED WITH OIL	C	TEST	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	
		d) OIL IS AT CORRECT LEVEL IN THE TRAN- FORMERS	B	TEST	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	
		e) EARTH-ING CON-NECTIONS ARE DONE	C	TEST	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	
		f) ARCING HORN GAPS ON BUSH-INGS ARE PROPERLY ADJUSTED	C	TEST	100%	AS PER IN-STRUCTION MANUAL		SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
14	**ENERZIS A- TION**	CHARGING THE TRANS-FORMER	A	VISUAL	100%	AS PER IN-STRUCTION MANUAL	NO ABNORMILITY SUCH AS VIBRATION OF THE PARTS, HUM NOISE SHOULD BE ABSORBED	SITE REGISTER	ABNORMILITIES IF NOTICED SHOULD BE CORRECTED AFTER FEW HOURS OF ENER-ZISATION AT NO LOAD.
SECTION - VI : EARTHING OF DTR STATION									
15	**IDENTIFI-CATION OF THE EARTH PITS AND EARTHIN G EQUIP-MENT**	1) IDEN- TIFY THE LOCATION WHERE THE EARTHING IS TO BE DONE	A	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN-DARDS	SITE REGISTER	
		2) IDENTIFY THE TRANS-FORMER NEUTRAL TERMINAL, LA TERMI- NAL AND OTHER ACCESSO-RIES	A	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN-DARDS	SITE REGISTER	
16	**PIPE TYPE EARTHIN G INSTALLA - TION OF DP STRUC-TURE**	1) EXCAVA-TION OF PIT SIZE	C	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN-DARDS J2	SITE REGISTER	
		2) INSTALL 40 DIA GI PIPE WITH 12 DIA HOLES IN THE PIT	C	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN-DARDS J2	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC- TERISTICS/ INSTRU- MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		3) FILL THE PIT WITH ALTERNATE LAYERS OF 300 mm CHAR COAL AND SALT	A	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN- DARDS J2	SITE REGISTER	IN CASE OF THE ORDINARY SOILS WHERE PIPE COULD HAMOURED IN, TREAT- MENT OF THE PIT WITH CHARCOAL AND SALT IS NOT NECESSARY
		4) CON- NECTIONS BETWEEN THE PIPE AND POLE WITH 8mm SWG WIRE	C	VISUAL	100%	AS PER APPROVED DRAWING	REFERE REC CON-STRUCTION STAN- DARDS J2	SITE REGISTER	
		5) CONNECT THE EQUIP- MENT TO BE EARTHED AND THE PIPE EARTHE TERMINALS WITH GI WIRE	C	VISUAL	100%	AS PER APPROVED DRAWING	THERE SHOULD NOT BE ANY LOOSE CON- NECTIONS	SITE REGISTER	
17	TESTING OF EARTH RESISTIV-ITY	TESTING OF EARTHING	A	TEST	100%	STANDARD PRACTICE	INSTRUCTION MANUAL	SITE REGISTER	
SECTION - VII : ERECTION OF DANGER BOARDS AND ANTICLIMBING DEVICES									
18		1) FIXING OF DANGER BOARDS	C	VISUAL	100%	INSTRUC- TION MANUAL	APPROVED DRAWINGS AND REC SPECIFICA- TION NO 57	SITE REGISTER	THE LANGUAGE OF LETTERINGS SHALL CONFIRM TO RULE NO 35 OF IE RULES 1956 AND SHALL BE IN HIN- DHI OR ENGLISH AND IN LOCAL LANGUAGE WITH SIGN OF SKULL AND BONES

