Guidelines for Operation & Maintenance of Electro-Mechanical Equipment

Water Resources Department
Government of Andhra Pradesh
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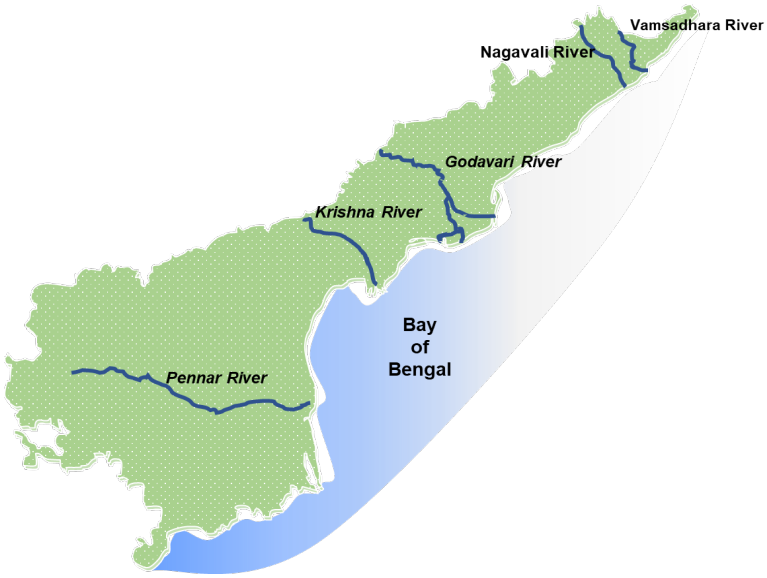
1. Introduction

Water is a scarce natural resource and a fundamental need of life. Water security is intimately tied to food security, livelihood, health, environment, economic development, and overall well-being of society. Managing water in days of rapid socio-economic growth and change is challenging.

Andhra Pradesh is a riverine state with about 40 major, medium, and minor rivers. The total water resources (surface water and groundwater) of Andhra Pradesh are estimated to be about 573 TMC. Most of the water is currently supplied for irrigation, although other needs are expected to grow in the future. The current trends of increase in water supply from all users will outstrip available supplies significantly by 2025



The state has about 40,000 minor irrigation sources spread over the thirteen districts. About 70% of the population of Andhra Pradesh is dependent on agriculture. The Geographical area of the state is about **402.70 lakh acres** out of which the total cultivable area is **199.04 lakh acres** and out of which the irrigation potential is created for **103.11 lakh acres** through the existing Major, Medium and Minor irrigation projects.

The state after its bifurcation has taken up the task of creating an ayacut of 1 Crore acres thereby increasing the overall IPC of the state to 2 Crore acres by adopting a multi-pronged strategy as follows:

a. Completing the ongoing priority projects in a time bound manner for irrigation needs

b. Enhancing the scope of certain existing and ongoing projects

c. Provide safe drinking water and meet the requirements for industrial water

For achieving the above, the state has given competes for irrigation infrastructure and accordingly have taken up number of projects which are in advanced stages of completion and cater to the IP when completed. Out of the 1 Crore acres to be created, 0.9 crore acres of IP shall be met by the ongoing projects and the state is progressing to achieve the target of 1 Crore acres.

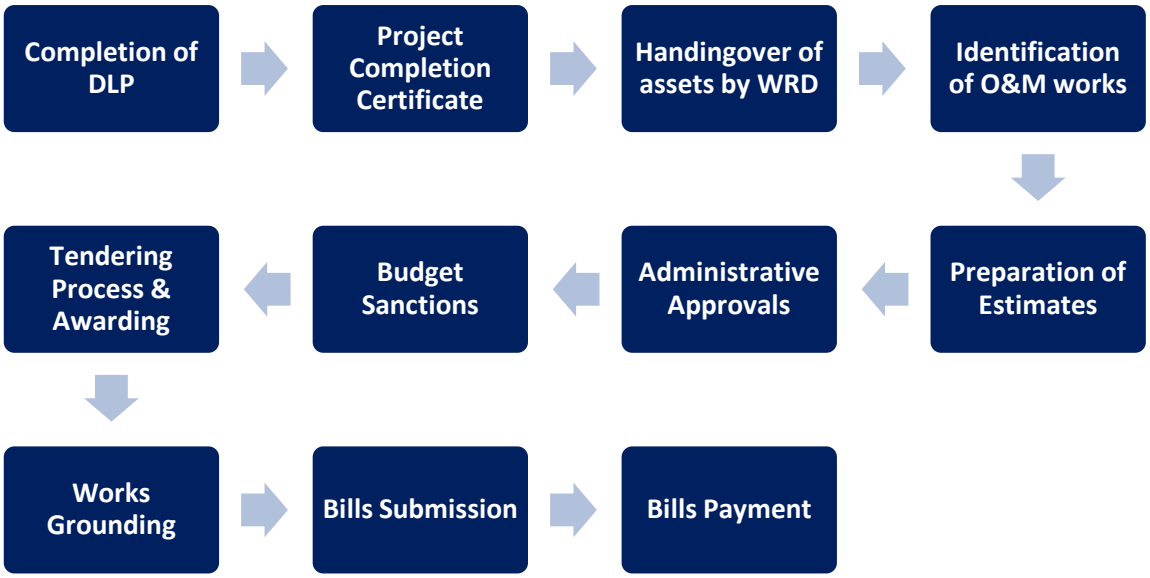
2. Need for robust O&M policy

The state of Andhra Pradesh has number of old projects which were commissioned many years ago, they have sustained extreme physical and weather conditions during their tenure. As years pass on due to the extreme and continuous pressure on the structures they tend to deteriorate and lose their designed capability. Either to predict or overcome these instances a periodic check has to be done from time to time in a paced manner.

Also, the ongoing projects once completed shall migrate into the **Operations and Maintenance phase.** Therefore, a comprehensive O&M manual on the key irrigation structural and electro-mechanical components such as canals, dams, reservoirs, LI schemes, gates, shutters etc. will be of immense help for optimum storage and water releases with improved water use efficiency.

2.1 Existing Procedure for completed projects

For all works taken up under **EPC mode**, post the issuance of the works completion certificate by the Executive Engineer, the **Defective Liability Period (DLP)** shall commence. The executing agency needs to fulfil its obligations as specified in the agreement towards carrying out the operations and maintenance works of all irrigation components in the DLP. Post completion of DLP, the executing agency shall apply for completion of DLP which shall be inspected by the concerned officer and report shall be submitted to the concerned circle.



In case of any damages / repairs to be taken up due to non-fulfilment of obligations by the executing agency, the concerned officer shall recover the costs which are expected to be incurred towards rectification of such damages / repairs from the agency and issue the completion certificate to the agency accordingly.

Necessary estimates shall be prepared based on the quantum of damages / repairs and submitted for approval to the Government. The Government shall review the proposals and issue administrative sanctions enabling the department to call for tenders. Once the tenders are awarded to the Agency followed by conclusion of agreements, works shall be grounded making progress against the defined scope of work.

2.2 Challenges in Existing Process

The existing system of preparation of estimates, obtaining sanctions for estimates, concluding agreements post tendering process is quite lengthier and may take considerable amount of time for grounding the works. In case of any unprecedented floods such mechanism when followed may further aggravate the damages to the water structures and adds to the further costs. Also due to restriction in carrying out works of similar nature – clause & explain its impact.

Based on the historical data, it is observed that there is considerable disparity in the administrative sanction amount vs. the proposed / requested amount making it difficult to attend all O&M needs in a comprehensive manner. Also, these O&M projects quite often

face mobilization challenges due to the lack of willingness from the top grade executing agencies and thereby depend on local / small agencies for executing the works. In case of specialized works requiring professionals with subject matter expertise shall further add to the delay in grounding the works.

2.3 Central Assistance Programs by GoI related to O&M

With an objective to improve the safety and operational performance of selected existing dams along with dam safety institutional strengthening the Government of India is implementing certain schemes which have a central component for funding the projects.

S.no	Name of the Scheme	Description
1	Dam Rehabilitation & Improvement Program (DRIP)	With financial assistance from the World Bank, GoI has initiated DRIP with an objective to improve the safety and operational performance
2	Dam Health and Rehabilitation Monitoring Application (DHARMA)	A system to monitor the health of dams, has been developed and is, at present, being used by 18 states`
3	Seismic hazard analysis information system (SHAISYS)	

Schemes such as **DRIP** are also co-financed by World Bank (WB) and Asian Infrastructure Investment Bank (AIIB) with **US$250 million** each, covers large dams in 19 states of the country The Budget Outlay for this scheme is **Rs 10,211 Cr** for an implementation period of ten (10) years. The scheme will be implemented in two Phases, each of six (6) years duration, with two (2) years' overlap. The program will fund physical rehabilitation of key dams as well as capacity building of dam operators in order to ensure the availability of trained and skilled manpower for better operation of dams.

3. Introduction to Electro-Mechanical Equipment

Regulating water discharges through dams, canals, tunnels, penstock, or other outlets for the purpose of irrigation, domestic use, flood control, navigation, power, etc., hydromechanical gates form the most vital component. Among the various types of gate installations, the vertical lift and radial gates are widely adopted in India and other parts of globe. Though the gates and allied works generally cost less compared to the total cost of the project, they are crucial structures in determining the success of the project performance and safety.

Therefore, reliable functional performance of gates is mandatory to assure safety of dams, storage, control, and surroundings. Even after performing best designs, manufacture and installation of gates, there are numerous experiences of gate failures.

The first being non-timely operation of the gates, due to many reasons, including lack of required skills among the field engineers operating staff. This aspect could be overcome by proper capacity building and adoption of scientific reservoir management techniques and safety plans. The second reason is the structural failure of gates itself, due to ineffective functional maintenance, omissions and negligence in preventive maintenance, operations, quality, and safety aspects, etc.

To ensure reliable performances of hydraulic gates and their operating equipment, periodic preventive maintenance is essentially adhered to. For all gate installations, the respective manufacturers and BIS standards provide preventive maintenance schedules, which shall be followed. The project engineers and their professional advisers, in charge of maintenance and operation of gates have full responsibility for ensuring the reliable operation. In addition, experienced engineers and experts in the field could be preferably associated for making a detailed and critical inspection as a second check, particularly in respect of the ageing gates and allied structures and when critical operational maintenance deficiencies are experienced. Such inspections should invariably review the maintenance program, health of the gates and hoist equipment, in addition to other allied civil structures and guide the field functionaries.

Inspection and trial testing at least twice a year i.e., pre-monsoon & post- monsoon, of the gates is very much necessary. Therefore, it is very essential to perform preventive maintenance operations of hydro mechanical gates for their smooth functioning, improved performance, and increased life. Some of the simple but critical checks in the maintenance

of gate installations, if not properly and timely examined and rectified, generally lead to structural damages and sometimes disastrous situations.

4. Gates

Gates are critical component in any water retaining structure as they regulate the inflows and outflows into the reservoirs. To achieve proper functioning of gated structures with hoisting equipment is more essential for which maintenance as per the manufacture's manual, IS Codes (IS: 10096 and IS: 7718) are needed.

Two types of gated structure are being adopted for monitoring and safe discharge of floods through spillways of Dam/ Barrages in Andhra Pradesh state which are

1) Wheeled type Vertical Gates operated by rope drum hoists

2) Radial gates operated by either rope drum or hydraulic hoists.

Further there is a provision of stoplog arrangement in the upstream of spillway gates for attending repairs whenever required without any hindrance for discharge of flood. The stoplog arrangement consists of stoplog elements for 10 percentage of no. of vents, which shall be stored on the piers duly secured at one pier each. They are operated for lowering / lifting with the help of movable gantry crane of suitable capacity.

Objectives of Maintenance:

- protecting hydraulic gates
- to extend the useful life by minimizing wear and tear, deterioration
- to ensure the operational readiness
- to ensure safety of dam and public
- to increase the utilization and reducing the down time.

4.1 Radial Gates

The Radial Gate is a different type of floodgate used to control the water flow through dam's' spillways and river barrage. The design of the Radial Gate consists of a reinforced curved skin plate with vertical stiffeners and horizontal beams to transfer the load to the main rotational arms located on either side. At the ends of the radial arms the rotation is being possible by a frame mounted 'trunnion' hub with bracket, fitted to yoke girder. This system enables circular rotation of the gate to be achieved during the 'opening/closing' operations. When closed, the outer curved surface of the skin plate is loaded against the water pressure with the radial arms and associated pivoting system located on the dry side.

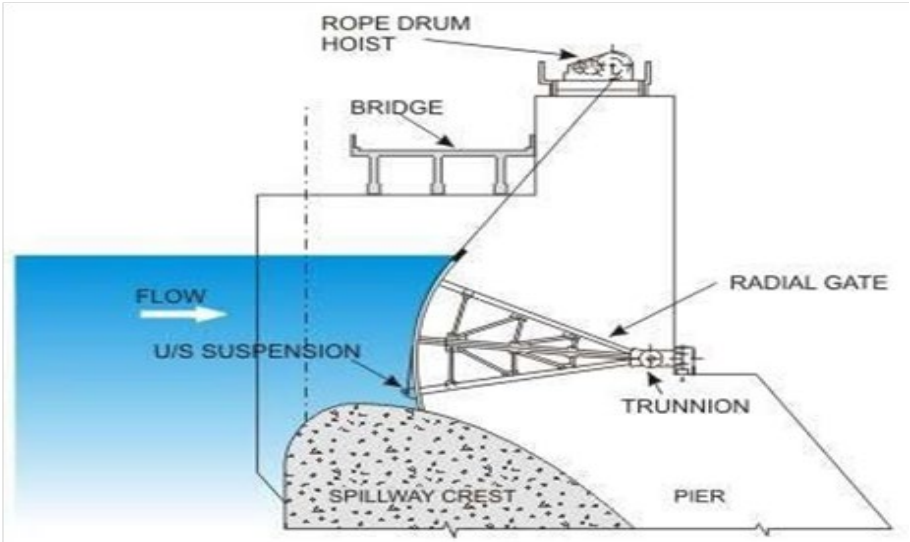


Fig: Radial Gate Shown With Rope Drum Hoisting Mechanism

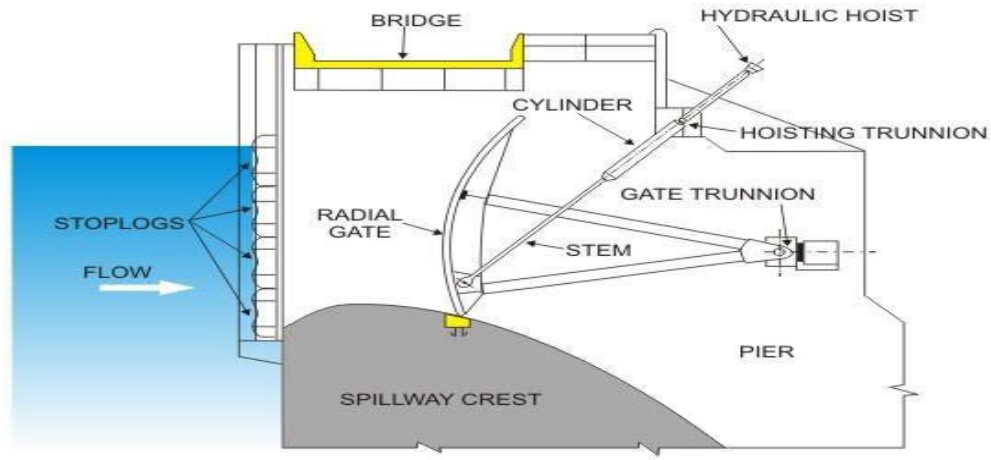


Fig: Modern Day Stoplogs Shown In Combination With A Radial Gate And Hydraulic Hoist

The Radial Gate and its operating system are divided into three groups i.e.,

I. Embedded parts- which are fixed in the concrete to transmit the load to civil construction.
II. Gate Leaf- Curved plate and its supporting structures which transfer the water thrust to embedded parts.
III. Operating system-Rope drum Hoists / Hydraulic hoists used for operation of gate.

