GOVERNMENT OF UTTARAKHAND
OPERATION & MAINTENANCE MANUAL

ASAN BARRGE

Project ID Code: GENUAWA001

Prepared by

UJVN Limited

(A Govt. of Uttarakhand Enterprise)

March, 2021

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Government of Uttarakhand
UJVN Limited

Disclaimer

This Operation and Maintenance Manual for Asan Barrage, in no way restricts the dam owner in digressing from her/his responsibilities. The UJVN Limited or the Central Water Commission cannot be held responsible for the efficacy of this Manual developed based on documents provided by the dam owner. The Dam Owner and her/his Operators must exercise appropriate discretion when implementing and using this Operation and Maintenance Manual for managing the O&M of Asan Barrage and its appurtenant structures.

The Manual was developed for the purpose of organizing and managing the Operation, Inspection and Maintenance of Asan Barrage which will help in reducing its risk and optimizing its performance.

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Preface

This Operation and Maintenance (O&M) Manual has been prepared under DRIP in accordance with the Guidelines for Preparing Operation and Maintenance Manuals for Dams issued by CWC in the year 2018. Basically this Manual is an up-gradation of the existing O&M Manual of Asan Barrage prepared at the time of commissioning of this project. It contains procedures and protocols for ensuring that the barrage is operated and maintained properly and timely and to reduce its health deterioration and their by extend its service life.

The Manual has been prepared primarily for the barrage operation's staff and their supervisors who are assigned the responsibility for the physical operations and maintenance of the barrage. It contains, as a minimum, all information and instructions necessary for them to perform their allotted tasks in a safe manner. In addition to instructions for barrage operations staff, the Manual includes all necessary instructions for other staff directly or indirectly involved in operating and maintaining the barrage.

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Approval and Implementation

This Operation and Maintenance Manual of Asan Barrage has been prepared by UJVN Limited in collaboration with Dam Rehabilitation and Improvement Project. This document is hereby approved and is effective immediately and supersedes all previous editions.

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Acronyms used in this publication are as follows:	
BIS	Bureau of Indian Standards
CDSO	Central Dam Safety Organization
CWC	Central Water Commission
SDSO	State Dam Safety Organization
DDMA	District Disaster management Authority
SDRF	State Disaster Response force
O&M	Operation and Maintenance
DRIP	Dam Rehabilitation and Improvement Project
DSRP	Dam Safety Review Panel
EAP	Emergency Action Plan
GPS	Global Positioning System (uses GPRS for data transmission)
FRL	Full Reservoir Level
MWL	Maximum Water Level
MDDL	Minimum Draw Down Level
DSL	Dead Storage Level
SCADA	Supervisory Control and Data Acquisition
EDA	Energy Dissipation Arrangement
HM works	Hydro-Mechanical works
DG set	Diesel Generator set
STP	Sewage Treatment Plant
RMU	Remote Monitoring Unit
PC	Personal Computer
TMC	Thousand-Million M^3
MCM	Million M^3
GM	General Manager
DGM	Deputy General Manager
EE	Executive Engineer
AE/JE	Assistant Engineer/Junior Engineer

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Table of Content

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1 Chapter 1: General Information

1.1 Introduction

This document is a detailed Operation and Maintenance (O&M) Manual for Asan Barrage, Dhalipur in district Dehradun, Uttarakhand. It contains procedures for ensuring a safe barrage operation and to keep it in a good condition by periodic inspections, repairs, and maintenance on a sustainable basis. Timely maintenance is important for the continued safe functioning and productive use of the barrage and reservoir.

The Manual has been prepared primarily for the barrage operators and supervisors who are assigned the responsibility for the physical operations and maintenance of the barrage. It contains, as a minimum, all information and instructions necessary for them to perform their allotted tasks in a safe manner. In addition to instructions for barrage operators, the Manual includes all necessary instructions for other staff directly or indirectly involved in operating and maintaining the barrage.

It is essential that the Manual or a copy of the Manual along with supporting data including the atlas of all drawings and technical documents of equipment installed is available at site for ready reference.

1.2 Back Ground details

After independence, the necessity of constructing water resources and hydropower projects was felt by the visionaries and architects of modern India. Many multi-purpose projects were conceived and executed. On December 23, 1949, the first Prime Minister of Independent India, Pt. Jawahar Lal Nehru laid a foundation stone at Dakpathar, 46 km from Dehradun, for construction of Yamuna Valley Hydroelectric Project Stage-I. But due to paucity of funds, the construction work could not be taken up immediately. The construction on the Project was started in 1956 but had to be stopped in 1958, since Koch Dam was proposed to be constructed on river Yamuna in the upstream of Tajewala Head Works by the State of Punjab. It was apprehended that the Yamuna Valley Hydroelectric Project Stage-I shall come under the submergence. However, the investigations and surveys conducted by the Engineers of Irrigation Department revealed that due to poor geological conditions, it was not feasible to construct the proposed Koch Dam Project. Later, in 1960, Yamuna Organization was established and the work on Yamuna Valley Hydroelectric Project Stage-I was re-started in 1961 and completed successfully.

After the successful construction of Yamuna Valley Hydroelectric Project Stage-I, construction of Yamuna Valley Hydroelectric Project Stage-II started in which Ichari Dam

and Chibro Power house were commissioned. Later, Khodri Power House was commissioned in this stage only.

Along with Yamuna Valley Hydroelectric Project Stage-II, the work of construction of Yamuna Valley Hydroelectric Project Stage-IV started simultaneously in which Asan Barrage, Kulhal Power House and later Khara Power House were commissioned.

1.3 Yamuna Hydro-Electric projects at a glance

S. No.	Project		Year	Installed Capacity, MW	Owner
1.	Yamuna Hydroelectric Project Stage-I (Dakpathar Barrage, Dhakrani, Dhalipur Power House)		1965	51.00+33.75 =84.75	UJVNL
2.	Yamuna Hydroelectric Project Stage-II Part 1 (Ichari Dam and Chhibro Power House)		1975	240	UJVNL
3.	Yamuna Hydroelectric Project Stage-II Part-2 (Khodri Power House)		1984	120	UJVNL
4.	Yamuna Hydroelectric Project Stage-IV Part 1 (Asan Barrage and Kulhal Power House)		1975	30	UJVNL
5.	Yamuna Hydroelectric Project Stage-IV Part 2 (Khara Hydroelectric Project)		1992	72	UPJVNL

1.4 Asan River

Asan river is fed by the streams of the western part of the Doon valley. The northern section of the river originates from the southern slopes of Mussoorie. There are several streams here that gradually merge into one river that emerge from Robber's cave. The river here is in a U-shaped valley meandering slightly in a south-westerly direction. It then moves on to Tapkeshwar Mahadev, a popular Shiva shrine before moving to a broad valley near Premnagar. The river proceeds south-west, receiving the waters of several streams flowing southward from the northern range spanning Vikas Nagar - Mussoorie; and northward from the lower Shiwalik forest hills that separate the Doon valley from Saharanpur district. In the lower section it is known as the 'Asan'. It flows into a relatively flat section which feeds the Asan barrage.

1.5 Asan Barrage

The Asan Barrage is in the Uttarakhand-Himachal Pradesh border region in Doon Valley, Dehradun District, situated at the confluence of the Eastern Yamuna Canal and the Asan River and about 18 km from Dakpathar and 42 km. northwest of Dehradun.

Directly behind the barrage on its eastern flank, water re-enters the Eastern Yamuna Canal on the west side of the Yamuna River. At a distance of 4.5 km from the barrage on the canal, water reaches the 30 MW Kulhal Power Plant at latitude 30°25′43″N and longitude 77°37′46″E. The power plant contains three 10 MW Kaplan turbine-generators and has a design hydraulic head of 18 m. Once discharged from the power station, the water is conducted by the canal for a length of another 13 km to the 72 MW Khara Power Station at latitude 30°21′02″N and longitude 77°36′06″E in Uttar Pradesh. The Khara Power Station contains three 24 MW Francis turbine-generators and has a net head of 43 m.

The barrage creates the Asan Reservoir, also called Dhalipur Lake. The lake is popular for bird watching and 53 species are known to make a habitat there, out of which 19 species are migratory from Eurasia.

1.6 Location of barrage:

Latitude	30°26’03” N	
Longitude	77°39’56” E	
Nearest town:	Vikasnagar, District Dehradun, Uttarakhand	14 KM
	Paonta, District Sirmaur, Himachal Pradesh	7 KM
Nearest railway Station:	Dehradun	42 KM

Nearest Airport:	Jolly Grant Airport, Dehradun	72 KM
In East direction:	Dhalipur Power House and Asan River	
In West Direction:	Yamuna river	
In North Direction:	Yamuna river	
In South Direction:	Village Kunja	

1.7 Description of project:

Yamuna Hydel Scheme, Stage-IV envisages power generation by utilizing the tail race water of the Yamuna Hydel Scheme Stage-I along with the flow of Asan River. Under this scheme, Asan Barrage and Head Regulator has been constructed across tail race of Yamuna Hydel Scheme Stage-I and river Asan to divert the flow into a 4 km long lined power channel of 198.20 cumec (7000 cusec) capacity. A Power house of 30 MW (3x10MW) installed capacity had been constructed at the end of the Power Channel near village Kulhal and the famous Ponta Sahib Shrine of the Sikhs. The construction of this project was started in 1965 and was completed in 1967 at a total cost of about Rs. 14.35 crores. Asan barrage of this scheme was constructed under Yamuna Hydel Scheme Stage-IV Part-I and rest of work of this scheme have been constructed under Yamuna Hydel Scheme Stage-IV, Part II.

Asan Barrage is situated across river Asan at Dhalipur in Distt. Dehradun. There is practically no observed stream flow and gauge data of Asan River. Only the record for river Yamuna at Tajewala having a catchment area of 11,200 sq. km. is available. The catchment area of river Asan at Barrage site is 715 Sq. km. which is very small in comparison to the catchment area of river Yamuna at Tajewala. The general characteristics of the two rivers are also not similar and as such the peak discharge of river Asan at the Barrage site was worked out from the various empirical formula at the time of construction and the following values were adopted for design purposes:-

1.	Design Flood	:	4500 cumec
2.	Maximum possible flood	:	6000 cumec
3.	Dominant flood (2/3 of design flood)	:	3000 cumec

The Barrage comprises of 14 bays, each 18.288 m (60 ft) wide separated by 2.438 m (8 ft) thick piers. The four bays on the left side are separated from ten bays on the right side by a divide wall. These four bays on the left side are called under sluice bays.

The main function of the divide wall is to isolate the head regulator from the main flow as it is useful in sediment exclusion due to formation of a still pond from which the off taking channel draws its discharge. The divide wall extends up to 80 m in upstream as well as 80 m in downstream side.

The cistern level and design of energy dissipater have been adopted as per I.R.I recommendations. The upstream floor levels of under sluice and barrage have been kept at 395.95 m. The corresponding downstream floor levels have been kept at 381.70 m with a connecting glacis of 3:1.

Water way for the design flood of 4500 cumec has been worked out using Lacey's waterway formula with looseness factor as 0.80.

The length of upstream floor has been kept as 41.45 m. The length of downstream floor has been kept as 25.4 m from the toe of the glacis; the upstream floor has been overlaid by 330 mm thick Boulder sets. Downstream floor has been overlaid by 610 x 460 x 460 mm Delhi granite stone.

In Asan Barrage vertical lift type gate of size 18.288 m x 5.55 m have been provided. These gates can be operated manually as well as electrically. For operation of these gates electrically, an electric motor of 5.0 HP, 400V, 3 phase 50 Hz has been installed over each gate. When operated electrically the rate of lifting or lowering of gate is 0.3 m per minute. When operated manually the rate of lifting is 25.4 mm per minute.

The various pond levels have been kept as below:-

i.	Design pond level	:	401.30 m
ii.	Pond level required to feed the required discharge in the power channel	:	400.25 m

1.7.1 Head Regulator:-

The head regulator takes off at an angle of 107^{O} towards left bank of the barrage. It comprises of 5 bays, each having clear span of 9.0 meters, thickness of piers being 1.5 m. The head regulator has been provided with a trash rack extending right up to the maximum pond level to check the entry of debris and timber into the power channel. The size of head regulator gates is 9 m x 3.5 m and these gates can be operated electrically as well as manually. 2 HP

motors have been installed over each gate for this purpose. When operated electrically the rate of lifting is 0.3 meter per minute. The sill level of head regulator has been 397.50 m.

1.7.2 Power Channel:-

The power channel takes off perpendicular to the head regulator axis and thereafter runs almost parallel to the river flow. The power channel has been designed to carry following discharges.

1. A discharge of 269 cumec should pass into the power channel up to silt ejector. This includes 70.8 cumec discharge to be passed through silt ejector.
2. A discharge of 198.20 cumec should pass into the power channel after the silt ejector.

   The bed slope of power channel has been kept as 0.15 m/km and side slope has been kept as 1.5 (H):1(V).

   The power channel has been provided with 100 mm thick concrete being laid in situ in the bed and one layer of 75mm thick bricks overlay with a layer 50 mm thick precast CC tiles with 12.5 mm thick sand witched cement plaster on the side slopes.

   The power channel during its entire length of 4.0 km crosses 6 minor and major cross drainages crossing at the following chain ages:-

   i. At 0.24 km. of power channel
   ii. At 1.30 km. of power channel
   iii. At 1.84 km. of power channel
   iv. At 2.47 km. of power channel
   v. At 3.25 km. of power channel
   vi. At 3.68 km. of power channel

1.7.3 Kulhal Power House:-

The power house is located at Chain age 4.0 km of power channel near village Kulhal and the famous Ponta Sahib, a Shrine of the Sikhs. The power house has got 3 nos. Kaplan turbines of 10 MW each to utilize a design head of 18 meters. A bypass channel has also been constructed on right bank of intake of power house to release water in case when power house is required to be fully or partly closed for maintenance purpose. Bypass channel has a

discharge capacity of 198.2 cumec and is provided with automatic gate (fish belly type) at its head to maintain a constant level in the fore bay.

1.7.4 Silt Ejector:-

At Chain age 0.24 km. of power channel, silt ejector tunnels have been provided to eject bed load material to prevent the runner blades of turbines from wearing out. The silt ejector covering the entire width of the channel comprises three similar compartments each containing 5 sub-tunnels with 2.6 m wide and 0.81m high mouth opening converging in to three twin tunnels. The ejector is operated by the gates provided at the end of each twin tunnel. The silt ejector channel is approximately 620 m long having its outfall in river Yamuna. The silt ejector channel has been provided with boulder pitching in the bed, as well as in sides. The design discharge of silt ejector is 70.80 cumec. The gate of silt ejector can be operated electrically as well as manually.

1.7.5 Control Room:-

A control room is provided on the second floor of building on the left bank of barrage. Various operation of gates, e.g. River gates, HR gates can be done from this Central Control room. SCADA console & HMI is installed in Control room for various operations & monitoring. CCTV system in the Barrage is also being monitored from the Control room.

1.7.6 Technical data

A. Barrage gates (4 no. in Under-sluice bays and remaining 10 no. in Barrage bays. Gates of both under-sluice and barrage bays have same dimensions and sill level)

1. Clear width of gate : 18.288 m
2. Height of gate : 5.55 m
3. Weight of each gate : 34.16 MT
4. Weight of each counter box : 5.00 MT
5. Hoist of gate : 24.00 MT
6. Lifting /lowering speed of gate
   - i. When operated electricity : 30 cm/minute
   - ii. When operated manually : 2.54 cm /minute
7. Electric equipment : Electric motor of 5 HP 400 volt, 3 phase 50 Hz

B. Head Regulator Gates :-

1. No of gates : 5 nos.
2. Clear width of gate : 9.0 m
3. Height of gate : 3.5 m
4. lifting /lowering speed of gate
   i. When operated electrically : 30 cm/minute
   ii. When operated manually : 2.54 cm /minute
5. Electric equipment : Electric motor of 2 HP, 400 volt, 3 Ø, 50 Hz

1.8 Salient Features of Asan Barrage

1	BARRAGE		
(a)	Location	:	The barrage is at 0.7 km. D/S of the confluence of tail race channel of Yamuna Stage-I with river Asan.
(b)	Catchment Area of Asan Barrage		
	(i) Yamuna River at Tajewala Headworks	:	11200 Sq. km.
	(ii) Asan River at Asan Barrage	:	685 Sq. km.
(c)	Maximum Pond level	:	EL 401.50 m.
(d)	Minimum Pond level	:	EL 400.50 m.
(e)	MDDL	:	EL 400.25 m
(f)	Gate size	:	14 Nos, 18.228 x5.55 m. Pier thickness - 2.438 m.
	(i)Under sluice Bays	:	01 to 04, sill level EL 395.95
	(ii)Barrage Bays	:	05 to 14, sill level EL 395.95
		:	4 bays on left side are separated by 10 bays on right side by a divide wall. These four bays on the left side are called under sluice bays. The main function of the divide wall is to isolate the head regulator from the main flow. The wall extends up to 80 m. in U/S and 80 m. on D/S side.
(g)	Design Flood	:	4500 cumec.
(h)	Maximum Possible Flood	:	6000 cumec.
(i)	Dominant Flood	:	2/3 of Design flood.
(j)	Road level of barrage	:	E.L. 403.00 m

2	HEAD REGULATOR	:	
(a)	Overall length	:	51 m.
(b)	No. & Size of spans	:	5 bays of 9 m each
(c)	Size of gates	:	9 m x3.5 m.
(d)	Sill level	:	EL 397.50
3	POWER CHANNEL	:	
(a)	Capacity	:	198.2 Cumec.
(b)	Total length	:	4.0 km.
(c)	(i) Bed width upto Ch. 0.5 km	:	42.5 m.
	(ii) From Ch. 0.5 to 4.0 km.	:	11 m.
(d)	Side slope	:	1.5:1
(e)	Bed slope	:	0.15 m/km.
4	SILT EJECTOR		
(a)	No. & size	:	5 sub-tunnels , 2.6 m wide and 0.81m high
(b)	Length of channel	:	620 m
(c)	Capacity	:	70.80 cumec
(d)	Electrical drive	:	Electric motor of 7.5 HP, 400 volt, 3Ø, 50 Hz
5	KULHAL POWER STATION		
(a)	Installed Capacity	:	3 x 10 MW
(b)	Location	:	Kulhal, district Dehradun
(c)	Commissioning Year	:	1975
(d)	Type	:	Surface Power Station
(e)	Water Conducting System	:	Open Channel
(f)	Length of Power Chanel	:	4 km
(g)	Design Discharge	:	195.4 Cumec
(h)	Design Head	:	18 m
(i)	No. & dia of penstocks	:	3 nos. of 4.5 m dia
(j)	Turbine Type	:	Vertical, Kaplan
(k)	Turbine Output	:	10.4 MW
(l)	Generator Type	:	Umbrella
(m)	Generator Output	:	11100 KVA
(n)	Main Transformer	:	12.5 MVA, 6.6/132 KV
(o)	Switchyard	:	132 KV
(p)	Design Energy	:	153.91 MU

1.9 Assignment of Responsibility

UJVNL is the owner and has the final authority and responsibility for the operation and maintenance of Asan Barrage. Identification of all areas of responsibilities connected with the operation and maintenance of the barrage are covered in this section. The Officer's responsibilities for the various functions are identified by their designation and in particular, the responsibilities of operating personnel are specifically identified below and includes regularly scheduled duties which staff personnel are required to perform as outlined in the following tables:

Table showing Overall Responsibilities for Asan Barrage

S. No.	Particulars	Remarks
1.	Implementing Agency	UJVNL (A Govt. of Uttarakhand enterprise)
2.	Headed by	Managing Director, UJVNL, Dehradun
3.	Operation & Maintenance Officer-In-Charge for UJVNL	Director (Operations), UJVNL, Dehradun
4.	Operation & Maintenance (Electrical and Hydro-mechanical) Officer-In-Charge for Yamuna Valley projects in UJVNL	General Manager (Yamuna Valley), Dakpathar
5.	Maintenance of Civil works in UJVNL Projects	General Manager (Civil Maintenance), Dehradun
6.	Operation & Maintenance (Electrical and Hydro-Mechanical) Officer-In-Charge for Dhakrani, Dhalipur, Asan Barrage and Kulhal Projects in UJVNL	Dy. General Manager, Hydel Generation Circle, Dhakrani
7.	Maintenance of Civil works in Yamuna valley projects	Dy. General Manager (Civil Maintenance-Yamuna Valley), Dhalipur
8.	Asan Barrage Operation & Maintenance (Electrical and Hydro-Mechanical)	Executive Engineer (E&M), Asan Barrage
9.	Asan Barrage Civil Maintenance	Executive Engineer (Civil), Project Civil Maintenance, Dhalipur

1.9.1 Roles and Responsibilities of the General Manager (YV) & General Manager (Civil Maintenance)

1. To issue notification to the villagers downstream through public addressing system, Newspapers etc. to be alert regarding the flood situation. [General Manager (YV)]
2. Co-ordinate with the CWC flood monitoring authorities and Disaster Management cell, Dehradun on the flood condition. [General Manager (YV)]
3. To co-ordinate with the District Administration to alert the downstream villagers to evacuate the flood zone to prevent loss of life and livestock. [General Manager (YV)]
4. Issue necessary instructions to the engineers to operate the reservoir based on the inflows, rainfall data, releases from the upstream reservoirs and status of the reservoir. [General Manager (YV)]
5. Observe the performance of the barrage and its structures / Gates and Hoists during flood water releases and to issue necessary instructions to the AE/EE/DGM. [General Manager (YV) & General Manager (Civil Maintenance)]
6. Co-ordinate with the downstream Hathnikund barrage Project Engineers. [General Manager (YV)]
7. Conduct Pre and Post Monsoon inspections of the barrage. [General Manager (YV) & General Manager (Civil Maintenance)]

1.9.2 Roles and Responsibilities of the DGM and EE

1. Coordinate with the Project Engineers of Ichari dam, Dakpathar barrage, Dhakrani Power House, Dhalipur Power House, Kulhal Power House, Khara Power House and Hathnikund Barrage. To get the information on the rainfall in the catchment and inflow status at the end to bring it to the notice of the GM. [DGM(E&M) and EE (E&M)]
2. To issue notification to the villagers downstream through public addressing system, Newspapers etc. to be alert regarding the flood situation. [DGM(E&M) and EE (E&M)]
3. Assist the GM to co-ordinate with the District Administration to alert the downstream villagers to evacuate the flood zone to prevent loss of life and livestock. [DGM(E&M) and EE (E&M)]
4. Assist the GM to co-ordinate with the CWC flood monitoring authorities, Disaster Management cell, Dehradun on the flood condition. [DGM(E&M) and EE (E&M)]
5. Submit to the GM on the inflows and releases from the reservoir and status of the reservoir twice in a day. [DGM(E&M) and EE (E&M)]

6. Observe the seepages in the banks of barrage and power channel. To immediately bring to the notice of the GM, in case of excessive seepage, leakage in any specific blocks and porous drains. [DGM(Civil) and EE (Civil)]
7. Observe the Gates, hoists and handling equipment during operation for the smooth movements and to immediately report any untoward excessive sounds in the motors, pumps or vibrations in the gate. [EE (E&M)]
8. Observe the vicinity and approach roads are well maintained by housekeeping personnel. [EE(Civil)]
9. Observe the performance of the barrage and its structures / Gates and Hoists during flood water releases and to report to the GM in case of any untoward incidents or malfunctioning of the gates of excessive seepages, leakages etc. [DGM(E&M) and EE (E&M)]
10. The DGM (E&M)/ Executive Engineer (E&M) shall inspect the barrage thoroughly and will ensure that the Assistant Engineer (E&M) /Junior Engineer (operation) has checked all the mechanical and electrical equipment of Asan Barrage, head regulator and silt ejector.
11. DGM (Civil)/Executive Engineer (PCM), Dhalipur will also ensure that all the civil structures and afflux bund of barrage has been inspected and well attended by Assistant Engineer (Civil).
12. DGM/EE will also ensure that the Assistant Engineer and Junior Engineer (E&M) & Assistant Engineer and Junior Engineer (Civil) are well conversant with regulation orders and necessary details therein. [DGM(E&M)/EE (E&M) & DGM(Civil)/EE (Civil)]

1.9.3 Roles and Responsibilities of the Assistant Engineer.

1. Co-ordinate with the Project Engineers of Ichari dam, Dakpathar barrage, Dhakrani Power House, Dhalipur Power House, Kulhal Power House, Khara Power House and Hathnikund Barrage. To get the information on the rainfall in the catchment and inflow status at the end to bring it to the notice of the EE/DGM/GM. [AE(E&M)]
2. Assist the EE/DGM/GM to issue notification to the villagers downstream through public addressing system, Newspapers etc. to be alert regarding the flood situation. [AE(E&M)]

3. Assist the EE/DGM/GM to co-ordinate with the District Administration to alert the downstream villagers to evacuate the flood zone to prevent loss of life and livestock. [AE(E&M)]
4. Assist the EE/DGM/GM to co-ordinate with the CWC flood monitoring authorities, Disaster Management cell, Dehradun on the flood condition. [AE(E&M)]
5. Maintain the reservoir water level gauge register and to update on hourly basis during flood and to bring to the notice of EE/DGM/GM. [AE(E&M)]
6. Assess the inflows in the reservoir as per the approved reservoir operation and to prepare proforma consisting of the status of the reservoir capacity and releases from the reservoir as per the standard Performa and to submit to EE/DGM/GM. [AE(E&M)]
7. Submit to the EE/DGM/GM on the inflows and releases from the reservoir and status of the reservoir twice in the day. [AE(E&M)]
8. Maintain the various operation log book and maintenance/ defect register etc. [AE(E&M)]
9. Operate the barrage gates for flood mitigation as per the instructions of the EE/DGM/GM and to update the Gate operation Log book. [AE(E&M)]
10. Observe the seepages in the bunds of barrage and power channel. To immediately bring to the notice of the EE/DGM/GM, in case of excessive seepage, leakage in any specific blocks and porous drains. [AE(Civil)]
11. Observe that the trash rack is free from debris/ trash and head loss across trash rack is within permissible parameters. In case the head loss is more than permissible limit, ensure to get the trash rack clean. [AE(E&M)]
12. Monitor the condition of necessary tools and tackles e.g. Welding transformers, gas cutting sets, umbrellas, raincoats, tool kits, torches, chain blocks, ropes, safety harness etc. on daily basis and to see that things are in place to handle any emergency situation. [AE(E&M)]
13. Observe the Gates, hoists and handling equipment during operation for the smooth movements and to immediately report any untoward excessive sounds in the motors, pumps or vibrations in the gate. [AE(E&M)]
14. Observe the vicinity and approach roads are well maintained by housekeeping personnel. [AE(Civil)]

15. Observe the performance of the barrage and its structures / Gates and Hoists during flood water releases and to report to the EE/DGM/GM in case of any untoward incidents or malfunctioning of the gates etc. [AE(E&M)]
16. Assistant Engineer (E&M) will be responsible for operation and maintenance of barrage and head regulator. He will ensure that the arrangement of all T&P and other materials has already been made in advance at barrage well before monsoon.
17. Assistant Engineer (E&M) will also ensure that the arrangement for necessary staff as per operation and maintenance manual has already been done.
18. Assistant Engineer (Civil) will inspect the guide and afflux bund, drains, silt ejector channel, other necessary works and will get the necessary repairs done before monsoon. It will be the duty of Assistant engineer to obtain the certificate from Jr. Engineer (Civil) about the clearance of drains and siphons before onset of monsoon.
19. Assistant Engineer (E&M) will inspect the position of gates, gauges and will record in the register in Central control cabin that the operation is being done as per instruction laid down in the operation and maintenance manual time to time.
20. Assistant Engineer (E&M) & Assistant Engineer (Civil) will not leave the head quarter during monsoon. If due to any unavoidable work, he/she has to leave headquarter, they will give the clear instruction to subordinate staff for regulation of Asan Barrage in writing.
21. Whenever the river discharge exceeds 640 cumec, Assistant Engineer-in-Charge will inspect the barrage regulation at least once in a day and will record the finding in instruction register.
22. After the monsoon is over, it will be the duty of Assistant Engineer (Civil) to inspect the upstream and downstream floor of barrage, Power Channel lining and escape Channel in details and to get the necessary repairs done at Priority in consultation with Executive Engineer (PCM), Dhalipur. He/she will ensure that the survey of upstream area of barrage is done up to 15th Nov and the graphs sent to the EE (Civil).
23. The respective Assistant Engineer of barrage should inspect all the mechanical and civil works of the barrage before 15th June, the start of monsoon. They will report in writing to the respective Executive Engineer before start of monsoon that he has inspected the barrage thoroughly and it is in perfect condition and all necessary arrangement have been made accordingly to the manual.

1.9.4 Roles and Responsibilities of the Junior Engineer.

1. All the mechanical and electrical parts of Asan Barrage; main barrage gate, head regulator, silt ejector will be looked after by Jr. Engineer (E&M) and all civil part of these structures will be looked after by Junior Engineer (Civil). JE(Shift) will look after the regulation of water in the Power Channel and river.
2. Junior Engineer (E&M) will ensure that the hoisting mechanism of gates of barrage, head regulator and silt ejector are kept at all times in perfect working order and the balance boxes are loaded as per requirement. The motor, shaft, bearing, lifting stems, rollers, ropes, gears etc. shall be kept well-greased and operative. All the bolts shall be kept tight. He will ensure that SCADA and CCTV system are operating fully.
3. The necessary repairs and maintenance of all the gates will be got done by Jr. Engineer (E&M) before monsoon period. After carrying out the entire necessary repair he shall submit the following certificate:-

   "All the gates of barrage, head regulator and silt ejector have been got attended and checked by me in every respect and these are in perfect working order"

   This certificate will be preserved by Assistant Engineer (E&M), Asan Barrage in his file.
4. During monsoon period all the above parts will be checked by Jr. Engineer (E&M) once every day and entry shall be made in the Defect register in the control room that all the gates are all right. If there is any defect which has developed during the operation, the same will be entered in the register and will be intimated to Assistant Engineer (E&M) and got rectified on priority. The action taken in this matter will also be recorded in the Defect register.
5. During monsoon when the river discharge exceeds 400 cumec, Junior Engineer (E&M) will check the above parts at least twice a day. When the river discharge exceeds 640 cumec, the Junior Engineer (E&M) will remain at barrage or near the barrage Round the clock.
6. If due to certain unavoidable reasons, Junior Engineer (E&M) has to leave the head quarter, all the mechanical parts will be checked by the head mechanic and all the electrical parts will be checked by the electrician and entry shall be made in the Defect register.
7. The areas in the vicinity of the barrage together with upstream and downstream areas will keep fully lighted by Junior Engineer (E&M).