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		2) EREC-TION OF ANTI CLIMBING DEVICES - BARBED WIRE	C	VISUAL	100%	INSTRUC-TION MANUAL	APPROVED DRAWINGS	SITE REGISTER	
SECTION - VIII : ERECTION AND COMMISSIONING OF LT DISTRIBUTION BOXES									
19	INSTALLA-TION	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL-LAN	STORES REGIS-TER	COMPONENTS WHICH ARE INSPECTED AND CLEARED SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPEC-TION	C	VISUAL	100%	APPROVED DRAWING	DAMAGED COMPO-NENTS SHALL BE STACKED SEPARATELY	STORES REGIS-TER	MAJOR DAMAGED MATERIAL SHALL BE DISCARDED.
		3) PROPER STORAGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	THE TRANSFORMERS AND THE ACCES-SORIES SHALL BE STACKED ON DRY LEVELLED AND RAISED PLATFORM. ALL PIPE WORK CONSERVA-TORS, RADIATORS SHOULD BE STORED WITH THEIR BLANKING PLATES IN POSITION HEATERS IN THE MARSHELLING BOX SHOULD BE KEPT ENERZIZED TO AVOID CONDENSATION	STORES REGIS-TER	
		4) EREC-TION OF LT DISTRI-BUTION BOXES	C	VISUAL	100%	STANDARD PRACTICE	AS PER APPRROVED DRAWINGS	SITE REGISTER	

S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		2) EREC-TION OF ANTI CLIMBING DEVICES - BARBED WIRE	C	VISUAL	100%	INSTRUC-TION MANUAL	APPROVED DRAWINGS	SITE REGISTER	
SECTION - VIII : ERECTION AND COMMISSIONING OF LT DISTRIBUTION BOXES									
19	**INSTALLA-TION**	1) RECEIPT AT STORES	C	VISUAL	100%	DELIVERY CHALLAN	CORRELATION OF THE LOT RECEIVED WITH THE DELIVERY CHAL- LAN	STORES REGIS-TER	COMPONENTS WHICH ARE INSPECTED AND CLEARED SHALL ONLY BE ACCEPTED ON RECEIPT
		2) VISUAL INSPECTION	C	VISUAL	100%	APPROVED DRAWING	DAMAGED COMPO- NENTS SHALL BE STACKED SEPARATELY	STORES REGIS-TER	MAJOR DAMAGED MATERIAL SHALL BE DISCARDED.
		3) PROPER STORAGE	C	VISUAL	100%	UTILITY / REC SPECI-FICATION or AS PER AC-CEPTANCE NORMS	THE TRANSFORMERS AND THE ACCES- SORIES SHALL BE STACKED ON DRY LEVELLED AND RAISED PLATFORM. ALL PIPE WORK CONSERVA- TORS, RADIATORS SHOULD BE STORED WITH THEIR BLANKING PLATES IN POSITION HEATERS IN THE MARSHELLING BOX SHOULD BE KEPT ENERZIZED TO AVOID CONDENSATION	STORES REGIS-TER	
		4) EREC-TION OF LT DISTRIBU-TION BOXES	C	VISUAL	100%	STANDARD PRACTICE	AS PER APPRROVED DRAWINGS	SITE REGISTER	

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S. NO	MAIN ACTIVITY& OPERA-TION	CHARAC-TERISTICS/ INSTRU-MENTS	CLASS OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK - Engineer-in-Charge	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	RE MARKS
		5) EARTH-ING OF LTDB	B	VISUAL	100%	STANDARD PRACTICE	AS PER APPRROVED DRAWINGS	SITE REGISTER	COVER OF THE BOX IS ALSO TO BE EARTHED BY WAY OF FLEXIBLE COPPER LINK OF SUIT- ABLE DIMENSION
	CLASS OF CHECK: A -- CRITICAL B -- MAJOR C-- MINOR								

NAME/ SIGNATURE OF THE CONTRACTOR/ ERECTION AGENCY

FIELD QUALITY PLAN FOR CT & PT

ITEM : ERECTION WORK

SUB SYSTEM : CT/ PT

DATE :