Components:

Embedded Parts are primary and secondary. Primary EM parts are erected while raising the main civil pier. The primary and secondary EM parts are bounded in concrete with the help of dowel bars of suitable length and diameter to transmit the load to civil structure. The secondary EM parts shall be erected within the tolerances. Otherwise, the gate operation will be difficult. The secondary concrete shall be pressure grouted to avoid leakages.

1. Sill beam Assembly
2. Wall plate Assembly
3. Horizontal Anchor Rods/Tie flats
4. Trunnion Girder /Anchor Girder/ vertical chair
5. Trunnion girder chairs/Rest plate
6. Thrust block

Gate:

1. Curved Skin plate Supporting Structure of Skin Plate
2. Vertical stiffeners
3. Horizontal Girders
4. Horizontal girder bracings
5. Guide roller
6. Seal arrangement
7. Arm Assembly
8. Trunnion hub with pin
9. Trunnion Bush
10. Trunnion Bracket
11. Tie between trunnion (thrust block) - components
12. Lifting Bracket
13. Turn buckle & equalizer plate Wire rope socket

The above are explained under chapters for understanding of field engineers attending

maintenance in an effective manner.

Inspection:

Periodical inspection of gates and hoists should be done at least twice a year and corresponding to the periods when the water level in the reservoir is at its FRL and lowest levels i.e., Pre-monsoon and Post-monsoon. The gates and hoist members to be inspected are as tabulated below.

Inspection of Radial Gates:

S.No.	Members to be inspected	Compliance
A	**Inspection of Sill beam and wall plates**	
	Check the following joints	
1	Wall plate to sill beam	Check for cracks of weld/ artificial joints and other defects and rectify by grinding and welding
2	Joints between two segments	Rectify the joints using proper welding rods
3	SS cladding to MS plate	-do-
4	Check wall plate and sill beam for pitting and rusting	Pitting is to be filled in by welding, rusted portion should be painted after cleaning
5	Check for leakage between secondary concrete of wall plate and seal beam	Grout it if there is any leakage.
B	**Inspection of Yoke girder/Trunnion girder, thrust block, trunnion assembly and anchorage**	
1	**Check nuts and bolts**	
I	Joints of anchor girder and pedestal	Check for tightness
II	Trunnion bracket to yoke girder	-do-
III	Nuts of horizontal to Radial Arm Trunion Pin Lock Plates	-do-

IV	Rusting of Vertical chair base plate	Concrete slope may be provided to avoid water stagnation.
V	Trunnion pin with lock plate	Lock plate shall be properly inserted in slots provided on pin for displacement
VI	Trunnion pin lock plates	Check tightness
VII	Check shear key if provided behind the trunnion bracket	Check for cracks
VIII	Nuts of the main tie rods	Check for tightness
2	Check the welding between yoke girder and Main ties	For soundness of weld
3	Check yoke girder and thrust block is covered	Cover it with 3mm thick MS plate or a thin layer of concrete so water does not accumulate in slots
4	Check grease in trunnion assembly	Carry out greasing
5	Check the welds of thrust block & Tie beam.	If any cracks found, grind and weld it
C	**Inspection of Skin plate assembly**	
	Check the following	Compliance
1	Vertical and horizontal joints of skin plate from upstream side and downstream side	Check for crack and other defects and rectify if necessary
2	Lifting bracket to skin plate	Check welding with a magnifying glass and rectify if required
3	The skin plate should be observed for pitting, scaling, and corrosion on upstream	Scaling formation should be filled with weld and grinded for finish. For corrosion, clean it and apply paint.
4	Check for the deformation of bottom Corners of gate leaf	Inform higher authority and take immediate action for repair

D	**Inspection of seal assembly**	
1	Leakages	Identify location where leakages are more than allowable range i.e., 6 litres / mtr
2	Check the condition of side and bottom rubber seal, corner joint.	If condition is poor, replace same. Check the cause of undue wear also before replacement.
3	Check all the nuts and bolts fixing rubber seal to skin plate.	Check for wear and tear, tightness and replace, if required.
4	Check if there is any undesirable material in between seal and clad plate, seal, and skin plate.	Remove it
5	Check for deformation of seal	Study the cause of deformation and rectify it
6	Check whether there is abnormal abrasion on seal seat	-do
7	Check for presence of debris/Logs/ foreign materials entrapped	Remove them
E	**Inspection of Horizontal Girder**	
	Check welding of	
1	Flange to web connection	Check for weld crack
2	Horizontal girder to ‘T’ stiffeners of skin plate	Check for crack and other defects and rectify accordingly (grind and weld)
3	Stiffeners of horizontal girder	Check for crack and other defects and rectify accordingly (grind and weld)
4	Check drain holes of horizontal girder	Clear them regularly if found chocked up. Drill holes if not provided

5	Check for any deformation of girders particularly at ends	Inform higher authority and take immediate action for repair
F	**Inspection of Guide Roller**	
1	Check the roller for its free movements/ Rotation	Make the roller free if jammed. Lubricate it.
2	Check the nuts, bolts, and guide roller	Check for wear and tear and tightness
G	**Inspection of End Arms**	
1	Check welding throughout length preferably with magnifying glass.	Check for cracks, grind, and weld it.
2	Check nuts and bolts, weld of end arm to horizontal girder and trunnion connection	Check for tightness of bolt/ soundness of weld. Rusted nuts and bolts to be replaced with HT bolts
3	Check whether drain holes drilled in the end arms and trunnion are clear	Clear them if found choked up and drill the drain holes if not provided
4	Check straightness of arm	Inform higher authority and take immediate action if it is bent.

Maintenance (As per IS Code (10096-3))

The maintenance of radial gates and hoist components should be done regularly. Proper record of inspection testing and maintenance should be kept by the officers in charge of the gates of Dam/Reservoir.

I. Critical weld joints:

- Defective welding should be chipped out and should be re-welded.

II. Tightening of Bolt & Nut:

- Damaged nuts, bolts, rivets, screws etc. should be replaced.
- Lock plate Bolts of trunnion bearing housing should be tightened wherever required

III. Greasing/Lubrication: (As per Annexure 12 P.69-70)

- Trunnion bearing should be greased when required. Keeping trunnion bearings in perfect working condition is very important. All other bolted connections should also be checked up for proper tightness.
- All the exposed EM parts, gates on upstream side, hoist bridges, lifting beams should be greased when required.
- The trunnion shall be greased by using pressurised grease gun so that old grease squeezed through the side of trunnion pins.
- Bearings of guide roller shall be greased. The guide rollers should be free so that the same can be rotated by hand. The gap between wall plates & the guide rollers shall be checked and if required the guide rollers should be adjusted. The base plate bolts shall be checked for proper tightness.
- The hoisting pulleys in case of D/S side hoisting arrangement should be lubricated.

IV. Oil replenishing:

- Oil level in the worm reduction unit should be maintained by suitable replenishment. Oil seals should also be replaced if required. Lubrication of other parts of hoists such as hand operation mechanisms, position indicators and limit switches should also be done.

V. Cleaning of Vegetation and debris:

- The gate leaf, exposed embedded metal parts, hoists and hoist supporting structure etc. should be thoroughly cleaned and repainted as per the guidelines contained in IS: 14177
- All the drain holes on the horizontal girders & end arms should be cleared of debris.

VI. Repairs to damaged painting areas:

- Any pitting noticed should be filled up by welding and finished by grinding if necessary.

VII. Heavy leakages and damages to seal:

- The seals of the gate should be checked for wear and tear and deterioration. These should be adjusted/replaced as and when necessary.
- The wall plates, sill beams shall be checked and repaired if necessary.

VIII. Wire rope tension and Condition:

- The wire rope tension should be checked & adjusted if required.
- Wire ropes should be properly lubricated.

IX. Drive Unit:

- The stroke of the brake should be reset to compensate for lining wear. Worn out brake linings should be replaced in time.
- Flexible couplings should be adjusted if required rubber bushes replaced with copper coated rubber bushes.
- Repairs and replacements of all electrical relays and controls should be attended to.

- Maintenance of alternative sources of Power such as Diesel Generating sets and alternative drives wherever provided should be carried out.
- The list of essential spare parts to be kept available should be reviewed and updated periodically. The condition of spares should be checked periodically, and protective coating given for use.

Maintenance Schedule:

Half Yearly Maintenance:

a) Guide Rollers: The guide roller bushes and pins shall be greased.

b) Trunnion Assembly: The Trunnion bushes should be greased by greasing gun till grease oozes out from the side.

c) Tighten the Lock plate bolts of trunnion pin bolt.

d) Central drive Unit:

(i) Brake drum and liners of EM Brake should be cleaned and kept free from grease, oil etc.

(ii) The spring and hinges of Electro Magnetic Brake should be lubricated

(iii) The electric motor bearing should be lubricated.

(iv) Oil level in worm gear reducer shall be checked and topped up if necessary

(v) Lubricate the manual operating system (chain, sprockets etc.)

e) End Reduction gears boxes :

(i) Teeth of all gears and pinions should be greased by smearing on the surfaces

(ii) The rope drum bushes shall be greased.

f) Position Indicator :

(i) All bushes of position indicator to be greased

g) Plummer blocks bearings : All Plummer block bearings shall be lubricated

Yearly Maintenance:

a) Before onset of monsoon all moving parts such as line shaft, brakes, motor bearings shall be lubricated with proper lubricants
b) Grease shall be applied to turn-buckle threads, pins and lifting bracket pins.
c) Grease shall be applied to equaliser plate assembly pins.
d) Oil in worm gear reducer shall be replaced every alternate year.
e) The limit switches and other contacts shall be checked for proper functioning.
f) The contact points shall be cleaned thoroughly.
g) Check the compression in spring of Electro Magnetic Brake and the stroke of the brake should be reset if wear and tear of brake lining is found.
h) Check the condition of wiring, switches, Electrical relay etc. for damage if any and for proper functioning and defects if noticed, may be rectified.
i) Wire Ropes: The wire rope should be cleaned by wire brushing before application of lubricant to the wire ropes. After cleaning, cadmium compound shall be applied to full length of wire rope by brushing. Cadmium compound may be applied by hand with leather gloves if the cadmium compound is heavy and non-flowing.
j) Check the hand drive arrangement if provided and lubricate the components. Operate the gate by using hand drive arrangement to check proper functioning of the same.

4.2 Vertical Gates

Vertical Gates are used in spillway for discharge of flood and regulation of water release through head regulator and cross cum escape regulators and off take gates. it consists of following 3 main components.

I. Embedded parts- which are fixed in the concrete to transmit the load to civil structure.

II. Gate Leaf- Skin plate and its supporting structures and roller cage with rollers.

III. Operating system-Rope drum Hoists / Hydraulic hoists/screw hoist used for operation of gate.

The entire load coming on to the gate is finally transmitted to the pier through rolling action of roller. The loads are

1. Water thrust
2. Self-weight
3. Friction due to sliding of seal and roller with their respective track.

Hence the functioning of rollers plays a vital in performance of gate operation for lowering and lifting for regulation/ discharge of flood. It is important to know the components which are involved in operation of gates for understanding their function and their properties.

Components

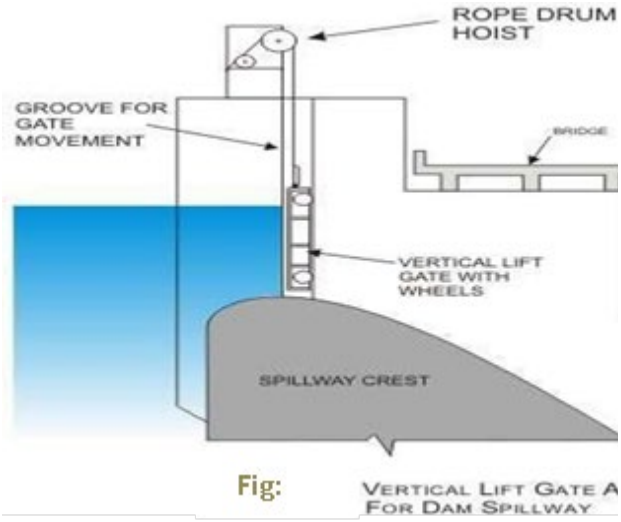


Fig: VERTICAL LIFT GATE A FOR DAM SPILLWAY

Embedded Parts

1. Sill beam Assembly
2. Roller track assembly
3. Seal seat/upstream guide
4. Top seal seat and side guide
5. Dogging arrangement
6. Corner Angle

Gate:

1. Skin plate support girder
2. Vertical stiffeners.
3. Horizontal Girders
4. Side guide shoe
5. Roller cage
6. Roller assembly
7. Seal assembly with bearing
8. Lifting arrangement

Hoist:

1. Drive unit assembly
2. Gear box assembly
3. Dial and Dial Assembly etc.,
4. Hoist bridge
5. Hoist supporting structure

Components: Sill

Components: Roller Track, Seal Track, Guide Track

Inspection:

S.No.	Members to be inspected	Compliance
A	**Sill beam and Seal tracks** (Check the joints)	
1	Seal track to sill beam	Check for crack and other defects and rectify. Check the joints.