8. The maintenance of the civil structure of barrage, head regulator, silt ejector and Power Channel will be the complete responsibility of Junior Engineer (Civil).
9. Junior Engineer (Civil) will ensure that all the necessary repair for efficient regulation (Such as repair of tiles, clearance of drains, Jungle clearance, safety of structure) have been carried out before monsoon.
10. The Junior Engineer (Civil) will check that the release of water in Power Channel and regulation of gates is being done as per instructions. During monsoon, he will also check that the silt samples are taken and required gauges are being observed and recorded in the log book as per instruction laid down. He will also checkup that regulation staff is well acquainted with regulation orders and instruction etc.
11. When the river discharge exceeds 640 cumec, Junior Engineer (Civil) will check the regulation at least twice a day and will record the gate opening as actually checked in the gauge register to ensure that they are in accordance with orders.
12. When the river discharge exceeds 1300 cumec, Jr. Engineer (Civil) will remain present at barrage.
13. During monsoon period, Junior Engineer (Civil) and Junior Engineer (E&M) will remain at head quarter and will keep the control supervisor on duty informed of their exact where about at all times of the day and night so that they may be called with the least possible delay whenever required.
14. The schedule of Chhibro Power House and release into the Power Channel fixed by Assistant Engineer, Dakpathar Barrage for the next day will be obtained by Junior Engineer (Shift)/ Control supervisor up to 11.00 hrs and will be recorded in the register.
15. Junior Engineer (shift)/ Control supervisor will intimate it to the Assistant Engineer (E&M) and will get the program of discharge through Power Channel fixed for the next day. The Program fixed for next day will be recorded by him in the instruction register and will be communicated to Assistant Engineer (E&M) Dakpathar and Dhalipur and Junior Engineer (E&M), Asan Barrage.
16. Junior Engineer (shift) will ensure that the water into Power Channel is being released as per manual. He will also ensure that the operation of gate of barrage, head regulator and silt ejector is being done as per manual.
17. Junior Engineer (shift) will ensure that all the registers are being filled and maintained in the desired program. He will observe all gauges and will ensure entry into the proper register.
18. It will be the duty of Junior Engineer (Shift) to ensure collection of the silt samples during monsoon period as per instructions.
19. The Junior Engineer(Shift) will record the telephone/SMS received from various agencies in the instructions register and will intimate the message to Junior Engineer (E&M) and Assistant Engineer (E&M).

20. In case of electric failure from feeders, power supply from DG set will be ensured. In case no power source available, it will be duty of Junior Engineer (Shift) to inform the UJVNL authority in writing as well as on phone and to get it rectified at the earliest. In the meantime the Junior Engineer (Shift) will arrange Vehicle and necessary announcement equipment. All the regulation staff who may be off the duty at that time, should collect at control room.
21. Any information required by Dhakrani and Dhalipur Power House shall be given by Junior Engineer (Shift) strictly as per record, gauge and discharge register.
22. In case, the Junior Engineer (Shift) of the next shift does not turn up at control cabin/ room in time, the Junior Engineer (Shift) of previous shift will not leave the shift till the other Junior Engineer (Shift) takes over charge of the control cabin/ room. In case, the next Junior Engineer (Shift) is not available even after ½ hour, he will intimate on telephone or by messenger to the Assistant Engineer (E&M), Asan barrage for further instructions, but in no case he will leave his duty till his reliever arrives.

1.10 Collection & Reporting of barrage and Reservoir Data

A proforma is provided to ensure that dates and times for the collection and reporting of vital information is recorded and documented for the record.

1. Reservoir water surface elevation.
2. Reservoir inflow.
3. Spillway outflow.
4. River releases.
5. Power channel release.
6. Weather related data.
7. Water quality

Instructions and a standard proforma for collection and reporting of inflow and outflow data, and other pertinent data, is shown are annexed below in this section:

Records (Logbooks) of the following operations at Asan Barrage are to be maintained in a chronological manner for reference. These records are helpful for identifying preventative maintenance measures that may need to be taken up, troubleshooting the cause of potential equipment failure and documenting development of any unusual conditions.

1. Date and Time
2. Attendance statement.
3. Operations of the gates.
4. Operating hours of equipment.
5. Testing/Operation of gates, and associated controls.
6. Testing/operation of gates and associated controls.
7. Maintenance activities carried out.
8. Reservoir and barrage inspections.
9. Unusual conditions or occurrences, including acts of vandalism.
10. Attendance statement at the barrage during emergency operations.
11. Changes to normal operating procedures.
12. Communication network checks.
13. Safety and special instructions.
14. Names and addresses of official visitors (e.g. staff carrying out inspection)
15. Any other item pertaining to the operation and maintenance of the barrage.

Following records will be kept and maintained in control room of Asan barrage.

1.10.1 Gauge Discharge Register

Information regarding upstream pond gauge, Power Channel gauge, river discharge of Yamuna and Asan, release of water in Power Channel, silt ejector, downstream of barrage, gate opening of barrage, head regulator and generation of Dhalipur Power House will be recorded in the register kept in control cabin/room. This register will be signed by Junior Engineer (Shift) at the end of each shift and will be handed over to next Junior Engineer (Shift).

1.10.2 Daily progress report

An abstract of gauge register shall be entered in the daily Progress report (DPR). It shall be entered by Junior Engineer (Shift) at 00:00 hrs for previous day. It will have maximum & minimum levels, average discharge, generation, rainfall data etc. At the end of each sheet, a cumulative data for the month shall be prepared, which will provide overall view of the month.

1.10.3 Message/ Instruction register

All the messages received from various agencies, instructions/message given by Junior Engineer (Shift), Junior Engineer (Civil), Junior Engineer (E&M), Assistant Engineer, (E&M), Executive Engineer (E&M) and Executive Engineer (PCM),

Dhalipur will be recorded in this register. Junior Engineer (Shift) /supervisor and gate operator will sign the instruction register at the end of each shift meaning there by that they have gone through the instructions. While handing over the register to next Junior Engineer (Shift), the instructions given in the previous shift will be signed by the Junior Engineer (Shift)/Supervisor and gate operator of next shift also. The Junior Engineer (E&M) will also sign the register at least once in a day and will ensure that all the concerned regulations staff had been well acquainted with the instructions. Assistant Engineer (E&M) will ensure that all the messages are recorded and complied.

1.10.4 Defect Register

Defect Register will be available at control room. Any fault/ defect will be recorded in the defect register, describing fault, its location, time and date & concerned Junior Engineer who is responsible for rectification of defect. It will be signed by the Junior Engineer (Shift). It will be responsibility of Junior Engineer (E&M)/ Civil to check defect register daily and to record their comments about rectification of fault with date and time. Assistant Engineer (E&M) shall daily check the defect register and will enter his / her comment.

1.10.5 Attendance register

An attendance / charge register for shift personnel will be placed at control room. All the shift personnel will ensure to sign the attendance on reporting time and departure time of shift. Junior Engineer will ensure that each personnel present in the shift, under his control has signed the register. Similarly for personnel under Maintenance duties/ general duties shall sign their attendance in the register available with Junior Engineer (E&M) in his Office. Assistant Engineer (E&M) will ensure to daily check the attendance register.

1.10.6 Checklist for information of flood pass/ flushing

A register shall be maintained in the control room, in which information of flood passed/ flushing shall be passed on to concerned Officers of UJVNL, control room of Kulhal, Khara power house, Hathnikund barrage and other important Organizations/ person related.

1.10.7 Shift check schedule & Maintenance check schedule

Shift check schedule shall be filled by concerned JE (shift) after inspecting all the components of barrage in each shift. JE (E&M) shall inspect the barrage daily and fill the Maintenance check schedule. AE (E&M) will ensure that the shift check schedules and maintenance check schedules are being filled properly.

Proforma for Hourly gauge register

UJVN LIMITED

HOURLY GAUGE REGISTER OF ASAN BARRAGE, DHALIPUR

Date……

Rainfall……...

Total Rainfall for the month…….

Total Rainfall for the year……

Time	Pond Level	Power channel Gauge Level	Kulhal Power House Intake Level	Kulhal Power House		Dhalipuir Power House		Dakpatthar Barrage	Asan River Discharge (Col. No. 6-8)	Total Discharge at Asan Barrage	Head regulator gates opening in mtr.					Total opening of Head regulator Gates	Head Regulator Discharge (in cusec)	Silt Ejector Channel Discharge (in cusec)	Power Channel Discharge (in cusec) (Col. No. 18-19)	Barrage gates opening in mtr.														Total opening of Barrage Gates	Discharge through Barrage Gates		Total Discharge through Barrage Gates	Signature of Shift In charge	Remarks
				Generation	Corresponding discharge	Generation	Corresponding discharge	Discharge			Gate No. 1	Gate No. 2	Gate No. 3	Gate No. 4	Gate No. 5					Gate No. 01	Gate No. 02	Gate No. 03	Gate No. 04	Gate No. 05	Gate No. 06	Gate No. 07	Gate No. 08	Gate No. 09	Gate No. 10	Gate No. 11	Gate No. 12	Gate No. 13	Gate No. 14		Gates	Leakage			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
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Proforma for Daily Progress Report Register

UJVN LIMITED

DAILY PROGRESS REGISTER OF ASAN BARRAGE, DHALIPUR

MONTH:- …….. YEAR:-…….

Date	Pond Level		Power Channel Discharge		Average Discharge in Power Channel	Average Discharge through Barrage gates	Average Discharge through Dhalipur Power House	Average Discharge of Asan River	Average Discharge of Dakpatthar barrage	Average Total River Discharge	Kulhal Power House Generation upto previous day MU	Kulhal Power House Generation today MU	Total Generation upto date MU	Kulhal Power House Generation today MW	Khara Power House Generation today MW	Rainfall	Total rainfall of the year	Signature of Shift In charge
	Maximum	Minimum	Maximum	Minimum														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																		
2																		
3																		
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Proforma for Message/ Instruction register

UJVN LIMITED

MESSAGE REGISTER OF ASAN BARRAGE, DHALIPUR

Date	Time	Message No.	Message From	Message To	Message Received No.	Message/Description	Signature of Shift Incharge

Proforma for Defect Register

UJVN LIMITED

DEFECT REGISTER OF ASAN BARRAGE, DHALIPUR

Sl. No.	Date	Description of fault	Signature of Shift Incharge	Remark related to fault	Signature of JE maintenance

Proforma for attendance register

UJVN LIMITED

ATTENDANCE/CHARGE REGISTER OF ASAN BARRAGE, DHALIPUR

DATE:-……

Sl. No.	Name of Official	Post	Signature on Arrival at 22:00 Hrs.	Signature on Departure at 06:00 Hrs.
1				
2				
3				
4				
5				
6				
7				
Sl. No.	Name of Official	Post	Signature on Arrival at 06:00 Hrs.	Signature on Departure at 14:00 Hrs.
1				
2				
3				
4				
5				
6				
7				
Sl. No.	Name of Official	Post	Signature on Arrival at 14:00 Hrs.	Signature on Departure at 22:00 Hrs.
1				
2				
3				
4				
5				
6				
7				

Proforma for Check list for Information of flushing/ flood passed.

Date:

Time:

S. No.	Activity	
1.	Information to Assistant Engineer (E&M), Asan Barrage	
2.	Information to Executive Engineer (E&M), Asan Barrage	
3.	Information to Control Room, Kulhal Power House	
4.	Information to DGM, HGC, Dhakrani	
5.	Information to General Manager (YV), Dakpathar	
6.	Information to Executive Engineer (Civil), PCM, Dhalipur	
7.	Information to Khara Power House	
8.	Information to Hathnikund Barrage	
9.	Siren / Alarm before release of water	
10.	Any other relevant Person/ Organization	

Proforma for Daily Shift Check Schedule
Asan Barrage, Dhalipur

Date: **Time:**

S. No.	Description/ Activity	Status
1.	Supply availability at LT Room	
	i) Through feeder No. 8	
	ii) Through Feeder No. 9	
	iii) DG set operation on trial (in morning shift)	
2.	Checking of Power supply in Control room	
	i) On distribution panel	
	ii) On Control panel	
3.	Checking of power supply on barrage gates	
	i) Barrage Gate No. 1	
	ii) Barrage Gate No. 2	
	iii) Barrage Gate No. 3	
	iv) Barrage Gate No. 4	
	v) Barrage Gate No. 5	
	vi) Barrage Gate No. 6	
	vii)Barrage Gate No. 7	
	viii) Barrage Gate No. 8	
	ix) Barrage Gate No. 9	
	x) Barrage Gate No. 10	
	xi) Barrage Gate No. 11	
	xii)Barrage Gate No. 12	
	xiii) Barrage Gate No. 13	
	xiv)Barrage Gate No. 14	
4.	Checking of power supply on HR gates	
	i) HR Gate No. 1	
	ii) HR Gate No. 2	
	iii) HR Gate No. 3	
	iv) HR Gate No. 4	
	v) HR Gate No. 5	
5.	Checking of power supply on Silt Ejector gates	
	i) SE Gate No. 1	
	ii) SE Gate No. 2	
	iii) SE Gate No. 3	
6.	Checking of power supply of STP	
7.	Functioning of CCTV system	
8.	Illumination of Barrage	
9.	Any other observation	

Checked by **Junior Engineer**

Daily Shift Check Schedule
Asan Barrage, Dhalipur

Date: **Time:**

S. No.	Description/ Activity	Status
10.	Checking of mechanical system of barrage gates	
	i) Barrage Gate No. 1	
	ii) Barrage Gate No. 2	
	iii) Barrage Gate No. 3	
	iv) Barrage Gate No. 4	
	v) Barrage Gate No. 5	
	vi) Barrage Gate No. 6	
	vii) Barrage Gate No. 7	
	viii) Barrage Gate No. 8	
	ix) Barrage Gate No. 9	
	x) Barrage Gate No. 10	
	xi) Barrage Gate No. 11	
	xii) Barrage Gate No. 12	
	xiii) Barrage Gate No. 13	
	xiv) Barrage Gate No. 14	
11.	Checking of Mechanical system of HR gates	
	i) HR Gate No. 1	
	ii) HR Gate No. 2	
	iii) HR Gate No. 3	
	iv) HR Gate No. 4	
	v) HR Gate No. 5	
12.	Checking of Mechanical system of Silt Ejector gates	
	i) SE Gate No. 1	
	ii) SE Gate No. 2	
	iii) SE Gate No. 3	
13.	Cleaning of Trash rack	
14.	Any other observation	

Checked by **Junior Engineer**

Proforma for Daily Maintenance Check Schedule
Asan Barrage, Dhalipur

Date: **Time:**

S. No.	Description/ Activity	Status
1.	Healthiness of LT supply	
	i) Through feeder No. 8	
	ii) Through Feeder No. 9	
2.	Healthiness of LT supply	
	iii) On distribution panel	
	iv) On Control panel	
3.	Healthiness of LT supply on panels and motors	
	i) Barrage Gate No. 1	
	ii) Barrage Gate No. 2	
	iii) Barrage Gate No. 3	
	iv) Barrage Gate No. 4	
	v) Barrage Gate No. 5	
	vi) Barrage Gate No. 6	
	vii)Barrage Gate No. 7	
	viii) Barrage Gate No. 8	
	ix) Barrage Gate No. 9	
	x) Barrage Gate No. 10	
	xi) Barrage Gate No. 11	
	xii)Barrage Gate No. 12	
	xiii) Barrage Gate No. 13	
	xiv)Barrage Gate No. 14	
4.	Healthiness of LT supply on panels and motors	
	i) HR Gate No. 1	
	ii) HR Gate No. 2	
	iii) HR Gate No. 3	
	iv) HR Gate No. 4	
	v) HR Gate No. 5	
5.	Healthiness of LT supply on panels and motors	
	i) SE Gate No. 1	
	ii) SE Gate No. 2	
	iii) SE Gate No. 3	
6.	Healthiness of LT supply of STP	
7.	Functioning of CCTV system	
8.	Healthiness of Illumination of Barrage	
9.	Any other observation	

Checked by **Junior Engineer**

Daily Maintenance Check Schedule
Asan Barrage, Dhalipur

Date: **Time:**

S. No.	Description/ Activity	Status
10.	Checking of mechanical system of barrage gates, e.g. Oil level, gear assemblies, abnormal sound, Braking system, condition of ropes etc.	
	i) Barrage Gate No. 1	
	ii) Barrage Gate No. 2	
	iii) Barrage Gate No. 3	
	iv) Barrage Gate No. 4	
	v) Barrage Gate No. 5	
	vi) Barrage Gate No. 6	
	vii) Barrage Gate No. 7	
	viii) Barrage Gate No. 8	
	ix) Barrage Gate No. 9	
	x) Barrage Gate No. 10	
	xi) Barrage Gate No. 11	
	xii) Barrage Gate No. 12	
	xiii) Barrage Gate No. 13	
	xiv) Barrage Gate No. 14	
11.	Checking of mechanical system of barrage gates, e.g. Oil level, gear assemblies, abnormal sound, Braking system, condition of ropes etc.	
	i) HR Gate No. 1	
	ii) HR Gate No. 2	
	iii) HR Gate No. 3	
	iv) HR Gate No. 4	
	v) HR Gate No. 5	
12.	Checking of mechanical system of barrage gates, e.g. Oil level, gear assemblies, abnormal sound, Braking system etc.	
	i) SE Gate No. 1	
	ii) SE Gate No. 2	
	iii) SE Gate No. 3	
13.	Any other observation	

Checked by **Junior Engineer**

1.11 Public and Project Staff- health & safety

As safety of Project Staff is of prime concern, safety instructions & protection measures at the barrage are followed by all staff / project personnel. Warning signboards are located on the left and right bank of barrage. Electronic Siren is provided on top of barrage structure, which is operated from control room. A Public notice is issued via print media in Newspaper every year before Monsoon for sensitizing public that excess river discharge shall be passed in downstream of barrage during 15 June to 15 October. It is done to make people aware that there may be increase in downstream flow and level. A vehicle mounted with public addressing system is rounded upto Kulhal-Paonta bridge and adjacent downstream area just before monsoon, to issue warning/ message to downstream public regarding release of excess discharge.

1.11.1 Restricted Areas

Certain areas of the barrage and reservoir are restricted for entry of the general public. The purpose of restrictions is for security of the barrage, public safety and uninterrupted safe operation of the barrage.

Restricted areas include the following:

1. Control room
2. Gate hoist operating areas.
3. Spillway and its approach area.
4. Power Channel up to silt ejector.
5. Silt Ejector cabin

1.11.2 Details of the Security arrangements at Asan Barrage.

The security arrangements of Asan Barrage are entrusted to the Uttarakhand Purv Sainik Kalyan Nigam Limited (UPNL). Ex-Army Personnel are deployed through UPNL for security of barrage.

Total strength of security personnel at Asan Barrage is 16, out of which 05 are Gunman and rest 11 are unarmed guards. There are three guard post at Asan barrage; One on right bank, second on left bank of canal and third is at the entrance of control room building.

There are four groups of guards which comprise atleast one gun man and 3 unarmed guards each. Guards are deployed in three shift for 8 hours of duty.

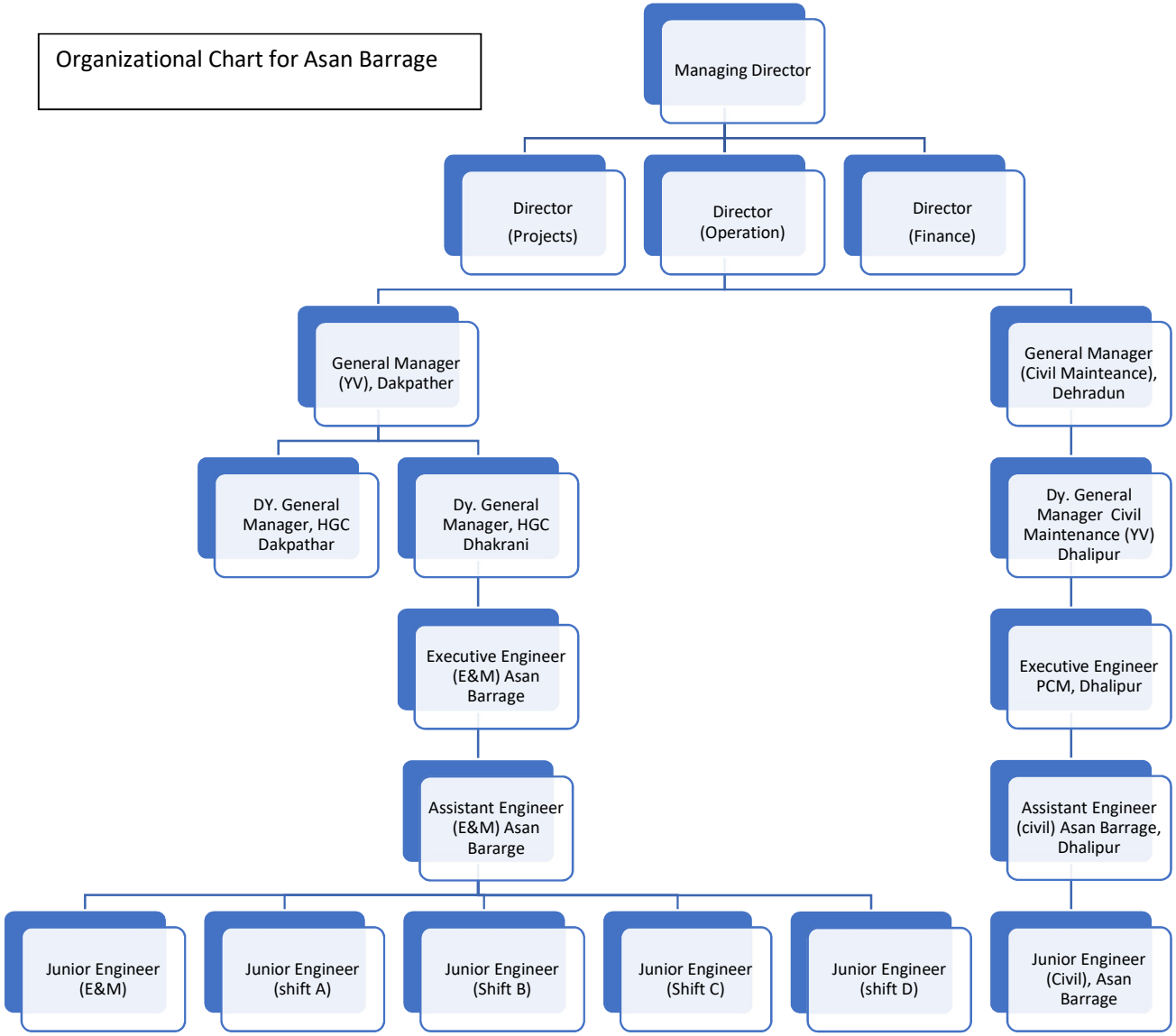
Guards work under the supervision of Assistant Engineer (E&M), Asan Barrage.

1.12 Staff Position, Communication & Warning System

The number & description of operating unit personnel posted/placed at different locations of the barrage are noted in supporting documents and referenced in this Manual. An engineering organizational chart is shown in figure appended below. The means of communications both in normal and emergency situations are identified in the Communication Directory. Available communication means including landline, mobile phones.

EPABX at different locations are available on the barrage. A utility room located below control room has all essential small tools, welding machine, gas cutter sets, chain blocks and ropes and consumables to facilitate O&M requirements. A brief description of the warning systems including alarms at the barrage is mentioned in the Manual. This includes information on downstream inundation areas during scheduled or unscheduled release of flood outflows from the barrage. Basic facilities like communication facilities, sirens, public addressing system etc. are provided.

Organizational Chart for Asan Barrage



1.13 Distribution of Operation & Maintenance Manuals

The list of unit officers to whom the O&M Manual is required to be distributed is shown in the table below.

S. No.	Officers/ Location	Number of Manual Distribution
1.	Principal Secretary (Power), GoU, Dehradun	1
2.	Chairman, UJVNL, Dehradun	1
3.	Managing Director, UJVNL, Dehradun	1
4.	Director (Operations), UJVNL, Dehradun	2
5.	Dam Safety Directorate, Dehradun	1
6.	General Manager (Yamuna Valley), UJVNL, Dakpathar	2
7.	General Manager (Civil), UJVNL, Dehradun	2
8.	DRIP Nodal Officer, UJVNL	1
9.	Dy. General Manager, HGC Dhakrani	1
10.	Dy. General Manager, PCM Dhalipur	1
11.	Executive Engineer (E&M), Asan Barrage	2
12.	Executive Engineer, PCM Dhalipur	1
13.	Assistant Engineer (E&M), Asan Barrage, Dhalipur	2
14.	Assistant Engineer, PCM, Dhalipur	1
15.	Control room, Asan barrage	1
16.	District Magistrate	1
17.	District Police Chief	1
18.	State Disaster Management Authority	1

1.14 Schedule of duties:

The duty schedules for operating personnel are given below. All activities should be recorded in barrage log book /site registers.

Sl. No	Component	Frequency	Personnel
1.	Visual inspection of components of barrage.	Daily	JE (shift)
2.	Record water surface elevation	Hourly	JE (shift)
3.	Record reservoir inflow and outflow discharge	Hourly	JE (shift)
4.	Record meteorological data.	Daily	JE (shift)
5.	Check security arrangements and safety devices.	Daily	JE (shift)
6.	Trial check of DG Sets	Daily	JE (shift)
7.	Cleaning of trash rack	Hourly	JE (shift)
8.	Checking of SCADA system	Daily	JE (E&M)
9.	Inspection of operation of DG Sets	Weekly	JE (E&M)
10.	Check illumination arrangement	Daily	JE (E&M)
11.	Check housekeeping	Daily	JE (E&M)
12.	Attending faults	As and where required	JE (E&M)
13.	Cleaning of trash rack	Daily	JE (E&M)
14.	Inspection of components of HR gates and its operation.	Daily	JE (E&M)
15.	Inspection of components of Barrage gates and its operation.	Daily during monsoon period	JE (E&M)
16.	Inspection of components of Silt Ejector gates and its operation.	Weekly during monsoon period	JE (E&M)
17.	Check functioning of CCTV system	Daily	JE (E&M)
18.	Check functioning of STP	Daily	JE (E&M)
19.	Visual inspection of Civil components of barrage.	Daily	JE (Civil)
20.	Inspection of barrage spillway, energy dissipater, Downstream bed	Daily during monsoon	JE (Civil)
21.	Inspection of Drains on the canal	Weekly	JE (Civil)
22.	Inspection of bunds	Weekly	JE (Civil)
23.	Housekeeping and gardening	Daily	JE (Civil)
24.	Visual inspection of components of barrage.	Weekly	AE (E&M)
25.	Inspection of log books & registers	Daily	AE (E&M)
26.	Check security arrangements and safety devices.	Weekly	AE (E&M)
27.	Cleaning of trash rack	Daily	AE (E&M)

Sl. No	Component	Frequency	Personnel
28.	Checking of SCADA system	Weekly	AE (E&M)
29.	Inspection of operation of DG Sets	Weekly	AE (E&M)
30.	Check illumination arrangement	Weekly	AE (E&M)
31.	Check housekeeping	Weekly	AE (E&M)
32.	Attending faults	As and where required	AE (E&M)
33.	Inspection of components of HR gates and its operation.	Weekly	AE (E&M)
34.	Inspection of components of Barrage gates and its operation.	Weekly during monsoon period	AE (E&M)
35.	Inspection of components of Silt Ejector gates and its operation.	Weekly during monsoon period	AE (E&M)
36.	Check functioning of CCTV system	Weekly	AE (E&M)
37.	Check functioning of Sewage Treatment Plant	Weekly	AE (E&M)
38.	Check Sign/Warning display boards near vulnerable locations	Monthly	AE (E&M)
39.	Check lubrication of wire rope	Quarterly	AE (E&M)
40.	Visual inspection of Civil components of barrage.	Weekly	AE (Civil)
41.	Inspection of barrage spillway, energy dissipater, Downstream bed	Weekly during monsoon	AE (Civil)
42.	Inspection of Drains on the canal	Monthly	AE (Civil)
43.	Inspection of bunds	Monthly	AE (Civil)
44.	Housekeeping and gardening	Weekly	AE (Civil)
45.	Visual inspection of components of barrage.	Monthly	EE(E&M)
46.	Inspection of log books & registers	Weekly	EE(E&M)
47.	Check security arrangements and safety devices.	Fortnightly	EE(E&M)
48.	Checking of SCADA system	Fortnightly	EE(E&M)
49.	Inspection of operation of DG Sets	Fortnightly	EE(E&M)
50.	Visual inspection of Civil components of barrage.	Monthly	EE (Civil)
51.	Inspection of barrage spillway, energy dissipater, Downstream bed	Fortnightly during monsoon	EE (Civil)
52.	Inspection of Drains on the canal	Quarterly	EE (Civil)
53.	Inspection of bunds	Quarterly	EE (Civil)
54.	Housekeeping and gardening	Monthly	EE (Civil)
55.	Review barrage operation procedures	Every 10 years	EE (E&M) and EE(Civil)

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2 Chapter 2: Project Operation

The operation plan of Asan barrage consists of step-by-step instructions for operating the barrage and reservoir during routine (normal) and emergency conditions. The operating procedures for normal operations are discussed in this chapter including operating criteria for the reservoir, barrage & power channel.

2.1 Requirement of Operation/ regulation: -

The regulation of the barrage and head regulator has to cater for the following requirements: -

- To absorb discharge variation of the power station of Yamuna stage-I, in the pond of Asan Barrage and to pass scheduled discharge in the power channel.
- To pass, down the barrage, surplus river discharge with adequate care of the following: -

i. Safety of structures.
ii. Non-accumulation of shoal in upstream of barrage.
iii. Ejection of finer bed load through silt ejector channel.