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Completeness of docu- ments, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan & Specification	MRC / Check List	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination for damage & defects	V	-	B	100%	Packing list / Instruc- tion Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of approved drawing / Instruction Manuals	-	
2.2	Availability of all materi- als	V	-	B	100%	Packing list, Ap- proved drawing & Bill Of Material	-	
2.3	CT foundation	V	-	B	100%	Civil foundation drawing	-	
2.4	Vertically of support structure	V	-	B	100%	GA/ Structural draw- ing	-	
3	**INSTALLATION**							
3.1	Rating plate details	V	-	B	100%	instruction manual	Site record	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep- tance Standard	"Format Of Records "	Remarks
1	2	3	4	5	6	7	8	9
3.2	Check that the C.T. have been installed in proper polarity (P1 & P2 position)	V	-	B	100%	As per EIC/SLD	-	
3.3	Check for the tightness of equipment base bolts with	V	-	B	100%	instruction manual	-	
3.4	Check overall alignment of C.T.	V	-	B	100%	instruction manual	-	
3.5	Check for the primary ratio connected as per requirement.	V	-	B	100%	Rating plate	-	
3.6	Earthing of support structure & CT frame.	V	-	B	100%	instruction manual	-	
3.7	Check provision of earthing and tightness of earthing connection.	V	-	B	100%	instruction manual	-	
3.8	Check for the tightness of clamps/connectors.	V	-	B	100%	instruction manual	-	
3.9	Check for secondary ter- mination tightness and crimping of leads.	V	-	B	100%	instruction manual	-	
3.10	Check the cable tags and ferrules are pro- vided	V	-	B	100%	Cable schedule	-	
3.11	Ensure that unused secondary core are cor- rectly shorted.	V	-	B	100%	instruction manual	-	
3.12	R,Y,B identification	V	-	B	100%	-	-	
3.13	Check for oil leackages	V	-	B	100%	instruction manual / No leackages	Site record	

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S. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Docu- ments & Accep- tance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.14	Check verticality of equipment on support structure	V	-	B	100%	instruction manual	Site record	
4	**PRE COMMISSIONING**							
4.1	Measure IR value using meggar		Megger	A	100%	instruction manual	TC	
	a. Primary to secondary cores and earth with 2.5 kV.	Test						
	b. Between secondary cores.	Test						
	c. Between secondary to earth.	Test						
4.2	Check polarity.	Test	Multimeter/ Dry cell	A	100%	instruction manual / SLD	TC	
4.3	Check for CT ratio by primary Injection method.	Test	Primary injection kit	A	100%	instruction manual	TC	
4.4	Magnetising curve	Test	-	B	100%	instruction manual	TC	
4.5	Final document review	-	-	B	100%	instruction manual/fi- nal document list	TC	
CONTRACTOR'S SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY					

FIELD QUALITY PLAN FOR Control & Relay Panel

ITEM : ERECTION WORK

SUB SYSTEM : Control & Relay Panel

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Completeness of documents, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan & Specification	MRC / Check List	
1.2	Unloading	V	-	B	100%	Instruction Manual	Site record	
1.3	Visual exmination for damage & defects	V	-	B	100%	Packing list / Instruction Manual	Site record	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of approved drawing / Instruction Manuals	Site record	
2.2	Availability of all materi- als	V	-	B	100%	Packing list, Approved drawing & Bill Of Material	Site record	
2.3	Panel inatallation space	V	-	B	100%	Control room detail	-	
3	**INSTALLATION**							
3.1	Rating plate details	V	-	B	100%	instruction manual	Site record	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.2	Verticality & levelling of panels on support stuctures.	Measure	-	B	100%	instruction manual	Site record	
3.3	Check earth bus con- nection	V	-	B	100%	instruction manual	Site record	
3.4	Check the floor leveling where the panels are to be installed.	V	-	B	100%	As per site conditionss	-	
3.5	Check the physical con- diton of the panels after opening the packing and verify the material as per BOM.	V	-	B	100%	Specification	Site record	
3.6	Ensure the panels are lifted using proper slings/ tackles.	V	-	B	100%	Erection manual	-	
3.7	Check the panels are levelled, aligned and erected properly.	V	-	B	100%	As per site conditionss	-	
3.8	Removal of top and side blanking plates.	V	-	B	100%	Approved panel drawing	-	
3.9	Inter panel wiring is comleted as per draw- ing.	V	-	B	100%	Approved panel drawing	-	
3.10	Check the tightness of inter panel nuts and bolts, Main bus, earth bus connection etc.	V	-	B	100%	Approved panel drawing	-	
3.11	Checked for broken glass, switch handle, lamp cover etc.	V	-	B	100%	Approved panel drawing	-	
3.12	Glanding of external cables	V	-	B	100%	Approved panel drawing	-	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	QUANTUM OF CHECK - Engineer-in-Charge	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
1	2	3	4	5	6	7	8	9
3.13	Blanking of unused cable entry locks	V	-	B	100%	Approved panel drawing	-	
3.14	Proper sealing & locking arrangement of panel door	V	-	B	100%	Approved panel drawing	-	
4	**PRE COMMISSIONING**							
4.1	Circuit diagram check	V	-	B	100%	Approved panel drawing	TC	
4.2	Auxiliary power supply test	Test	Multimeter	B	100%	Approved panel drawing	TC	
4.3	Functional & operation test of fittings on the panels.	V	-	B	100%	Approved panel drawing	TC	
4.4	Relay settings as per recommendation	V	-	B	100%	Approved panel drawing	TC	
4.5	Scheme check	V	-	B	100%	Approved panel drawing	TC	
4.6	IR Value check	Electrical	Megger	A	100%	Instruction manual	site record	
4.7	Secondary injection test for relays	Electrical	Injection kit	A	100%	Instruction manual	site record	
4.8	Check minimum pick up & drop out voltage of all coils & auxiliary contacts	Electrical	Voltmeter	A	100%	Instruction manual	site record	
4.9	Final document review	V	-	B	100%	Approved panel drawing / Final document list	TC	
CONTRACTOR'S SIGNATURE							NAME & SIGN OF APPROVING AUTHORITY	