3	SS cladding to MS plate	Rectify the joints using proper welding rod
4	Check seal track and sill beam for pitting and rusting.	Pitting is to be filled in by welding, rusted portion should be painted after cleaning
5	Check for leakage between second stage concrete of seal track and sill beam.	Grout it if there is any leakage.
B	**Inspection of Skin plate assembly**	
1	Vertical and horizontal joints of skin plate from upstream side and downstream side	Check for crack, other defects and rectify if necessary.
2	Lifting bracket to skin plate	Check welding with a magnifying glass and rectify if required.
3	The skin plate should be observed for pitting, scaling, and corrosion on upstream	Scaling formation should be filled with weld and grinded for finish. For corrosion, Clean it and apply paint.
4	Check for the deformation of bottom Corners of gate leaf	Inform higher authority and
C	**Inspection of seal assembly**	
1	Check the condition of side seals bottom rubber seal, corner seals.	If condition is poor, replace same. Check the cause of undue wear also before replacement.
2	Check all the nuts and bolts fixing rubber seal to skin plate.	Check for wear and tear, tightness and replace, if required.
3	Check if there is any undesirable material in between seal and clad plate, seal, and skin plate.	Remove it.
4	Check for deformation of seal	Study the cause of deformation and

		rectify it.
5	Check whether there is abnormal abrasion on seal seat	-do
D	**Inspection of Horizontal Girder**	
	Check welding of	
1	Flange to web connection	Check for weld crack
2	Horizontal girder to 'T' stiffeners of skin plate	Check for crack and other defects and Rectify accordingly
3	Stiffeners of horizontal girder	Check drain holes of horizontal girder
E	**Check for any deformation of girders particularly at ends**	
1	Check the roller for its movements	Make the roller free if jammed
2	Check the nuts, bolts, and guide roller	Check for wear and tear and tightness
3	Check the roller when it is jammed.	Adjust the rollers assembly to ensure that all the rollers rest uniformly on S.S. track particularly while moving and in closed condition.
4	Check the roller when it is jammed.	Open the roller and see the condition of the 'O'-ring & Oil seal. Clean the bearing and replace the damaged seals and apply grease for ensure the free movement of roller.
F	**Inspection of Roller assembly**	
	1. Contact	Check Critical Dimensions and adjust
	2. Free rolling	Cleaning by solvent

	3. Oil seal /'O' ring	Protect from Rust
E	Lifting arrangements (engaging / disengaging mechanism)	Cleaning by solvent and greasing
F	Pulley	Greasing

Maintenance (As per IS Code (7718)):

The maintenance of vertical gates and hoist components should be done regularly. Proper record of inspection testing and maintenance should be kept by the officers in charge of the gates.

I. Critical weld joints:

- Defective welding should be chipped out and should be re-welded.
- Damaged nuts, bolts, rivets, screws etc. should be replaced without delay.

II. Tightening of Bolt & Nut:

- All nuts, bolts, check nuts and cotter pins of the lifting devices should be checked periodically.
- The roller assembly should be adjusted by the eccentricity arrangement to ensure that all the rollers rest uniformly on the track plates, particularly in the closed position of the gate.

III. Greasing/Lubrication: (As per annexure-12 P.69-70)

- Gate roller bearings and guide roller bushes should be properly lubricated. Whenever necessary these should be opened for rectifications of defects; and after cleaning and lubrication, should be refitted. These may be replaced if repairs are not possible.
- Hoisting connection on the gate leaf should be lubricated where necessary and defects if any should be rectified.
- All components should be greased and lubricated according to codal provisions. Recommended and approved oils and grease only should be used.

IV. Cleaning of Vegetation and debris: (Refer page no. 24,25,26)

- The gate slot and platform should be cleaned periodically. Scales formed over the embedded parts should be removed. All bottom & corners should be cleaned and accumulations, removed. Secondary concrete around anchorages should be checked for any developing cracks or slackness etc. and repair should be attended immediately.

- Where filling valves are provided as part of the gate structure, all the nuts, bolts, checkouts etc should be checked periodically. It shall also be ensured that the filling valves completely shut-off the passage of water when the load is removed. To ensure, the springs and other components shall be periodically checked and replaced if necessary.
- Appropriate repairs should also be carried out wherever excessive pitting and other surface damages are noted.

V. Repairs to damaged painting areas: (As per annexure-15 P.93-97)

- The gate leaf should be thoroughly cleaned and repainted, as and when necessary, according to the procedure recommended by the paint manufacturer.

VI. Heavy leakages and damages to seal:

- The seals of the gate should be checked for wear and tear and deterioration.
- These should be adjusted/replaced as and when necessary.
- All nuts and bolts fixing the seal to the gate should be tightened uniformly. when damaged or found leaking excessively, should be adjusted, repaired, or replaced as considered necessary.
- The wall plates, sill beams shall be checked and repaired if necessary.
- Maintenance charts showing the components of gates and hoists and their periodically undertaken checking maintenance. A register showing the time, the date of operation, the amount of opening, discharge etc. should be maintained (As per annexure-11 P.68).

Vegetation deposited on Embedded Metal Parts removed to avoid rusting

Cleaning vegetation and Debris

Water Stagnation at vertical chair of Radial Gate

Debris removed on trunnion girder / yoke girder

Maintenance Schedule:

Yearly Maintenance: During annual maintenance following additional checks or maintenance shall be carried out.

- All the embedded parts shall be checked for defects/ damages and rectified whenever noticed.
- The sill beam and guides shall be cleared for all grit, sand etc.
- The wire rope shall be checked for equal tension. If broken strands are noticed, the wire rope shall be replaced.
- The wire ropes shall be greased.
- Gate roller bearings and guide roller bushes should be properly lubricated. Whenever necessary, these should be opened for rectifications of defects and after cleaning and lubrication, should be refitted. These may be replaced if repairs are not possible.
- Hoisting connection of the gate leaf should be lubricated where necessary and defects if any should be rectified.
- All nuts, bolts, check nuts and cotter pins of the lifting devices should be checked periodically.
- All components should be greased and lubricated. Only recommended, approved oils and grease should be used.
- Appropriate remedial measures should be taken so that the salient dimensions and alignment of components of IS 7718 are set right. Appropriate repairs should also be carried out where excessive pitting and other surfaces are damaged are noted.
- Roller assembly should be adjusted by the eccentricity arrangement to ensure all rollers rest uniformly on the track plates particularly in the closed position of the gate.
- Where filling valves are provided as part of the gate structure, all the nuts, bolts, check nuts etc., should be checked periodically. It shall also be ensured that the filling valves completely shut -off the passage of water when the load is removed. The springs and other components shall be checked periodically and replaced if necessary.

5. Hoist System

There are three types of hoist systems:

1. Rope drum hoist

2. Hydraulic hoist
3. Screw hoist

The Rope drum can be either upstream or downstream. Hydraulic hoist is always on downstream.

Hoist:

1. Drive unit assembly: Induction Motor, EM Brake worm reducer, line & shaft, Flange coupling, Plummer Block, manual operation.
2. Gear box assembly: gear wheels & pinion with shaft and rope drum with Shaft.
3. Fixed end support
4. Hoist chassis& Hoist Bridge
5. Line shaft support girder
6. Lifting arrangement, Dial indicators and Dial Assembly etc.
7. Limit Switch arrangements

5.1. Rope Drum Hoist

Components - Salient Features & Specifications:

1. Induction Motor: Capacity, Rpm, Squirrel cage, Shaft, Voltage, Supply, Phase, Hoist duty, Insulation
2. EM Brake: Type, Power type, Coil rating, Insulation, Size, Braking Torque, Make, Working Voltage, break drum dia.
3. Worm Reducer: Reduction, Size, input mechanical power at 1000 rmp, Output tongue, Output running off, starting efficiency, Make-Elecom/Premium/Shanti
4. Line Shaft
5. Flange Coupling
6. Plummer Block with Bearing: Dynamic load, Static load, Bearing, Sleeve, Dynamic load, Static load, SNA 522 TC with 22222K Bearing, H322 Sleeve
7. Gear Wheels: Outer Diameter, Pitch circle diameter, Inner Diameter, Root diameter, Bush, Locking at arms, No. of teeth module, Hardness, Yield Point, Ultimate Tensile Strength, Material grade, Pressure angle, Module, no. of teeth.
8. Shaft: Material, Grade, Outer Diameter
9. Rope Drum: Outer Diameter, Pitch Circle Diameter, Inner Diameter, Length of drum, Material, Grade, Hardness,

10. Rope groove angle Bush: Length, diameter, Grade, Material
11. Drum Shaft: Diameter, Length, Material

Upstream Hoist:

Upstream Rope drum Hoist – Gear Train Assembly

Downstream Hoist:

Downstream Rope Drum Hoist and its components

Dial Indicator

Inspection:

S.No.	Members to be inspected	Compliance
A)	**Drive Unit**	
1	Check condition of E.M. Brake	Replace worn out liner, adjust brake shoes carefully, so that both the shoes hold the drum when supply is cut off or both the shoes should move out simultaneously if switched on. Brake drum and liner should always be free from grease oil.
2	Check all electrical connections of hoist	Check for loose connection and proper insulation. Overload relay of the starter is to be adjusted for correct position and should not be disturbed. Lugs are to be provided for all electrical connections
3	Check manual operation arrangements	Adjust gears/chain, sprockets etc., if required.
4	Check speed reducer/reduction unit	Check for smooth operation and check oil level.
5	Check for gate position indicator	Check for proper function and rectify
6	Check the current drawn by motor during operation of gate	If excess current drawn by motor, stop the hoist and find out reason for excess current drawn by motor.
B)	**Line Shaft**	
1	If any vibration	Check alignment
2	Check condition of rubber bushes of coupling	Replace rubber bushes with copper coated rubber bushes
C)	**Gear Train Assembly**	
1	Check position of gear and pinion	Check for proper meshing if any deviation, bring them to correct position
2	Check condition of gears and pinions	Check uneven wear and contact and adjust properly
3	Check for breakage of any teeth	Rectify it by welding and machining.

4	Check shaft and couplings used for connecting drive unit &gear train	Visual inspection and coupling nuts to be checked
5	Check for jamming of any bearing	Rectify/replace it.
D)	**Wire ropes, Equalizer plates**	
1	Check condition of wire rope	If 10% broken wires are within the length of one meter and more than 20% within length of 10 meters, wire ropes should be replaced.
2	Check turn buckle, Equalizer plate assembly and sockets	Check condition of pin. Every year these should be removed, cleaned refitted after lubrication
3	Check lifting bracket pin	Check for rusting, jamming in the turn buckles
4	Check tension in wire ropes	Adjust all wire ropes for equal tension
5	Check the wire rope is properly fastened to the drum	If found loose, tighten the studs provided. The clamping position of wire rope should be changed once in three years. Provide Thimble at the ends of wire rope.
6	Check if the end of wire rope is fixed properly	Re-fix with zinc metal, if found necessary fix with timbles.
E)	**Hoist Platform**	
1	Check anchor rod nuts or base plates	Tighten nuts of anchor rods if found loose.
2	Check welding of hoist bridge girders, cross members	Rectify the welding joints by grinding and welding.
F)	**Check Nuts and Bolts**	
	Hoist Frame Drive Unit Gear Boxes Muff Couplings	Check for wear and tear and tighten if required or replace for undue wearing

Wire Rope drum:

1. Gears and Shaft – cleaned and greased once in a year duly removing old grease with kerosene.
2. Alignment of shaft and gear train to be checked.

3. Clamping of rope be decamped and reclamped once in three years.

Motor with EM Brake

Screw gear box for well type head sluice / off take

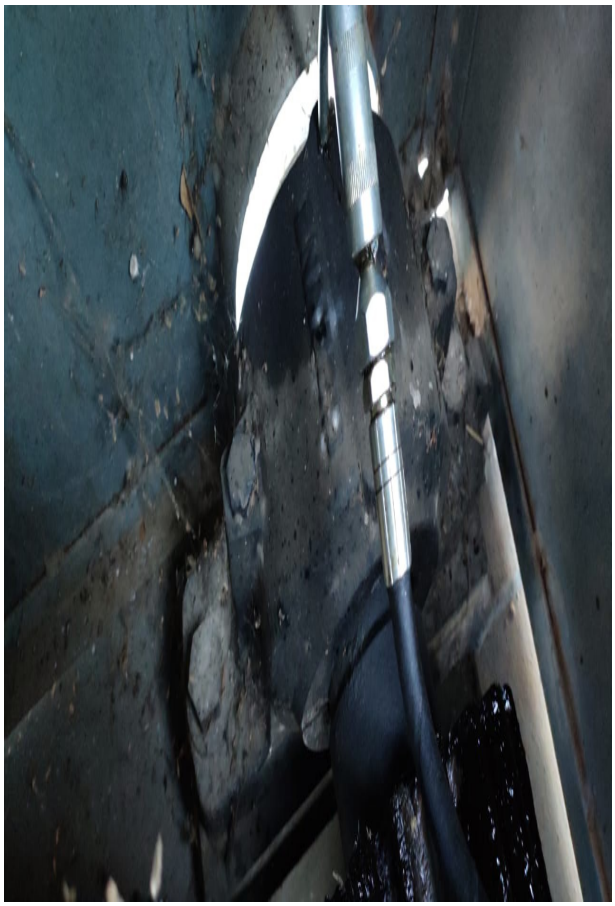
Turn buckle with wire rope in socket

Erection of Anchor girder of independent unbounded plates anchorage system

Grease Lubrication of Worm gear box

Removal of Water Stagnation at control Panel

Lubrication of P1, P2 shafts of plummer box shafts



Maintenance:

Maintenance of wire rope means shifting the points of wire clamping by shifting wire rope on drum ends or by changing the rope end, and adequate lubrication.

Lubrication: In manufacture, wire ropes are fully lubricated to reduce internal abrasion, to exclude external moisture and delay corrosion. In service, the initial lubricant will tend to dry out and, therefore, it is desirable to lubricate all ropes at regular intervals. There are many methods of applying lubricant, such as vertical or horizontal grease boxes through which the rope runs, application by brush, leather gloves, drip or by spraying.

Wire rope lubricants have two principal functions:

1. To reduce lubrication as the individual wire-rope stands move over each other.
2. To provide corrosion protection and lubrication in the core, inside wires and on the exterior surfaces.

Lubrication steps:

Cleaning of Wire rope: It is very desirable that the rope be clean and dry before application of lubricant. A jet of air or wire brushing with solvent are used to clean the wire rope before application of lubricant.

Application of lubricant: An easy and effective method of applying lubricant is to slightly heat the lubricant before application, to get smooth and better penetration. The brush is dipped into the lubricant and applied. In some cases, it is applied by hands with leather gloves. Lubrication of wire rope near the drum or at pulley where strands open and to allow better penetration inside the strands and inside the core to get better lubrication.

Wire rope lubricant brands: Indian oil Servo coat 140, Bharath petroleum Max camex compound grade ‘F’, Balmerol Blue coat2.

Heating of cardium compound

Application of cardium compound to wire rope with brush

5.2. Hydraulic Hoist

Hydraulic hoists are used for operating various types of gates installed in hydraulic structures. It is important to ensure that these hoists work smoothly and efficiently so that the gates may be operated flawlessly at critical operation time.