2.2 Definitions:-

a. Normal and fair weather season means period from 16th October to 15th June.
b. Flood season means the period from 16th June to 15th October.
c. General Manager (YV), Dakpathar means GM-in-charge of Yamuna Valley for E&M works.
d. General Manager (Civil Maintenance), Dehradun means GM-in-Charge for Civil Maintenance works.
e. Deputy General Manager (E&M) means DGM-in-charge of HGC, Dhakrani.
f. Deputy General Manager (Civil Maintenance), Dhalipur.
g. Executive Engineer (E&M) means Executive Engineer-in-charge for operation and maintenance of Barrage, head regulator E&M works.
h. Executive Engineer PCM, Dhalipur means Executive Engineer-in-charge for Civil maintenance of Barrage, head regulator etc.
i. Assistant Engineer (E&M) means the Assistant Engineer in charge for operation and maintenance of barrage and head regulator E & M works etc.
j. Assistant Engineer (Civil Maintenance), Asan Barrage, Dhalipur means Assistant Engineer-in-charge for Civil maintenance of Barrage, head regulator etc.
k. Junior Engineer (Operation/shift) means Junior Engineer-in-charge for operation of Barrage, Head Regulator, silt ejector etc.

l. Junior Engineer (E&M) means Junior Engineer-in-charge for maintenance of Barrage, Head Regulator, silt ejector etc. and electrical maintenance of Barrage.

m. Junior Engineer (Civil) means Junior Engineer –in-charge for maintenance of Civil works/ structures of barrage

n. Operation staff means Supervisor, Gate operator, electrician, helper under the Junior Engineer (Operation)/ Junior Engineer (E&M).

o. Maintenance staff means Mechanic, electrician, helper under the Junior Engineer (Maintenance).

p. Shift means 8 hourly shifts; there would be 3 shifts along with one general day shift as given below-

i.	06:00 Hr. to 14:00 Hrs	-	1st Shift
ii.	14:00 Hr. to 22:00 Hrs.	-	2nd Shift
iii.	22:00 Hr. to 06:00 Hrs.	-	3rd Shift

The timings of the shifts can be modified by the Engineer-in-charge as and when considered necessary.

2.3 Staff and Duties for Operation:-

The following staff shall remain on duty and will work as per orders of Engineer-in-charge.

i. One Junior Engineer (E&M), one fitter, one mechanic and one electrician will remain in general day shift. The Junior Engineer (E&M) shall be over all in-charge of all gates, hoist, trash rack and all mechanical and electrical system. The head mechanic, mechanic and fitter shall work under him.

ii. One Junior Engineer (Operation) will remain in each of 3 shifts. The Junior Engineer (Operation) shall be over all in-charge of all operations necessary for regulation of Barrage. His main duty will be to receive instructions and to pass them to person concerned and the regulation staff and confirm the compliance of orders etc. All operating staff will work under him.

iii. One Supervisor will remain in each of 3 shifts. The main work of supervisor to maintain the daily hourly gauge register and to note down in register of all received instructions and messages. He will assist Junior Engineer (Shift) for all operations related to regulation of barrage.

iv. One Gate operator will remain in each of 3 shifts. The main work of gate operator will be to operate the gates of barrage, head regulator and silt ejector channel to meet the regulation orders.

v. Two helpers will remain in each of 3 shifts. The main work of helpers will be to observe the gauges at various points, PPM of pond, rainfall and will watch the works and installation and miscellaneous works as per instructions.

2.4 Mode of Instruction for operation:-

Instruction about the regulation of barrage and head regulator will be given by Engineer-in-charge/Junior Engineer(Shift) on duty to his subordinates. No, other persons of rank, lower than these persons will be entitled to issue regulation instructions.

Regulation instructions issued by officers of the rank of Executive Engineer and above of UJVN Limited will also be complied with by the Engineer-in-charge/ Junior Engineer on duty.

All regulation instructions shall be issued in writing and recorded in regulation instruction register maintained in the control cabin. If any telephonic instruction is received, the same shall be recorded by the supervisor in the regulation instruction register and shall promptly be brought to the notice of Engineer-in-charge/Junior Engineer on duty, who shall give the orders for further necessary action.

The Engineer-in-charge/Junior Engineer shall always issue precise and clear instructions in the regulation instructions register regarding operation of various gates etc.

2.5 General Instruction for Regulation:-

The maximum water to be released in power channel shall be as follows:-

U/S of silt ejector	:	269.00 cumec
D/S of silt ejector	:	198.20 cumec

The maximum pond level at barrage will be kept as follows:-

During normal and fair weather	:	El. 401.45 m
During monsoon	:	El. 400.50 m

The gates of under sluice bays, barrage bays and HR will always be operated in the following sequence:-

Under Sluice Bays	:	2, 3, 1, 4
Barrage Bays	:	5, 9, 10, 8, 11, 7, 12, 6, 13, 14
Head regulator gates	:	3,2,4,1,5

The difference between openings of various gates should not be generally more than 0.3 meter.

The differential head across the piers and the divide wall on upstream as well as downstream side should not exceed 1.0 meters. If any such thing is noticed the gate opening of the bays should be adjusted.

The refilling of power channel should be done generally not exceeding 15 cumec/2 minutes. The drawdown of Power channel should also be done with same rate.

The supply in power Channel should not exceed the authorized discharge.

Whenever the barrage gates are to be operated to release water downstream of the barrage, the electric siren will be blown 10 minutes in advance of opening of gates to warn the people on downstream. During this 10 minutes interval, the siren will be blown three times for one minute duration each. In case of failure of power supply or electric siren, this will be done with the help of announcement through Vehicle, information to local Village heads on telephone, announcements through Local Masjids and Gurudwara.

2.6 Regulation during Normal and fair weather i.e. from 16th Oct. to 15th June.

During normal and fair weather, the available discharge is generally less than 200 cumec and it is important to draw the schedule of the water for the next day to ensure scheduled discharge in power channel.

The schedule of water in the Power Channel will be fixed as follows:-

i. Assistant Engineer (Operation) Chhibro will account for the reservoir capacity at Ichhari Dam and any specified load pattern required by SLDC, Dehradun to be followed for the next day and will draw the load schedule of Chhibro Power House for the next day and will intimate the A.E. (E&M), Dakpathar Barrage by 11:00 hours positively.

ii. After the load schedule of Chhibro Power House is received, the Assistant Engineer (E&M), Dakpathar Barrage will work out the water to be received through Chhibro Power House. The total water which would be available during next 24 hours will be calculated by adding the average discharge of Yamuna River at Dakpathar Barrage. The average discharge of river Yamuna will be taken on the basis of previous day discharge.

iii. The Assistant Engineer (E&M) Asan Barrage will then fix up the release of water through Power Channel for the next day considering the following:-

a) Pond level and capacity at Dakpathar and Asan Barrage.
b) Average discharge of Asan River.
c) Demand of water at Power House on downstream.

Release pattern of water from Dakpathar barrage will be fixed in such a way that constant release from Asan Barrage is possible. In case any difficulty or disruption in regulation

is anticipated due to limitation of reservoir capacity; the Assistant Engineer (E&M Dakpathar will intimate Assistant Engineer (Operation), Chhibro and Assistant Engineer (Operation), Dhakrani for rearranging their schedule. The release of water so fixed from Dakpathar barrage for the next day will be recorded in the register and intimated to Assistant Engineer (E&M), Asan barrage.

The release pattern intimated from Dakpathar Barrage shall be noted in regulation register of Asan barrage. After receiving the release pattern of water in power channel of Dakpathar Barrage, Assistant Engineer (E&M), Asan Barrage will also calculate that whether the diurnal variation in water to be received through Power Channel can be absorbed in Asan Barrage pond, if he feels that variation in discharges cannot be absorbed in Asan Barrage pond, he will request Assistant Engineer(E&M), Dakpathar Barrage to get the load schedule of Chhibro Power House rearranged and to rearrange the release of water into Power Channel from Dakpathar Barrage.

It will be the duty of Assistant Engineer (E&M), Asan Barrage to ensure constant supplies/ scheduled supplies in power channel d/s of head regulator. In case river discharge at Asan Barrage is more than 198.20 cumec, the excess water will be stored in pond at Asan Barrage till the pond level reaches EL 401.45. After reaching that level, surplus water which cannot be stored in pond will be released through under sluice bays to be operated in sequence of 2,3,1,4. During non- monsoon period, caulking of barrage gates as required will be done continuously to minimize the leakage from Barrage gates. Silt ejector gates shall remain closed during non- monsoon period except during the winter flood when the river supply is in excess of requirement.

In order to have an appropriate liasioning between different officers concerned with the regulation system, phone have been provided at the following places:-

1. Control room at Dakpathar Barrage.
2. Assistant Engineer(E&M), Dakpathar Barrage, Dakpathar
3. Control room at Kulhal Power House
4. Control room at Asan Barrage.
5. Assistant Engineer(E&M), Asan Barrage, Dhalipur
6. Executive Engineer(E&M), Asan Barrage, Dhalipur
7. Executive Engineer(E&M), Kulhal Power House, Kulhal
8. Executive Engineer(E&M), Dhalipur Power House, Dhalipur

A list of telephone numbers shall be displayed at control room of Asan Barrage which shall include contact numbers of control room of upstream dam/ barrage, power house, downstream powerhouse, barrage, Engineers associated with respective dam/ barrage, authorities of local administration, Village panchayats, District and State Disaster Management cell etc.

2.7 Regulation during Flood season means the period from 16th June to 15th Oct (Monsoon period)

During monsoon period pond level at Asan barrage shall not exceed the R.L 400.50 m. In case pond level starts exceeding, the regulation at different discharges will be made as per table below:

Sl. No.	Total Discharge in River (in cumec)	Discharge in Power Channel (in cumec)	Discharge through Under sluice bays (in cumec)	Discharge through Barrage bays (in cumec)	Under sluice/Barrage Gates to be opened by.
1	269 to 400	269	131	NIL	Gate no. 3,2,1,4 each by 0.30 meter
2	400 to 640	269	131	240	Gate no. 3,2,1,4 & 5,9,10,8,11, 7,12, 6,13, 14 each by 0.30 meter
3	640 to 770	269	261	240	Gate no. 3,2,1,4, each by 0.60 meter and rest by 0.30 meter each.
4	770 to 1010	269	261	480	All the gates by 0.60 meter each
5	1010 to 1140	269	391	480	Gate no. 3,2,1,4 each by 0.90 meter and rest by 0.6 meter each
6	1140 to 1380	269	391	720	All the gates by 0.90 meter each
7	1380 to 1500	Nil	521	960	All the gates by 1.20 meter each
8	Exceeding 1500	Nil	To be calculated	To be calculated	All the gates of under sluice and barrage bays shall be raised further in order of sequence mentioned above.

Whenever the bottom level of any gate is equal to the gate opening required to pass a particular discharge, that gate shall be further raised by 1.8 m to avoid any damage to bottom seal by floating trees etc.

When river discharge in monsoon period become more then 270 cumec (9535 cusec), the additional water will be released through bays gate No. 01-04 maintaining the pond level at R.L 400.50. The Gate No. 01-04 shall be operated in the sequence mentioned above and will be raised by 0.30 meter each in first phase.

If the pond level still starts rising above El.400.50 m even after operating the gates from 01 to 04 described as above, the excess water will be released through barrage gates No. 05 to 14. The barrage gates will be operated in the sequence mentioned above and will be raised by 0.30 meter each.

If the pond level still starts rising above El.400.50 m, first the gate no 01 to 04 will further be raised by 0.30 meter and then the barrage bays 5 to 14 will further be raised by 0.30 meter. However sequence will remain the same as described above.

This process of raising the gates no (1 to 4) & (5 to14) by 0.30 meter in steps will continue till the pond level stops rising above 400.50.

Whenever bottom of any gates becomes just above the water level, it should be raised further by 1.8 m to avoid any damage to bottom rubber seal by floating trees etc.

Whenever river discharge is more than 640 cumec, the Junior Engineer (Civil) & Junior Engineer (E&M) shall inspect the regulation at least twice a day and will check that the regulation is being done in accordance with operating guidelines.

Whenever river discharge starts exceeding 640 cumec, Junior Engineer (Civil) &) Junior Engineer (Mech.) shall remain at barrage for all the time except very pressing circumstance when he/she may leave the barrage site with the permission of Engineer-in-charge. In such case, Engineer-in-charge shall also inspect the regulation at least once a day and will ensure the correctness of regulation.

Whenever river discharge starts exceeding 1300 cumec the Executive Engineer (E&M) and Executive Engineer (Civil) will be kept informed of every hourly gauge, discharge and regulation under this condition. The regulation in this condition shall be done by Assistant Engineer-in-charge in his presence.

Whenever river discharge starts exceeding 1500 cumec, the Executive Engineer (E&M) and Executive Engineer (Civil) shall also inspect the barrage regulation at least once a day.

Whenever river discharge exceeding 2000 cumec, the Executive Engineer-in-charge shall camp at Dhalipur /Dhakrani/ Kulhal as the case may be, so as to be available immediately, in case of emergency.

Whenever river discharge starts exceeding 3000 cumec DGM, HGC Dhakrani/ DGM PCM Dhalipur shall inspect the headworks at earliest and shall report the damages, if any, to the concerned GMs and shall issue necessary order for the repairs.

The order of preference of operation of gates is tentative and care should be taken to ensure a reasonable uniform silt removal of u/s pond and also to have fairly uniform flow in d/s river. In case of partial opening of gates, there is a tendency to cause scour u/s of

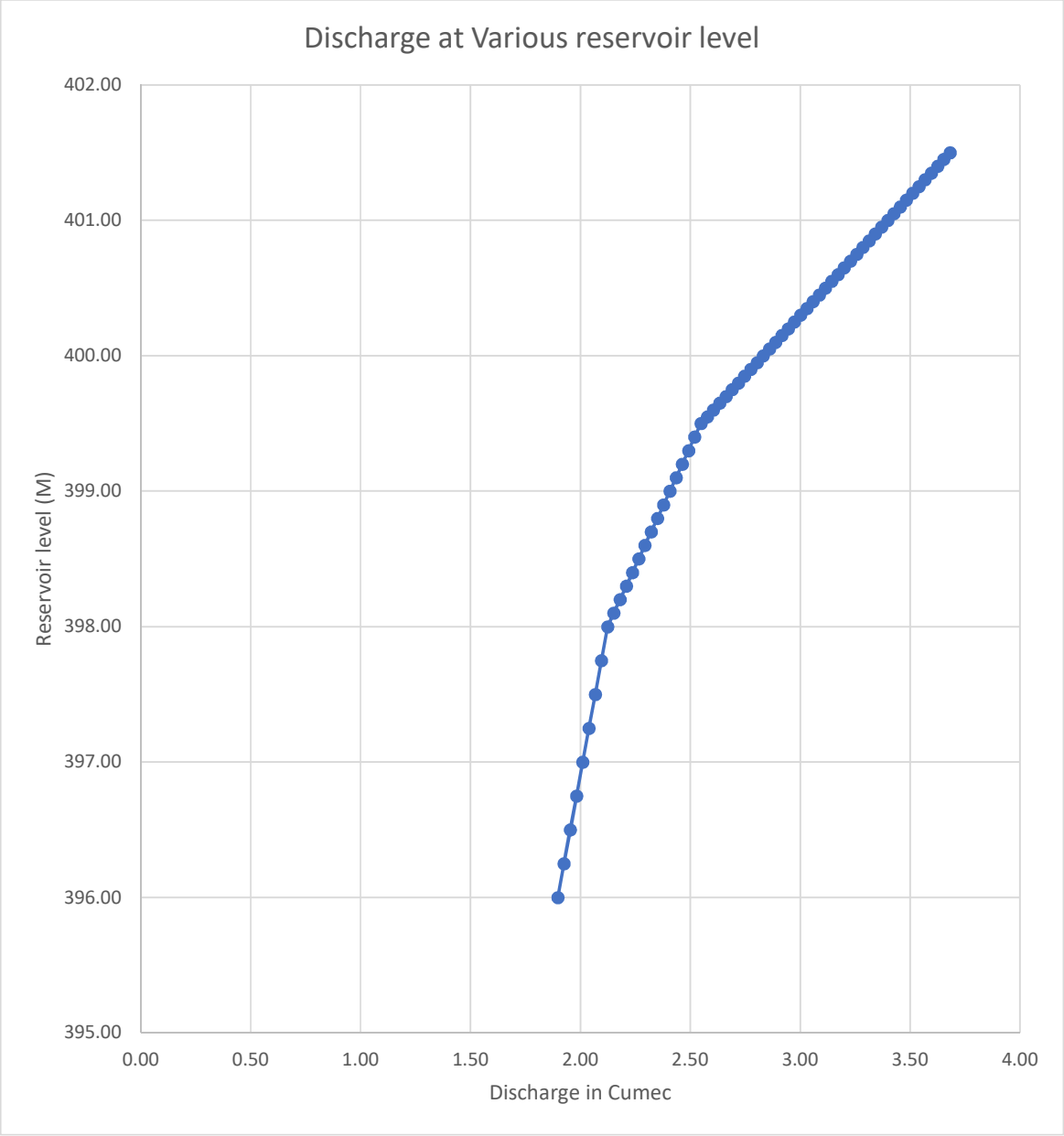
floor, Junior Engineer (Civil) and Assistant Engineer (Civil) should therefore remain vigilant about these conditions. In case of scour developing tendency, full under sluice gates be opened for a clear flow of water.

During all operation, d/s scouring and jump formation should be watched. The hydraulic Jump should always form on the sloping glacis; more attention should be paid to water action on the noses. In case jump forms outside glacis, the discharge through the concerning bays should be so reduced that jump forms within the glacis. Special attention should be paid that the release from gates is so adjusted that differential head on any pier or divide wall does not increase more than 1.0 m.

2.8 A table showing discharge per inch (25.4 mm) opening of each barrage/under-sluice gate at various reservoir levels is given as below:

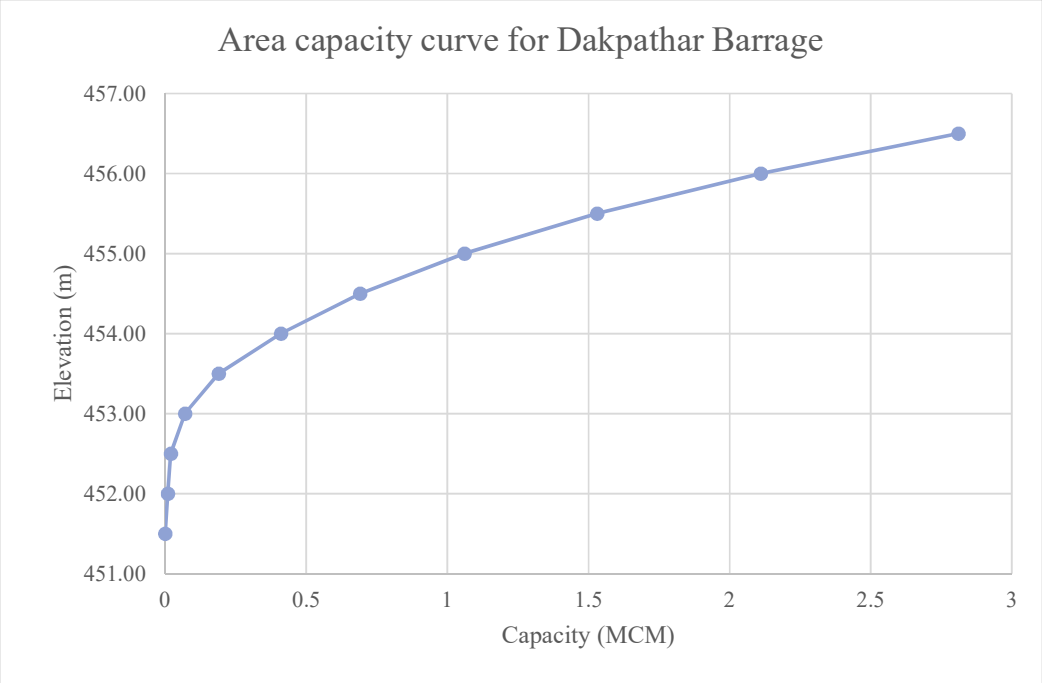
Reservoir level (Meter)	Discharge (cumec)	Reservoir level (Meter)	Discharge (cumec)	Reservoir level (Meter)	Discharge (cumec)
396.00	1.90	399.40	2.52	400.55	3.14
396.25	1.93	399.50	2.55	400.60	3.17
396.50	1.95	399.55	2.58	400.65	3.20
396.75	1.98	399.60	2.61	400.70	3.23
397.00	2.01	399.65	2.63	400.75	3.26
397.25	2.04	399.70	2.66	400.80	3.28
397.50	2.07	399.75	2.69	400.85	3.31
397.75	2.10	399.80	2.72	400.90	3.34
398.00	2.12	399.85	2.75	400.95	3.37
398.10	2.15	399.90	2.78	401.00	3.40
398.20	2.18	399.95	2.80	401.05	3.43
398.30	2.21	400.00	2.83	401.10	3.45
398.40	2.24	400.05	2.86	401.15	3.48
398.50	2.27	400.10	2.89	401.20	3.51
398.60	2.29	400.15	2.92	401.25	3.54
398.70	2.32	400.20	2.95	401.30	3.57
398.80	2.35	400.25	2.97	401.35	3.60
398.90	2.38	400.30	3.00	401.40	3.62
399.00	2.41	400.35	3.03	401.45	3.65
399.10	2.44	400.40	3.06	401.50	3.68
399.20	2.46	400.45	3.09		
399.30	2.49	400.50	3.11		

2.8.1 Graph showing discharge per inch opening of one gate of barrage/under-sluice at various reservoir level



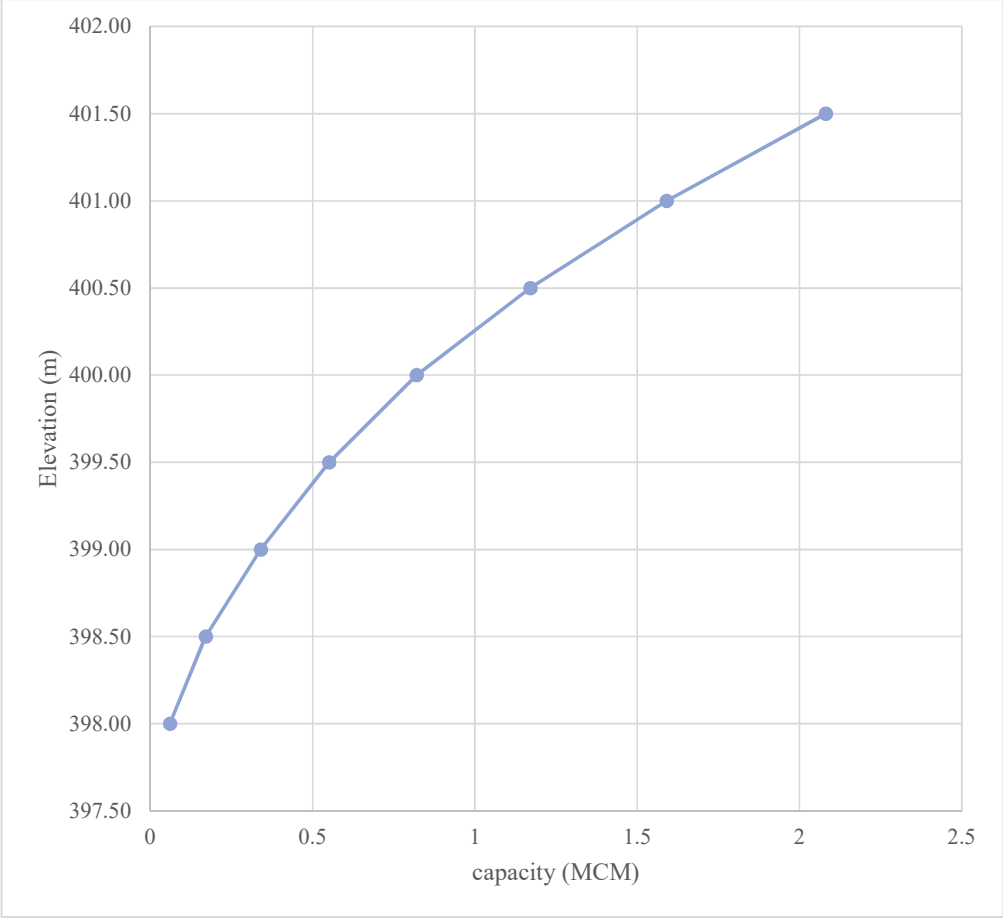
2.9 Area Capacity curve of Dakpathar Barrage

Elevation (m)	Capacity (MCM)
451.50	0
452.00	0.01
452.50	0.02
453.00	0.07
453.50	0.19
454.00	0.41
454.50	0.69
455.00	1.06
455.50	1.53
456.00	2.11
456.50	2.81



2.10 Area capacity curve for Asan Barrage

Elevation (m)	Capacity (MCM)
397.50	0
398.00	0.06
398.50	0.17
399.00	0.34
399.50	0.55
400.00	0.82
400.50	1.17
401.00	1.59
401.50	2.08



2.11 Historical Flood data of Asan Barrage

S. No.	Year	Date	Discharge (cumec)
1.	1993	11.07.1993	210.1
2.	1994	08.07.1994	1095.7
3.	1995	18.08.1995	560.6
4.	1996	02.09.1996	812.6
5.	1997	21.07.1997	689.4
6.	1998	17.08.1998	603.4
7.	1999	19.08.1999	748.2
8.	2000	05.09.2000	3529.1
9.	2001	16.07.2001	594.6
10.	2002	04.08.2002	174.6
11.	2003	05.07.2003	1056.4
12.	2004	08.08.2004	262.8
13.	2005	11.07.2005	224.6
14.	2006	23.07.2006	251.1
15.	2007	04.07.2007	121.6
16.	2008	*	*
17.	2009	*	*
18.	2010	08.09.2010	1979.3
19.	2011	06.08.2011	1365.4
20.	2012	03.09.2012	1591.4
21.	2013	16.06.2013	3128.9
22.	2014	14.08.2014	1772.6
23.	2015	20.08.2015	1800.9
24.	2016	22.08.2016	1112.8
25.	2017	12.07.2017	1423.8
26.	2018	26.07.2018	1656.5
27.	2019	01.09.2019	1135.5
28.	2020	10.08.2020	818.3

*Data not available

2.12 Operating Instructions:

2.12.1 Operation of under sluice & Barrage gates: -

i. Operation of gate can be carried out from local control panel located near the hoist of the gate or from SCADA panel provided in the control room.

ii. The raise push button is to be pressed when raising of the gate is required, similarly lower push button to be pressed when lowering of gate is required, to stop the motion of gate while raising / lowering, push button stop may be pressed.

iii. Emergency hand operating mechanism has also been provided on the hoist to operate the gate in case of power failure, for which persons are required to be engaged for manual operation of gate by rotating the handle of emergency hand operating mechanism.

iv. In case gate is found to remain stuck in any position during operation or making unusual sound, "stop" push button should immediately be pressed and the gate should be operated in reverse direction for some time and then again in desired direction. If gate still remains stuck the operator should stop the motion and report to his superiors for necessary action. The gate should be put into operation again only after the cause of trouble is found out and properly attended.

v. During monsoon period lot of debris/ boulders and trees etc. are carried out by flood water, it is therefore advisable that while lowering the gate from control panel the gate should never be lowered to sill level because during monsoon there is always a possibility that before resting on sill, the gate may rest on any boulder or log lying on the top of bottom sill, which may cause damage to gate or stem. The gate, if being operated from control panel, it should be stopped in operation leaving a gap of at least 0.30 meter between sill level and bottom of gate. The gate should then be further lowered from local control panel located near the hoist i.e. at the top of super structure. In such case, one helper should stand on the pier of gate and should give indication to operator that gate is going downward without any hindrance. If the helper finds that gate does not sit properly on the sill and some boulder or log is lying between gate and bottom sill, he will give indication to operator to stop the motion of gate and to raise the gate instead of lowering so that the boulder or log lying on the sill is flushed with the rush of water.

vi. During night hours, gate should not be operated from control room and should be operated from panel located near hoist only, as far as possible.

2.12.2 Operation of Head Regulator Gates: -

i. Operation of gate can be carried out from local control panel located near the hoist of the gate or from SCADA panel provided in the control room.

ii. The raise push button is to be pressed when raising of the gate required, similarly Lower push button to be pressed when lowering of gate is required, to stop the motion of gate while raising / lowering, push button "stop" may be pressed.

iii. Emergency hand operating mechanism has also been provided on the hoist to operate the gate in case of power failure, for which persons are required to be engaged for manual operation of gate by rotating the handle of emergency hand operating mechanism.

iv. In case gate is found to be stucking in any position during operation or making unusual sound "stop" push button should immediately be pressed and the gate should be operated in reverse direction for same time and then again in desired direction. If gate still stucks the operator should stop the motion and report to his superiors for necessary action. The gate should be put into operation again only after the cause of trouble is found out and properly attended.

v. During night hours, gate should not be operated from control room panel and should be operated from panel located near hoist only, as far as possible.

2.12.3 Operation of Silt Ejector gates:

i. Whenever silt content in power Channel d/s of silt ejector is more than 3000 PPM or river discharge exceeds 1400 cumec, the power channel shall be closed.

ii. Operation of gate can be carried out from local control panel located at Silt Ejector gate cabin or from SCADA panel provided in the control room.

iii. The raise push button is to be pressed when raising of the gate required, similarly Lower push button to be pressed when lowering of gate is required, to stop the motion of gate while raising / lowering, push button "stop" may be pressed.

iv. Whenever power channel is closed and silt ejector channel is running, the silt ejector gates shall be closed after about 15 minutes of closure of power channel.

v. Whenever supply in Power Channel is resumed and silt ejector is also to run, it should be opened 10 minutes prior to running of Power Channel.

2.12.4 Other Important Regulation Instructions: -

i. The I.S. 7349-1974 code of practice, operation and maintenance of barrage specified general rules and regulations shall be referred to whenever necessary.

ii. The I.S 7718-1972 Code of practice for inspection, testing and maintenance of fixed wheel gates, specified general rules for operation and maintenance of such gates shall be referred whenever necessary.

iii. Water level on 2 sides of piers, divide wall shall never have difference of more than 1.0 meters.

iv. The gate opening generally be not less than. 0.3 meter in order to avoid damage to bottom seals by moving boulders and debris etc.

v. Whenever river discharge exceeds 1400 cumec, it will be informed to DGM, HGC Dhakrani, DGM (Civil Maintenance), Dhalipur, Executive Engineer (E&M) Asan Barrage, Executive Engineer, PCM, Dhalipur on Telephone as well as on SMS.

vi. When the river discharge exceeds 2800 cumec telephone/SMS worded as below is to be issued to General Manager (YV), General Manager (Civil Maintenance), DGM, HGC Dhakrani, DGM (Civil Maintenance), Dhalipur, Executive Engineer (E&M) Asan Barrage, Executive Engineer, PCM, Dhalipur, Flood control room, GoU, Dehradun, Distt Magistrate, Dehradun and Saharanpur, Executive Engineer, Hathnikund Barrage, and Superintending Engineer Irrigation Yamuna Nagar, Haryana.