Legends :
"CLASS OF CHECK:
A -- CRITICAL B -
- MAJOR
C--MINOR MRC: Material Reciept Certificate TC: Test Certificate V : Visual
EIC : Engineer In Charge

ITEM : ERECTION WORK								
DC SYSTEM								
Sr. No.	**CHARACTERISTICES / ITEMS**	**Type of Check**	**Instruments**	**Class**	**Quantum/ Frequency**	**Reference Documents & Acceptance Standard**	**"Format Of Records"**	**Remarks**
1	2	3	4	5	6	7	8	9
1	**RECEIPT & STORAGE**							
1.1	Receiving inspection (Com- pleteness of documents, test certificates, instruction manual etc.)	V	-	B	100%	Delivery Challan & NESCL Specification	MRC / Check List / DC / 06	
1.2	Unloading	V	-	B	100%	Instruction Manual	-	
1.3	Visual exmination for dam- age & defects	V	-	B	100%	Packing list / Instruc- tion Manual	-	
1.4	Proper storage	V	-	B	100%	Instruction Manual	-	
2	**PRE INSTALLATION**							
2.1	Availability of instruction manual and drawing, lifting arrangement	V	-	B	100%	List of approved drawing / Instruction Manuals	-	
2.2	Availability of all materials	V	-	B	100%	Packing list, Ap- proved drawing & Bill Of Material	-	
2.3	Completion of civil / ventila- tion requirement of battery room.	V	-	B	100%	Control room detail	-	
3	**INSTALLATION - BATTERY**							
3.1	Rating plate details	V	-	B	100%	instruction manual	Site record	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	Quantum/ Frequency	Reference Documents & Acceptance Standard	Format Of Records	Remarks
3.2	Check availability of safety devices, water and first aid box.	V	-	B	100%	BOM / NESCL Specifcation	-	
3.3	Check installation of batteries and rack as per approved layout.	V	-	B	100%	Instruction Manual	-	
3.4	Check the specific gravity of the electrolyte prior to pouring in thecells.							
3.5	Check for availability of electrolyte level up to required level and there is no leakage.	V	-	B	100%	Instruction Manual	-	
3.6	Check alignment and level of each cell	V	-	B	100%	Instruction Manual	-	
3.7	Check for tightness inter cell connection and application of grease.	V	-	B	100%	Instruction Manual	-	
3.8	Check for provision of earthing and tightness of earthing connection. Ensure cell are not earth anywhere.	V	-	B	100%	Instruction Manual	-	
3.9	Checkallcellno.areproperly fixed and are visible.	V	-	B	100%	Instruction Manual	-	
3.10	The cabling from Battery Charger to first, last and tap cells iscompleted.	V	-	B	100%	Instruction Manual	-	
3.11	Check all the cells are connected incorrectpolarity.	V	-	B	100%	Instruction Manual	-	
3.12	Painting ofbatterystand	V	-	B	100%	Instruction Manual	-	
4	**INSTALLATION - BATTERY CHARGER**							