Components:

1. Oil Reservoir
2. Filler Breather
3. Suction Strainer
4. Oil Level Gauge
5. Oil level Switch
6. Hydraulic Pump
7. Electric Pump
8. Bell Housing & Coupling
9. Non-Return Valve
10. Pressure Relief Valve
11. Pressure Gauge
12. Direction Control Valve
13. Flow Control Valve
14. Shut off Valve
15. Pressure Switch
16. Temperature Indicator
17. Check Valve
18. Throttle Valve
19. Pilot Check Valve
20. Reducing Valve
21. Drain Valve
22. Hydraulic Cylinder
23. Return Filter
24. Hand Pump
25. Hand Operated DC Valve
26. Junction Box

Inspection:

a) Power Pack	
Oil level in Power pack	Oil level is to be maintained by checking regularly to the desired level
b) Valves	
Relief Valves and Flow control valves	Check the valves and adjust them to desired position Repair, if any leakages are found
c) Switches	
Pressure Switches, Flow Switch, Solenoid Valves	Check and adjust the switches. Repair, if necessary
d) Filters	
All filters and Silica Gels	Check all the filters and clean them weekly
e) Seals	
Oil Seals, O-rings, argon welding etc	Check all the seals, rings and welds repair and replace if required
f) Pressure measuring gauge Systems	
1. Main and Pilot Pressure Systems	Check and maintain desired pressure levels. Repair, if required
2. Measuring Systems	Check and adjust the measuring systems
g) Electrical Systems	
1. Electric Panels, wiring	Check for all the connections. Repair and replace if necessary
2. Electrical contacts, switches, fuses etc	-do-

h)	**Hydraulic Accumulator**	
	Charging Pressure	Check and maintain charging pressure of the hydraulic accumulator
i)	**Lubrication**	
3.	For Entire Equipment	Check and ensure perfect lubrication with recommended lubricants

Stoplog Elements and Lifting Beam:

Generally, 10 percentage of spillways stop log are planned to attend repairs to spillway gates. The stop logs, gates shall be operated by gantry crane for both lowering and raising with the help of lifting beam attached to gantry crane, which moves on rail track fixed on the roadway bridge over the dam with the provision of an automatic engaging and disengaging mechanism. During Pre-monsoon period, the stoplog elements must be lowered at least in one vent and stock on the piers with help of dogging arrangement or on separate bay.

Inspection and Maintenance of Stop log Elements:

1. Check defective/damaged/cracked welding.
2. Damaged nuts, bolts, screws etc.
3. Examine the gate leaf cleaned and repainted whenever necessary.
4. Rubber seals should be adjusted, if required to bring it in alignment. All nuts and bolts for fixing.
5. Check all components greased and lubricated with the recommended oil and grease only.
6. Adjust the roller assembly by the eccentricity provision to ensure that all the roller rest uniformly on tract plates particularly in the closed position of the stop log gate.
7. Clean the drain holes in horizontal girders, web plate.
8. Clean the gate slots and remove scaling over embedded parts.

Inspection and Maintenance of Lifting Beam:

1. Examine Lifting beam for both raising & lowering of spillway stop log units with the use of Gantry crane.
2. Lifting beam shall mainly comprise of two number structural steel channel or fabricated channels with back-to-back connection to make it a single fabricated structural frame.
3. Two side guide rollers shall be provided on each side of the lifting beam. The depth of lifting beam/frame sufficient to accommodate to rollers on each side located at sufficient distance from one another to enable proper guided movement.

4. The depth of lifting beam should not be less than one tenth of the length/span of the lifting beam or 500 mm whichever is more. Lifting beam hook mechanism by the movement of the hook block. The two hooks are mechanically linked together for simultaneous operation.
5. Check all the rotating parts of lifting beam as they shall be provided with corrosion resistant steel pins and Aluminum Bronze bushings/roller bearings and lubricate regularly.

6 Gantry Crane

Components:

The Gantry crane consist of following components.

1. Gantry rail track
2. Gantry travel assembly
3. Columns
4. Crane girder
5. Tie girder
6. Counterweight

7. Crab assembly

Maintenance:

Hoisting trolley of the Gantry cranes is built on top of a wheeled mobile gantry structure travelling over fixed rails and is used to straddle an object or load over a workspace. Following aspects need to be considered and attended to during maintenance:

1. Oil level in the gear boxes. It is very important to ensure that the correct oil level is maintained. Over filling causes overheating and leakage, therefore, care should be taken that the breather holes are not clogged by any foreign material like dust, paint etc.
2. The insulation resistance of motor windings. In case it is found to have dropped below a prescribed value, the motor should be dried prior to putting back in

service. If weak insulation becomes a regular feature, the winding should be given a good coat of insulating varnish after the motor has been dried.

3. Checking of all the electrical connections.
4. Lubrication of each part of crane
5. Removal of any loose/foreign material along the rail track
6. Actuating tests of limit switches
7. Actuating tests of brakes.
8. All fuses in the control panel should be checked and if necessary, it should be replaced.
9. Necessary terminal connections of motors, brakes etc. is to be checked.
10. Overload relay should be checked.
11. Visual inspection of wire ropes for any snapped loose wire and its proper lubrication.
12. Checking of rope clamps on the drum and tightening of bolts if required.
13. Gearbox assembly should not have any leakage of oil.
14. Unusual noise/vibration if any should be checked and rectified before operation.

7. Screw Hoist

This type of hoist is used when positive thrust is required to close the gate, though efficiency of this hoist is low, there is overall economy because, it is more compact than other type of hoists. Due to the preference to single point suspension is more in case of small gates like sluice gates etc. screw hoist in limited to 15 tonnes capacity.

Screw Gear Box

Worm Gear Box

Worm Gear Box Motorised and manual operation:

SCREW HOIST with worm gear

Components

1. Gear box assembly (Screw and Nut, Worm, Bevel)
2. Motor
3. Worm reducer.
4. Line Shaft and couplings.

5. Manual operating System

7.2. Inspection

Before operation, the gates, hoists, and allied structures are inspected as specified below

	Members to be inspected	Compliance
A)	**Inspection of Screw Rod**	
1	Check the straightness of Screw rod	Straighten it if any bend observed/ Replace if it is damaged (i.e., if Threads are damaged to greater extent)
B)	**Drive Unit**	
1	Check all electrical connections of hoist	Check for loose connection and proper insulation. Over load relay of the starter is to be adjusted for correct position and should not be disturbed. Lugs are to be provided for all electrical connections
2	Check manual operation arrangements	Adjust gears/chain, sprockets etc., if required.
3	Check speed reducer/reduction unit	Check for smooth operation and check oil level.
C)	**Hoist Platform**	
1	Check anchor rod nuts or base plates	Tighten nuts of anchor rods if found loose.
2	Check welding of hoist bridge girders, cross members	Rectify the welding joints by grinding and welding.
D)	**Check Nuts and Bolts**	
	Hoist Frame Drive Unit Gear Boxes Flange Couplings	Check for wear and tear and tighten if required or replace for undue wearing
E)	**Line Shaft**	
1	If any vibration	Check alignment
2	Check condition of rubber bushes of coupling	Replace rubber bushes with copper coated rubber bushes

Maintenance:

I. Stems and bushes: The stems and split bushes should be lubricated.

II. Lifting bracket bush and pin: The lifting bracket bush and pin should be lubricated.

III. Gear Box Assembly:

a. The screw rod should be lubricated.

b. The worm, worm wheel, worm shaft & thrust bearing and taper roller bearing should be lubricated.

IV. All bolts and nuts should be checked for slackness and shall be tightened if found loose.

V. The worm wheel and nut to be bronze material for smooth running of Gear box.

VI. Proper bottom oil seal is to be provided to avoid leakage of lubricant.

8. Electrical Equipment & Maintenance

The electrical parts should be inspected and maintained as mentioned below during pre-monsoon and post-monsoon inspection schedule.

1. All cable lines should be arranged properly and checked frequently for puncture. If so, then it should be removed immediately to avoid accident.
2. Cable clamps and lugs should be checked, tightened or replaced, if found faulty.
3. Installation check should be done by megger. If cable is faulty then it should be replaced.
4. Contacts of main switch should be cleaned.
5. Overload relay may be checked and tested and put in operational condition.
6. Check wiring contacts of starters and tighten as required. Burnt or worn out one may be removed and replaced. Connecting lugs of cable may be checked and tightened as required.
7. Measuring the amperes of motor for initial starting. Check up the insulation of motor by megger in every rainy season.
8. Check the capacity and plunger for proper load of magnetic coil brake and clean periodically the plunger and barrel of the magnetic brake as any deposition of dust or dirt will make the brake to produce chattering noise and humming. Adjust brake shoes of the magnetic brake depending upon the wear of the shoes. If brake coil is found burnt then it should be re-winded or replaced.

9. Check periodically the T.P.I.C switch of the hoist for proper contact of all the three phases. Otherwise, any single phasing will result in burning of the motor.
10. Starters should be cleaned, free of moisture and dust.
11. All wearing parts should be examined to take note of any wear which may have occurred during operation.
12. If the contactor hums, the magnet faces should be cleaned (Blackening of contacts caused by deposition of silver due to arching is of no importance).
13. Clean the surface of the moving armature and magnet core which comes together when the contactor closes, free of dust or grease of any kind.
14. Examine the mechanical interlocks between the reversing contactor and see when the contact tips of one of the contactor units are touching, it is impossible to get the contact tips of the other unit to touch.
15. The contact tips should be kept free from bums or pits by smoothening with fine sandpaper or emery paper.
16. Replace the contact tips which have worn away half-way.
17. Do not lubricate the contacts.

9. Diesel Generator

Besides good maintenance programs, a reliable power supply for gate is important. Nonoperation of gate will not only cause the overflow of gates but also over topping of the dam, leading to failure of the dam/reservoir. Therefore, there is regular maintenance and periodic operation of generator for Its reliable operation when needed in emergency situation.

Components:

1. Engine.
2. Alternator
3. Fuel system.
4. Voltage Regulator
5. Cooling and Exhaust system.
6. Lubrication system.
7. Battery Charger.

8. Control panel.

Inspection and Maintenance:

a)	**Lubrication System**	
1.	Oil Leaks	Check for oil leaks and arrest the leakage
2.	Oil Filter	Clean the filter regularly and replace after recommended running hours.
b)	**Coolant System**	
1.	Radiator Coolant level	Check and Maintain the coolant level regularly. Also check for air blockage in the system
2.	Fan hub, drive pulley and water pump	Check, repair and replace if necessary
c)	**Air Intake System**	
1.	Air Leaks	Check for air leaks and arrest the leakage
2.	Air Filter	Clean the filter regularly and replace after recommended running hours.
3.	Air Cleaning Elements	Check and replace yearly.
d)	**Fuel System**	
1.	Governor Linkages, fuel transfer pump, fuel line	Check for all connections and repair them if leakages are found.
2.	Fuel tank, change fuel filter and fuel tank breather	Drain Sediments from these tanks regularly and maintain necessary levels.
e)	**Main Generator**	
1.	Air Inlet	Check if there are any obstruction to air inlet and clean them.
2.	Electrical connections	Check for the tightness of all connections
3.	Stator Winding	IR measurement to be done regularly

4.	Slip ring and its brushes	Check/Clean them yearly.
5.	Protection/Control relays and alarms	Testing for soundness of these systems
f)	**Exhaust System**	
1.	Air Exhaust	Check if there are any obstruction to air exhaust and clean them
2.	Manifold and Turbo charge	Check and tighten the exhaust manifold and turbo charge screws
g)	**General**	
1.	Battery Voltage and Specific Gravity Measurement	Check and measure battery Voltage and Specific gravity regularly.

10. Operating Instructions

The gate should be operated by an experience and qualified operator who should be sincere and prompt to his duties.

Before the gates are operated, the people of the villages living on or near the bank of the river in the downstream should be warned to reach to the safe position at least 1 hour before the opening of the gate. The electric siren provided for this purpose should be operated first before opening the gate. Check the following before opening the Gates.

1. Check the oil level in worm reduction unit.
2. Check the surface contact of the roller on both sides.
3. Check the spaces between
   a. Trunnion and trunnion bracket (for radial gates)
   b. Guide roller and wall plate to see that no foreign objects are there
   c. Gate rollers and roller track should be free from foreign particles
4. Check whether the power supply from grid is available. If it is available, check the voltage.
5. If power supply from grid is not available or supply voltage from grid is insufficient i.e., less than 380V to 480V, immediately start the Diesel generator. Check the generating voltage.

6. No motor of the gate should be operated with 2 phase supply. Switches, relays should be set for operation.
7. Before operating the gates, the E.M. Brake should be ensured for its proper working.
8. Check the direction of rotation of line shaft for closing or opening as per arrows marked on the central drive unit.
9. Keep the battery, line tester, spanners, screw drivers, pliers etc, handy

10.1. Operation and Maintenance

- Operating personnel shall be properly trained and experienced so that they can use their initiative and judgment based on their past experience for situations which may arise during operation.
- Day to-day experience on operation and difficulties if any, encountered should be carefully recorded in the logbook of gates to be available for studying the behavior of various structures and equipment.

- Detailed instructions for inspection and normal maintenance and repairs of gate installation should be given in operation and maintenance manual. However, for carrying out special repairs to gates if any, it is advisable to refer to Experts to execute.
- Inspection and maintenance experience are compiled in the form of History register of any installation to be useful for future designs, investigation of any failure, improper and unusual operation of gates. All such observations shall be recorded in the gates history register which is maintained for this purpose.

10.2. Dry Testing of Gates:

- Checking of all critical dimensions and proper seating of gate over embedded parts is to be ensured. Records of readings may be maintained for future reference.
- Worm reducer, plumber blocks, trunnion pin, gate wheels and gear wheels should be lubricated.
- Removal of temporary supports if any.
- Checking of weld between horizontal girders, arms and trunnions, tees and horizontal girders, cross girders and hoist bridge girders, final welding of lifting

bracket etc., are to be welded if left over. A comprehensive check list is to be maintained.

- Checking tightness of bolts between trunnion with arms and trunnion with horizontal girders, lock plate bolts of trunnion pin, wire rope clamp bolts and other bolts if used are to be tightened properly
- In case of unbounded anchorage, one must ensure the expansion of tie flats and yoke girder under load.
- The gates are to be inspected thoroughly for projections, temporary supports coming in the way of gate movement and excess concrete are to be removed if any.
- In case of new rubber seals, all the rubber seals are to be made wet before lowering the gate preferably with water to reduce heat generated between seal and seal seat and ensure fixing of all bolts and mouldings of site joints.
- Light test may be conducted for checking gap between seal and seal seat or by feeler gauge.
- All weld tests are to be conducted.