ASAN RIVER AT DHALIPUR IN LOW FLOOD DISCHARGE ……CUMECS AT ……...HOURS ON DATED……..……

vii. When river discharge exceeds 4950 cumec the telephone/SMS worded as below will be issued to above mentioned officers

ASAN RIVER AT DHALIPUR IN MEDIUM FLOOD DISCHARGE ……....CUMECS AT …….HOURS ON DATED……

2.12.5 Prevention of Sediment Entry to Power Channel

Whenever river supplies exceed 198.20 cumec, the silt Ejector channel shall be operated. However, the Silt Ejector gates will not be partially opened. If due to some unavoidable circumstances, it is desirable to pass lesser discharge through the Silt Ejector the required nos. of gates to be opened can be reduced. Silt samples of suspended load are to be taken daily - for testing. The silt samples will be taken at following places:-

i. In power channel between silt ejector and Head regulator.
ii. In power channel d/s of silt ejector.
iii. In Silt ejector channel.

The results of these will be obtained and will be kept in separate file. Whenever the silt content in power channel d/s of the Silt Ejector exceeds 3000 PPM, the power channel will be closed. However, this should be done with due intimation to Executive Engineer /Assistant Engineer, Kulhal Power Station. Generally, whenever the river Discharge exceeds 1400 cumec, the silt content will be more than 3000 PPM. Therefore, if there

is no such system to assess silt content in the water, the power channel should be closed immediately whenever the discharge exceeds 1400 cumec.

2.12.6 Cleaning of trash rack

During monsoon period considerable amount of debris, trash, shrubs etc. are carried with the river discharge, which accumulate along the trash rack of head Regulator. Such debris choke up the head regulator and reduce the entry of required discharge in the power Channel. Whenever discharge in power Channel is reduced below 170 cumec due to choking of trash rack, the trash rack should be cleared in the following manner.

i. The control Supervisor will intimate the pond level and discharge in power Channel to the Junior Engineer (Operation) and will obtain their consent to clean the trash rack. After obtaining the consent, the Junior Engineer (Operation) will intimate the extent of chocking to Assistant Engineer (EMOU) & Executive Engineer, Kulhal power house and will fix up the program for flushing.

ii. The program of flushing fixed with Assistant Engineer (EMOU) & Executive Engineer, Kulhal power house will also be intimated to Dakpathar Barrage.

iii. Before doing the flushing, the electric siren will be blown to warn the people on the d/s of Asan Barrage. The siren will be blown 10 minutes in advance of flushing and it will be blown 3 times.

iv. For flushing, gates of H. R gates will be closed gradually and flushing shall be done through under sluice gates.

v. After closing gates of H.R, the gates of silt ejector will also be closed. The silt ejector gates will be closed after 15 minutes of the closing of H.R gates so that the sediment which has entered the H.R may pass down the silt ejector.

vi. The flushing should generally be taken between 8:00 hrs. to 18:00 hrs i.e. in daylight.

vii. After cleaning of trash rack, the water shall be released in the power channel gradually. It shall be ensured that before releasing water in power channel, the silt ejector gates are opened.

2.13 Data Transfer and Data Management System

The following are the major components of Barrage Automation and Control system installed at the barrage complex.

i.	Barrage Control Console	: 1 No.
ii.	Barrage Monitoring System	: 1 No.
iii.	Local control panel for Barrage Gates	: 1 No.
iv.	Local control panel for HR Gates	: 1 No.
v.	Local control panel for Silt Ejector Gates	: 1 No.
vi.	Radar Level Monitors	: 2 Nos.
vii.	Gate position sensors for barrage gates	: 5 Nos.
viii.	Gate position sensor for HR gates	: 5 Nos.
ix.	2 KVA on-line UPS System	: 1 No.

The system is designed for latest safety standards as per safety requirements of bulk water handling dams/ barrages/ plants. The following features have been implemented in this barrage automation & control system.

- All gates shall be operated for a predetermined time as set by the internal timers of the system and shall stop automatically after that time. This avoids any operator dependency for stopping the gates after a certain opening.
- This system beeps during operation of gates alerting everyone around control room.
- In no case, the gates can be operated from control panel unless the operator changes the control to remote from local panel.
- Control cannot be taken from local to remote from control room.
- System stops the operation of gates in case of power resumes after failure.
- The system generates alarms for any abnormal conditions.
- The control of gates is provided with a lockable switch which can be locked by the supervisor for avoiding un-authorized operation.
- The system power requirements are following:
  Voltage: 415V AC, 3 Ø with neutral & ground. Frequency: 50 Hz
  Voltage range: +/- 10% of nominal voltage

POWER GROUND:

The motor drive power panels require proper grounding network capable of handling at least 25 kA of fault current. The resistance of the grounding network shall be at least 1.0 Ohm. All the panels shall be solidly connected to the appropriate grounding system by using MS/GI grounding strip of at least 25X5 mm size.

CONTROL & SIGNAL GROUND:

The control & power panels, transmitters, control power supplies communicating to main barrage control panel require separate control ground in addition to power ground. This control grounding network shall be capable of handling at least 1 kA of fault current. The resistance of the grounding network shall be at least 1.0 Ohm. All the panels shall be solidly connected to the appropriate grounding system by using at least 1 sq. mm copper flexible wire connected to main grounding network. The main barrage control panel shall be connected to this control ground with the same wire in addition to power ground.

The following check points should be taken care of before first start of the system:

- Inspect the panel externally & internally for physical damage.
- Inspect the wiring for loose connection or hanging wires.
- Inspect for any hanging item in the panel.
- Check for position of the all control MCBs. All control MCBs shall be in ON position.
- Inspect the incoming power at the point of UTILITY power supply.
- Inspect for proper power & control grounding of the system.
- Check for proper motor rating connected to the panels.
- Check for proper BRAKE POWER cable connection.
- Check for proper control & power voltage using multi-meter.

Check Points at First Start

The following check points should be taken care of at first start of the system:

- Check the incoming voltage level.
- Check for GLOWING "Power ON" light in the panel.
- Check all the relevant indicating lamps such as RYB power indications, OFF indication etc.
- Check for position of all power SWITCHES/MCCBs, Such as changeover switches.
- Check for any abnormal sound, smoke, heat, vibrations.

OPERATION OF MOTOR DRIVE POWER PANELS

The following sequence shall be provided for operating the motor drive power panels.

A. OUTDOOR TYPE PANELS OF GATES.

These panels are designed for LOCAL/REMOTE operation. Local operation is defined as operation from the Motor Drive Power Panel installed in the field i.e. near barrage gate motor and HR gate motor at structures. The Remote operation is defined as operation from Main Control Panel in the barrage Control Room.

OPERATION IN LOCAL MODE:

- Approach the Motor Drive Power Panel on Site near the MOTOR of the desired gate.
- Open the outer door of the panel using the panel KEY.
- Check for Power 'ON' Light. It should glow for control power.
- Put ON the MCB provided for Main power by lifting it UPWARD.
- Change the LOCAL/REMOTE rotary control switch in 'LOCAL' position.
- Push 'OPEN' for opening (lifting) the gate & Close for Closing (lowering) the gate.
- The gate shall start operation and Hooter shall haul during the gate operation.
- To stop the gate operation in between press 'STOP' button.
- For further opening / closing of gate, press OPEN/CLOSE button again & again until the desired position of gates reached.
- The gates shall also stop automatically on reaching FULL OPEN or FULL CLOSE position and shall not operate further in that direction.
- In case of any problem with the system, Open the inner gate of the panel and RESET the Drive by pressing 'OK' on the drive. Start operating after resetting as described above.
- In case of CLOSING the gate, it can STOP automatically and indicate FULL CLOSE few mm before the gate completely sit on the sill due to error in limit switch. In this situation keep pressing LOWER LIMIT and press CLOSE button until the gate is properly closed and water leakage is minimized. Release LOWER LIMIT to stop the gate operation.
- After completion of operation, keep main MCB in 'ON' position and LOCAL/REMOTE push in 'REMOTE' position and close inner & outer gate for proper protection.

OPERATION IN REMOTE MODE:

Normally the gates shall be operated and monitored remotely from Control Room. To operate the gates from control room:

Pre- conditions for REMOTE Operation of Gates.

A. The mains power should be kept 'ON' on the Motor Drive Power Panel.

B. The LOCAL/REMOTE selector switch should be in 'REMOTE' position in Motor Drive Power Panel.

Operation of Gates from Main Control Panel in Control Room.

- Check for CONTROL ENABLE indication of the corresponding gate to be 'ON'. If this indication is NOT glowing, the gate can NOT be operated from Control Room Main Panel.
- Go to the Local Control Panel and put the position of LOCAL / REMOTE switch to REMOTE mode. Also put the Mains power MCB in 'ON' position by lifting the same upward.
- If the above conditions are checked, the CONTROL ENABLE indication shall come 'ON' in Main Control Panel.
- Press 'OPEN' push button on the panel for OPENING (lifting) the Gate. OPENING indication shall glow on staring of gate opening and HOOTER on the Motor Drive Power Panel shall start hauling.
- To stop the gate operation in between press 'STOP' button.
- For further opening / closing of gate, press 'OPEN/CLOSE' button again &

again until the desired position of gates is reached.

- Monitor for gate position reading on Digital Display.
- The gates shall also stop automatically on reaching FULL OPEN or FULL CLOSE position and shall not operate further in that direction.
- In case of any problem with the system, Open the inner gate of the Motor Drive Power Panel and RESET the Drive by pressing 'OK' on the drive. Start operation after resetting as described above.
- In case of CLOSING the gate, it can STOP automatically and indicate FULL CLOSE on Motor Drive Power Panel few mm before the gate completely sit on the sill due to error in limit switch. In this situation the operation should be completed from Motor Drive Panel only.
- Go to corresponding Motor Drive Power Panel & change the control from LOCAL/REMOTE selector switch in 'LOCAL' mode. Keep pressing LOWER LIMIT and press 'CLOSE' button until the gate is properly closed and water leakage is minimized. Release LOWER LIMIT to stop the gate operation.
- Once the gate is properly closed to the desired position, change the control of LOCAL/REMOTE selector switch to 'REMOTE' mode again and keep the main MCB ON, close the door of panel. The IOT Server transmits the Data to the SCADA Server through the OPC-UA Port when it gets the Fresh Reservoir Level Data. The SCADA System uses this Data for calculating the Discharge.

2.14 Operation Procedure/Instruction for CCTV Camera

DO'S:

1. Before use of the system, read carefully all instructions and operational manuals
2. When you want to switch off the system, first switch off all individual switches of the equipment and then switch off the sub MCBs and the Main MCB
3. When you switch on the system, first switch on the Main MCB and after the Sub MCB and then individual switches of the equipment
4. Keep the equipment free of dust
5. Use dry cloth for cleaning of equipment

DON'TS

1. Never switch off the system only through the Main MCB. Never switch on the system only through the Main MCB
2. Don't place anything on the operating console which might flow and fall inside of the equipment
3. Don't use liquid cleaner on the equipment

2.15 Operation Procedure/Instruction for DG Set (50KVA)

The following checks should be performed prior to starting the generator set:

Ensure the Control Switch / Key Switch is off. A visual inspection should take only a few minutes and can prevent costly repairs and accidents – For maximum generator set life, visually inspect the generator set before starting. Look for items such as:

- Loose fastenings / fixings, worn-out belts or loose connections. Repair as necessary.
- The fan and exhaust guards must be at the correct positions and securely fixed. Repair damaged / loose guards or renew missing guards.
- Wipe clean all filler caps before the engine is serviced or fluids are topped up to reduce the chance of any system contamination.
- For any type of leak (coolant, lubricating oil or fuel), clean away the fluid. If a leak is observed, find the source and correct the leak. If a leak is suspected, check the fluid levels frequently until the leak is found and repaired.
- Accumulated grease and/or oil on an engine is a fire hazard. Remove it by cloth etc.
- Ensure that the coolant pipes are fitted correctly and that they are secure. Check for leaks. Check the condition of all pipes for splits or signs of rubbing.

Fluid levels

- Check the engine oil and coolant levels – replenish as necessary (see engine handbook for locations). Ensure fluids used are as recommended within the engine handbook.

The following procedure should be used for normal starts of a generator set

Note: The generator set may be stopped at any time by turning the Key Switch to Position “0” (Off).

1. Complete Pre-Start checks.
2. Check the battery voltage by turning the Key Switch from Position “0” (Off) to Position “1” (On) and reading the battery voltmeter. A fully charged battery will indicate 12 to 14 volts on a 12 volt system. Return the Key Switch to Position “0” (Off).

3. The engine will not start if any fault indicators are illuminated. Reset the control system by turning the Key Switch to Position “0” (Off). Ensure the faults have been corrected prior to attempting to start the generator set.

WHEN ENGINE HAS STARTED

4. Check for any abnormal noise or vibration.
5. Carry out visual checks for system leaks.
6. Check the control panel for indications of engine temperature and oil pressure
7. Switch the alternator output circuit breaker to “ON” (handle up).

To shut the generator set down, turn off the load by switching the Alternator Output Circuit Breaker to “OFF” (handle down). Allow the generator set to run without load for a few minutes to cool. Then turn the Key Switch to Position “0” (Off). The generator set will shut down. In case of an emergency where immediate shutdown is necessary, the Key Switch should be turned to Position “0” (Off) immediately without disconnecting the load.

Note: Turning the Key Switch to Position “0” (Off) will also reset the protective circuits after a fault has been detected. Ensure that the fault has been rectified prior to restarting the generator set

2.16 Sewage Treatments Plant

Process description of Sewage Treatments Process (MBR technology based Biological treatment)

The STP unit with the least state of art Membrane Bio reactor (MBR) technology based system products consistent quality, ultra filtered output with highest possible bacterial reduction without adding any chemicals with fully automatic operation of submerged modules which will be backwashed and cleaned automatically through PLC control system. All the diffusers are Teflon coated and SSI USA make and are fixed in equalization and biological tank on unique pattern of SS air drop line instead of hanging with flexible piping. The MBR works efficiently to produce desired quality parameter which is good for horticulture.

Technical Specification

Collection Pit

Qty	One no
MOC	RCC
Screen	One No
MOC	Stainless Steel 316

Feed pump from collection pit to aeration tank.

Quantity	Two nos
Working	One working , One standby

Type	Non Clog. Submersible
Material Construction	Cl Body
Discharge capacity	5 m3 /hr@1.5kg/Cm2
Drive Motor	TEFC, 3-Phase, 415 Volt, 2900rpm
Make	Kirloskar
Accessories	Butterfly Valve and line for standby arrangement

Biological Chamber

Twin lobe air blowers complete with interconnecting pipelines, valves and fitting for standby arrangement	2 Nos.
Tank for biological and MBR unit, MOC-MS rubber lined	10 KL
Fine bubble diffusers	1 Lot, Suitable to supply air as per process requirements
Air heater manifold to be laid over the aeration tank	1 lot, MS
Inter connecting pipeline of blower and air headers	1 Lot, MS/ UPVC

Pipe line and valves for MBR

Stainless steel structure complete with connection and fitting for mounting the MBR modules	1 No
Interconnection pipe line of MBR unit with butterfly valves and actuator make Saunders, solenoids valves make rotex for fully automatic operation through pneumatic control.	1 Lot

MBR outlet Tank

Quantity	One no
Material of Construction	MS Rubber lined

Chlorine dosing unit at final outlet

No off	Two nos
working	One working
Feeder	Electronic Metering pump
capacity	0.5 LPH/ Prominent
Solution Tank	PP
Capacity	100 Lts

Pump to transfer treated water to horticulture

Quantity	Two nos
Working	One working
Type	Non clog centrifugal
Material of construction	CL Body
Discharge Capacity	3 M^3/hr @ 2.0 Kg/cm^2
Drive Motor	TEFC, 3-Phase, 415 Volt, 2900rpm
make	Kirloskar

Accessories	Butterfly Valve and line for standby arrangement

Sludge dewatering unit

Quantity	One no
MOC	Ms Rubber lined

2.17 Operation Procedure/Instruction for fire-fighting equipment

Fire extinguishers should not be used by people who have not been trained. Before tackling a fire with a fire extinguisher, make sure you or someone else has sounded the fire alarm and that you have a safe evacuation route.

Using the correct type of extinguisher for the fire, use the four-step PASS technique.

1. Pull: Pull the pin, this will break the tamper seal.
2. Aim: Aim low, pointing the nozzle or hose at the base of the fire. Do not touch the horn on a CO_2 extinguisher, it gets very cold and can damage the skin.
3. Squeeze: Squeeze the handle to release the extinguishing agent.
4. Sweep: Sweep from side to side at the base of the fire, the fuel source, until the fire is out.

   If there is the slightest doubt or uncertainty about tackling the fire, evacuate the building immediately.

Which type of Fire extinguishers to be used:

1. **CO_2 Type fire Extinguishers**:

   A carbon dioxide fire extinguisher (CO_2) is one of the cleanest types of extinguishers to use as it leaves no residue and requires no cleanup. The CO_2 extinguisher does exactly that – extinguishes CO_2. By doing so, it removes oxygen from the fire, effectively suffocating it of oxygen. It is perfect for use on class B fires that involve flammable liquids and on electrical fires.

2. **Mechanical Form Type fire Extinguishers**

   Foam type fire extinguishers are suitable for class A and the flammable liquids of class B, though not effective for gaseous fires. They spray a type of foam that expands when it hits the air and blankets the fire. This blanket prevents the vapors from rising off the liquid to feed the fire, thus starving it of fuel. Also, because the foam is mixed with water, it has a cooling effect as well. Foam extinguishers are

some of the best for liquid fires, such as gasoline fires, but can also be used on Class A fires involving solid combustibles like wood.

3. **ABC Powder type fire Extinguishers**

   An ABC powder fire extinguisher has numerous advantages as it is a multi-purpose extinguisher and is therefore one of the most common extinguishers to have on hand. A powder extinguisher sprays a very fine chemical powder composed most commonly of mono ammonium phosphate. This acts to blanket the fire and suffocate it. Powder extinguishers are effective for class A, B and C fires, since it is not an electrical conductor and since it can effectively break the chain reaction in a liquid or gas fire, something a water extinguisher cannot do.

2.17.1 Location, Type and Number of Fire fight Extinguishers at Asan barrage

The details are shown in the table below:

Place	CO_2 Type (4.5 Kg)	Mech. foam Type (50 Liter)	Mech. foam Type (9 Liter)	ABC Type (9 Kg)	ABC type (6 Kg)	Fire buckets	Total
Control Room	1	-	-	2	1	-	**4**
Barrage gate pathway	1	-	1	3	1	-	**6**
HR Gate pathway	-	-	-	2	1	-	**3**
Silt Ejector cabin	1	-	-	1	2	-	**4**
Near DG set	1	1	1	1	2	3	**9**
11/0.4 KV Transformers	1	1	-	1	3	3	**9**
Total	**5**	**2**	**2**	**10**	**10**	**6**	**35**

2.18 Latest Design flood review study carried out under DRIP

The Asan Barrage has been built across River Asan, a major tributary of River Yamuna in Dehradun district of Uttarakhand. The catchment area of Asan River up-to the barrage site is 685 sq km. The maximum height & storage capacity of the barrage are 19.8 m & 1.6 MCM respectively. As per BIS:11223 -1985 criteria, the barrage qualifies for 100-year return period flood as design flood and SPF as check flood. The original design flood for the project (commissioned in 1967) was 4500 m^3/s.

In the latest flood review study carried out by CWC under DRIP, a 100- year retum period 24- hour duration rainfall of 42 cm was adopted from Iso-pluvial Maps. Storm duration has been taken as 24 hrs. and, corresponding time distribution as given in PMP Atlas for Ganga River Basin has been adopted. Slightly modified catchment response function with a loss rate of 0.4 cm./hr., Areal reduction factor of 0.892 and base flow of 0.05 m3/s/sq.km from FER Sub-zone 7 have been considered in the analysis. The peak value of 100- year retum period flood works out as 4442 m3/s. Further, considering one day areal SPS depth of 58 cm, loss rate of 0.3 cm/hr. and other parameters same as adopted for 100- year retum period flood analysis, the SPF has been worked out as 8056 m3/s. As the project was originally designed to carry 4500 m3/s, the same was recommended as design flood with a SPF with peak of 8056 m3/s as check flood.

Detailed flood review report is appended as Appendix-VII.

Calculations to determine the u/s HFL for the revised check flood are yet to be carried out.

2.19 Emergency Operation:

The emergency operation will be carried out following the Emergency Action Pan (EAP). The emergency conditions are outlined in chapter 4 under clause 4.2.1 on Immediate Maintenance. The EAP together with this Manual will be present at site at all times.

2.20 Reservoir Capacities:

The reservoir capacity may reduce with time because of reservoir sedimentation. Bathymetric survey on a periodic basis is to be considered after every 10 years.

2.21 Record Keeping:

Following records of reservoir operations are being maintained:

1. Rainfall record on daily basis throughout the year.
2. Reservoir levels on daily basis on half hourly basis throughout the year.

3. Gate openings and Outflow over the barrage on half hourly basis during monsoon or as required.
4. Head Regulator Gate openings and Power channel releases on half hourly basis.
5. Silt ejector opening and discharge on half hourly basis during monsoon.
6. Generation from Kulhal and Dhalipur power house on half hourly basis.
7. Measurement of silt concentration in ppm on half hourly basis during monsoon.

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3 Chapter 3: Project Inspection

3.1 Introduction

The barrage gates, HR gates and their hoist are used very frequently during monsoons and in winter rains. The consideration for maintenance will therefore be protection of metal part surface, particularly those which are machined, through application of lubricants and protective coatings. Wear and damage may result if lubrication is neglected.

3.1.1 Inspection and maintenance schedule for Gates:

The complete inspection of barrage & HR gates will include the gate and all associated parts e.g. guides, seal seats, bottom sill and gate tracks.

The inspection of embedded parts can only be carried out when the complete pond is dewatered. This inspection shall therefore be carried out during non-monsoon months.

For inspection of gate, it will be necessary to take out the gate from the slot and hold it on raised position.

3.1.1.1 Quarterly inspection

1. The greasing of gear system of Barrage & HR gates shall be carried out. For this purpose water resistant grease shall be used.
2. Topping up of Gear oil of gear box of Barrage & HR gates shall be carried out.
3. Checking & maintaining of hydraulic oil level in braking system of barrage & HR gates
4. Check the bolts securing the rubber seal to the gates. Tighten the bolts where necessary.

3.1.1.2 Annual Inspection

This will be carried out during non-monsoon months when power house is closed and there is no pond demand for bird sanctuary.

1. Examine and clear all structural members of the gate.
2. Inspect all exposed metal work and check all bolts. Wherever required, tighten or replace bolts, caulk or weld seams.
3. If oxidation is found to be wide spread or if the protective coating is flaking off or is in a doubtful condition, all of the coating that is not firmly adhered, shall be removed by the sand blasting or other practical means. During sand blasting, the wheel assemblies shall be properly protected so that no sand particle gets inside and ruins their bearings and contact surfaces. When oxidation has been removed, repaint the gate.
4. The wheel assemblies shall be washed with water and all sediments and trash shall be removed.

5. Examine wheels thoroughly for cracks and damage by magnifying glasses. Replace if doubtful conditions exists on any wheel.
6. Lubricate the bearings.
7. If any bearing does not move freely after lubrication, it shall be investigated and corrective action to be ensured.
8. Check alignment of the wheels.
9. The condition of rubber seals and the mounting bolts which secure the seats to the gate shall be checked. Tighten or replace the bolts as necessary. The rubber sections shall always completely seal the entire gate openings. If the rubber section is damaged, the entire rubber is to be changed. The joints between the new rubber and the old one must be affected by means of a suitable cold applied binder. Spare rubber seals are to be stored in a cool place away from the solar radiations.
10. Check the guide rollers, clean and lubricate.
11. Clean guides, tracks and seal seats. Mineral deposits shall be removed, where existing, from the stainless steel seal seats. The guides, tracks and seal seats must be heavily greased.
12. In case there is any badly corroded area on tracks or on seal seats, repair by building up metal and grinding.

3.1.2 Inspection and Maintenance schedule for the hoists

Operation of the hoist without lifting the gate is not possible and need not therefore be attempted. It will be possible to operate the unit and observe the operation of load carrying hoist components when gate is being lifted or lowered for regulation.

IMPORTANT: Never open any bolt or nut on motor, gear boxes, rope drums and other load carrying hoist components when the gate is in raised position. The gate should be fully closed before carrying out any work on hoist components including motor and solenoid breaks and other electrical equipment.

3.1.2.1 Monthly Inspection:

1. Check the oil level in gear boxes and replenish where required with ‘Indian oil EP-90’ or equivalent. (Make use of oil indicator or eye drainage hole only to inspect oil level and make use of inspection covers only for filling gear boxes with oil).
2. All bolts and nuts on gear boxes, hoist drums and shaft couplings should be checked for tightness.
3. Check all fuses on the power lines.
4. Clean all hoisting equipment and hoist platform.

5. Water resistant grease or equivalent shall be applied by grease gun through all the grease nipples.

Electrical Maintenance:

(i) Starter should be cleaned free of moisture and dust.

(ii) Each individual contactor should be tried by hand, to make sure that it operates freely.

(iii) All bearing parts should be examined in order to take note of any wear which may have occurred during operation.

(iv) If the contactor hums, the magnet faces should be cleaned. (Blakening of contacts caused by deposition of silver due to arching is of no importance)

(v) Examine all connections to see that no wires are broken and no connections are loose.

(vi) Clean the surface of moving armature and magnet core, which come together when the contactors closes, free of dust or grease of any kind.

(vii) Examine the mechanical interlocks between the reversing contactors and see that 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.

(viii) Check the contact tips (the contact tips of the contactors should be renewed when worn half way through in order to prevent possibility of failure due to bad contact. The contact tips should be kept free from burns or pits, being smoothened occasionally with fine sand paper or emery cloth. Do not lubricate the contacts as they are self-cleaning).

(ix) Fixing bolts of the brake solenoid should be inspected.

(x) Check A.C. Solenoid (should A.C. solenoids become noisy when energized, this may be caused by.

a. Mal-adjustment of the connector between plunger and mechanism, thus preventing plunger from completing stroke.
b. Foreign matter lodging on pole face and preventing plunger from completing stroke.
c. Broken winding on plunger. In this event, plunger should be replaced).

3.1.2.2 Quarterly inspection

1. Drain the sample of gear oil from each of the gear boxes. If excessive water, foreign particles or sludge is found, the gear boxes shall be drained, flushed and filled with new oil.

3.1.2.3 Annual inspection

1. Check all machinery for loose mounting bolts. Flange and flexible couplings shall be checked for loose bolts and tightened as necessary. The structural steel hoist bridge shall be examined, and any defect shall be rectified as required.
2. Remove oxidation, touch up bare metal with primer and apply finish paints.
3. The lifting rope shall be checked and all visible oxidation shall be removed. Also remove all trash sediment and foreign particles of any type. All rope shall be greased with Shell cardium compound 'D' or equivalent brand. The rope shall be examined for wear particles at drums.
4. Check insulation resistance of all electrical equipment and circuits and take remedial measures wherever required.
5. Check the overload relay to see that it trips off starter for current at which it is set corresponding to motor rating.
6. Operate the gate and observe the following:
    i.) Movement of gate should be smooth without any indication of jamming on the side guides.
    ii.) When the gate is being operated there should not be any noise or chatter in the gears, this will indicate that all gears are matching properly.
    iii.) Local position indicator should indicate '0' when the gate is fully closed and 24 meters when it is cut off in maximum raised position by the limit switch.
    iv.) The brake should be capable of overcoming a torque not less than the running torque of the motor. The effectiveness and slip of the brake should be observed by stopping the gate during upward as well as downward movement of the gate. In case any adjustment is required it should be adjusted.
    v.) Limit switch should be able to stop the motor at '0' and 24 meter opening.
    vi.) Raise, Lower or stop buttons should be able to operate or stop the motor as required.
    vii.) Raise, Lower or stop buttons in the control room panel should be able to operate or stop the motor as required.

3.1.3 Inspection and maintenance of Intake Trash rack

The trash rack screens are visible up to 1.50 meter from deck level. Complete trash rack screens will be visible during closure / flushing of barrage.

3.1.3.1 Daily Inspection

Inspect the reservoir surface near the intake and remove trash and floating debris manually

Important:

(i) During monsoon (16th June to 15th October) and winter rains particularly when river flow is rising, special watch shall be kept and any trash & floating debris collecting near the intake should be concurrently removed.

(ii) Soon after the monsoon, a short closure of few hours will be taken to lower the reservoir level below the sill of the trash racks and if any rack isdamaged significantly warranting the replacement, it shall be replaced.
It is desirable that a similar inspection is done and when conditions permit or warrant during monsoons.

3.1.3.2 Special Inspection

If chocking of trash rack is indicated, it will be necessary to inspect and clean the trash racks. All entangled debris shall be removed during inspection before rising the reservoir level again.

3.1.3.3 Biennial Inspection

Remove the entangled debris and repair the racks as necessary. The trash bars shall be straightened which required to maintain about 140/70 mm distance from centre to centre. All oxidation shall be removed by using electric wire brushes and protective coating shall be touched up where necessary.

3.1.3.4 Five Year Inspection:

This inspection will be similar to biennial inspection. However, protective coating shall be more thoroughly examined after every five years, unless it is necessary to apply the protective coating more often, as may be revealed during biennial inspections. Chip off the coating where flaked or suspected to have oxidized underneath. Painting which is sound shall be left undisturbed. Clean all bare metal with electric wire brushes until oxidation has been removed and then apply new protective coating.

3.1.4 Inspection and Maintenance of civil works (for works under water)

Necessary surveys/ inspection of barrage shall be carried out regularly to study the performance of barrage. Such inspections shall usually be carried out annually for all the follow work after monsoon

i. Reservoir area
ii. Silt ejector tunnels and escape channel
iii. Guide and afflux bunds
iv. Head Regulator & Barrage

The repairs as necessary due to results of above survey/ inspection shall be carried out well before the next monsoon. Any serious defects noticed shall be reported to Executive Engineer / Deputy General Manager.

3.1.5 Types of Inspection

In general four different types of dam/ barrage safety inspections are available for Asan Barrage. The inspections discussed in earlier paras are part of scheduled, unscheduled and informal inspections described below.