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	Quantum/ Frequency	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
4.1	Rating plate details	V	-	B	100%	instruction manual	Site record	
4.2	The quantity, ratings, type and make of the devices are as per the BOM as given in approved drawings.	V	-	B	100%	Instruction Manual	-	
4.3	No physical damages are there in any devices of the panels and replacement of damaged parts.	V	-	B	100%	Instruction Manual	-	
4.4	The inter panel Earth bus connections and connection to the earthing grid are tightened properly.	V	-	B	100%	Instruction Manual	-	
4.5	Fuses provided are of rating as shown in the approved drawings.	V	-	B	100%	Instruction Manual	-	
4.6	Check that the labeling of devices is as per the approved drawings.	V	-	B	100%	Instruction Manual	-	
4.7	Check the wiring is completed as per the approved drawings.	V	-	B	100%	Instruction Manual	-	
4.8	External cabling and termination with glands is completed as per the Cable schedule.	V	-	B	100%	Instruction Manual	-	
4.9	Cable tags, ferrules for cores are provided as per cable schedule.	V	-	B	100%	Instruction Manual	-	
4.10	Dressing and clamping of cables is done properly.	V	-	B	100%	Instruction Manual	-	

Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	Quantum/ Frequency	Reference Documents & Acceptance Standard	Format Of Records	Remarks
4.11	Check the phases sequence of the Mains supply to the battery charger.	V	-	B	100%	Instruction Manual	-	
4.12	Check functioning of all relays/meters/selector switches etc.	V	-	B	100%	Instruction Manual	-	
4.13	All alarms & annunciations, indications are functioning properly.	V	-	B	100%	Instruction Manual	-	
4.14	Check the Float & Boost charger operation, set the o/p voltage (if reqd).	V	-	B	100%	Instruction Manual	-	
4.15	Check the current limiting feature of charger & set the current limit (if reqd).	V	-	B	100%	Instruction Manual	-	
4.16	IR Value check	Measure	-	A	100%	Instruction Manual		
5	**PRE-COMMISSIONING**							
5.1	Check that all the assembly activities are completed.	V	-	B	100%	Instruction Manual	TC	
5.2	The cabling from Battery Charger to first, last and tap cells is completed.	V	-	B	100%	Instruction Manual	TC	
5.3	Check the polarity of the DC connection from Battery charger to Battery.	Test	Multimeter	B	100%	Instruction Manual	Site Record	
5.4	Check that the charging & discharging cycle is completed as per guidelines of manufacturer to prove battery AH capacity at 10 hr discharge rate.	V	-	A	100%	Instruction Manual/IS 1651	TC	

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Sr. No.	CHARACTERISTICES / ITEMS	Type of Check	Instruments	Class	Quantum/ Frequency	Reference Documents & Acceptance Standard	"Format Of Records"	Remarks
5.5	Recharge	Electrical	-	B	100%	Instruction Manual	Site record	
5.6	Final document review	V	-	B	100%	Approved panel drawing / Final document list	TC	

CONTRACTOR'S SIGNATURE NAME & SIGN OF APPROVING AUTHORITY

Legends :

"CLASS OF CHECK:

A -- CRITICAL -- TO BE WITNESSED BY NESCL SITE AND SURVEILLANCE BY NESCL, CC. B -

- MAJOR -- TO BE WITNESSED BY CONTRACTOR AND NESCL SITE

C-- MINOR -- TO BE WITNESSED BY CONTRACTOR AND SURVEILLANCE BY NESCL SITE"

TC : Test Certificate

MRC : Material Receipt Certificate

V : Visual

EIC : Engineer In Charge

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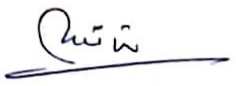
NOTE

This Handbook has been approved by Public Works Department, Govt. of Himachal Pradesh vide letter no. PW-CTR-29-/IQCS/2020-21/0252-53 dated 05/07/2021 and minutes of meeting no. PW/CTR-29-QCS/2020-21-297-10306 dated 05/07/2021. However, the provisions in the relevant manuals & IS Codes with upto date amendments shall supercede the provisions in this handbook in case of any variation.

For WAPCOS Ltd.



(Sumitt Mittal)
Addl. Chief Engineer & Project Manager
Chandigarh Office