10.3. Inspection and Checks by officers:

Periodical checks to be done by AE/AEE:

- The section officer shall arrange for regular dusting out of all the installations including Generator room to see that they are all kept well-trimmed and tidy.
- The Section officer shall make physical verification of all the tools and 7F material at regular intervals and make a note of the fact in the relevant register.
- He shall check up all the electrical installations, Generators etc. with the help of Electrician to ensure that all are in working condition. He shall get the generator tested weekly to ensure its trouble-free service. A note of all the facts shall be entered in the relevant registers.
- He shall check up all the painting works. Such of the portions exposed to atmosphere having lost their painting shall be got painted with the relevant specification paints as patch work as per the guidelines indicated in IS: 14177.

Quarterly checks by the S.O

- Once in a quarter, the section officer in charge of the gates should test the gantry and hoist to ensure their working condition.

- All such parts needing greasing including wire ropes shall be examined by the Section officer and he should see that the right type of grease applied wherever necessary.

Half yearly checks by the S.O.

- All the nuts and bolts of the vulnerable items such as those of wire ropes, counterweight, shaft couplings, flexible joints, rubber seals etc., should be checked for their slackness if any and rectified.
- Slackness in the wire ropes if any may be checked by adjusting the turnbuckles provided for that purpose. ·
- The entire welds shall be examined carefully to find if there are any cases of defective welds coming to light. If such cases are there, they should be got rectified without delay by competent welders.

Quarterly inspections by the S.D.O./Dy.E.E.:

The Sub-Divisional Officer/Dy.Executive Engineer who is in charge of maintenance and operation of gates on a Project or Projects should conduct quarterly inspections. He should see that one of the quarterly inspections should invariably fall before the on-set of monsoons so that his inspection covers the annual maintenance of the gates and allied equipment of the project or projects.

The purpose of the Quarterly inspection by the S.D.0./Dy.E.E. is to see that the gate installations are properly maintained, all the equipment including gantry and standby Generator are in good working order. The S.D.O. should also inspect all the technical records like History Book, Registers of T&P, maintenance, 7F account, Check slip etc., and attest the entries for having satisfied with their correctness.

Half yearly Inspection by the Executive Engineer:

The Executive Engineer should go round all the Projects on inspection at least once in a half year, The Executive Engineer will be responsible for the proper upkeep of the gate installations of the projects under his charge. He should see that the detailed maintenance charts of each installation are carefully drawn up depending on the type of equipment and scrupulously followed by the maintenance staff for a trouble-free service of the equipment. The Executive Engineer is also responsible in regard to the stocking of adequate replacement parts and spares such as rollers, roller bearings, rubber seals, grease retainers, bolts & nuts etc. at the Project site in the custody of S.O. in-charge of the gates.

With the systematic maintenance and timely attending to minor repairs, chances for any major repairs to gates and allied equipment become remote. Thereby operational hazards and heavy expenditure on major repairs can be virtually set-aside. The Executive Engineer should also be critical with regards to technical matters. As he happens to have the privilege of observing the operation part of the various equipment critically, he should be able to suggest the erection, fabrication, and design units for improvements if any. The Executive Engineer should be able to pass on technical information to the units concerned, say design office or workshop on any specialty be observed about the performance of various equipment. This is like "feedback" information to the concerned. and will help for the rectification of defects or making improvements at the design, fabrication and erection stages at least in respect of future works.

Yearly Inspection by the Super indenting Engineer:

The Superintending Engineer is expected to visit annually every project that falls under his jurisdiction. The purpose of his visit is to satisfy himself that the maintenance and operation works are carried out smoothly and systematically without any slackness anywhere. The tendency to do things in a crude manner, which might have been allowed in emergency for example, caulking of gates i.e., gate groove etc. to arrest leakage should be curbed.

The Superintending Engineer may convene meetings with all concerned and discuss matters of mutual interest pertaining to gate operation and maintenance and send the proceedings to all the concerned. The Superintending engineer shall ensure providing required quarters for maintenance staff stationed at Project site.

Pre-Monsoon:

EE/DEE/AEE/AE in charge of gates of dam/barrages along with DEE/AEE of mechanical division shall conduct the pre-monsoon inspection during the period April-May and record their observations in the check slip appended as per Annexure-I.

1. All the nuts and bolts of the vulnerable items such as those of wire ropes, counterweight, shaft couplings, flexible joints, rubber seals etc., should be checked for their slackness if not and rectified.
2. Slackness in the wire ropes if any may be checked by adjusting the turnbuckles provided for that purpose.

3. The entire welds shall be examined carefully to find if there are any cases of defective welds coming to light. If such cases are there, they should be got rectified without delay by competent welders.
4. Gantry and hoist to ensure their working condition.
5. Lubrication/greasing shall be carried as mentioned in the chart as per Annexure.12.
6. Gates shall be operated for dry testing by lowering stoplog elements with the help of gantry crane.
7. Free rolling action of rollers to be ensured.

Post-Monsoon:

EE/DEE/AEE/AE in charge of gates of dam/barrages along with DEE/AEE of mechanical division shall conduct the post monsoon inspection during the period November- December and record their observations in the check slip appended as Annexure-I of the following:

1. Leakages, and location are to be recorded.
2. Rollers, contractors-observation to be recorded.
3. Electrical components to be checked.
4. Check generator running – condition – update of logbook.

The observations recorded by the field staff AEE/AE in the register to be counter signed by the concerned SE of the project duly inspecting gates randomly.

ANNEXURE-I

PREMONSOON INSPECTION OF MECHANICAL STRUCTURES OF VARIOUS MAJOR/MEDIUM IRRIGATION PROJECTS LOCATED IN THE DIST.

Name of the Inspection Officer		
Date of Inspection		
Name of the Project inspected and location of the Project and Year of completion		
Name of the Executive Engineer		
1	Type of Gates, Size of Crest Gates with Numbers	
2	No. & Size of scour vents	
3	No. & Size of Head sluice Gates	
	a) Right Head Sluice	
	b) Left Head Sluice	
I	E.M. Parts	
	Condition of Sill beam	
	Condition of Roller Track	
	Condition of Seal Track	
	Condition of Guide Track	
	Condition of Roller cage	
	Condition of Roller	
	Condition of Roller Pin	
	Condition of Roller Bearings	
	Condition of independent Roller train of Gates if any	
	Condition of Painting	
	Date of Painting	
II	a) Whether the E.M. Parts are provided for the Emergency Gates	

	b) Condition of the E.M. Parts	
III	Crest Gates:	
	a) Condition of Skin Plate	
	b) Condition of the Vertical Gates Trusses, Reinforcement.	
	c) No of Trusses to each crest Gates and Condition of the numbers	
	d) Condition of Trusses for all gates	
IV	Radial gates	
	Condition of Radial Arms	
	Condition of Trunnion Brackets	
	Condition of Anchor Boxes	
	Condition of the Paint	
V	Condition of General Remarks	
	A) Gates Seals	
	i) Condition of Wire Ropes	
	ii) Condition of Side Seals	
	iii) Condition of Seal Bolts & Nuts	
	iv) Condition of Seal Flat	
	v) Whether the stop log gates provided and condition of the gates	
	B) Wire Rope Rings, Pulleys:	
	i) Condition of wire Ropes	
	ii) Last date of Replacement of Wire Ropes	
	iii) Last date of application of cardium compound	
	iv) Condition of wire rope rings	
	v) Condition of Hinge Pins	

	vi) Condition of Rope Drums	
VI	Hoist Bridges:	
	i) Condition of Hoist Bridges	
	ii) Condition of Hoist Mechanism	
	iii) Condition of Drive Units	
	iv) Condition of Motors	
	v) Condition of Radicons	
	vi) Condition of E.M. Brake	
	vii) Condition of Hand operating Mechanism	
	viii) Condition of Drive Shaft	
	ix) Condition of Plummer Bolts & keys	
	x) Grease cups provided to plummer box and grease nipples	
	Drive Units	
	i) Condition of Gear Wheels	
	ii) Condition of Lubricants	
	iii) Condition of Gear Shafts	
	iv) Condition of Covers of drive unit	
	Counterweights:	
	I) Type of counterweight	
	ii) Condition of Rope or chain	
VII	Electrical installation	
	i) Condition of Motor Wiring for Motors, Starters, Panel Boards	
	ii) Condition of Syron	
	iii) Condition of Lighting arrested	
	iv) Condition of Generator set	
	v) Condition of Batteries for Generator	
VIII	Sluice gate	
	a) Head Sluice	
	b) No of Vents & Size	

	c) C.E.P. Parts & Gate condition	
A	(Service Gates)	
	a) Head Sluice	
	b) No of Vents & Size	
	c) C.E.P. Parts & Gate condition	
	d) Condition of E.M. Parts and Gates, Hoist, and painting	
B	(Emerg. Gate)	
	a) Head Sluice	
	b) No of Vents & Size	
	c) C.E.P. Parts & Gate condition	
	d) Condition of E.M. Parts and Gates, Hoist and painting	
IX	Condition of Link Rods or wire rope, Operation System	
	Condition of Gear Box, Screw Rods Link rod Support brackets	
	Condition of Plat Form (Hoist Bridge)	
	Scour Sluice	
	Condition of Motors, Starters, Panel Boards of Head Sluice	
	Condition of Hand operation mechanism	

RIGHT SIDE SLUICE

	Present water level	
1	Vent Size	
2	No of Vents	
3	No of Gates	
4	Vertical Gate	
5	Screw Rod / RDH	
6	Hand Operation	

7	Sill Level	
8	Length of the canal	
9	Bed Width	
10	F.S.D.	
11	Discharge	
12	Ayacut	
13	Ayacut Area	
14	Crop	

LEFT SIDE SLUICE

	Present water level	
1	Vent Size	
2	No of Vents	
3	No of Gates	
4	Vertical Gate	
5	Screw Rod / +-RDH	
6	Hand Operation	
7	Sill Level	
8	Length of the canal	
9	Bed Width	
10	F.S.D.	
11	Discharge	
12	Ayacut	
13	Ayacut Area	
14	Crop	

Chart for Maintenance Schedule of Gates

		IS:7718 Part III, IS:10096 Part III	
Every Quarterly	**Every year**	**Every 3 years**	**Every 6 years**

		IS:7718 Part III, IS:10096 Part III	
Every Quarterly	**Every year**	**Every 3 years**	**Every 6 years**
General cleanliness of EM parts, Gate, Hoist components	In addition of quarterly maintenance schedule, the following are to be checked.	In addition of yearly maintenance schedule, the following are to be checked.	check for weld damages at
Check for oil level in Radicons	check the tightness of foundation bolts of motors, Radicons, Plummer blocks, coupling joints	Check the condition of wire ropes pulleys, sheaves,limit switch, brake and gear box.	1.Skin plate joints 2.Tee girders to horizontal girders 3. Horizontal girders to arm 4. Arm bracings 5. Horizontal girder bracings 6. End boxes 7.Gate stiffeners
Greasing of pulleys and pins	Check for smooth operation of gate by raising and lowering.	Check gate seals for damages.	Check wheel assemblies for any 1.Breakagre 2.Freezing 3.Corrosion 4.Misalignment
Trunnion pin, Rope hoist, Gear wheels, operation of shaft, rollers, Gate wheels drum Hand Guide	Check for the condition of painting of all the components.	Check seal bolts for damages.	Check for sill beam, side guide, roller track for damages, corrosion, pitting
Check for operation of Brakes			Check hoist foundation for Tightening bridge bolts
Check for loose connections			

		IS:7718 Part III, IS:10096 Part III	
Every Quarterly	**Every year**	**Every 3 years**	**Every 6 years**
In case of fixed wheel gates 1. wheels are to be greased properly 2.movement of wheels should be smooth, and it can be rotated by hand			

Lubrication Charts

VERTICAL GATES:

S.No.	Parts to be lubricated	Mode of Lubrication.	Lubricant.	Schedule time.
1	Roller track, Guide track, corner angle	Oil bath	Mobil oil	Half Yearly
2	Wheel bearing	Pressure grease gun	Servo gear – 20 or bearing grease	Half yearly
3	Guide shoe	Grease Gun	Grease	Half Yearly
4	Lifting Bracket, Pulleys, Bush Bearings	Grease Gun	MP 3 Grease	Half yearly
5	Electric Motor bearing	Grease Gun	Servogum2	Half yearly
6	Electro Magnetic Brake pins	Grease Gun	Servogum-2	Half yearly
7	Worm Reducer	Oil bath	HP 90 Gear Oil	Half Yearly
8	Line Shaft, Plummer Blocks	Grease Gun	MP 3 Grease	Half yearly
9	Open Gear Reduction	Hand applied	Chassis Grease	Half yearly
10	Rope Drum Shaft Bush	Grease Gun	Chassis Grease	Half yearly
11	Wire Rope	Hand applied	Servo coat 120 (Cardium	Yearly

			Compound)	
12	Manual operating System	Grease Gun	Bearing Grease	Half yearly

RADIAL GATES:

Sl.No.	Parts to be lubricated	Mode of lubrication	Lubricant	Schedule time
1	Trunnion pin bush bearing	Pressure grease gun	bearing grease	Half Yearly
2	Roller bearing	Pressure grease gun	Bearing Grease	Half Yearly
3	Guide rollers	Pressure grease gun	Bearing grease	Half Yearly
4	Hoisting wire rope	Hand applied	Servo coat 120 (Cardium Compound)	Yearly
5	Worm reducer	Oil bath	HP 90 Gear Oil	Half yearly
6	Spur Gear Bearings	Pressure grease gun	Bearing grease	Half Yearly
7	Line shaft bearings	Pressure grease gun	Bearing grease	Half yearly
8	Gear Wheels/Pinions	Hand applied	M.P. Grease	Half yearly
9	Drum shaft	Pressure grease gun	M.P. Grease	Half Yearly
10	Lifting Arrangement and Turn bu	Hand applied	M. P. Grease	Half yearly
11	Hand operation mechanism and other relating parts	Hand applied	M.P. Grease	Half yearly

LUBRICATION:

Gates and Hoist system all moving components are lubricated to reduce friction, to increase the life span of components

Roller bearings/Bush Bearings: Roller bearings/bush bearings are Grease lubricated to reduce friction between moving components and smooth operation.