The four different types of inspections are:

1. Comprehensive evaluation inspections
2. Scheduled inspections (Pre & Post monsoon inspections & other scheduled inspections).
3. Special (unscheduled) inspections.
4. Informal inspections

The frequency of each type of inspection depends on the condition of the barrage and State DSO regulations, etc.

Typical inspection elements and the detail of the safety inspections are provided below. More detailed descriptions are given in the Guideline for Safety Inspection of (CWC 2018). A checklist has been modified from the guideline to fit Asan Barrage requirements and is found in Appendix. This comprehensive checklist allows for recording the status of each item being inspected and the overall condition of the equipment along with any consequential risks the condition may have on the health of the barrage.

3.1.5.1 Comprehensive Evaluation Inspection

For comprehensive dam/ barrage safety evaluation for each dam/ barrage an independent panel of experts known as Dam Safety Review Panel (DSRP) needs to be constituted for determining the condition of the barrage and appurtenant works. The panel will undertake evaluation of the barrage once in 10 years or on occurrence of any extreme hydrological or seismic event or any unusual condition of the barrage or in the reservoir rim. The terms of reference of the comprehensive barrage safety evaluation shall include but not be limited to;

1. General assessment of hydrologic and hydraulic conditions, review of design flood, flood routing for revised design flood and mitigation measures.

   - Review and analysis of available data of barrage design including seismic safety, construction, operation maintenance and performance of barrage structure and appurtenant works.
   - Evaluation of procedures for operation, maintenance and inspection of barrage and to suggest improvements / modifications.
   - Evaluation of any possible hazardous threat to the barrage structure such as barrage slope stability failure or slope failures along the reservoir periphery.

A comprehensive evaluation inspection of Asan barrage consists of five major parts:

1. Review of project records (i.e. study of all design / construction records/drawings, history of barrage's performance, past inspection notes/ reports, notes on distress observed/ any rehabilitation measures undertaken earlier, instrumentation data and its interpretation.
2. Inspection of the barrage and its appurtenant works.
3. To review the results and reports of additional field investigations & laboratory testing as required.
4. Review of design studies e.g. review of design flood, checking of the adequacy of spillway capacity, freeboard requirements, barrage stability, any special study as required.
5. Preparation of a detailed report of the inspection.

Details to be provided to DSRP before inspection

All relevant details / data / drawings for Asan Barrage to be examined by the DSRP, shall be provided at least 3 months in advance of the proposed visit. This will include:-

i. General information and scope of the project

ii. Emergency preparedness

iii. Details of key personnel

iv. Hydrology original and reviewed

v. Reservoir operation and regulation plan

vi. Basic data and issues related to safety of barrage

vii. Problems, if any, during construction

viii. Drawings of barrage under-sluices, head regulator, gates and appurtenant structures

ix. Seismicity aspects & details

x. Status of the instrumentation

xi. Construction history

xii. Geological report including special problems at site and their treatment

xiii. Field Inspection Observation and recommendation regarding remedial measures

xiv. Barrage incidents and reservoir filling details.

3.1.5.2 Scheduled Inspection

Scheduled inspections shall consist of Pre-monsoon & Post-monsoon inspection and any other inspections carried out by the State Dam Safety Organization / any Expert panels constituted by the barrage owner.

These inspections are performed to gather information on the current condition of the barrage and its appurtenant works. This information is then used to establish needed repairs and repair schedules, and to assess the safety and operational adequacy of the barrage. Scheduled inspections are also performed to evaluate previous repairs.

The purpose of scheduled inspections is to keep the barrage and its appurtenant structures in good operating condition and to maintain a safe structure. As such, these inspections and timely maintenance will minimize long term costs and will extend the life of the barrage. Scheduled inspections are performed more frequently than comprehensive evaluation inspections to detect at an early stage any developments that may be detrimental to the barrage. These inspections involve assessing operational capability as well as structural stability and detection of any problems and to correct them before the conditions worsen. The field examinations should be made by the personnel assigned responsibility for monitoring the safety of the barrage. If the barrage or appurtenant works have instrumentation, the individual responsible for

monitoring should analyse measurements as they are received and include an evaluation of that data. Barrage Inspection Report should be prepared following the field visit.

Scheduled inspections include the following four components as a minimum:

- File review of past inspection reports, monitoring data, photographs, maintenance records, or other pertinent data as may be required.
- Visual inspection of the barrage and its appurtenant works;
- Preparation of a report or inspection brief, with relevant documentation and photographs. The report should be filed in the barrage owner's project files.

The schedule for carrying out the pre-monsoon and post monsoon inspections jointly by the Executive Engineer (E&M) and Executive Engineer (PCM), Dhalipur will be as under:

Type of Inspection	Last date for	
	Completion of inspection	Sending inspection reports to General Manager (YV) and General Manager (Civil) UJVNL
Pre- monsoon	15th May	30th June
Post-monsoon	30th November	31st December

3.1.5.3 Special (Unscheduled) Inspection

Special inspections may need to be performed to resolve specific concerns or conditions at the site on an unscheduled basis. Special inspections are not regularly scheduled activities, but are usually made before or immediately after the barrage or appurtenant works have been subjected to unusual events or conditions, such as an unusually high flood or a significant earthquake. These inspections are to be carried out after an initial assessment based on informal inspection carried out by project personnel reveal barrage safety related concerns like cracking in the barrage, damages, erosion/ scour, undermining/ piping/ sink holes/ liquefaction or any such undesirable feature. A special inspection may also be performed during an emergency, such as an impending barrage breach, to evaluate specific areas or concerns. They are also made when the ongoing surveillance program identifies a condition or a trend that appears to warrant a special evaluation. Special inspections should focus on those barrage components that are affected by the unusual event and should include at least three elements: 1) review of relevant files or data, 2) visual inspection, and 3) report preparation.

More detailed site investigations / studies may be required (such as drilling, surveys, or seepage flow estimates) if the special inspection reveals the need for the same. Photographic documentation is to be included as part of the inspection.

3.1.5.4 Informal Inspection

The last type of inspection, an informal inspection, is a continuing effort by on site personnel (barrage owners/operators and maintenance personnel) performed during their routine duties. Informal inspections are critical to the proper operation and maintenance of the barrage. They consist of frequent observations of the general appearance and functioning of the barrage and appurtenant structures.

Operators, maintenance crews, or other staff who are posted at Asan Barrage site conduct informal inspection. These people are "first line of defense" in assuring safe barrage conditions and it is their responsibility to be familiar with all aspects of the barrage. Their vigilance in watching the barrage, checking the operating equipment, and noting changes in conditions may prevent serious mishaps or even barrage failures.

Informal inspections are important and are performed at every available opportunity. These inspections may only cover one or two barrage components as the occasion presents itself or they may cover the entire barrage and its appurtenant structures. The informal inspections are not as detailed as comprehensive evaluation, scheduled or special inspections and will only require that a formal report is submitted to the barrage owner's project files, if a condition is detected that might endanger the barrage. Report is to be submitted detailing the condition discovered along with photographs, time and reservoir water level etc.

3.1.5.5 Reservoir Area

The pond extends up to about 40 km from the barrage. Survey pillars shall be made at every 50.0 m on both bank of river and cross section shall be observed across the pillars every year just after monsoon. These cross sections shall be superimposed on the original cross section. Shoaling if any, river behavior and reservoir capacity shall be assessed after construction and running of barrage. Necessary measures to remove shoaling by operation of gates shall be taken whenever necessary under instructions of Executive Engineer.

3.1.5.6 Guide and Afflux Bunds

Guide and Afflux Bund shall be inspected thoroughly after every monsoon and necessary repair shall be completed before next monsoon.

3.1.5.7 Silt ejector Tunnels

The Silt ejector Tunnels shall be inspected at least once in five years or so for assessing shoaling in the tunnels. Condition of lining is to be checked and necessary repairs shall be carried out.

The escape channel shall be inspected after every monsoon to assess the flow condition and condition of side slopes fall and other masonry works. Necessary repairs if any required shall be carried out and completed before next monsoon.

3.1.5.8 Head Regulator & Barrage

The works shall be carefully and thoroughly inspected at least once in five years or so during closure and necessary repairs shall be carried out.

3.1.6 MATERIAL TO BE PROCURED IN ADVANCE BEFORE MONSOON

The following materials shall be procured before monsoon in advance so that any repair/ damaged may be attended immediately without any loss of time for arrangement of material.

S. No.	Item	Quantity (Tentative)
1	Boulder	200 m^3
2	G.I. wire crate of size (30x1.0m)	50 Nos.
3	Empty cement bag	2000 Nos.
4	RBM	200.00 m^3
5	Control kits	25 Nos.
6	Limit switch	10 Nos.
7	Main contact set	10 Nos.
8	Relay Assembly	04 Nos.
9	Steel wire rope of size 16 mm dia.	50 m.
10	U-wire clamp	12 Nos.
11	Coupling bolt with R. C. Bush	50 Nos.
12	Bearing for 5 HP motor	50 Nos.
13	Luminaries	10 Nos.
14	Different size of cables	1 lot
15	Contactors	10 Nos.
16	Spare motor	3 Nos.
17	Indication lamps	10 Nos.

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4 Chapter 4: Project maintenance

A good maintenance program will protect the barrage against deterioration, prolong its life, and greatly reduce the chance of its failure. The project authorities and operating and maintenance personnel must be aware of the potential problems which can lead to failure of the structure. Nearly all the components of the barrage are susceptible to damage and deterioration if not well maintained.

This Manual is to be referred to mainly for routine maintenance works.

The designs, drawings and technical specifications for most of the condition based and immediate maintenance works will need to be arranged by UJVNL. Guidance of experienced engineers/panel of experts will need to be taken.

4.1 Maintenance Priorities

For Asan Barrage, maintenance activities require to be prioritized as immediate maintenance or preventative maintenance.

4.1.1 Immediate Maintenance

The following conditions are critical and call for immediate attention & reservoir lowering, if warranted. These conditions may include, but are not limited to:

1 The barrage is about to be overtopped or being overtopped during high flood.

2 The barrage embankments/slope protection works about to be breached by erosion, slope failure etc.

3 The bunds of barrage showing signs of piping or internal erosion indicated by increasingly cloudy seepage or other symptoms.

4 The barrage has some inoperable gates.

5 Evidence of excessive seepage appearing anywhere on the barrage site.

When such conditions exist then an Emergency Action Plan will need to be invoked

4.1.2 Preventive Maintenance

This can be further classified as Condition based Maintenance and Routine Maintenance.

4.1.2.1 Condition Based Maintenance

The following maintenance should be completed as soon as possible after the defective condition is noted. These includes but are not limited to:

1 Remove all vegetation and bushes from the bunds of the barrage and restoring any eroded areas and to establish a good grass cover.

2 Fill animal burrows on bunds.

3 Restore and reseed eroded areas and gullies on bunds.

4 Repair of defective gates and other hydro-mechanical equipment.

5 Repair any concrete or metal components that have deteriorated.

6 Repair any damage on under sluices/barrage glacis, piers, energy dissipaters, training/divide walls, protection works, upstream and downstream areas etc.

7 Repair of any crack/cavity/joint in concrete/masonry of barrage structure.

However, many of these works will require the services of experienced engineers/expert panels.

4.1.2.2 Routine Maintenance

Several tasks should be performed on a continuous basis. These include but are not limited to the following:

1 Routine mowing, restore and reseed eroded areas and gullies on downstream face of the bunds and general maintenance including repairs/cleaning of surface drains on non-water facing face and in the downstream areas.

2 Maintenance and treatment of any cracks/joints/ cavities in barrage structure.

3 Maintenance of Electrical & Hydro-Mechanical equipment and systems e.g. Servicing of gates, hoisting arrangements, DG Set etc.

4 Maintaining proper lighting at barrage.

5 Maintenance of all barrage roads & access roads.

6 Operation of electrical and mechanical equipment and systems including exercising gates.

7 To keep the gate slots clear of silt/debris.

8 Maintenance/testing of monitoring equipment and safety alarms.

9 Testing of communication equipment.

10 Any other maintenance considered necessary.

4.2 Routine Maintenance

4.2.1 Barrage Bunds:

a) Controlling Vegetation :

i. Keep the entire barrage and its bunds clear of unwanted vegetation such as bushes or trees. Excessive growth may cause several problems.

ii. It can obscure the surface of bunds and not allow proper inspection of the barrage. Large trees can be uprooted by high wind or erosion and leave large voids that can lead to breaching of the barrage.

iii. Some root systems can decay and rot, creating passageways for water, leading to piping erosion.

iv. Growing root systems can lift concrete slabs or structures.

v. Rodent habitats can develop undetected.

vi. All bushes/trees should be as far as possible removed by root to prevent regrowth. The resulting voids must be backfilled with suitable, well-compacted soils.

vii. It is recommended to remove the plants/vegetation at their early stage to prevent or minimize their growing into big trees/bushes, etc. In cases where trees and bushes cannot be removed, the root systems should be treated with environmentally-friendly herbicides (properly selected and applied) to retard further growth. Concerned Government Agencies must be consulted for selection of appropriate herbicides & their use for control of vegetation on barrage structures or any water bodies.

b) Controlling Animal Damage

Livestock are not allowed to graze on the bund section of the barrage. When soil is wet, livestock can damage vegetation and disrupt the uniformity of the surface. Moreover, livestock tend to walk in established paths and thus can promote erosion.

c) Controlling Ants and Termites (White Ants)

Ants and termites have become one of the most serious pests for bunds of barrage. They both need water to survive and have been found on most of the bunds of barrages in India. These insects can create problems in the barrage itself and with any of its electrical components. In some habitats, ants and termites can move as much or more soil as earthworms, thereby reducing soil compaction. Nest galleries can penetrate in a V-shaped pattern below the nest, penetrating as much as more than one meter deep in the soil. These galleries can create pathways for surface water to penetrate in the barrage bunds, resulting in internal erosion and collapse of the surface. Ants and termites left undisturbed can build mounds that can become quite large. These can create problems for mowing. However, frequent mowing can induce the colonies to migrate to neighboring, undisturbed areas. There are many options for managing ants and termites.

Use only pesticides labeled as suitable for the location you want to treat. Make every effort to avoid contaminating water with pesticides and ensure.

4.2.2 Barrage Structure

Various issues/problems that may require maintenance/repairs include but are not limited to:

i. Damages on the glacis/floor of under sluices and barrage bays, piers, divide walls, energy dissipaters, Head Regulator, power channel, downstream areas (probable causes are cavitation, abrasion, un-symmetrical flows, unfavorable down-stream conditions)

ii. Vegetation growth on barrage structure.

However remedial measures for most of the above damages may require advice of experienced engineers /Panel of Experts.

4.2.3 Gates & Hoisting Equipment

The safe and satisfactory operation of Asan barrage depends on proper operation of its Gates & Hoisting Equipment. Maintaining under sluice, barrage and head regulator gates in working condition is critical for barrage safety and is to be assigned the highest priority. If routine inspection of the Hydro-Mechanical Equipment shows the need for maintenance, the work should be completed as soon as possible.

The aspects to be inspected and maintained periodically for ensuring proper operation of the gates are as under:

1 The gate slot and bottom platform/sill beam should be cleaned periodically. Scales formed over the embedded parts should be removed. Second-stage concrete should be checked for any development of cracks / leakages and repairs should be attended immediately.

2 The gate leaf should be thoroughly cleaned and repainted as and when necessary according to the procedure or guidelines- indicated in IS: 14177 or as per the recommendations of the paint manufacturer. All drain holes provided in the gate assembly should be cleaned.

3 Rubber seals should be smoothed, if required, for proper alignment. All nuts and bolts fixing the seal to the gate should be tightened uniformly to required

torques. Seals, if found damaged or found leaking excessively should be adjusted, repaired or replaced as considered necessary.

4 The wheel shall be rotated to check their free movement. Gate roller bearings and guide roller bushes should be properly lubricated. Whenever necessary, these should be opened for rectifications of defects, cleaning and lubrication and should thereafter be refitted. These may be replaced if repairs are not possible.

5 Hoisting connection of the gate leaf should be lubricated where necessary and defect if any should be rectified.

6 All nuts, bolts, check nuts and cotter pins of the hoisting assembly should be checked periodically.

7 All components which require lubrication should be greased and lubricated. Recommended and approved oils and grease only should be used.

8 All welds shall be checked for cracks/ damages. Any weld that might have become defective should be chipped out and redone following the relevant code provisions. Damaged nuts, bolts, rivets, screws etc. should be replaced without delay.

9 The guide-assemblies, wheel-assemblies and sealing-assemblies shall be cleared of grit, sand or any other foreign material.

10 The wheel pin shall be coated with corrosion resistant compound. All nuts and bolts shall be tightened.

11 Embedded Parts:

All the sill beams and wall plates shall be inspected for crack, pitting etc. and defects shall be rectified.

12 General Maintenance:

- Defective welding should be chipped out and it should be re-welded duly following the relevant code provision (IS: 10096, Part-3).
- Damaged nuts, bolts, rivets, screws etc. should be replaced.
- Any pitting should be filled up by welding and finished by grinding if necessary.
- The gate leaf, exposed embedded metal parts, hoists and hoist supporting structure etc., should be thoroughly cleaned and repainted when required keeping in view the original painting system adopted and as per the guidelines contained in IS: 14177.

- 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.
- Wire ropes should be properly lubricated.
- Oil level in the gear assembly unit should be maintained by suitable replenishment. Oil seals should also be replaced if required. Lubrication of other parts of hoists such as chains, position indicators and limit switches should also be done.
- 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.
- Repairs and replacements of all electrical relays and controls should be attended to.
- Maintenance of alternative sources of Power such as Diesel Generating sets 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.

4.2.4 Electrically operated fixed hoists

General Instructions:

a) Operation of fixed hoist without lifting the gate is not possible and need not therefore be attempted. It will be possible to operate the unit and observe operation of load carrying hoist component when gate is being lifted or lowered.

b) Never open any bolt or nut on motor, gear boxes, rope drums and other load carrying hoist components when the gate is in raised position. The gate should be fully closed or rested on the gate latches before carrying out any work on hoist components including motor brake and other electrical equipment.

c) The aspects to be inspected and maintained periodically for ensuring proper operation of Rope drum hoists are as under;

i. Entrance to all hoist platforms shall be kept locked. All keys shall remain with the shift supervisor.
ii. A cursory daily inspection shall be made of hoist and gate to ensure that there is no unusual happening.
iii. Clean all hoisting equipment and hoist platform.
iv. Check oil level in gearboxes and replenish as and when required with oil of proper grade.
v. Apply grease of suitable grade by grease gun.
vi. Lubricate all bearings, bushings, pins, linkages etc.
vii. Check all the fuses on the power lines.
viii. All bolts and nuts on gear boxes, hoist drum and shaft couplings should be checked for tightness.
ix. Check the supply voltage.
x. Drain sample gear oil from each of the gear boxes. If excessive foreign particles or sludge is found, the gear box shall be drained, flushed and filled with new oil.
xi. All the geared couplings shall be greased.
xii. Raise and lower the gate by hoist motor and check for smooth, and trouble free operation of gate without excessive vibration.
xiii. Observe current drawn by motor at the time of lifting and check if it is more than normal. If so, stop the hoist and investigate the cause and rectify.
xiv. Check the condition of painting of various components and remove rust wherever noticed and repaint the portion after proper cleaning as per painting schedule.
xv. All trash, sediments and any other foreign material shall be cleared off the lifting rope and lifting attachment.
xvi. All ropes shall be checked for wear and tear and if broken wires are noticed, the rope shall be replaced.
xvii. All the wire ropes shall be checked and all visible oxidation shall be removed.
xviii. All wire ropes shall be greased with cardium compound.
xix. Check the overload relays for proper functioning.

xx. Check all the nuts, bolts, rivets, welds and structural components for hoisting platform and its supporting structure for wear, tear and damage. All damages shall be rectified. All bolts shall be tightened. The portion with damaged painting shall be touched up.

xxi. Check the pulleys, sheaves and turn-buckles.

xxii. Raise and lower the gate for its full lift several times (at least three to four) and observe the following:

a) Check the limit switches and adjust for design limits.

b) The effectiveness and slip of the breaks shall be checked by stopping the gate in raising and lowering operations. The brakes shall be adjusted if needed.

c) When the gate is operated, there should not be any noise or chatter in the gears.

xxiii. Adjust the rope tension of wires if unequal.

Check for all gears and pinions for uneven wear and adjust for proper contact. Grease the gears.

xxiv. Repaint the hoist components, hoisting platform and its supporting structures as per requirement.

xxv. The periodic maintenance of commercial equipment like motors, brakes, thrusts etc. shall be carried out as per manufacturers operation and maintenance manual.

4.2.5 Maintenance of Electrical components of Fixed Rope Drum Hoists:

The electrical components to be inspected and maintained periodically are as under:

i) Starters should be cleaned free of moisture and dust.

ii) Each individual contactor should be tried by hand to make sure that it operates freely.

iii) All wearing parts should be examined in order to take note of any wear which may have occurred during operation.

iv) If the contactor hums, the contact faces should be cleaned.

v) Examine all connections to see that no wires are broken and no connections are loose.

vi) 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.

vii) 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.

viii) The contact tips should be kept free from burns or pits by smoothening with fine sand paper or emery paper.

ix) Replace the contact tips which have worn away half-way.

x) Do not lubricate the contacts.

xi) Blow out windings thoroughly by clean and dry air to clear air passage in the stator and the rotor of any accumulated dirt. The air pressure shall not be too high to damage the insulation.

xii) Examine earth connections and motor leads.

xiii) Examine motor windings for overheating.

xiv) Examine control equipment.

xv) Examine starting equipment for burnt contacts.

xvi) Check and tighten all nuts and bolts.

xvii) Clean and tighten all terminals and screw connections. All contact surfaces shall be made clean and smooth.

xviii) Lubricate the bearings

xix) Overhaul the controllers.

xx) Inspect and clean circuit breakers.

xxi) Wipe brush holders and check bedding of brushes. Blow out windings thoroughly by clean and dry air. The pressure shall not be so high that insulation may get damaged.

xxii) Check the insulation resistance of the motor between any terminal and the frame. If the measured resistance is less than the prescribed value, then steps shall be taken to dry-out the motors either by passing a low voltage current through the windings or by placing the stator and rotor only in a warm dry place for a day or so. WARNING: The complete motor shall never be put in an oven for drying as that may melt the grease out of bearings.

xxiii) Coat the windings with an approved high temperature resisting insulation enamel or varnish.

xxiv) Overhaul the motor, if required.

xxv) Check the switch fuse units and renew, if required.

xxvi) Check resistance or earth connections.

xxvii) Check air gap.

Solenoid Operated Brakes

i. All fixing bolts shall be checked and tightened at least once in three months.

ii. The magnet stroke should be reset to compensate for wear.

iii. Re-adjust the brake when the magnet stroke reaches the value given on the instruction plate.

iv. Brake lining should be checked and replaced when required.

v. Examine all electrical leads and connections.

vi. Rubber bushes or couplings should be checked and replaced if defective.

vii. The pins should be tightened.

viii. Brake drum shall be cleaned to remove any dust or grease.

4.2.6 Lubrication and Maintenance of reduction gear unit

1 Satisfactory performance of grease required that the lubricating oil should be kept clean, and free from dirt, grit, moisture and sludge. Depending upon operating conditions, the oil eventually becomes contaminated and should be drained periodically. During operation, the oil level should be periodically checked, too high level results loss of power and oil leakage, too low oil results in friction in bearings and on gear teeth causing overheating. Use proper graded oil.

2 Oil level should be checked with the help of dipstick or the oil indicator and should be topped up, if necessary.

3 Where the bearings of the unit are grease lubricated, the same should be filled with the top of grease gun.

4 Care should be taken that the breather holes are not clogged by any foreign materials, like dust, paint etc.

5 During cleaning gear casing should be flushed with the same sort oil that is used under working Conditions. If encasing is opened for cleaning, all sealing compound must be removed.

4.2.7 Maintenance of wire ropes

Frequently the inspection of the entire length of rope is necessary. Watch constantly for broken wires, excessive wear and lubrication, see that the number of broken wires does

not exceed as laid down in different regulation. Prompt attention must be given to a broken wire in a rope otherwise damage to other wires and serious accidents may results. Cleaning wire rope with brush or compressed air and giving it a light coating of special wire rope dressing is essential. This lubricant puts a protective film on each individual wire, repels water and stops corrosion.

4.2.8 Check for tightness of bolts

1 Fixing bolts of motor and reduction gears.

2 Plummer Block base Bolts.

3 Bolts of all Coupling.

4 Inspect the keys in the Couplings for its correct position once in every six months.

5 The wire Rope is fixed over the winding drum by means of clamps and bolts. These are to be checked for its tightness periodically.

4.2.9 Surface Preparation and Painting of HM Works

1 Protection of painted surfaces is considered essential for protection & enhancement of service life. Gates, their embedded parts, gate leaf, hoists and its supporting structures need to be protected against corrosion due to climatic condition, weathering, biochemical reaction and abrasion etc. This equipment is likely to deteriorate or get damaged to any extent that the replacement of parts may become necessary and such replacement may become difficult and costly.

2 Surface preparation & Painting requirements: Painting for hydro-mechanical works is to be carried out as prescribed in IS 14177 for both newly manufactured as well as old & used gates, hoists and associated works after proper surface preparation. The preparation includes thorough cleaning, smoothing irregular surfaces, rusted surfaces, weld spatters, oil, grease, dirt, earlier applied damaged layers of primers/ paint by use of mechanical tools, by use of solvents, wire brush etc. The sand / grit blasting process is used for surface preparation to a level of Sa 2½ of the Swedish standard.

3 Surfaces not requiring painting & their protection during surface preparation, painting process:

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

- Machine finished or similar surface
- Stainless steel overlay surfaces.
- Surfaces in sliding or rolling contact

- Galvanized surfaces, brass and bronze surfaces.
- Aluminum alloy surfaces.

b) The Surfaces of stainless steel, nickel, bronze and machined surface adjacent to metal work being cleaned or painted shall be protected by using sticky protective tape or by other suitable means over the surfaces not to be painted.

4 Application of primer &finish coats on embedded parts and gates:

a) EMBEDDED PARTS:

- The prescribed primer shall be applied as soon as the surface preparation is complete and prior to the development of surface rusting and within the specified time prescribed by Indian Standards or the Paint Manufacturer. In case there is lapse of considerable time beyond the prescribed time limit, the surfaces shall be again cleaned prior to priming.
- Two coats of zinc rich primer with epoxy resin shall be applied to all embedded parts surfaces 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.
- This shall be followed by three coats at an interval of 24hours of coal-tar blend epoxy resin so as to get a dry film thickness of 80 microns in each coat. Total dry film thickness of paint shall not be less than 300 microns.

b) GATES:

i. 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.

ii. Finished paint:

- 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 of 150±5 microns. The total dry film thickness

of all the coats including primer coating shall not be less than 350 microns.

c) Hoist and supporting structure:

i. Structural components: Primer coats of zinc phosphate primer shall be applied to give a dry film thickness of 40±5 microns. Final Coats: One coat of alkalized 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 primer coat shall not be less than 175 microns.

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

- Primer coats: One coat of zinc phosphate primer paint to give minimum film thickness of 50 microns. Motors and other bought out items shall be painted if necessary.
- Finished coats: The finished paint shall consists of three coats of aluminum paint confirming to IS2339 – 1963 or synthetic enamel paint confirming to IS 2932 – 1977 to give a dry film thickness of 25±5 microns per coat to obtain a total minimum dry film thickness of 125 microns.

d) Machined surfaces:

All machined surfaces of ferrous metal including screw threads shall be cleaned by suitable solvent and given a heavy uniform coating of gasoline soluble removable rust preventive compound or equivalent. Machined surfaces shall be protected with the adhesive tapes or other suitable means during the cleaning and painting operation of other components.

5 Application of paint:

Mix the contents thoroughly as directed by paint manufacturer before and during use. Painting at shop can be done by any of the three methods namely Brush / roller, Conventional spray, Airless spray etc. The paint can be made to suit the adopted method. But once the gate and equipment is in erected

position the general method adopted is only brush / roller. In case of spray, lot of precautions are to be taken.

For More details: Refer IS: 14177 Part (II) – 1971.

Appendix A – Brushing of paint

Appendix B – Spraying of paint

Appendix C – Spray painting defects: Causes and remedies.

6 Removal of old paint / rust and carrying out fresh painting:

Carrying out of fresh painting is to be considered under the following conditions:

The rusting is noticed all over the surface or

Rusting is severe or

Cracking and blistering has damaged the primer coat exposing the metal and is noticed all over the surface or

The paint film has eroded badly, the scrap of entire paint film to the base metal and carry out fresh painting.

Note: In case of maintenance and renovation: Refer IS 14177 (Part II) – 1971 for checking and repainting.

7 Removal of old paint for repainting: Caution should be exercised while removing the old paint. The surfaces shall be de-rusted and descaled by either mechanically by one or more of the methods, namely:

a) Wire brushing, Scraping, and chipping. Sand papering or cleaning with steel wool or abrasive paper

b) Power tool cleaning

c) Flame cleaning

d) Sand blasting or shot blasting and

e) Chemical rust removal.

Note: The method of application shall be decided based on conditions existing. After cleaning, painting is to be carried out as originally proposed. Some are painted without removal of old paint and rusting this will amounts to no painting and deteriorate faster than the original one.

8 Inspection and testing of painting of H. M works:

The following steps are involved in inspection of painting:

General inspection before and during painting

Viscosity test of paints

Paint thickness test – using Elco-meter.

Inspection of general appearance of finished work.

General:

The aim of inspection and testing is to ascertain whether the recommended practice is being employed correctly during every stage of application and whether the final results fulfill the object of painting. Any test carried out should be of non – destructive nature or, if it is of destructive nature, it should be either restricted to areas which can be restored without marring the general appearances or be such that it is possible to restore easily without necessitating a complete repetition of the work.

Inspection of surfaces prior to painting: Inspection methods will depend on whether it is to be painted for the first time or is to be repainted.

New Works (Not previously painted): The following shall be decided by inspection:

The method of pre cleaning feasible or recommended;

The intermediate protective treatments to be applied, if found necessary;

The final painting schedule and the specifications for the paint for ensuring the particular performance:

The method of application, whether by brush, roller or spray.

Old Work (Which requires repainting): The following shall be decided by inspection:

Whether the entire existing paint requires removal; and/or

Whether repainting without paint removal would be adequate.