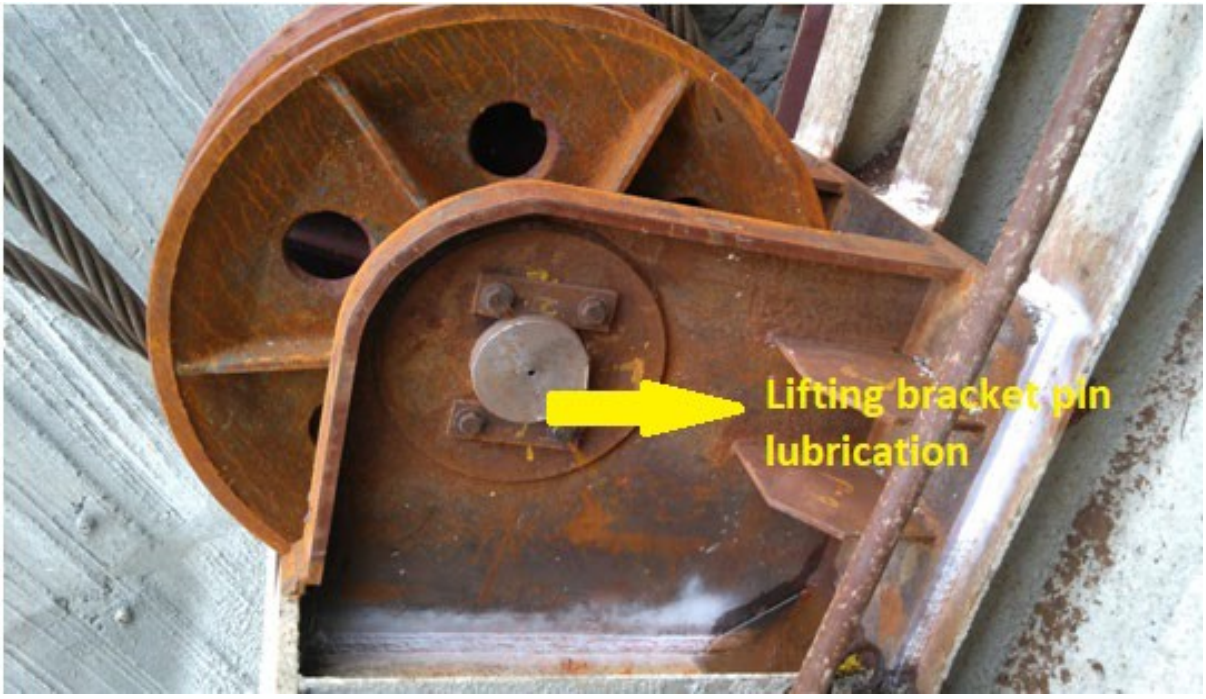
Roller Components: Collar, Pin, Cover Plate, Bearing, O-Ring and Rubber Washer.

Lifting bracket pins: The lifting bracket pulleys are provided with plain bronze bushings. Turning on fixed pins. These bush bearings are lubricated with bearing grease using grease gun for every 6 months.

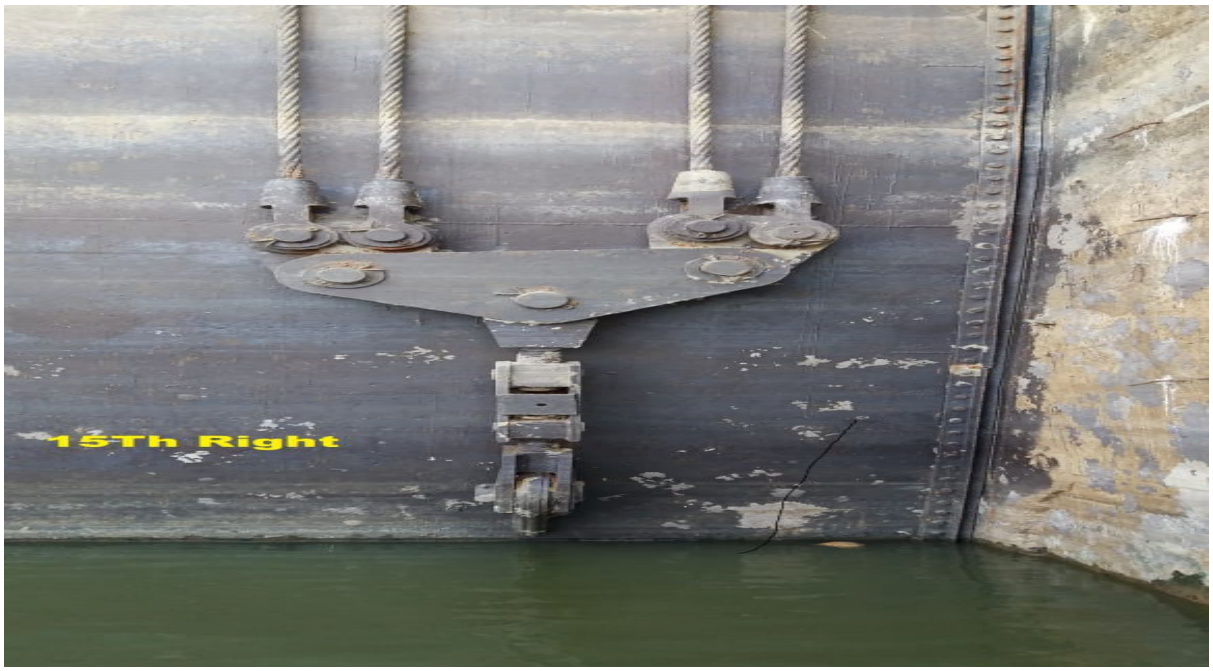
Guide Rollers: Guide rollers provided with grease nipples for greasing. Hence greasing is to be done with pressure grease gun once in Six (6) months.

Trunnion bush Pin: Grease nipples provided for greasing bush bearing provided in the trunnion hub. Greasing is to be done by means of pressure grease gun once in Six (6) months and lubrication to pin to be done while the gate in operating position for better lubrication.

Lifting bracket pin: Apply the Mp3 greasing lifting bracket pulleys bushing from the hole in the lifting bracket pin using grease gun for every 6 months.



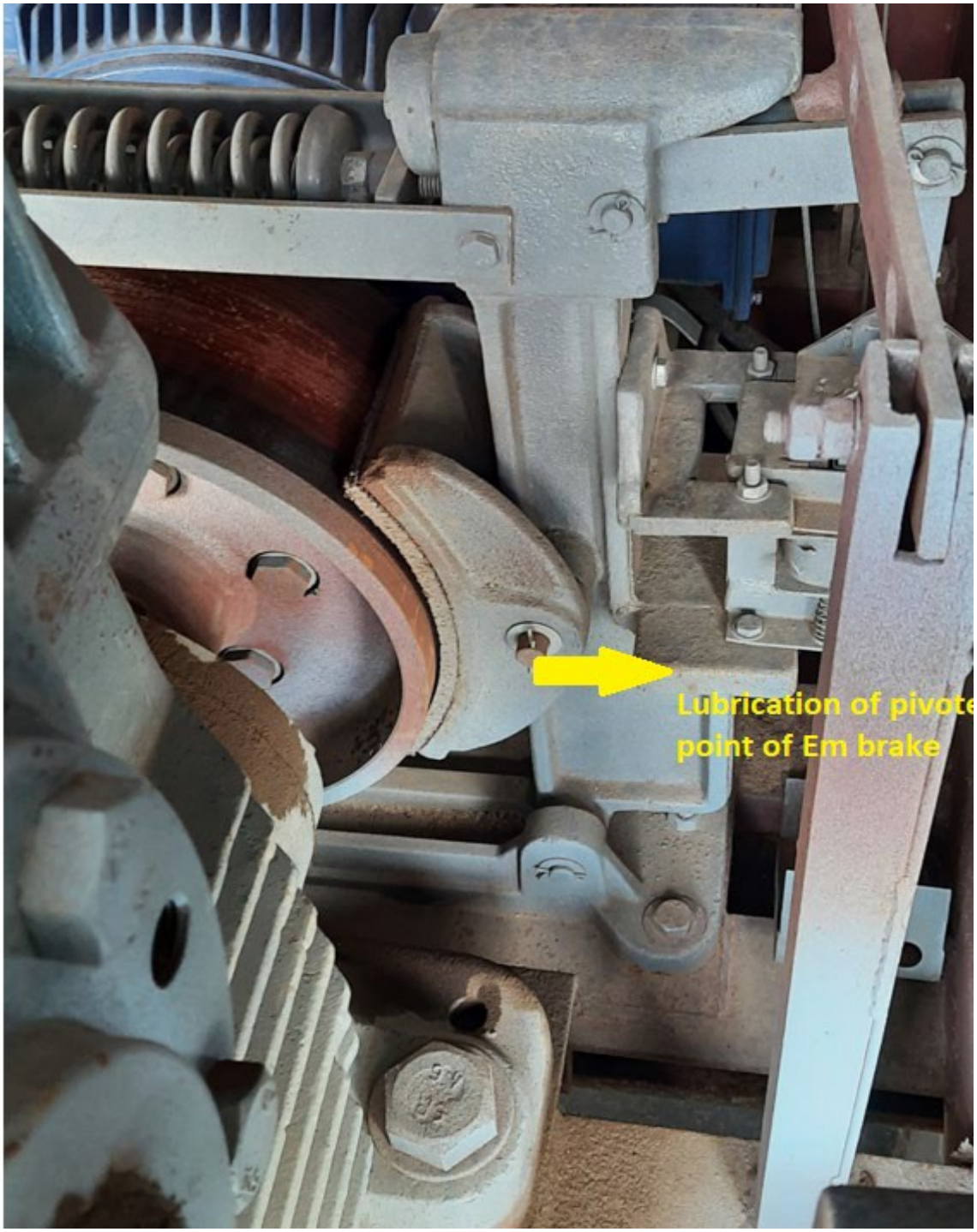
Turn buckles: Apply the oil lubrication to the screw stem pins with Mobil oil for smooth operation for every 6 months.



Motor: The motor is the heart of the hoist system. Open the covers of both ends of motor. Apply the pressure grease lubrication to the ball bearing of rotor for smooth operation.

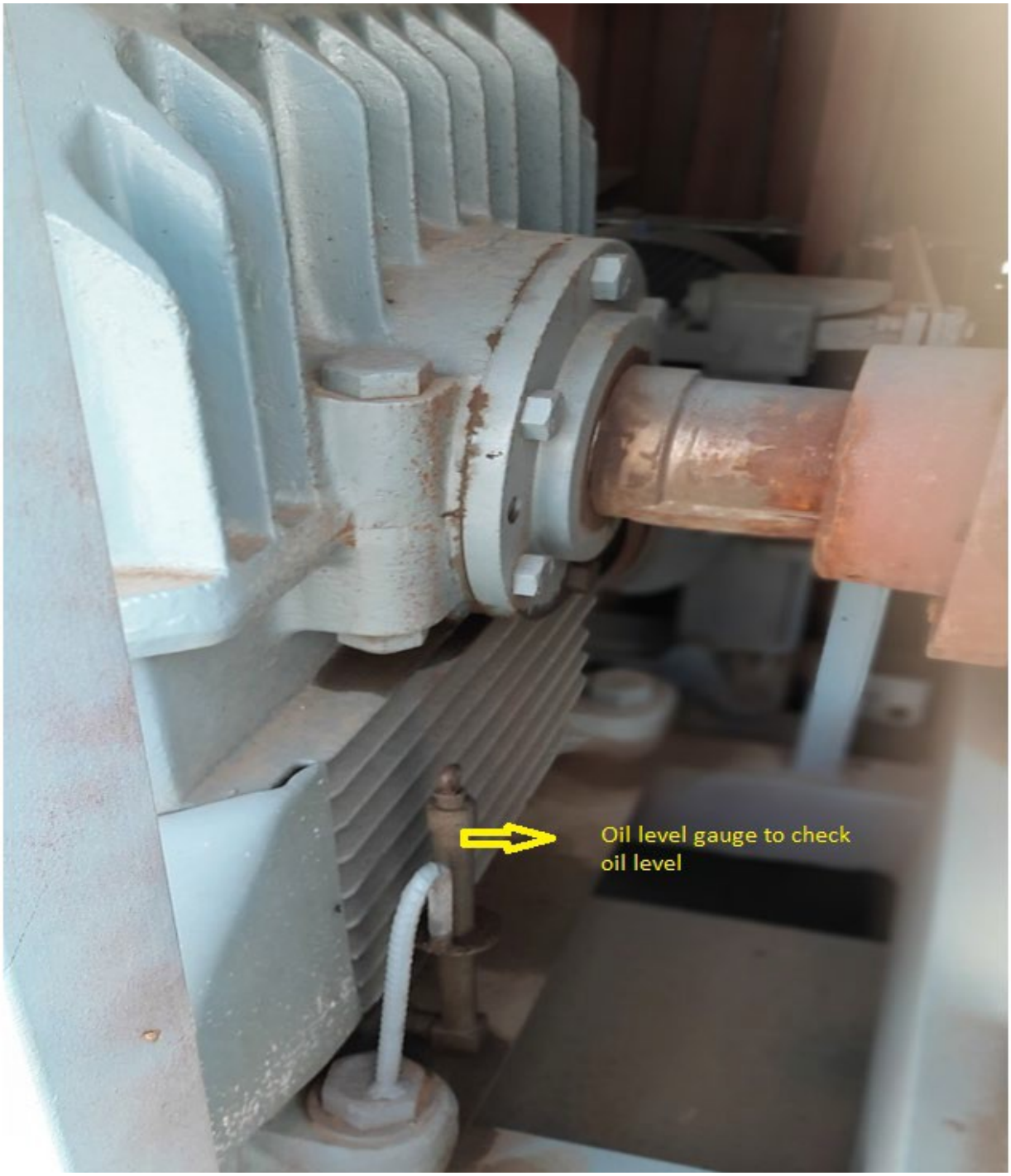

GEAR OIL 320
HAVELLS

Electromagnetic brake: It is provided between motor and worm reducer. The Electromagnetic brake pivoted pins are oil lubricated for smooth operation of gate for every 6 months.