4.3 Electrical System

Electricity is typically used at a barrage for lighting and to operate the gates, hoists, recording equipment, and other miscellaneous equipment. It is important that the Electrical system be well maintained, including a thorough check of fuses and a test of the system to ensure that all parts are properly functioning. The system should be free from moisture and dirt, and wiring should be checked for corrosion and mineral deposits. All necessary repairs should be carried out

immediately and records of the works kept. Maintain generators used for auxiliary emergency power -- change the oil, check the batteries and antifreeze and make sure fuel is readily available.. Open areas are particularly susceptible to vandalism. As such all electrical fittings like bulbs, lights, loose wires etc. in open areas should be checked routinely and replaced / repaired where needed.

4.4 Maintenance of Metal Gate Components

All exposed, bare ferrous metal of an outlet installation, whether submerged or exposed to air, will tend to rust. To prevent corrosion, exposed ferrous metals must be either appropriately painted (follow the paint manufacturer's directions) or heavily greased in respect of moving parts & on surfaces like guides & track seats on which there is movement of gates. When areas are repainted, it should be ensured that paint is not applied to gate seats, wedges, or stems (where they pass through the stem guides), or on other friction surfaces where paint could cause binding. Heavy grease should be applied on friction surfaces to avoid binding. As rust is especially damaging to contact surfaces, existing rust is to be removed before periodic application of grease.

4.5 Access Roads

For a barrage to be properly operated and maintained, there must be a safe means of access to it at all times. Access road surfaces must be maintained to allow safe passage of automobiles and any required equipment for servicing the barrage in any weather conditions. Routine observations of any cut and fill slopes along the sides of the road should be made. If unstable conditions develop assistance of experienced Engineers/Expert Panels should be obtained and remedial measures initiated. Drains are required to be provided and maintained along roads to remove surface and subsurface drainage. This will prolong the life of the road and help reduce deterioration from rutting. Road surfacing should be repaired or replaced as necessary to maintain the required traffic loadings. In most cases, specialized contractors will be required to perform this maintenance.

4.6 General Cleaning

As already suggested, for proper operation of barrage, spillway bays, under sluice bays, approach channels, inlet and outlet structures, stilling basin / energy

dissipation arrangements, power channel, trash racks, debris control devices etc., regular and thorough cleaning and removal of debris is necessary. Cleaning is especially important after large floods, which tend to send more debris into the pond/reservoir.

4.7 Materials and Establishment Requirements during Monsoon Period

Materials required during monsoon period for both immediate maintenance and preventive maintenance must be stocked in adequate quantities for emergency situations that may arise. Needful instructions in this regard are enclosed in this O&M Manual in Chapter 3.

4.8 Preparation of O&M budget

The O&M budget shall essentially include but not limited to the following items:

1 Establishment Cost of Regular Staff - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, pension benefits, etc. (as applicable).

2 Establishment Cost of temporary/ contractual Staff - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, Pension benefits, TA and DA , etc. (as applicable).

3 Establishment Cost of Daily wage Staff - Salaries and allowances, TA and DA etc. (as applicable).

4 Office Expenses– Rent for office, Telephone/ Mobile/any other Telecommunication bills, Electricity bills, water bills, Office stationery, Day to day office requirements.

5 Motor Vehicles - Running and Maintenance cost of inspection vehicles, Cost of hiring of vehicles as required

6 Maintenance of Colony - Maintenance of staff quarters, colony roads, Electricity, Sanitary and Water supply systems etc.

7 T&P - T&P requirements for offices, colony, works etc. as applicable.

8 Works -Painting, oiling, greasing, overhauling of HM equipment's, Repair/replacement of gates seals & wire ropes, electricity charges and maintenance of Electric systems of site, specific requirements for all Civil, H.M & Electrical maintenance works, vegetation removal and maintenance of access roads & basic facilities, provision for flood contingency works during monsoon, unforeseen events/items (about 10% of the cost of works) etc.

4.9 General List of Maintenance Records

Maintenance records are of utmost importance. Records are kept of all maintenance activities, both immediate and preventive maintenance works. Essential information to be recorded include the following:

- Date and time of maintenance.
- Weather conditions.
- Type of maintenance.
- Name of person.
- Title and / or contractor performing maintenance.
- Description of work performed.
- Length of time it took to complete the work with dates.
- Equipment and materials used, and before and after dated photographs.

The data is recorded by the person responsible for maintenance.

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5 Chapter 5: Instrumentation and control

Instrumentation, proper monitoring and evaluation are extremely valuable in determining the performance of a barrage. A barrage‘s instrumentation furnishes data for deciding if the structure is functioning as intended and provides continuous monitoring to warn of any unsafe developments. Monitoring physical phenomena that can lead to a barrage failure may draw information from a wide spectrum of instruments and procedures ranging from simple to complex.

List of equipment installed at Asan Barrage for Supervisory Control and Data Acquisition system and other monitoring.

S. No.	Equipment	Quantity	Frequency of measurement
1.	Radar Type Level Measuring Instrument	02	Continuous
2.	Laser type Position Monitoring transmitter	10	Continuous
3.	Data logger	1	Continuous
4.	CCTV Cameras PTZ	3	Continuous
5.	CCTV Cameras dome type	10	Continuous
6.	Rain gauge	1	Manual monitoring
7.	Display panel for barrage data at Kulhal Power House	1	5 sec

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6 Chapter 6: Previous rehabilitation efforts

Before DRIP, maintenance activities were limited to routine greasing, oiling, and patch painting of hydro-mechanical devices; routine repair of electrical systems; routine mowing, vegetation removal, repair of eroded section, etc. Apart from these routine maintenance activities, no major rehabilitation was carried before the involvement of DRIP.

Under DRIP, major Rehabilitation Works have been carried out at Asan Barrage at a total cost of about INR 32.41 Crores (with some activities still ongoing during the preparation of this O&M manual).

The rehabilitation works under DRIP include:

SL NO	DESCRIPTION OF WORK
	Component 1
	Civil works
1	Repair of Service Road around barrage.
2	Protection works at Upstream and Downstream of barrage
3	Special Repair of Damaged Power Channel Stage IV (from Asan Barrage to Intake of Kulhal Power House) and Kulhal Power House Complex during Closure
4	Civil works and repair of eroded surface of piers and floor of barrage during closure
5	De-Silting of Asan reservoir, tail race channel and D/S of Asan Barrage, Construction of temporary diversion bunds at different locations in U/S of barrage.
6	Providing and laying concrete canvas (Geo synthetic composite mat) for repair of Power channel of stage -III Dakpathar to Dhalipur HEP & Stage IV Asan Barrage to Kulhal HEP.
7	Special repair of silt ejector channel, slope and Floor at Yamuna Hydel Scheme - IV
8	Special repair of Kulhal Power House Intake bye-pass channel and downstream channel during proposed closure
9	Special maintenance and repair work of Power Channel from Dhalipur Power House TRC.
	E&M Works
10	Repair and Overhauling of Hydro Mechanical System of Barrage gates (14 Nos.) and Head Regulator gates (5 Nos.) of Barrage
11	Painting of Barrage gates , Head Regulator gates and Silt ejector gates of barrage
12	Complete Automation including engineering, design, supply, erection, testing & commissioning of Barrage control and monitoring system for water distribution and barrage management of barrage along with AMC for 5 years
13	Design, manufacturing, supply, installation, testing & commissioning of one no. hydraulically operated movable Trash Rack Cleaning Machine (TRCM) along with new trash rack panels including dismantling of existing TRCM & trash rack panels
14	Publishing of Operation & Maintenance Manual
15	Preparation of Emergency Action Plan (EAP)

	Component 2
1	Procurement of IT Equipment.
2	Procurement of Furniture for office /Training center at Dakpathar
3	Construction of office and residential building
	Component 3
1	Consultancy and Supervision for Closure Work Such as Repair of Damaged Panels of Power Channel From Dakpathar to Kulhal,

Rehabilitation and Improvement works carried by UJVNL with its own resources

1	SITC of EPABX system.
2	SITC of CCTV surveillance system.
3	SITC of sewage treatment plant.
4	P&F of Firefighting equipment.
5	Strengthening of Hoist pathway platform.
6	Refurbishment of LT system of Asan Barrage including illumination

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7 Chapter 7: Updating the Manual

Updating information in the O&M Manual should be done whenever any major changes are made either in the Barrage or in the u/s and d/s areas like construction of an additional spillway for the barrage, construction of dam/barrage on the upstream etc. Aspects to be considered when updating include:

1 Increase/decrease in the frequency of an inspection or the maintenance routine based on additional data/ experience acquired.

2 Changes in the operation and/or maintenance procedures based on additional data/experience acquired.

3 Alterations to the project data because of changes/modifications in the barrage by way of additional spillway etc.

All up-dates/revisions of the O&M Manual need to be sent to all the locations/addresses to whom the copies of the original O&M Manual had been sent earlier. The O&M Manual is to be updated after every 10 years by the E.E.(E&M), Asan Barrage and EE(PCM) Dhalipur, which shall be reviewed by DGM, HGC Dhakrani and DGM, PCM Dhalipur. Overall review of the updated O&M manual shall be done by General Manager (Yamuna Valley), Dakpathar and General Manager (Civil Maintenance), Dehradun.

Updated and reviewed O & M Manual will be approved by the Director (Operations), UJVNL after getting the needful checking done.

7.1 Training and Exercises

Training: The training of the personnel, involved in implementation of the O & M Manual will be conducted by the Dy. General Manager, HGC Dhakrani once in a year so as to make the implementing staff familiar with the elements of the O&M plan, their responsibilities and duties, the available equipment, detection of problems and remedial measures.

A sufficient number of people will be trained to ensure adequate coverage at all the time.

Exercises (Testing): The Dy. General Manager, HGC Dhakrani shall organize following exercises.

1. Orientation
2. Mock drills

Orientation: The Dy. General Manager, HGC Dhakrani and Dy. General Manager PCM Dhalipur will regularly carry out orientation meetings with personnel involved in implementation of the O&M Manual

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Appendix I

Appendix-I: Scheduled Dam Safety Inspection Form (To be suitably modified for the barrage)

Part 1a - Inspection Details:

Dam Name:	**Asan Barrage, Dhalipur, Dehradun**	**Project ID Code (PIC):**	**GENUAWA001**
Dam Type:	**Barrage**	**Dam Purpose:**	**Hydro-electric power generation**
Dam Owner:	**UJVN Limited**	**Hazard Classification:**	
Dam Operator:	**UJVN Limited**	**Type of Inspection:**	
Commissioning Date:	**June 1967 (1967-68) Full impoundment/ completion**	**Inspection by:**	
City/State/PIN:	**248142**	**Date of Inspection:**	
District:	**Dehradun**	**Reservoir water level in metre on the date of inspection:**	
Latitude:	**30°26'03" N**	**Storage Capacity (MCM):**	
Longitude:	**77°39'56" E**	**Weather Conditions:**	**Normal**
Important Controlling Level	**a) TBL RL ……. b) MWL RL …… c) FRL RL …….. d) Spillway Crest RL …… e) MDDL RL …… f) Lowest River bed RL …….. g) Deepest foundation level RL ……**		

Part 1b - Inspection Remarks:
Please provide any additional information or comments not covered by Part 1a form above.

Part 2a - Inspection Checklist:

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
A-Reservoir						
A-1.1	**General Condition**					
1.1.1	Is the reservoir water level unusually high or low?					
1.1.2	Are there signs of decline in water quality?					
1.1.3	Are there signs of recent sediment deposition?					
1.1.4	Is floating debris present?					
1.1.5	Any indication of major active or inactive landslide area in the reservoir rim If so, indicate their locations and extent.					
1.1.6	Are there people or livestock in and around reservoir?					
1.1.7	Any other issue?					
B-Dam and Dam Reach (Embankment)						
B-1.1	**General Condition**					
1.1.1	Any major alteration or change to the dam since the last inspection?					
1.1.2	Is there any new nearby development in the downstream floodplain?					
1.1.3	Any misalignment of poles, fencing or walls due to dam movement?					
B-1.2	**Upstream Slope**					
1.2.1	Any sign of bulging or concavity (depressions)? If so, indicate their locations and extent. (Check up the cross-sections with tape and level at random locations, at least two)					
1.2.2	Does the section of the dam and upstream slope appear structurally sound and stable?					
1.2.3	Presence of longitudinal or transverse cracks					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.2.4	Whether any signs of distress to stability of slopes noticed at any time in any part of the dam? If so, give brief details of the incidents and location, the method of treatment adopted and its effectiveness. Indicate the general condition of upstream pitching.					
1.2.5	Any degradation to slope protection (rip-rap)?				Left side Upstream side	
1.2.6	Is there any profuse growth of bushes or weeds over any portion of the dam? If so, indicate the locations.				Slope Pitching	
1.2.7	Does the upstream slope shows existence of crab holes or holes made by rodents or burrowing animals or ant hills? If so, indicate the locations.					
1.2.8	Any other issue?					
B-1.3	**Crest of Dam**					
1.3.1	Is the crest profile at proper elevation? (To be test checked at random locations by taking level)					
1.3.2	Does it show any sign of excessive and/or uneven settlement? If so, indicate such locations and extent of settlement. (Surface settlement points must be installed for observing this aspect)					
1.3.3	Is the surface of the crest free from undulations and local depressions or heaving?					
1.3.4	Does it provide an all-weather road surface?					
1.3.5	Any degradation to access road (sealed/unsealed)?		N			
1.3.6	Does it develop any visible cracks in transverse or longitudinal directions? If so, attach a map showing their locations and extent. Depth of cracks must be ascertained by taking open		N			

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	trenches extending below the bottom of cracks.					
1.3.7	What is the condition of the edges of crest? Have got eroded and cut up resulting in reduced effective width?					
1.3.8	Is the crest free from local slips throughout its length on either sides?					
1.3.9	Do the headers, guard stones and parapet wall provided at the edges of the crest appear in proper profile and plumb?					
1.3.10	Any degradation to upstream parapet or downstream curb wall?					
1.3.11	Evidence of livestock on dam crest?					
1.3.12	Trees or profuse growth of weeds/bushes at any location?					
1.3.13	Proper lighting arrangement at dam top?					
1.3.14	Any other issue?					
B-1.4	**Downstream Slope**					
1.4.1	Any sign of bulging or concavity (depressions)?					
1.4.2	Are there any wet or slushy patches or any concentrated leaks, springs or trickles observed on the downstream slopes or the toe? If so, indicate their locations and extent. Please look out for patches of extensive vegetation growth and examine them carefully and record the findings.					
1.4.3	Presence of longitudinal or transverse cracks					
1.4.4	Any sign of distress to the stability of slopes?					
1.4.5	Are rain cuts/erosion channels present at any location?					
1.4.6	Are all the rain cuts and erosion channels properly treated and made					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	good? Please indicate location of recurring damages, if any.					
1.4.7	Is there any profuse growth of bushes or weeds over any portion of the dam? If so, indicate the locations.					
1.4.8	Does the downstream slope shows existence of crab holes or holes made by rodents or burrowing animals or ant hills? If so, indicate the locations.					
1.4.9	Any other degradation to slope protection (turfing)? Indicate the general condition of downstream pitching/ turfing and rock toe.					
1.4.10	Is the downstream area clear of debris and free draining?					
1.4.11	Any other issue?					
B-1.5	**Downstream Drainage**					
1.5.1	Are there any sign of water logging, slushy conditions or growth of aquatic weeds on the downstream of the dam? To be checked upto 300 m downstream of toe					
1.5.2	Are there any standing pools of water in the downstream of dam? If so, give their locations and extent. To be checked upto 300 m downstream of toe					
1.5.3	Are there any boils observed in the vicinity of the downstream toe of the dam? If so, give locations.					
1.5.4	Is the downstream area sufficiently clear and free draining?					
1.5.5	What is the depth of ground water table on the downstream as evident from the existing wells in the vicinity of the dam To be checked upto 300 m downstream of toe. Does the water table show any marked variation in				a) Max. ground water level…… b) Location …… c) Date…… …	