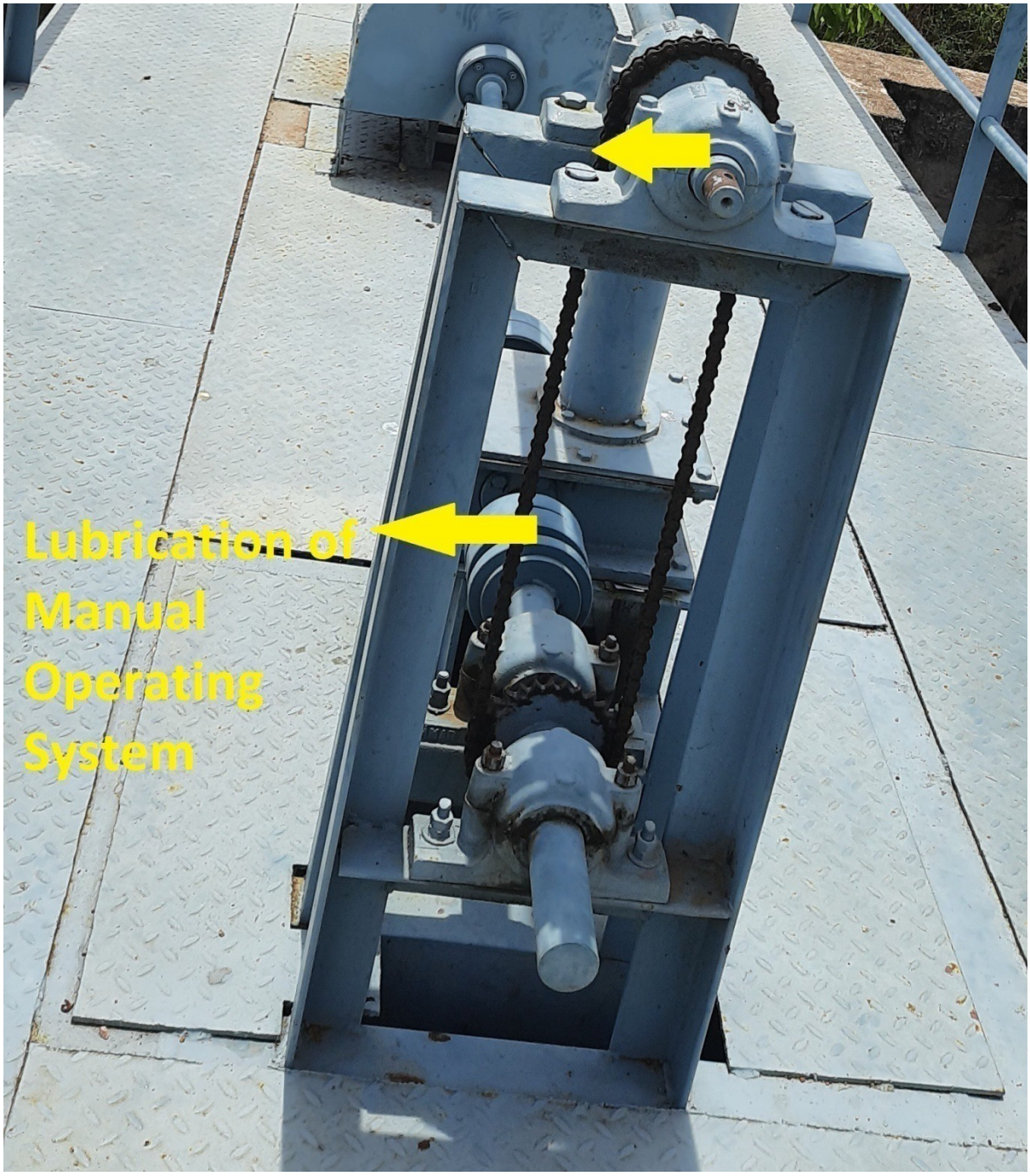
Warm Reducer: Oil level in the warm reducer must be maintained to the gauge level indicated by the needle provided in each warm reducer. The oil level is to be checked before

starting the hoist. Clean the breather for smooth escape of evolved gases during operation of gate and to protect oil seal.

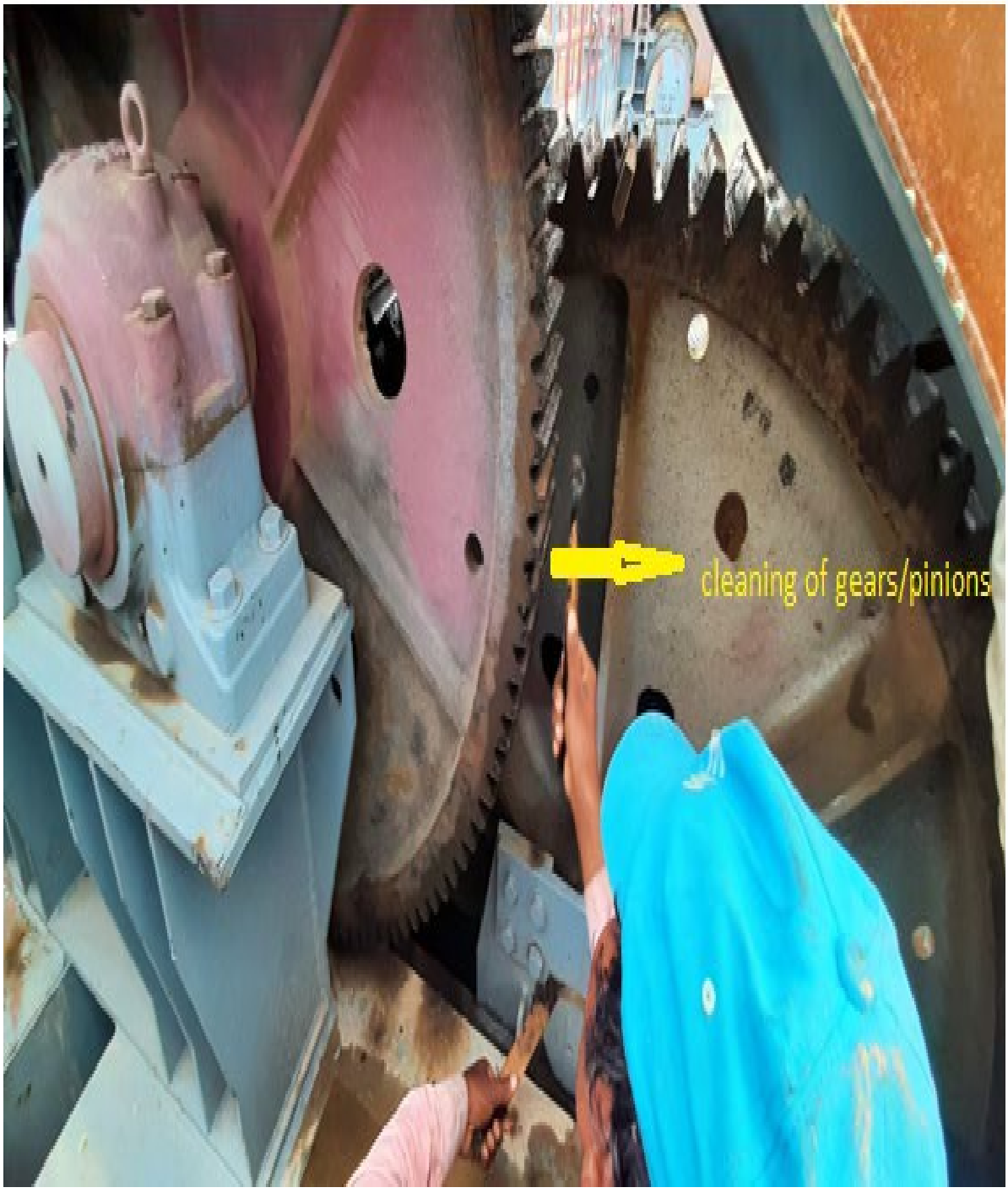


WARM REDUCER

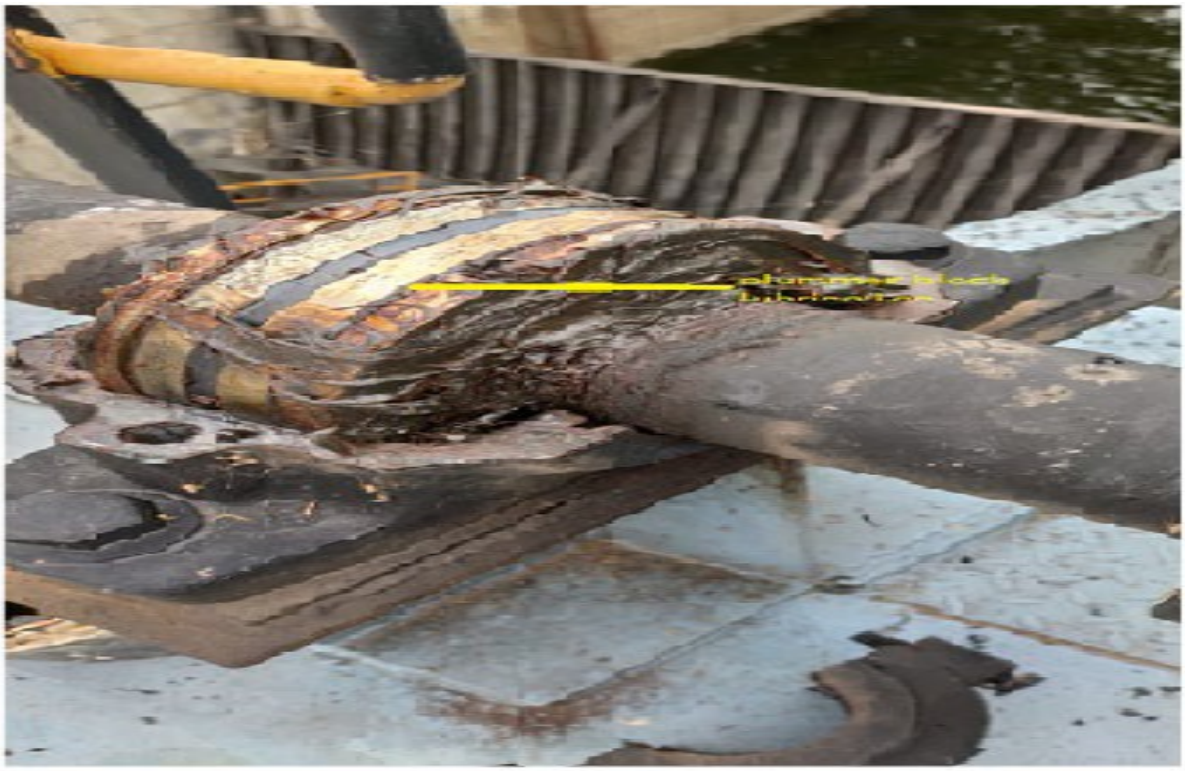
Manual operating system: Hand operating system consists of sprockets, chain and Plummer blocks. These are applied with MP3 grease once in 6 months in a year by hand



Gear Wheels and Pinions: -Gears/pinions old grease removed by a putty knife. Inspect tooth for undue wear, damage, and alignment. All the gear wheels/pinions shall be greased with thick MP3 Grease once in 6 months in a year by hand application. By pressing thumb against the tooth of gear and find thumb impression on gear teeth indicates the better lubrication has done.



LINE SHAFT SUPPORT BEARING: All the line shaft supports provided with plumber block and a grease cup on plumber block. Greasing is to be done regularly once in Six (6) months by grease gun.



DRUM SHAFT: DRUM SHAFT: Grease nipples are provided on both sides of drum shaft having a hole leading to bush bearing of drum. The greasing is to be done once in Six (6) months by means of pressure grease gun

Fixed end Shaft: Grease nipple is provided on fixed end shaft having a hole leading to bush bearing of pulleys. The bearing grease is applied once in 6 months by means of pressure grease gun.

Troubleshooting Chart:

Trouble	Probable Reasons	Remedies
1.Gates does not rise	1.No supply or low voltage (supply)	
	2.Obstruction in rubber seals/ Roller track	
	3.Obstruction in guide rollers/Track	
	4.Fault in electric motor	
	5.Fault in wiring	
	6.Blown out fuse	
	7.Brake shoes jammed	
	8.Wire rope broken	
	9.Malfunctioning of electrical contacts due to any reason	
2.Gate vibrates or produces noise	1.Lack of lubrication in trunnion and guide rollers	
	2.Rope length not identical on both sides	
	3.Lack of lubrication or fault in wire rope pulley sheave arrangements	
3.Gate travel not smooth	1.Uneven contact of side seals	Check alignment and adjust seal. If embedded parts are not properly erected or seal not smooth, this may occur.
	2.Drive shaft alignment or coupling defective	Check drive shaft for bends, slack, coupling keys, pedestal bolts.

Trouble	Probable Reasons	Remedies
	3.Gears not meshing smoothly	Check for defective gear profile, gear alignment, plummer block may be loose.
	4.Trunnion binding	Check for debris clean and grease the trunnion bearings.
	5.Unequal wire ropes tension	Check wire rope in gate closed position and adjust.
	6.Wire rope riding on the ridge of groove	Check alignment of drum and gate
	7.Improper alignment of Trunnion axis	Check and try to adjust by shims. This defect is Difficult to eliminate.
Trouble	**Probable Reasons**	**Remedies**
4.Motor does not function	1.No supply	
	2.Starter not in order	
	3.Blown out switches in fuses	
	4.Low voltage	
	5.All fuses are not working	
5.Starter not working	1.No supply to starter	
	2.Fixed and moving contacts not in order	
	3.Limit switch engaged	
6.Unusual sound	Verify the spot and attend to the following:	
	1.Misalignment of any component	
	2.Shearing of connecting bolts and nuts	
	3.Lack of lubrication	
	4.Entry of any extraneous matter into guide roller assembly or pulley sheaves or trunnion	

Trouble	Probable Reasons	Remedies
	assembly	
7. Wire rope snaps	1.a) Wire rope strands broken rusted/corroded.	Check and replace worn out parts
	b) Wire ropes out of pulley groove	
	c) Broken pulleys	
	d) Worn out bushings of pulley	
	2.Wire rope length uneven	Adjust turn buckle
	3.Turn buckle threads worn out	Replace turn buckle by one in forged steel
	4.Wire rope slipping from socket or clamp	Check wire rope clamp on Drum.
		Check socket, wedge wire rope clamps etc., and tighten.
		Ensure more than one idle winding of rope on the drum in closed position of gate.
	5.Motor does not stop at extremes of travel	Adjust limit switches
8.Hoist platform vibration	1.Loose bolts of deck plate or broken weld	check and tighten or weld where possible
	2.Wire rope rubbing against hoist parts	Check and rectify alignment
	3.Wire rope not moving in the groove on drum	Check alignment
	4.Gears not meshing properly	Check alignment.

Trouble	Probable Reasons	Remedies
		Pedestal blocks keys.
		Grease open gears.
	5.Defective gear profile	If gears are not manufacture by "Hobbing", accurate profile is not achieved, and gears do not run smoothly. This manufacturing defect is difficult to rectify.
	6. Hoist platform foundation bolts loose.	Check and rectify.
	7.Gate is vibrating	At small gate opening flow is unsteady. Change position.
9. Seals of side and bottom leaking	1.Debris	Check and remove
	2.Worn out/damaged seals	Check and replace during maintenance.
	3.Missing SS seal travel plate	Sometimes, due to defective manufacture SS seal seat gets peeled off during operation. Find cause and set right.
	4.Defective erection of embedded parts	Rectify after proper planning.
	5.Loose or broken clamp bolts	Check and rectify.
	6.Side sway of gate during travel	Trunnion alignment to be checked.

Trouble	Probable Reasons	Remedies
10.Side sway of Gates	1.Guide rollers missing	Check and replace.
	2.Trunnion alignment not correct	Check and adjust by shims to the extent possible.
	3.Unequal length of wire rope	A new wire rope stretches under load. So, replace both wire ropes or adjust turn buckle.
11.Shifting of yoke girder	Check anchorage bolts, nuts, tie bars etc.	Shifting of yoke girder.
12.Inaccurate alignment of embedded parts while erecting	Inaccurate alignment of embedded parts while erecting	Plan rectification, consult expert.
13. Excessive torsional twist of line shaft in the case of CDU located on pier	Excessive torsional twist of line shaft in the case of CDU located on pier	Check and use larger die shaft or hollow shaft
14.Gate creeps	1.Hoist brake not proper	Adjust brake shoe, clean with petrol. Replace worn parts, check spring and solenoid.
	2.Gear profile not accurate	Stub spur gear accurately hobbed are self-locking.
15.Manual operating device not working	Clutch not engaging or slipping	Check and rectify clutch linkages, brake shoe.