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	accordance with the variations in reservoir water level?				d) Correspondin g Reservoir level…	
1.5.6	Are all the exposed drains working satisfactorily?					
1.5.7	Toe drains and cross drains. i. Are the portions of longitudinal toe drain and exposed cross drains beyond the downstream toe of the dam in regular section and freely draining? ii. Is the pitching to these drains intact? iii. Is there any weed growth in these drains? iv. Indicate other defects noticed in the drains, if any.					
1.5.8	Outfall Drain: (a) Is the outfall drain in proper shape and grade and freely draining? (b) Is the outfall drain properly cleaned and maintained? Does the outfall drain show any stagnant pools of water or weed growth?					
B-1.6	**Surface Drainage of Downstream Slope**					
1.6.1	Is the condition of the downstream slope drainage arrangements, if provided, satisfactory?					
1.6.2	Is the paving to these drains intact?					
1.6.3	Are all the drains properly maintained and free of vegetation growth and debris?					
1.6.4	Does the slope have a tendency to develop severe rain cuts at any location?					
1.6.5	Enumerate any other defects noticed in the surface drainage of downstream slope.					
B-1.7	**Seepage Measurement**					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.7.1	Is the quantity of seepage being daily or periodically measured and recorded? Please check the registers and record observations.					
1.7.2	Does it show any abnormal rise or fall? If so, does it have any relation to a certain reservoir level elevation?					
1.7.3	Does the seepage show a turbid colour at any stage? Was such a phenomenon observed at any stage at any location in the past?					
1.7.4	What is the measured rate of seepage flow with date and reservoir level; i. On the day of present inspection ii. Maximum since last June iii. Minimum since last June				a) Date b) Rate of seepage flow (LPM) c) Reservoir level (m)	
1.7.5	Is the portion upstream and downstream of measuring points of seepage easily accessible with proper steps and paths and free of vegetation growth?					
1.7.6	Are the measuring points properly located, constructed and maintained so as to give accurate and reliable measurements of seepage in accordance with the relevant IS Codes?					
1.7.7	Is the method of taking seepage measurements satisfactory?					
B-1.8	**Breaching Section (if provided)**					
1.8.1	Is the breaching section easily accessible?					
1.8.2	Is the condition of the breaching section satisfactory?					
1.8.3	Is the note of instructions as to when and how to operate the breaching section available on record?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.8.4	For reconstruction after the breach are the following items decided in advance? a) Quarry for embankment material b) Suitable routes of access Is the maintenance staff fully aware of the instructions related to operation of the beaching section and for reconstruction after the breach					
1.8.5	Ascertain and indicate the latest event of operation of breaching section and its performance.					
1.8.6	Evidence of recent degradation?					
1.8.7	Any other issues?					
B-1.9	**Junction of Earth work with Masonry/Concrete dam sections and outlets**					
1.9.1	Is there any existence of leaks, springs or wet spots in the earth work in the vicinity of the junctions between earth work and masonry works? If so, what is the approximate rate and colour of the leakage? Does it turn turbid at any time? Please ascertain from enquiries and record the findings.					
1.9.2	Is there any tendency for separations, cracking, settlement or upheaval of the earth work in the vicinity of masonry or concrete? If so, indicate the locations and the exact nature of deficiency.					
1.9.3	Is there any tendency for surface erosion or slope instability at the junction?					
1.9.4	If the outlet conduit is located in the earth dam section, is the entire length of the conduit in perfect order and profile and free from offsets, open joints, cracks and leakage? Examine the conduit carefully from the downstream or from inside, if possible,					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	and indicate the deficiencies observed, if any.					
1.9.5	Any other issue?					
B-1.10	**Relief Wells**					
1.10.1	Are the relief wells in good working condition and functioning well?					
1.10.2	Are the relief properly surged and cleaned periodically?					
1.10.3	Please indicate the dates of last surging and cleaning and the next surging due.					
1.10.4	Are the necessary plant and equipment for cleaning the relief wells, available with the office?					
1.10.5	Is the record of periodical measurements of discharge from each relief well maintained? If so, indicate total discharge and maximum discharge observed from a single well on the date of inspection.					
B-1.11	**Abutment Contacts**					
1.11.1	Any presence of leaks, springs or wet spots near the abutment?					
1.11.2	Any presence of cracking, settlement or upheaval of earthwork?					
1.11.3	Any evidence of erosion or slope instability?					
1.11.4	Trees or profuse growth of weeds/bushes?					
1.11.5	Any degradation to up/downstream slope protection (rip-rap, turfing)?					
1.11.6	Any other issue?					
C-1	**Dam and Dam Block/Reach (Concrete/Masonry)**					
C-1.1	**General Condition**					
1.1.1	Any major alterations or changes to the dam since the last inspection?		N			
1.1.2	Is there any new nearby development in the downstream floodplain?					
1.1.3	Any misalignment of poles, fencing or walls due to dam movement?		N			
C-1.2	**Upstream Face**					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.2.1	Evidence of surface defects (honeycombing, staining, stratification)?		N			
1.2.2	Concrete/masonry deterioration (spilling, leaching, disintegration)?					
1.2.3	Is cracking present (structural, thermal, along joints)?					
1.2.4	Evidence of differential settlement (displaced/offset/open joints)					
1.2.5	Presence of vegetation (growth in joints between blocks)					
1.2.6	Evidence of any other damage to joints and/or water stops					
1.2.7	Any other issue?					
C-1.3	**Crest of Dam**					
1.3.1	Evidence of differential settlement (displaced/offset/open joints)					
1.3.2	Presence of cracking (structural, thermal, along joints)					
1.3.3	Profuse growth of weeds/grass/plants at any location					
1.3.4	Any degradation to access road?					
1.3.5	Any degradation to upstream parapet or downstream curb wall?					
1.3.6	Any other issue?					
C-1.4	**Downstream Face**					
1.4.1	Evidence of surface defects (honey-combing, staining, stratification)					
1.4.2	Concrete/masonry deterioration (spalling, leaching, disintegration)					
1.4.3	Presence of cracking (structural, thermal, along joints)					
1.4.4	Evidence of differential settlement (displaced/offset/open joints)					
1.4.5	Presence of vegetation (growth in joints between blocks)					
1.4.6	Evidence of any other damage to joints and/or water stops					
1.4.7	Excessive seepage/sweating at any location on downstream face					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.4.8	Significant leakage at any location on downstream face					
1.4.9	Any other issue?					
C-1.5	**Abutment Contacts**					
1.5.1	Any presence of leaks, springs or wet spots in vicinity of abutment					
1.5.2	Any presence of cracking or settlement					
1.5.3	Profuse growth of weeds/grass/plants at any location					
1.5.4	Any other issue?					
D	**Gallery/Shaft and Drainage (Concrete/Masonry)**					
D-1.1	**General Condition**					
1.1.1	Slushy condition or water logging immediately downstream of dam					
1.1.2	Any evidence of boiling in vicinity of dam toe?					
D-1.2	**Gallery/Shaft Condition**					
1.2.1	Any problem accessing or inspecting gallery/shaft (obstruction)?					
1.2.2	Any safety issue (inadequate handrails, lighting or ventilation)?					
1.2.3	Problems of inadequate drainage (slippery stairs, water logging of gallery, clogged porous or foundation drains)					
1.2.4	Evidence of differential settlement (displaced/offset/open joints)					
1.2.5	Excessive seepage/sweating at any location along gallery/shaft					
1.2.6	Significant or excessive leakage at any location along gallery/shaft / porous drain? If yes, provide location(s).					
1.2.7	Are proper arrangements made for the measurement of seepage into the gallery? Is the seepage measured separately from- 1. Porous pipes 2. Foundation drains 3. Monolith Joints					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
	Are the above arrangements satisfactory?					
1.2.8	Has there been substantial progressive reduction in the seepage through the foundations? Is it due to choking of the drain holes? If so, indicate number of holes choked.					
1.2.9	Are all the foundation and porous holes periodically cleaned with reaming tool and air water jetting? Indicate the last date of such cleaning and extent of variation observed in the seepage discharge before and after the cleaning.					
1.2.10	Is the seepage water and the deposit, if any, from the seepage being regularly examined for chemical composition? If so, indicate the result and the probable source of dissolved salts, if any.					
1.2.11	Are any seepage water springs observed in the downstream area any where? If so, indicate the locations and state the physical nature of this seepage. Look out for such seepage spots particularly near the dykes, fault zone etc. Ascertain if chemical testings are made of water samples from such springs for dissolved salts.					
1.2.12	Is there any leachate deposition? If yes provide location					
1.2.13	Any other issues?					
D-1.3	**Drain Condition**					
1.3.1	Is the flow in the drain unusually high or low?	NA				
1.3.2	Presence of calcium or other deposits in drain?					
1.3.3	Is dewatering pumping station fully operational?					
1.3.4	Any problem inspecting pump?					
1.3.5	Any obstruction preventing or impairing smooth operation?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.3.6	Any deterioration of pump and associated equipment?					
1.3.7	Is sump well clean and maintained?					
1.3.8	Is V-notch before sump well clean and maintained?					
1.3.9	Any other evidence of the drain being blocked/having reduced section?					
1.3.10	Is the flow in the drain noticeably sporadic/irregular?					
1.3.11	Does the drainage water have unusual color (leachate)?					
1.3.12	Any other issue?					
D-1.4	**Body Wall (Masonry/Concrete) of 'NOF' Dam and Spillway**					
1.4.1	What is the total seepage into gallery from the porous pipes in the dam at lake full condition? How does it compare with the seepage when the reservoir was first filled? (For the corresponding water level)					
1.4.2	If there has been substantial reduction in this seepage? Ascertain and indicate the probable reasons therefore.					
1.4.3	Has there been a tendency for gradual reduction of drainage through pipes and progressive appearance of sweating on the downstream face of the dam?					
1.4.4	Has there been considerable leaching from the seepage water and deposition of lime near the seepage exit spots?					
1.4.5	Are the samples of the seepage water and reservoir water being regularly tested for reactive and corrosive properties?					
1.4.6	Is there excessive seepage, sweating at any locations on the downstream face of the dam? (Examine the monolith or construction joints for such seepage and leaching and indicate the findings)					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.4.7	Is there any swelling or cracking observed on the downstream face especially near the points of concentration of stresses like the toe or locations of abrupt change in geometry of the face of the opening? If so, indicate the details of observations.					
1.4.8	Is the pointing on upstream face of the dam in good condition? If not, indicate the nature and extent of deficiency.					
1.4.9	Are the registers and graphs showing the periodical measurements of seepage discharge from the porous drains in the gallery and from the downstream face at various lake levels maintained at site?					
D 1.5	**Waste Weir Bar and Tail Channel**					
1.5.1	Is the Concrete/masonry spillway bar in good condition? Is there any leakage through the masonry or from the foundation? If so, what remedial measures are proposed/taken for minimizing the leakage? Is the record of leakage measurement maintained? What is the quantity of Seepage/Leakage on the date of inspection?	NA				
1.5.2	Is the coping over the spillway bar in good condition?					
1.5.3	Does the upstream and downstream face of waste weir bar need pointing?					
1.5.4	Is there any scouring on downstream side of the bar and/or EDA? If so what remedial measures are proposed/taken?					
1.5.5	Are there any damages or undermining to guide walls, divide wall and other appurtenant? If so, what remedial measures are proposed/taken?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
D 1.6	**Structural performance of the 'NOF' and 'OF' Portions of Dam Foundations**					
1.6.1	Are there any signs of structural distress noticed in the dam spillway and foundations in the form of- i. Excessive deflection with respect to permissible deflection at the time of design ii. Tendency of gradual sliding iii. Cracking and upheaval or settlement in any part of the body wall or foundations, iv. Excessive uplift, v. Excessive seepage and leaching through the body of the dam and the foundation.	NA				
1.6.2	Conspicuous weathering of materials or components in any portion of the body wall or the foundations.					
E	**Spillway and Energy Dissipation Structure**					
E 1.1	**Spillway**					
1.1.1	Any problem inspecting spillway (obstructed access, damaged catwalk)?					
1.1.2	Any obstruction in or immediately downstream of the spillway?					
1.1.3	Evidence of abrasion, cavitation or scour on glacis (e.g. exposed reinforcement)					
1.1.4	Presence of displaced, offset or open joints					
1.1.5	Presence of cracking (structural, thermal, along joints)					
1.1.6	Evidence of surface defects (honeycombing, staining, stratification)					
1.1.7	Concrete/masonry deterioration (spalling, leaching, disintegration)					
1.1.8	Presence of vegetation (growth in joints between blocks)					
1.1.9	Evidence of any other damage to joints and/or waterstops					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.1.10	Excessive seepage/sweating at any location on spillway glacis					
1.1.11	Significant leakage at any location on spillway glacis					
1.1.12	Any other issue?					
E-1.2	**Energy Dissipation Structure**					
1.2.1	Any problem inspecting energy dissipation structure?					
1.2.2	Any obstruction in or immediately downstream of dissipation structure?					
1.2.3	Evidence of abrasion, cavitation or scour on dissipation structure					
1.2.4	Presence of displaced, offset or open joints					
1.2.5	Presence of cracking (structural, thermal, along joints)					
1.2.6	Evidence of surface defects (honeycombing, staining, stratification)					
1.2.7	Concrete/masonry deterioration (spilling, leaching, disintegration)					
1.2.8	Presence of vegetation (growth in joints between blocks)					
1.2.9	Evidence of any other damage to joints					
1.2.10	Any problem with under-drainage (blockage of open drain holes)					
1.2.11	Can the tail pond be drained easily for inspection of the stilling basin or bucket? If not, what are the alternatives available for dewatering? Please ascertain and indicate the last event of inspection of stilling basin (or bucket).					
1.2.12	From the examination of the levels and contour plans and reference marks in tail channel; ascertain if there is progressive erosion and retrogression in the tail channel. If so, indicate the extent and location of such erosion with reference to the various					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
	components of dam, spillway, outlet, power house etc.					
1.2.13	Is the concrete surface of the stilling basin and apron (or bucket) in good condition? Are there any indications of pitting, cracking, spilling or wearing of the surface of bedding concrete? If so, please give details of the nature and extent of the damage.					
1.2.13	Is there any indication of abrasion and cavitation damage (pitting of concrete) especially at friction blocks , chute blocks and slotted roller teeth, the surface near the lower tangent point and the end sill? If so, please give the details of nature and extent of damage.					
1.2.14	Is the under drainage of the stilling basin (or bucket) satisfactory? Are all the open drain holes clear and functioning well?					
1.2.15	Any other issues?					
F	**Intake/Outlet and Water Conveyance Structure**					
F-1.1	**Intake/Outlet Structure**					
1.1.1	Any problem inspecting intake/outlet structure (obstructed / unsafe access)?					
1.1.2	Any obstruction in, upstream or downstream of intake/outlet structure?					
1.1.3	Evidence of abrasion, cavitation or scour on intake/outlet structure					
1.1.4	Any evidence of structural distress (displaced/offset/open joints, cracking)?					
1.1.5	Any evidence of surface defect and/or concrete/masonry deterioration?					
1.1.6	Any other issue?					
F-1.2	**Water Conveyance Structure**					
1.2.1	Any problem inspecting intake/outlet structure (obstructed/ unsafe access)?					
1.2.2	Any obstruction in, upstream or downstream of water conveyance structure?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.2.3	Evidence of abrasion, cavitation or scour on structure					
1.2.4	Any evidence of structural distress (displaced/offset/open joints, cracking)?					
1.2.5	Any evidence of surface defect and/or material deterioration?					
1.2.6	Any evidence of seepage or leakage from water conveyance structure?					
1.2.7	Any other issue?					
G-1	**Hydro-Mechanical Component and Pump**					
G-1.1	**Spillway Gates (Radial gates, Vertical lift gates, Automatic gates)**					
1.1.1	Any problem inspecting gate/Stop-logs (obstructed/unsafe access)?					
1.1.2	Is the condition of the steel surface and the surface paint deteriorated?					
1.1.3	Are any connection bolts of rubber seals loosened or damaged? If so, indicate the details of defects.					
1.1.4	What is the general condition of rubber seals? Do any of the rubber seals show signs of weathering, hardening, cracking or tearing and damage?					
1.1.5	Are the rubber seals of side and bottom touching uniformly all along the sealing surface?					
1.1.6	Do the rollers (wherever applicable) touch the track plates uniformly? Are the rollers well lubricated?					
1.1.7	Are the embeded parts of spillway gates, emergency gates and stop-logs in sound condition and free from corrosion, uneven wear, cracking, chipping and dents? If not, state the nature of defects or deficiencies and observation, if any, regarding such defects.					
1.1.8	Check the following for structural soundness of all members and welded, bolted and riveted connections, uneven					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
	wear, uneven bearing, cracking, chipping and dents and indicate the findings: (1) Gate leaf and stiffeners (2) End arms (3) Trunnion girders / Yoke girder (4) Tracks (5) Trunnion bracket (6) Chains/ wire ropes (7) Bridge structure					
1.1.9	Are the trunnion bearings of radial gates properly lubricated?					
1.1.10	Is there any damage or wear caused to the seal plates? If so, indicate the nature of damage noticed.					
1.1.11	Are any of the mechanical or structural components and fasteners or seals subjected to excessive wear? If so, please give details. Is there any tendency for recurring damage to any particular component? If so, please give details.					
1.1.12	Is sufficient stock of spares which need frequent replacement maintained at the site?					
1.1.13	Any issue with storage of equipment					
1.1.14	Any deterioration, corrosion, scaling, pitting or cracking of equipment (connecting bolts, welds)					
1.1.15	Any obstruction preventing or impairing smooth operation?					
1.1.16	Any problem with the rollers (not touching tracks, inadequate lubrification)?					
1.1.17	Any debris etc. in the gate grooves?					
1.1.18	Any damage to Gate trunnion pins, gate arms, lubrication etc.?					
1.1.19	Any damage to embedded parts above waterline, access structure?					
1.1.20	Any damage to concrete grooves?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.1.21	Is the staff posted at the site for maintenance and operation of gates, hoists, equipment and electrical installations, well experienced, fully trained and conversant with the job requirements and responsibilities?					
1.1.22	Are the following documents maintained at the respective location of all the units? (1) Maintenance schedules specifying each operation, its frequency and 'due' and' done' dates. (2) Operating instructions with 'dos' and 'don't' for all operational units.					
1.1.23	Are the trunnion hub and the brackets well maintained?					
1.1.24	Are the trunnions likely to get submerged during actual working of the spillway? if so, ascertain the causes for the same and specify. Please enquire for occurrence of such events, if any.					
1.1.25	Are all the nuts of connecting bolts and anchorages properly tightened?					
1..1.26	Any other issue?					
G-1.2	**Hoists, Cranes and Operating Mechanisms**					
1.2.1	Are the hoists working satisfactorily?					
1.2.2	Any problem inspecting hoist/crane/operating mechanism?					
1.2.3	Is sufficient stock of spares which need frequent replacement maintained at the site?					
1.2.4	Is the full length of the chains or wire rope of the hoist in sound condition and free from broken strands?					
1.2.5	Is the electrical wiring in sound condition?					
1.2.6	Is the alternative power system for gate operation working properly?					
1.2.7	Is the alternate hand operation system of hoist working					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.2.8	Any deterioration of equipment (connecting bolts, welds, surface, paint work?)					
1.2.9	Any wear or damage to wire cables and other moving parts?					
1.2.10	Any obstruction preventing or impairing smooth operation?					
1.2.11	Any health and safety concerns (e.g. lack of "danger" sign during maintenance)?					
1.2.12	Any other issue?					
G 1.3.	**Spillway Bridge, Hoist Bridge, Trunnion Level Bridge Catwalks**					
1.3.1	Are the decking, girders and structural supports of spillway bridge, hoist bridge, trunnion level bridge and catwalks structurally sound?					
1.3.2	Is the chequered platform of the bridge structurally sound and safe?					
1.3.3	Is there satisfactory arrangement to prevent unauthorized entry into the control structures and bridges?					
1.3.4	Are the structural members and joints sound and free from corrosion?					
1.3.5	When were the steel components painted last?					
1.3.6	Is the surface of steel work and paints satisfactory?					
1.3.7	Is the parapet or railing over the bridges sound, safe and painted?					
1.3.8	Is the walkway properly anchored to the piers?					
1.3.9	Are the track rails for gantry cranes structurally sound and intact?					
G-1.4	**Valves**					
1.4.1	Any problem inspecting valve?					
1.4.2	Any obstruction preventing or impairing smooth operation?					
1.4.3	Any deterioration of valve and associated equipment?					
1.4.4	Any other issue?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
G-1.5	**Walls: Guide walls/Divide walls/Junction walls/Return walls/Spray walls etc. (Strike out whichever is not applicable)**					
1.5.1	Are all the locations of such wall accessible for inspection, maintenance and repairs?					
1.5.2	Is the drainage of back sides of the walls (wherever applicable) from the weep holes satisfactory? If not, indicate the nature of deficiencies.					
1.5.3	Is there any tendency for the water to undercut the ends of the walls?					
1.5.4	Is there any foundation erosion or scour noticed in the vicinity of such walls? If so, give the details of nature and extent of such damage.					
1.5.5	Is there any surface erosion/damage caused, to face or body of such walls?					
1.5.6	Do any of the walls show symptoms of unusual settlement, developments of cracks and tilting? If so, give details of the defects noticed.					
1.5.7	Is there any damage to guide bunds? If so, give details of the damage.					
G-1.6	**End Weir**					
1.6.1	Is it accessible?					
1.6.2	Is there any erosion, pitting or spalling of the concrete or masonry surface? If so, give details					
1.6.3	Is there any scour noticed on the immediate downstream of such weir? If so, give details of location and extent of such damage.					
G-1.7	**Hydraulic Performance of Energy Dissipation Arrangements**					
1.7.1	Do the flow conditions in the stilling basin (or bucket) have a tendency to draw material into the bucket and cause its churning and abrasion damage to the surface of buckets baffle blocks, apron and end sill?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	Is the hydraulic performance in agreement with the results of model studies? (wherever applicable) Ascertain the performance from observed tail water rating curves and deficient observation, if any, such as sweep outs and excessive erosion under plunge pools and locations of secondary rollers and retrogression.					
G-1.8	**Trash Racks**					
1.8.1	Is the trash rack fixed or movable?					
1.8.2	What is the mode of cleaning? Is it manual or by TRCM?					
1.8.3	Is the welding work on Trash Rack in sound health?					
1.8.4	Any problem inspecting trash rack?					
1.8.5	Problems of excessive debris and/or inadequate cleaning?					
1.8.6	Any deterioration of trash rack (rust, corrosion, and damaged blades)?					
1.8.7	Any other issue?					
G-1.9	**Trash Rack Cleaning Machines**					
1.9.1	Any problem inspecting trash rack cleaning machine?					
1.9.2	Missing or inadequate spare parts (particularly requiring regular replacement)?					
1.9.3	Any deterioration of equipment (wheel trolleys, gantry structures, operating mechanism, connecting bolts, welds, surface, paint work?)					
1.9.4	Any wear or damage to wire cables and other moving parts?					
1.9.5	Any obstruction preventing or impairing smooth operation?					
1.9.6	Missing or inadequate provision of back-up/standby power supply?					
1.9.7	Any health and safety concerns (e.g. lack of "danger" sign during maintenance)?					
1.9.8	Any other issue?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
G-1.10	**Pumps**					
1.10.1	Any problem inspecting pump?					
1.10.2	Any obstruction preventing or impairing smooth operation?					
1.10.3	Any deterioration of pump and associated equipment?					
1.10.4	Any other issue?					
G-1.11	**Approach b r i d g e , operation platform and cabin (for outlets):**					
1.11.1	Are the decking, girders and structural supports of approach bridge structurally sound?					
1.11.2	Is the floor of the operating platform structurally sound and safe?					
1.11.3	Is there satisfactory arrangement to prevent unauthorized entry into the control structures of the outlet?					
1.11.4	Are the structural members and joints sound and free from corrosion?					
1.11.5	When were the steel components painted last?					
1.11.6	Is the surface of steel work and paint satisfactory?					
1.11.7	Is the parapet or railing over the control tower, operating platform and approach bridge sound and safe?					
G-1.12	**Outlet**					
1.12.1	Is the air vent periodically cleaned?					
1.12.2	Are there any structural damages to the intake well?					
1.12.3	Is there any leakage observed through the well proper and the conduit concrete or masonry? If so, give details of its location and extent.					
1.12.4	Is there any damage noticed to the conduit concrete, breast wall and gates lots?					
1.12.5	Is the bye-pass valve/filling-in-valve (wherever provided) operating satisfactory? (a) Take operation trials of the following as provided and record					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
	the observations and defects noticed, if any. (1) Service gate(s). (2) Emergency gate(s). (3) Stop-log gate(s). (4) Sluice valves. Note- (i) The operating trial for the emergency gate shall be taken with service gate in partially open position to test the capability of emergency gate for self-closing under these conditions. The trial for the operation of the emergency gate under balanced condition of water pressure also needs to be taken (ii) To guard against the possibility of outlet gate hoist being operated forcibly after closed position of gate a "Distinctive Mark" should be insisted or check the functioning of the limit switches.					
1.12.6	Are there vibrations and noise noticed in operation of out-let gates at any time? If so, are any periodical observations taken to ascertain their severity?					
1.12.7	Is the energy dissipation arrangement working satisfactorily for all the discharges? Is there any structural damage to the energy dissipation structure? If so, give details of nature and extent of damage.					
1.12.8	Is the conduit structurally sound and reasonably leak proof? If not, give details of nature and extent of the defects.					
1.12.9	Is there any seepage noticed around the conduit as ascertained from the observations of the downstream					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
	conditions? If so, is it likely to cause (In case of earth dams) erosion and piping?					
G-1.13	**Outlet Gates**					
1.13.1	Is the surface of gates and the paint deteriorated?					
1.13.2	Are the connecting bolts of rubber seals properly tightened or damaged?					
1.13.3	Do the rubber seals show signs of weathering and damage and need replacements?					
1.13.4	Are the rubber seals of side sand bottom touching the bearing surface uniformly?					
1.13.5	Do all the rollers touch the track plates?					
1.13.6	Are the rollers well lubricated?					
1.13.7	Are the stem rods for lifting the gates perfectly straight?					
1.13.8	Is the operation of outlet gates smooth? Are the actual operations of lifting and lowering of the gates and hoist mechanisms adequate and smooth?					
1.13.9	Are all the gears and hoist mechanisms well lubricated?					
1.13.10	Is the storing arrangement for emergency gate leaves and the stop logs in satisfactory condition?					
1.13.11	Are the seal plates/seats in sound condition?					
1.13.12	Is the full length of wire rope (wherever applicable) of the hoist in serviceable condition and free from any broken strands?					
1.13.13	Are all the nuts of connecting bolt and anchors properly tightened?					
1.13.14	Are all the lifting beams in proper working order and in levelled condition. If not ascertain the nature and extent of problems. Do any of the mechanical or structural parts of the					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
	gate, fasteners of hoist show signs of excessive wear? If so, please give details.					
1.13.15	Is there any tendency for recurring damage to any particular component or components? If so, please give details.					
1.13.16	Is sufficient stock of spares, which need frequent replacement, maintained at the site?					
G-1.14	**River Outlet/River Sluice**					
1.14.1	Is the overall condition of river outlet works/river sluices satisfactory? Is the operation of the gate (Service/Emergency/Stop-log) satisfactory as ascertained by taking operating trial? If not, indicate the defects noticed.					
1.14.2	Are the trash racks (wherever provided) cleaned before monsoon?					
1.14.3	Is there excessive silting on the upstream of the sluice?					
1.14.4	When were the gates last opened for desilting, etc.?					
1.14.5	Please indicate the approximate quantity of the leakage through the gates, if any.					
1.14.6	Is there any seepage or leakage through the conduit surface?					
1.14.7	Is there any damage to the upstream and downstream convergence of the conduit?					
1.14.8	Is the condition of energy dissipation arrangement satisfactory? If not, indicate nature and extent of damage. Is there any retrogression noticed in the downstream channel? If so, give details of nature and extent of damage.					
H-1	**Access Road**					
H-1.1	**General Condition**					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.1.1	Any problem ensuring security of dam site (including gates and fencing)?					
1.1.2	Is there a properly constructed and well maintained all weather access road to the dam site?					
1.1.3	What is the type of the pavement of the access road and its condition?					
1.1.4	Are there properly constructed and well maintained access road arrangements to the following components for inspection, maintenance and repairs? Top of Dam Spillway Gates and hoisting arrangement Drainage gallery, adits and exits Bridge structure Downstream stilling basin Junction and abutments Outlet control tower Outlet gates Toe of earth dam, downstream drainage arrangements and berms. All saddle dams.					
1.1.5	What is the general condition of all the masonry structures on various access roads?					
1.1.6	Are all the structures on the access roads adequately safe for allowing passage of plant machinery for emergent repairs?					
1.1.7	Any obstruction along or at entrance to access road (temporary or long-term)?					
1.1.8	Any slope stability issues (road embankment or adjacent slopes)?					
1.1.9	Profuse growth of weeds/grass on or in vicinity of access road					
1.1.10	Any drainage problem (standing water on or adjacent to road)?					
1.1.11	Any other degradation to road surface (ruts, potholes, cavities, cracking)?					
1.1.12	Any other issue?					
I-1	**Instrumentation**					
I-1.1	**General Condition**					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	N A		
1.1.1	Are all the instruments installed accessible? (Attach separate list). Are all the locations properly lighted, ventilated and adequately protected from possibilities of damage?					
1.1.2	Any problem inspecting instrument (obstructed/unsafe access)?					
1.1.3	Is the instrument vulnerable to damage or theft (inadequate protection)?					
1.1.4	Any problem ensuring correct functioning of instrument (lighting, ventilation)?					
1.1.5	Any evidence of degradation to condition of instrument (rusting, vandalism)?					
1.1.6	Are all the instruments in working order? Ascertain the cases of instruments going out of order and indicate.					
1.1.7	Are all the registers of observations posted up-to-date? Please take test observations and initial the register.					
1.1.8	Are all the plotting of the instrumentation data completed up-to-date? Are sufficient stocks of spares, gauges, master gauges, stationary items etc., maintained at the site for uninterrupted data collection?					
1.1.9	Operator or public safety issues?					
1.1.10	Any other issue?					
I-1.2	**Communication Facilities**					
1.2.1	Are following facilities available at dam site? (1) Wireless Telephone / mobile/Fax/Internet					
1.2.2	Any other issue (please indicate part, location, etc., as necessary)					
K-1	**Emergency Preparedness**					
K-1.1.	**Emergency Action Plan**					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
1.1.1	Is the Emergency Action Plan (EAP) prepared for the dam as per the national guidelines? If not, the expected date of preparation of guidelines					
1.1.2	When EAP was last updated?					
1.1.3	If not, are any dam staff unaware or insufficiently conversant with the EAP?					
1.1.4	Any concerned authorities unaware or insufficiently conversant with the EAP?					
1.1.5	Are communication directories/contact details and other dynamic information are being updated annually?					
1.1.6	Any problem accessing or operating the communication/ warning system?					
1.1.7	Are inundation maps updated and available to concerned authorities?					
1.1.8	Are the concerned authorities informed about the system of emergency reporting procedures and warning?					
1.1.9	Are available safety spots on the downstream of the dam identified and made known to the concerned authorities? Are adequate warning devices and facilities provided at the dam?					
1.1.8	Are proper arrangements made for security of the dam and preventing cases of unauthorized trespass, vandalism and sabotage to the dam works?					
1.1.9	Date of last annual stakeholder consultation meeting along with mock drill exercise conducted					
1.1.10	Does the EAP disseminated to all the concerned stakeholders?					
1.1.11	Any other issue?					

Sl. No.	Inspection Item	Response			Observations and recommendations, if any, of the authorized inspecting officer	Condition[b] (Unsatisfactory /Poor/Fair/ Satisfactory)
		Y	N	NA		
K-1.2	**Inspection of Records**					
1.2.1	Whether following Dam Safety Documents are prepared and approved by the competent authority? I. As Built Drawings II. EAP III. Completion Report IV. Data Book V. O and M Manual					
1.2.2	Are the relevant documents reviewed and updated from time to time?					
1.2.3	Are all the members of the maintenance staff adequately trained and fully conversant with their responsibilities concerning. (a) Designer's Operation Criteria. (b) Standing Operating Procedures. (c) Maintenance and Vigilance Procedures of the dam. (d) Maintenance and operation of all control equipments. (e) Reservoir Operation Schedules, Gate Operation Schedule (f) Maintenance and Operation of all instruments. (g) Identification of signs of deficient behavior. (h) Reporting Procedures of emergency situations. (i) Emergency repairs					

L-1.1	Inspection Photographs	
1.1.1	Information to be furnished as per Annexure - II	

[a]Respond either yes (Y), no (N) or not applicable (NA).
[b]Condition: Please rate the condition as either Satisfactory, Fair, Poor or Unsatisfactory as described below:

1. Satisfactory - No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static,

	hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.	
2.	Fair - No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.	
3.	Poor - A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.	
4.	Unsatisfactory - A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.	

Part 2b – Consolidated Dam Health Status Report:

SN	Observations/Significant Deficiencies Noticed	Remedial Measures Suggested
1.		
2.		
3.		
..		
..		
10.		

Overall condition of dam based on above inspection – Unsatisfactory/Poor/Fair/Satisfactory (tick appropriate)
Overall Safety Category* of the Dam -

*Category I– deficiencies which may lead to failure;
Category II – major deficiencies requiring prompt remedial measures;
Category III – minor remedial measures which are rectifiable during the year

Name of Official(s) and Signature(s):

Date:

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Appendix-II

Appendix-II: Checklist of Various Instruments Installed on Barrage

Name of Dam/ Barrage:

Location:

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/ No)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
HYDRO-METEOROLOGICAL INSTRUMENTS											
1.	Rain gauge on Dam										
2.	Rain gauge in the Catchment										
3.	Pan Evaporimeter										
4.	Wind Velocity Recorder										
5.	Wind Direction Recorder										
6.	Wave Height Recorder										
7.	Wet and dry bulb Thermometer										
8.	Barometer										
9.	Thermometers for air Temp.										
10.	Thermometers for Reservoir Water Temp.										
11.	Automatic Weather Station										
12.	Reservoir level										

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/ No)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	gate (i) Staff gate (ii) Automatic										
13.	Other Hydro-meteorological Instruments, if any (i) (ii) (iii)										
	GEO-TECHNICAL INSTRUMENTS										
1.	Piezometers (i) Stand pipe (ii) Casagrande (iii) Twin Tube (iv) Vibrating wire										
2.	Uplift pressure cell (i) For permeable foundation (ii) For Rock foundation										
3.	Strain Gauge (i) Mechanical Strain Gauge (ii) Electrical Strain Gauge										
4.	Strain Meter										

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/ No)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	(i) Vibrating wire										
5.	Thermometers (i) Resistance (ii) Vibrating Wire										
6.	Stress Meter (i) Mechanical (ii) Electrical										
7.	Seepage Measurement (i) V-Notch (ii) Other devices										
8.	Automation (i) Data logger (ii) Data Acquisition system (iii) Computers										
9.	(i) Plumb Bob – Direct (ii) Plumb Bob – Inverted (iii) Detachable Gauges for Surface Displacement (iv) Joint meter for internal joint movement										

Sl. No.	Name of Instruments	Nos.	Location	Since when installed (Month/ Year)	Whether in working condition (Yes/No)	Date last calibration / Date for next calibration	Observations maintained (Yes/No)	Agency responsible for data collection and processing	Analysis of data done at field level (Yes/No)	Data sent to DSO regularly? (Yes/ No)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	(v) Tilt Meter (vi) Foundation Settlement Deformation Meter (vii) Inclinometer										
10.	Other Geotechnical Instruments, if any (i) (ii) (iii)										
GEODETIC INSTRUMENTS											
1.	Total Station										
2.	Survey Markers										
3.	Settlement Plates										
SEISMIC INSTRUMENTS											
1.	Seismograph										
2.	Accelerograph										

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Appendix-III

Appendix-III: Summary Table for Annual O&M Budget

NO.	BUDGET ITEM	PREVIOUS YEAR YR 2019-20 COST (Rs)	CURRENT YEAR BUDGET YR 2020-21 COST (Rs)	REMARKS
A.	**ESTABLISHMENT**			
1	SALARY OF REGULAR STAFF INCLUDING ALL OTHER BENEFITS	**6932871.00**	**7094291.00**	
2	TRAVEL EXPENSES	**96312.00**	**44400.00**	
3	OFFICE EXPENSES	**265030.00**	**403939.0**	
4	MOTOR VEHICLE EXPENSES	**441825.00**	**515000.00**	
5	MAINTENANCE OF OFFICE & COLONY COMPLEX	**2502442.00**	**2828696.00**	
	SUB-TOTAL - A	**10238480.00**	**10886326.00**	
B.	**WORKS**			
1	CIVIL WORKS			
1.1	BARRAGE STRUCTURE	**1285793.00**	**408152.00**	
1.2	EARTHEN BUNDS			
1.3	BARRAGE ABUTMENTS AND PROTECTION WORKS			
1.4	INLET CHANNEL, POWER CHANNEL, HEAD REGULATER & OTHER STRUCTURES	**2386192.00**	**4765279.00**	

NO.	BUDGET ITEM	PREVIOUS YEAR YR 2019-20 COST (Rs)	CURRENT YEAR BUDGET YR 2020-21 COST (Rs)	REMARKS
1.5	APPROACH / INSPECTION ROADS			
2	HYDRO-MECHANICAL WORKS			
2.1	GATES & HOISTS IN BARRAGE , HEAD REGULATOR & OTHER STRUCTURES	**1300009.00**	**2224770.00**	
2.3	TRASH RACKS/ TRASHRACK CLEANING MACHINE ETC.	**1425027.00**	**1367488.00**	
2.4				
3	ELECTRICAL WORKS			
3.1	ELECTRICAL FITTINGS, MOTORS, CONTROLS FOR ALL GATE HOISTS	**5510.00**		
3.2	POWER SUPPLY LINES	**11398.00**		
3.3	ELECTRICAL FITTINGS ON BARRAGE & OTHER STRUCTURES.			
3.4	STANDBY POWER / DIESEL GENERATOR	**73886.00**	**120000.00**	
3.4	REMOTE CONTROL/CCTV		**885000.00**	
4	INSTRUMENTATION			
5	MISCELLANEOUS WORKS	**787815.00**	**2272940.00**	

NO.	BUDGET ITEM	PREVIOUS YEAR YR 2019-20 COST (Rs)	CURRENT YEAR BUDGET YR 2020-21 COST (Rs)	REMARKS
6	SALARY OF TEMPORARY STAFF INCLUDING ALL BENEFITS	**7867092.00**	**9890499.00**	
7	MATERIALS TO BE STORED BEFORE MONSOON			
	SUB-TOTAL - B	**15142722.00**	**21934128.00**	
8	CONTINGENCY (10%) ON SUB-TOTAL OF A & B	**2538120.20**	**3282045.40**	
9	TOOLS & PLANTS			
	SUB-TOTAL- C			
10	TOTAL ANNUAL COST	**27919322.20**	**36102499.40**	

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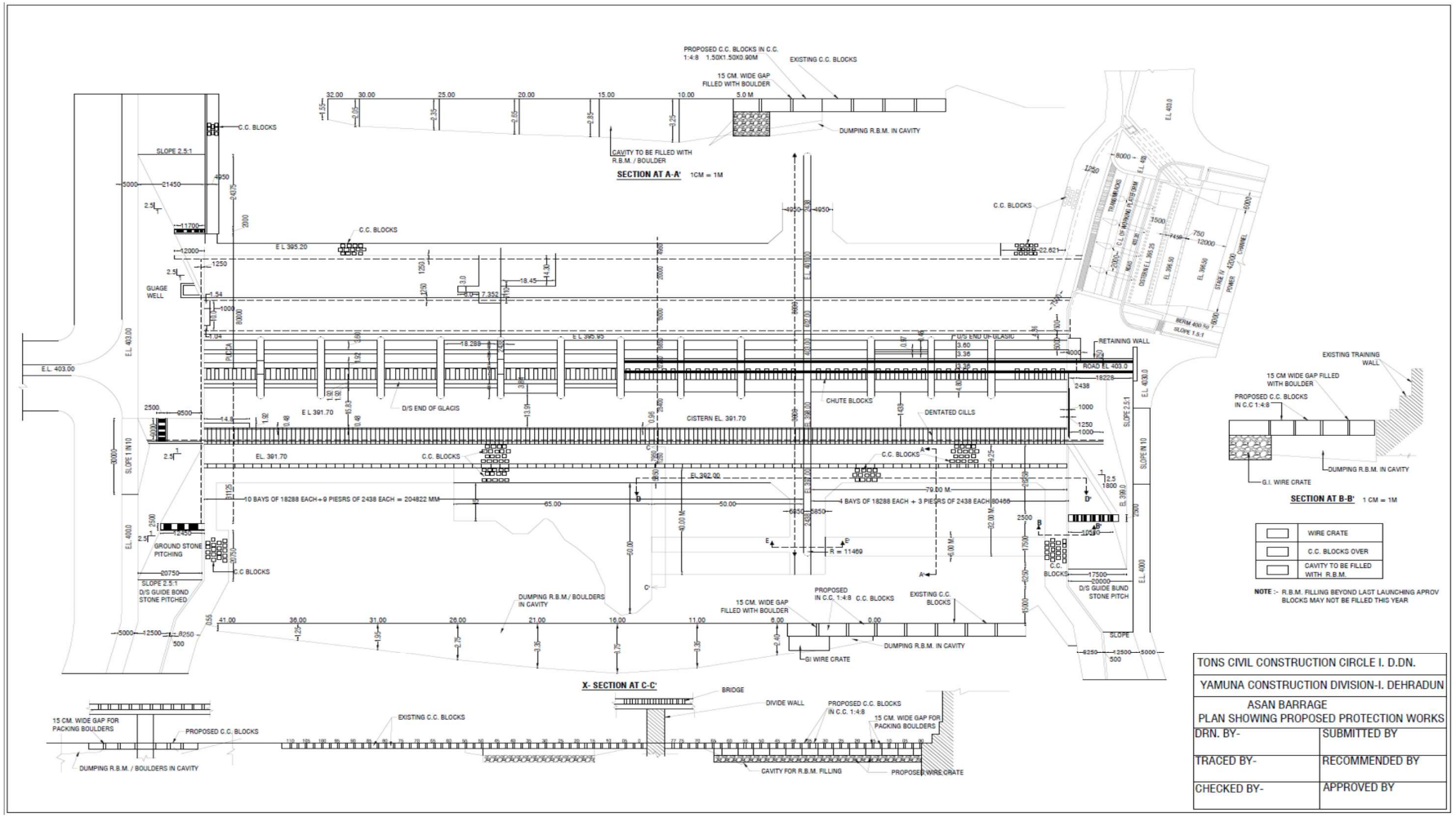
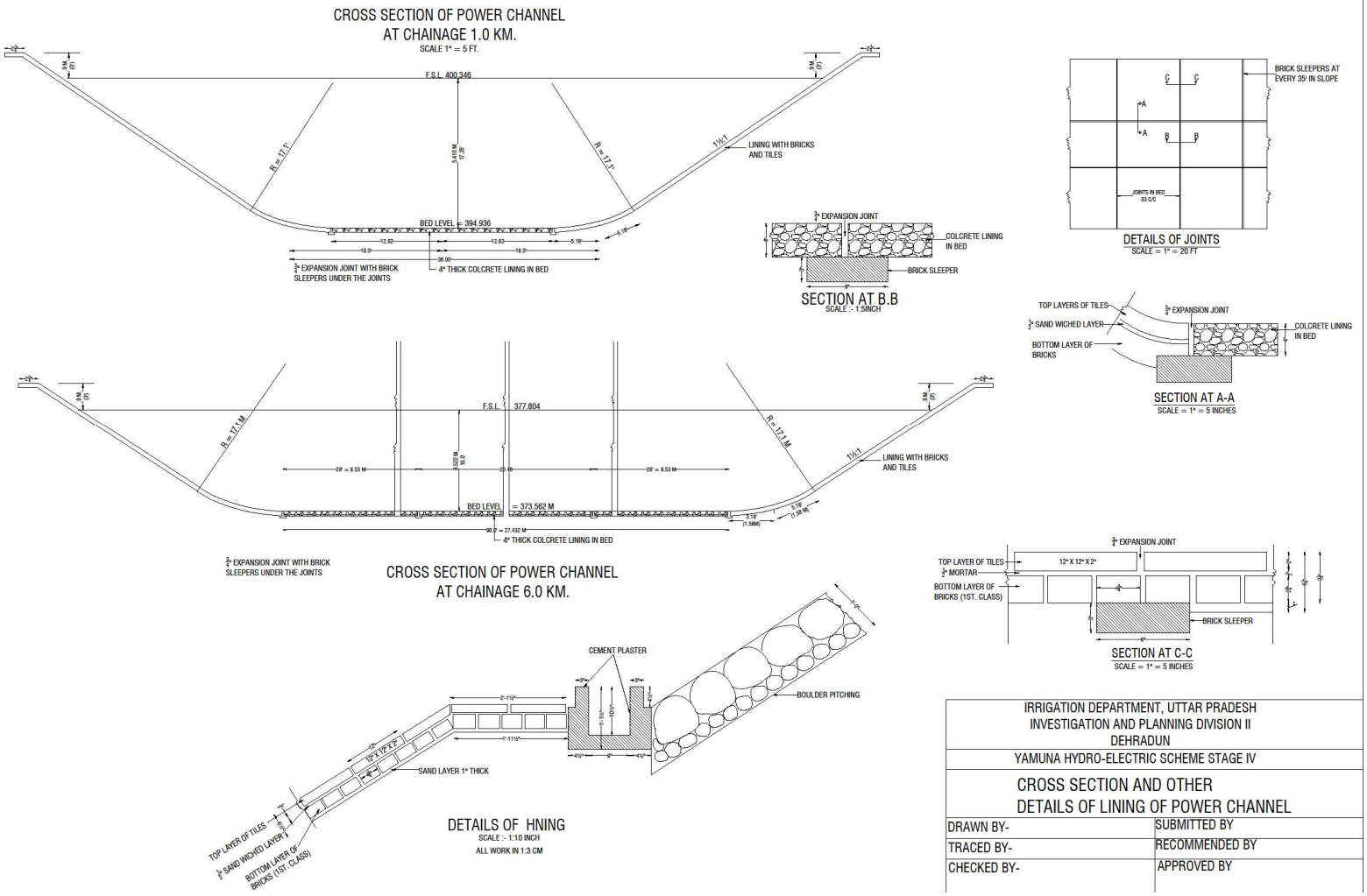
Appendix-IV