Trouble	Probable Reasons	Remedies
16.Dial reading not accurate	Dial disc loose on shaft or drive chain loose.	Tighten screw. Adjust drive chain links, calibrate, and correct zero error.
17.Motor getting hot	1.Defective power supply, low voltage	Check all 3 phases for voltage.
	2.Overload	Gate may be stuck and not free.
	3.Moisture in winding	Check resistivity in winding, dismantle and varnish and heat coils.
	4.Clogged ventilation	Check and clean the fan.
	5.Loose bearings	Check and replace
	6.Solenoid brake of central drive unit not released when motor starts.	Check and adj ust brake.
18.Motor direction changed	Phase connection at the starter might have got interchanged	Check starter phase contact might have got interchanged.

DO's	DONT's
1. Authorised Personnel should be allowed near control Pane for operation of gates.	1. Un authorized persons should not be allowed to operate gates
2. Technically qualified or trained operators should be allowed to operate gates.	2. Unqualified persons technically should not be allowed to operate gates.
3. Operate the gates only when there is required power supply as per the design is available.	3. Not to operate gates during low voltage period
4. Adjust the brakes when the gate is lowered fully	4. Not to adjust the brakes when gate is not

DO's	DONT's
and rest on sill.	dogged
5. Attend maintenance during pre-monsoon Season	5. Not to adjust the brakes when gate is not dogged
6. Use proper tools for attending repairs / Adjustments	6. Maintenance works should not be attended during rains.
7. Conduct Dry test before putting into operation	7. Do not operate gates without Dry testing
8. Maintain cleanliness of hoist platform, trunnion Platforms	8. Not to keep any slippery material on Hoist walkway
9. Insulate damaged electrical wiring, which are exposed to atmosphere	9. Do not allow any persons to operate gate if Bare wires are seen
10. Protect Hoist gear box and motors from rains	10. Not to keep gear box cover open after daily maintenance
11. Ensure wire rope tightness on either side equally before operating gate	11. Not to operate gate when the wire rope is slacked
12. Safety precautions should be taken during maintenance works	12. Not to wear loose dresses during operation of gates
13. Cut off power supply after operation of gates	13. Do not allow power supply to motors when it is not at all required.
14. Check connections and functioning of limit switches before operation	14. Advised not to operate gate if limit switches are not functioning
15. Ensure before operation that no foreign materials fall in the gear teeth	15. Not to switch on Hoist motors if foreign material found in between teeth of gear Wheels
16. Check tightness of Plummer block, drive unit, line shaft, coupling bolts	16. Do not operate gate if any bolts of Plummer block and coupling bolts are found loose
17. Ensure no foreign particles stuck up in between roller and roller track/ wall plate and rubber seals etc.,	17. Not advised to operate gates if foreign material found in between rollers and roller track and wall plates and rubber seals etc.,

DO's	DONT's
18. Maintain oil as per level indicator in the gear box.	18. Not to operate gates with low oil level in gear box
19. Check tightness of wire rope clamps before operation.	19. Not to operate gate if wire rope clamps Are found loose
20. Operate gate only when grooves are clean without any obstructions	20. Do not operate gate if there is any projection, in the grooves which obstruct movement of gates
21. Provide proper approaches for attending maintenance at grunion bushes and grunion pins, grunion girders etc.,	21. Not to use manila rope / wire ropes as approach for attending maintenance works at Trunnions, trunnion girders etc.,

Tools and Equipment:

Equipment:

1. Chain Block Pulley – 2 T, 5 T, 10 T
2. Hydraulic Jack – 10 T
3. Spanner Set
4. Elen Screw Set
5. Hammer
6. Gat Set
7. Welding Set
8. Grease Gun

Instrumentation:

1. Paint – Elcometer
2. Speed – Tachometer
3. Rubber Hardness – Shove A Hardener
4. Outside Diameter, Inside Diameter – Callipers
5. Thickness of Plate – Ultrasonic Thickness Gauge
6. Voltage – Voltmeter
7. Current continuity – Megger

Tools and Equipment Table:

1.	Double ended spanner set 6 mm to 38 mm	2 sets
2.	Ring spanner sets 5 mm to 30 mm	2 sets
3.	Screwdriver 150 mm, 200mm and 300 mm	2 each
4.	Anchor rod spanner as per six of anchor rod nut (40 mm to 100mm)	1 No.
5.	Spanner for rubber seal (Box and ring)	4 each
6.	Spanner for Trunnion bracket bolts	1 No.
7.	Grease gun 20 litre capacity	1 No.
8.	Hand grease gun	1 No.
9.	Oil Can 20 ml. capacity	2 Nos. Each
10.	Insulating pliers 150 mm & 200 m	2 Nos. Each
11.	Cutting pliers 150 mm & 200 m	2 Nos. each
12.	Cutting pliers 150 mm & 200 mm	2 Nos. Each
13.	Line tester 500 volts	1 No.
14.	Multimeters	1 No.
15.	Spirit Level 150 mm, 300 mm	2 Nos. Each
16.	Outer and inner calliper 250mm	2 Nos. Each
17.	Assorted files set 300mmlong	2 Nos. Each
18.	Hammer sets 1 kg. 2 kg. & 5 kg	2 Nos. Each
19.	Steel rule 300, 600 & 900 mm	1 No. Each
20.	Straight edge 1200 mm	1 No.
21.	Steel tapes 2 mtr. 15 mtr. & 30 mtr	2 Nos. Each
22.	Chain pulley block 2 ton & 5 ton	1 No.
23.	Single and double sleeve pulley block 150 mm. dia	2 Nos. Each
24.	Single phase welding set optional	1 No.
25.	Hacksaw frame 300 mm	1 No.
26.	Pipe wrench 250, 300, 450 & 600mm	1 No.
27.	Battery charger 24 volts	1 No.
28.	Electric grinder, straight/angle 100/180	1 No.

29.	Wire brush 100 mm	12 Nos.
30.	Probable drill (Electric) 12 mm. caps.	1 No.
31.	Parallel jaw bench vice 100 mm	1 No.
32.	Punch 6 mm to 25 mm for rubber seals	1 No.
33.	Centre punch 100 mm	2 sets
34.	Plumb bob 65 mm Dia.	6 Nos.
35.	Pulling and lifting machine 5-ton capacity Tir – for make	1 No.
36.	Electrical tong tester 600V per 200 Amps.	1 No.
37.	Gas cutting regulator Oxygen	1 No.
38.	Gas cutting regulator Acetylene	2 Nos.
39.	3 cell torches	1 No.
40.	Commander torch	1 No.
41.	Buckets of various sizes 10lits. 16 lits and 20 lits	1 No.
42.	Measuring cans 1 lit. 2 lit., 5 lit.	1 No. each
43.	Electrically operated portable warning signal (siren)	1 No.
44.	Blow lamp	1 No.
45.	First aid box	1 No.
46.	Tool boxes	3 Nos.
47.	Steel Cupboards Small Steel Cupboards Big	1No. 2 Nos.
48.	Tachometer	1 No.
49.	Magnetic drilling machine	1 No.
50.	Wire rope slings of 10 mtr/E	2 Nos.
51.	Polyester rope 1” dia or Manila 30mm dia – 10 mtr	1 No.

11. Painting

As a part of maintenance operation, all gates, embedded metal parts and hoists should be inspected at an interval of 2 years. All these components and their supporting structures should be protected against corrosion due to climatic condition, biochemical reaction and abrasion due to different forces acting on it. Else this equipment may deteriorate to extent that the replacement of parts may be necessary and such replacement may become difficult and costly. Therefore, it is necessary to paint to protect the equipment and to increase the life.

Therefore, application of the paint film has two main purposes. The first one is to protect the steel from corrosion and increase life span of steel structures and the second for decorative appearance.

Painting for hydro mechanical works shall be carried out as per IS 14177 The painting system for gates and equipment shall be attended at 2 stages.

I. Applying paint as fresh at the time of manufacture.

II. Removal of old paint, rust and repainting during maintenance.

Surface Preparation: After the equipment has been fabricated, it is essential that before any primer coat of paint is applied, the surface is properly prepared. Such preparation shall include through cleaning, smoothing, drying and similar operation that may be required to ensure that the primer and or paint is applied on suitable surfaces.

The procedure for surface preparation shall be as follows:

1. Weld spatters or any other surface irregularities shall be removed by any suitable means before cleaning.
2. All oil grease and dirt shall be removed from the surface using clean material spirits, Xylol or white gasoline and clean wiping materials.
3. Following the solvent cleaning, the surfaces to be painted shall be cleaned of all rust, mill scale and other lightly adhering objectionable substances by sand blasting. Blast cleans to a minimum of Sa 2½ Swedish standard SIS 05 5900 with a surface profile not exceeding 65 microns.
4. Surface of stainless steel, nickel, bronze, and machined surface adjacent to metal work being cleaned or painted shall be protected by making tape or by other suitable means during the cleaning and painting operations.

5. Primers shall be applied as soon as the surface preparation is complete and prior to the development of surface rusting. In case there is considerable time gap, the surface shall be cleaned prior to priming.

11.1. Shop painting:

1 **Embedded parts which come into contact of concrete**:

All embedded parts which come in contact with concrete shall be cleaned and given two coats of cement latex to prevent rusting during the shipment while awaiting installation.

2 Embedded parts which are not in contact with concrete and gate parts:

Two coats of zinc rich primer with epoxy resin shall be applied to all embedded parts surface which are not in contact with concrete and shall remain exposed to atmosphere or submerged in water to obtain a dry film thickness of 75 microns. Over the primary coat two coats at an interval of 24hours of coal tar blend epoxy resin part to get a dry film thickness of 80 microns in each coat. Total dry film thickness of paint shall be 300 microns.

3 **Surfaces not to be painted:**

The following surfaces are not to be painted unless or otherwise specified

a) Machine finished or similar surface.
b) Surfaces which will be in contact with concrete.
c) Stainless steel overlay surfaces.
d) Surfaces in sliding or rolling contact.
e) Galvanized surfaces, brass, and bronze surfaces.
f) Aluminium alloy surfaces.

All finished surfaces of ferrous metal including bolts, screw threads etc., that will expose during shipment or while awaiting installation shall be cleaned and given heavy uniform coating of gasoline soluble rust preventive compound or equivalent.

4 Gates:

Primer Coat:

Over the prepared surface one coat of inorganic zinc silicate primer giving a dry film thickness of 70 ± 5 microns should be applied. Alternatively, two coats of zinc rich

primer, which should contain not less than 85% zinc on dry film should be applied to give a total dry film thickness of 75 ± 5 microns.

Finished paint:

Over the primary two coats of solvent less coal tar epoxy paints. These shall be applied at an interval of about 24 hours. Each coat shall give a dry film thickness of150±5 microns. The total dry film thickness of all the coats including primer shall not be less than 350 microns.

5 Hoist and supporting structure:

Structural components:

Primary coat: Over the prepared surface Primer coats of zinc phosphate primer shall be applied to give a dry film thickness of40±5 microns.

Final Coat: Over the primary surface one coat of alkyd based micaceous iron oxide paint to give a dry film thickness of 65 ± 5 microns followed by two coats of synthetic enamel paint confirming to IS 2932 – 1974 to give a dry film thickness of 25 ± 5 microns per coat. The interval between each coat shall be 24hours. The total dry thickness of all coats of paint including the primary coat shall not be less than 175 microns.

Machinery:

Except machined surfaces all surfaces of machinery including gearing, housing, shafting, bearing pedestals etc., shall be given.

Primary coat:

Over the prepared surface One coat of zinc phosphate priming paint to give minimum film thickness of 50 microns. Motors and other bought out items shall be painted if necessary.

Finished coat:

The finished paint shall consist of three coats of aluminium paint confirming to IS2339 – 1963 or synthetic enamel paint confirming to IS 2932 – 1977to give a dry film thickness of 25±5 microns to obtain a minimum dry film thickness of 125 microns.

11.2. Repainting:

If repainting is considered necessary, surface preparation should be carried out by appropriate hand and power tool cleaning.

Visible oil, grease, dirt and other foreign material should be cleaned by using solvents by the use of clean mineral spirits, xylol or white gasoline. However, specific instructions should be given on the extent of the surface to be blast cleaned while repainting.

In preparing previously painted surface, it is necessary to remove all corrosion and all paint which shows evidence of corrosion, peeling, brittleness, blistering, scaling or general disintegration. While attending to the maintenance painting, it is not ordinarily intended the total sound adherent old paint be removed unless it is excessively thick or flexible. It is essential that the removal of old paint be carried back around the edges of spot of area until an area is completely intact and adhering paint film, with no rust or blisters underneath is attained. Edges of tightly adherent paint remaining around the area to be recoated must be feathered, so that the repainted surface can have a smooth appearance.

S.no	Description of Item	Surface Preparation	Primary Coat	Thickness	Finished coat	Thickness	Total thickness of paint
1	EM Parts (Exposed)	Sand blasting/Power tool cleaning	1 coat Inorganic Zinc Silicate	75 µ	2 coats Solvent less Coal tar Epoxy paint	300µ	375µ
2	EM Parts (embedded in concrete)	Sand blasting/Power tool cleaning	Cement Latex	150µ			150µ

3	Gate	Sand blasting/Power tool cleaning	1 coat Inorganic Zinc Silicate	75µ	2 coats Solvent less Coal tar Epoxy paint	300µ	375µ
4	Hoist (Structural parts)	Sand blasting/Power tool cleaning	2 coats Zinc Phosphate primer	80µ	1 coat of micaceous iron oxide+2 coats Synthetic enamel Paint	65µ+50µ	195µ
5	Hoist (Machinery)	Sand blasting/Power tool cleaning	1 coat Zinc Phosphate primer	50µ	3 coats Aluminium paint or Synthetic enamel paint	75µ	125µ
6	Lifting Beam	Sand blasting/Power tool cleaning	2 coats Zinc Phosphate primer	80µ	2 coats of micaceous iron oxide	130µ	210µ

12. Gate Operation and Record

S.No.	Date	Time	Reservoir level	Gate No.	Gate lifted		Gate lowered		Name & signature of operator	Gate operation ordered by name/ designation/ signature available	Remarks
					in meter	R.L of bottom of gate in meter	in meter	R.L of bottom of gate in meter			
1	2	3	4	5	6	7	8	9	10	11	12

The gates are required to be operated as per the reservoir operation manual prepared based on the hydrological condition only under written order from the competent authority. For each project, reservoir operation manual should be prepared considering flood pattern and downstream channel condition. Based on that, the sequence of the gates to be operated can be decided first.