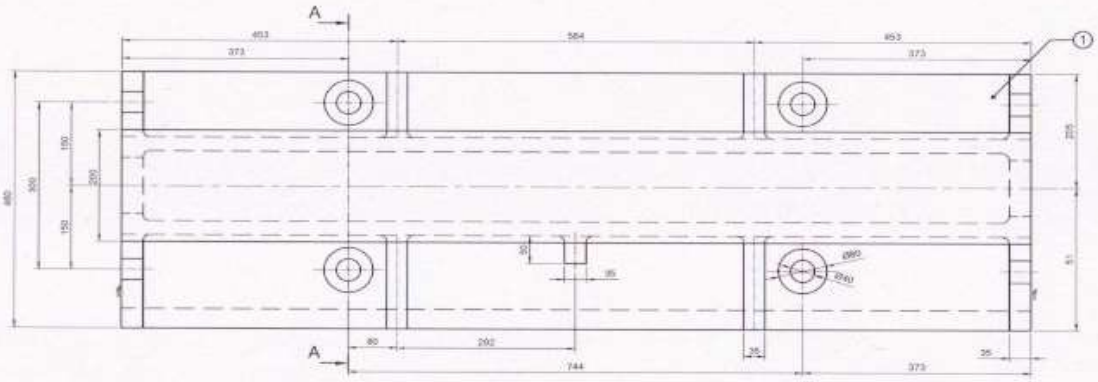
Appendix-IV : Basic Drawings of Asan Barrage

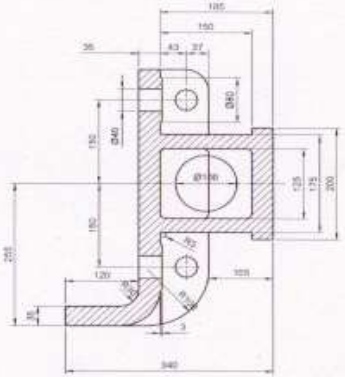


Plan showing proposed protection work

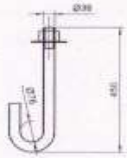


Cross-Section and other details of power channel

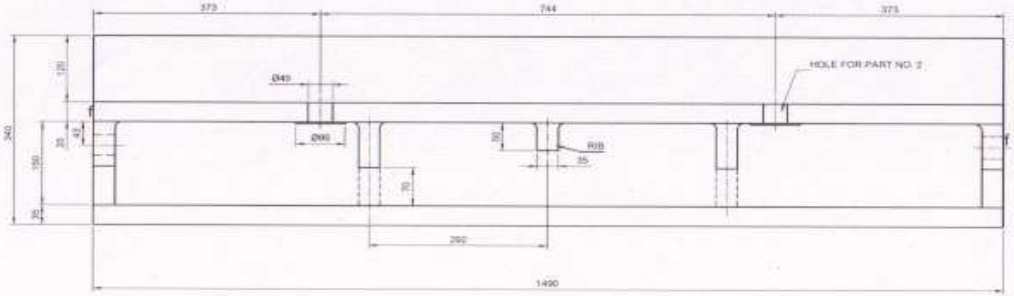




'A-A'



PART NO 2



NOTE-
1. ↑ INDICATES MATCHING.
2. EACH OF THE GUIDE JOINTS SHOULD BE PROVIDED WITH 3mm THICK LEAD SHEET AT THE TIME OF JOINING AT SITE CALICKED.
3. FOR TOP GUIDE BOTTOM PIECE SEE DRG. NO G43/YBGD 13.
4. FOR TOP GUIDE TOP PIECE SEE DRG. NO G43/YBGD 14.
5. FOR ASSEMBLY SEE DRG. NO G43/YBGD 15.

THIS DRG. IS COPIED FROM DRG. NO. Y.B.G.D 11/043 OF OF IRRIGATION WORKSHOP CIRCLE DESIGN DIVISION KANPUR

PART NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
4	BOTTOM GROUTING BOLT	4	M.S.	SAME AS PART NO 2
3	JOINING BOLT Ø32 x135 WITH NUT & WASHERS	16	M.S.	MATERIAL OF GUIDE IS CAST IRON HAVING WEAR CORROSION RESISTING PROPERTIES PREFERABLY NICKEL BASED CHROME ADDITION IN PROPER %
2	J BOLT Ø36 450Lg WITH NUT & WASHER	40	M.S.	
1	C.I.BACK GUIDE	10	C.I.	

SCALE 1:5

DRN.
AE
EE
SE

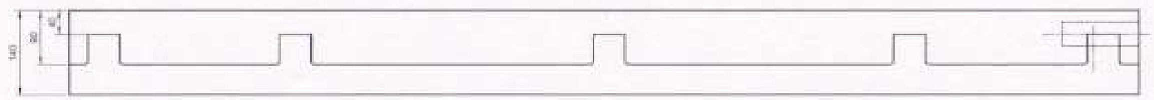
C.I. BACK GUIDE FOR DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT

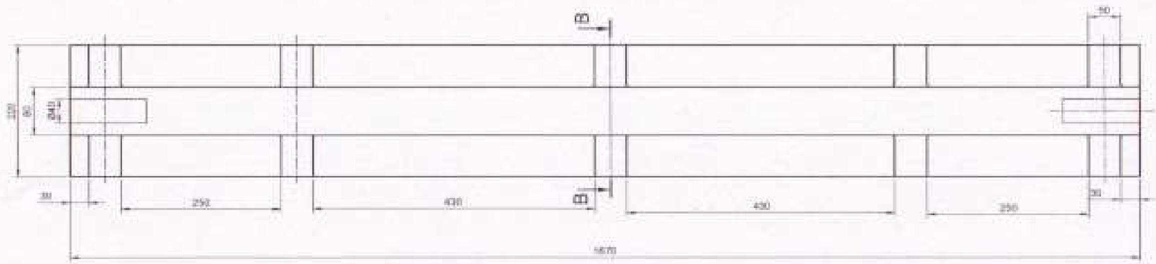
SUPERTENDING ENGINEER IRRIGATION WORKSHOP & ERECTION DIVISION ROORKEE

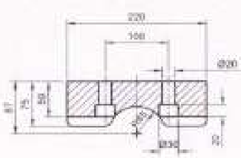
DRG. No. BG/

DATE

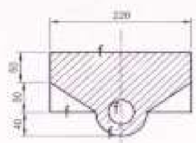
SHEET No.





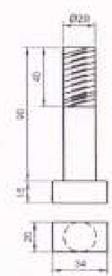


'A-A'



'B-B'

PART NO. 6.
ROCKER



PART NO. 7 T-BOLT
SCALE 1:2

NOTE-
1. f INDICATE MATCHING
2. PART NO 2 (PIN) SHOULD BE PUSH FITTED AND SHOULD BE PERFECTLY VERTICAL HAVING UNIFORM CLEARANCE AROUND THEM IN THE HOLE OF ROCKER

NOTE-
COPIED FROM DRG. NO. Y.B.G.D 25 G43 OF OF IRRIGATION WORKSHOP CIRCLE DESIGN DIVISION KANPUR

PART NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
9	LEAD SHEET 1 mm THIK	2	LEAD	
8	LOCK PLATE	36	M.S	
7	T HEAD BOLT WITH NUT	72	M.S	
6	ROCKER	6	C.I SAE30	
5	ROCKER SEAT	6	C.I SAE30	
4	—	—	—	
3	—	—	—	
2	END BLOCK PIN	4	BRIGHT S	
1	END BLOCK	4	C.I SAE30	

SCALE 1:2.5

DIMENSIONS ARE IN mm GEN. TOL. AS PER IS 2102

AMENDMENTS — No. — DATE

DRN. / AE / EE / SE

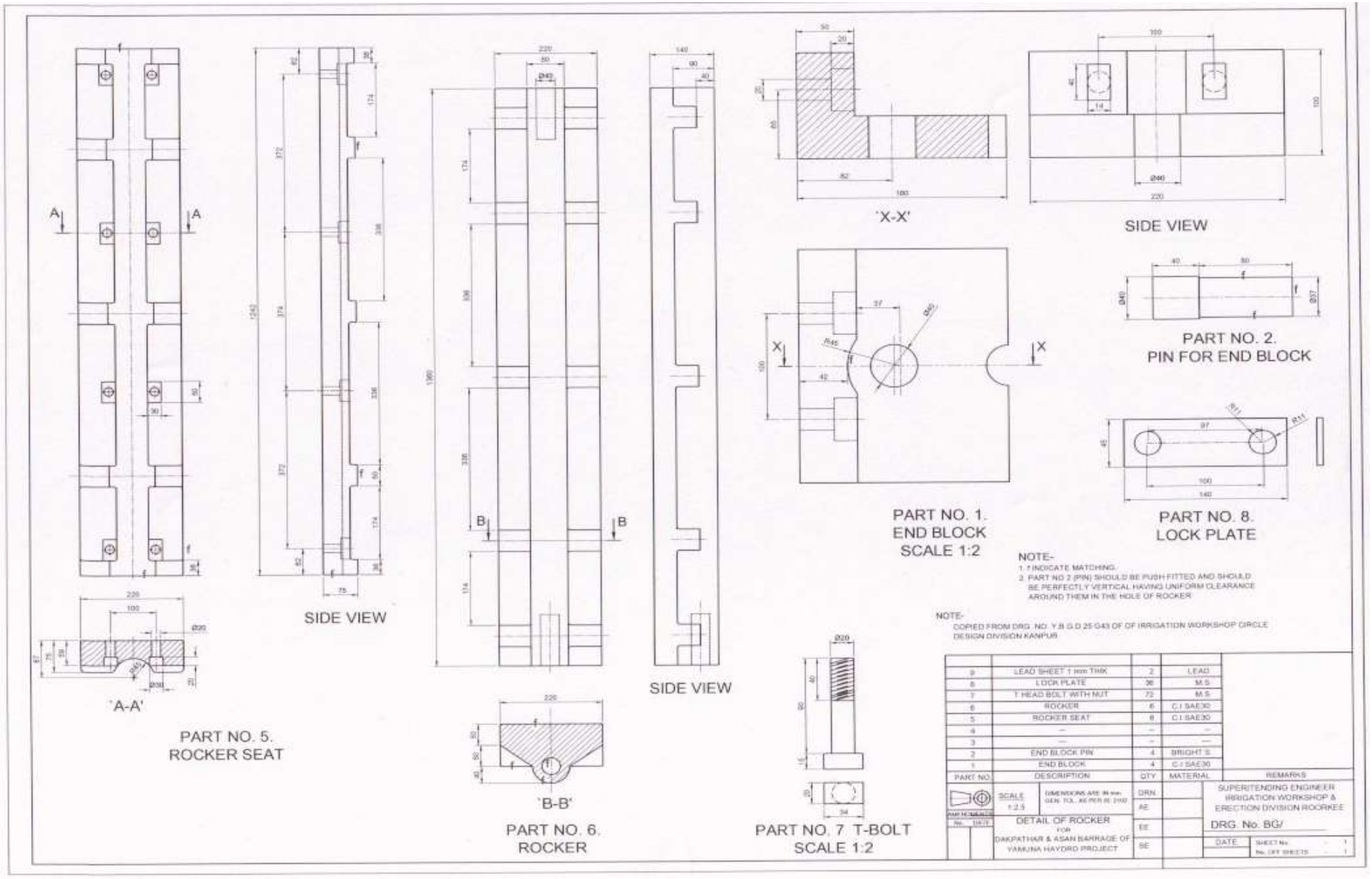
DETAIL OF ROCKER 1670
FOR
DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT

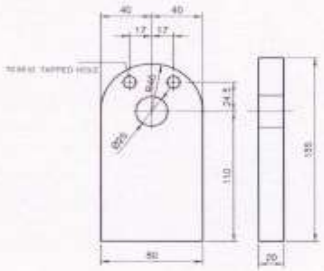
SUPERITENDING ENGINEER
IRRIGATION WORKSHOP &
ERECTION DIVISION ROORKEE

DRG. No. BG/

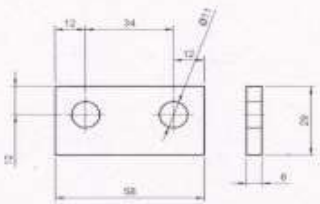
DATE

SHEET No. - 1
No. OFF SHEETS - 1


A
A
SIDE VIEW
'A-A'
PART NO. 5.
ROCKER SEAT
B
B
SIDE VIEW
'B-B'
PART NO. 6.
ROCKER
'X-X'
SIDE VIEW
X
X
PART NO. 1.
END BLOCK
SCALE 1:2
PART NO. 2.
PIN FOR END BLOCK
PART NO. 8.
LOCK PLATE
PART NO. 7 T-BOLT
SCALE 1:2
NOTE-
1. ↑ INDICATE MATCHING.
2. PART NO 2 (PIN) SHOULD BE PUSH FITTED AND SHOULD BE PERFECTLY VERTICAL HAVING UNIFORM CLEARANCE AROUND THEM IN THE HOLE OF ROCKER
NOTE-
COPIED FROM DRG. NO. Y.B.G.D 25 G43 OF OF IRRIGATION WORKSHOP CIRCLE DESIGN DIVISION KANPUR
9 LEAD SHEET 1 mm THK 2 LEAD
8 LOCK PLATE 36 M.S
7 T HEAD BOLT WITH NUT 72 M.S
6 ROCKER 6 C.I SAE30
5 ROCKER SEAT 6 C.I SAE30
4 — — —
3 — — —
2 END BLOCK PIN 4 BRIGHT S.
1 END BLOCK 4 C.I SAE30
PART NO. DESCRIPTION QTY MATERIAL REMARKS
SCALE 1:2.5
DIMENSIONS ARE IN mm
DETAIL OF ROCKER
FOR
DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT
DRN.
AE
EE
SE
SUPERITENDING ENGINEER
IRRIGATION WORKSHOP &
ERECTION DIVISION ROORKEE
DRG. No. BG/
DATE
SHEET No. 1
No. OF SHEETS 1

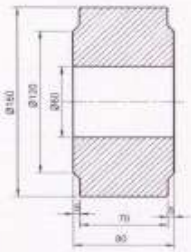


PART NO. 3
FULCRUM PLATE

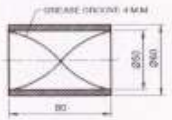


PART NO. 5
KEY PLATE
SCALE 1:1.5

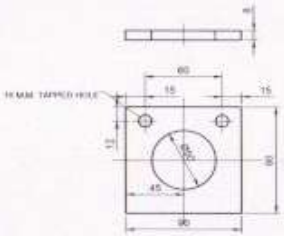
PART NO. 4
FULCRUM PIN



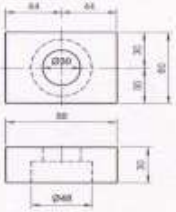
PART NO. 13
ROLLER



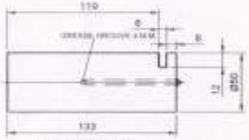
PART NO. 14
BUSH



PART NO. 17
STRENGTH PLATE



PART NO. 8

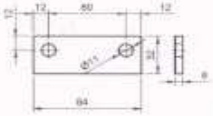


PART NO. 15
ROLLER PIN

PART NO. 23
LOCKING PLATE

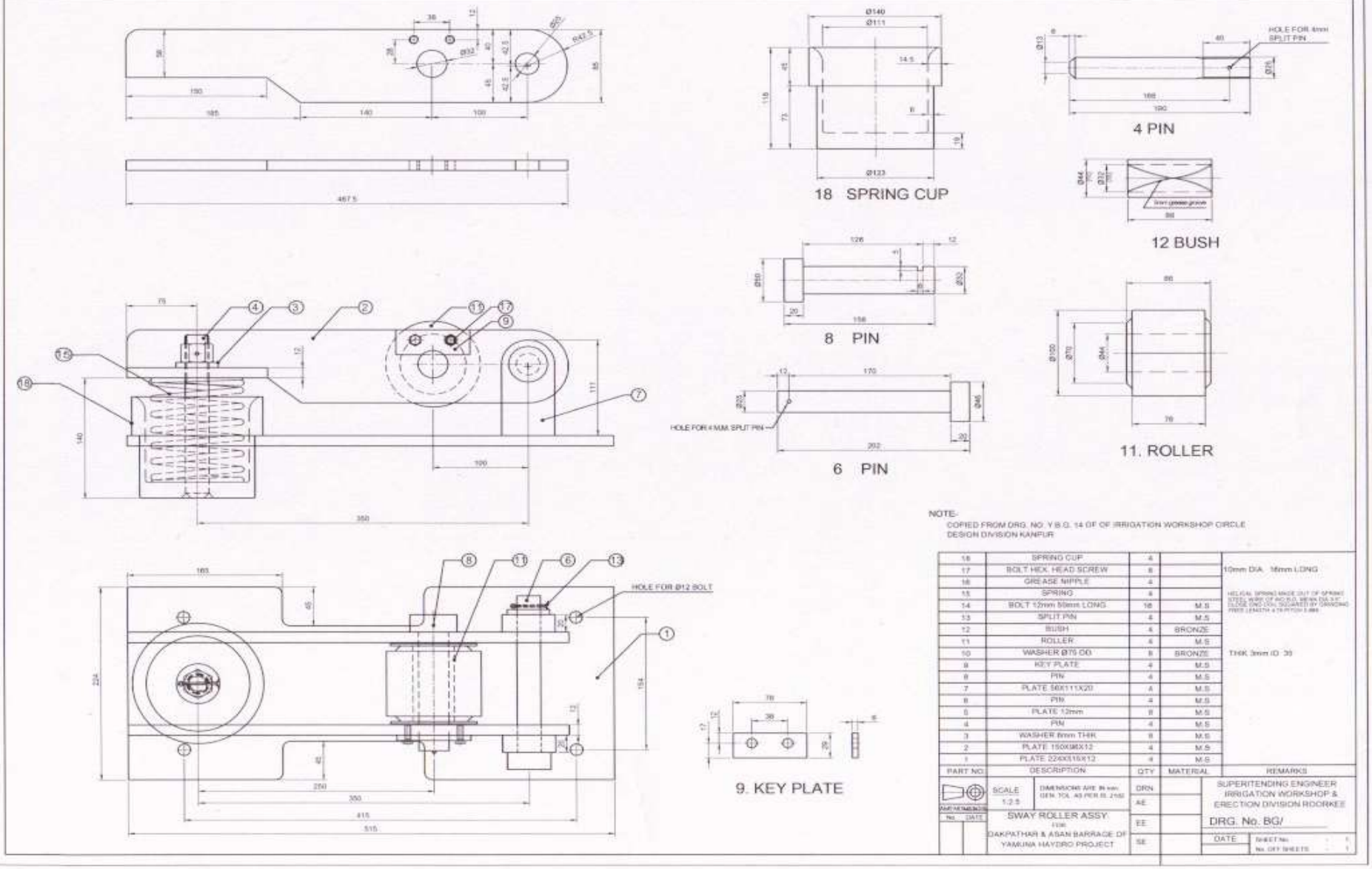
PART NO. 19
BOLT

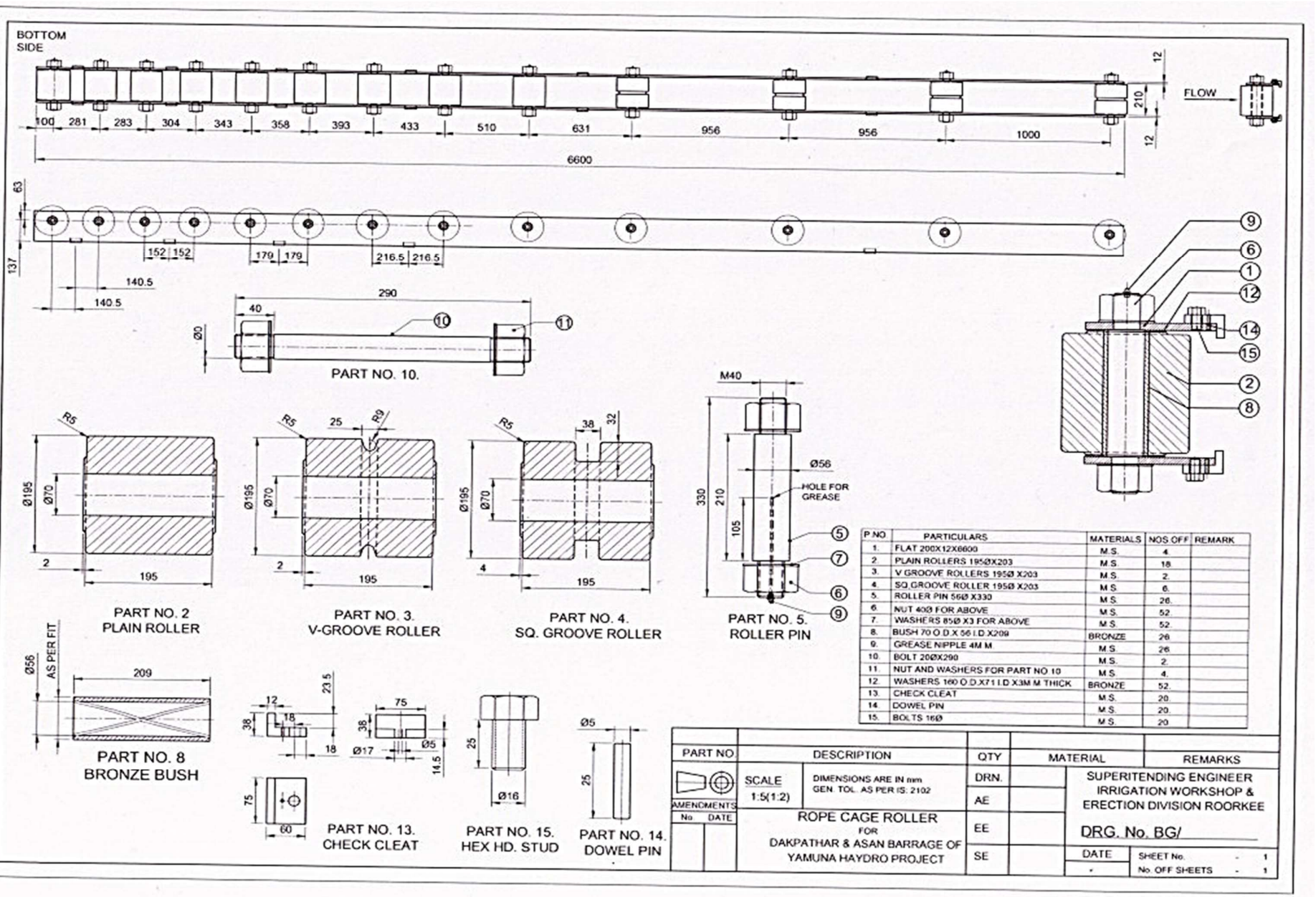
NOTE:
COPIED FROM DRG. NO. Y.B.G.15 G43 OF OF IRRIGATION WORKSHOP CIRCLE
DESIGN DIVISION KANPUR



PART NO. 18
KEY PLATE

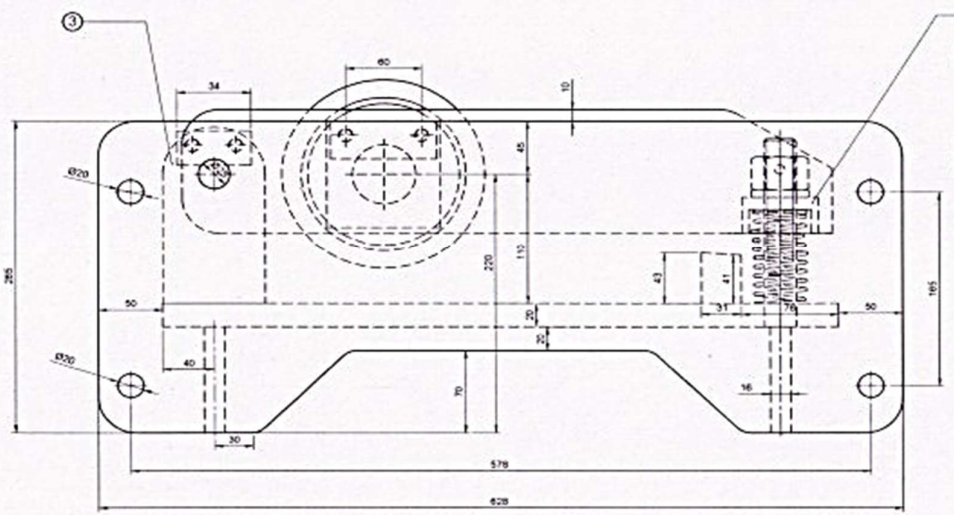
PART NO.	DESCRIPTION	QTY	MATERIAL	REMARKS
	SCALE 1:2.5	DRN.		SUPERITENDING ENGINEER IRRIGATION WORKSHOP & ERECTION DIVISION ROORKEE
	ASSEMBLY OF COUNTER GUIDE FOR DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT	AE		DRG. No. BG/
		EE		DATE
		SE		

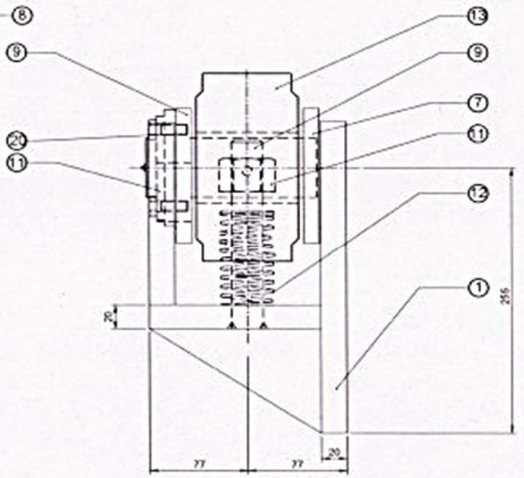

18 SPRING CUP
4 PIN
12 BUSH
8 PIN
11. ROLLER
6 PIN
9. KEY PLATE
HOLE FOR 4mm SPLIT PIN
HOLE FOR Ø12 BOLT
NOTE-
COPIED FROM DRG. NO. Y B.G. 14 OF OF IRRIGATION WORKSHOP CIRCLE DESIGN DIVISION KANPUR
SPRING CUP
BOLT HEX. HEAD SCREW
GREASE NIPPLE
SPRING
BOLT 12mm 50mm LONG
SPLIT PIN
BUSH
ROLLER
WASHER Ø75 OD
KEY PLATE
PIN
PLATE 565X111X20
PIN
PLATE 12mm
PIN
WASHER 8mm THK
PLATE 150X98X12
PLATE 224X316X12
PART NO.
DESCRIPTION
QTY
MATERIAL
REMARKS
10mm DIA. 16mm LONG
THK 3mm ID 39
SCALE 1:2.5
SWAY ROLLER ASSY.
OAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT
SUPERITENDING ENGINEER IRRIGATION WORKSHOP & ERECTION DIVISION ROORKEE
DRG. No. BG/
DATE

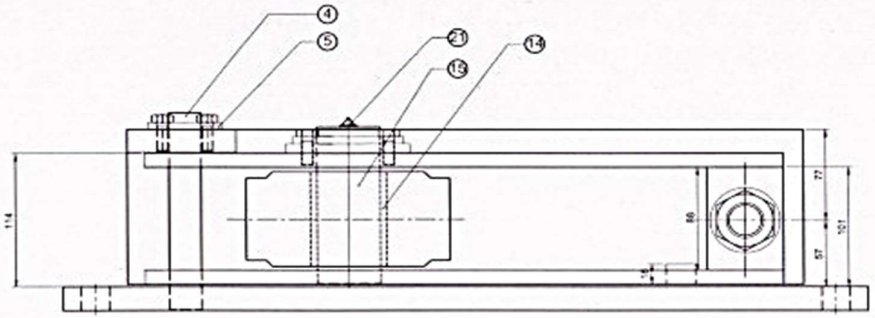


P.NO	PARTICULARS	MATERIALS	NOS OFF	REMARK
1.	FLAT 200X12X6600	M.S.	4.	
2.	PLAIN ROLLERS 195ØX203	M.S.	18.	
3.	V.GROOVE ROLLERS 195Ø X203	M.S.	2.	
4.	SQ.GROOVE ROLLER 195Ø X203	M.S.	6.	
5.	ROLLER PIN 56Ø X330	M.S.	26.	
6.	NUT 40Ø FOR ABOVE	M.S.	52.	
7.	WASHERS 85Ø X3 FOR ABOVE	M.S.	52.	
8.	BUSH 70 O.D.X 56 I.D.X209	BRONZE	26	
9.	GREASE NIPPLE 4M M.	M.S.	26.	
10.	BOLT 20ØX290	M.S.	2.	
11.	NUT AND WASHERS FOR PART NO.10	M.S.	4.	
12.	WASHERS 160 O.D.X71 I.D.X3M M.THICK.	BRONZE	52.	
13.	CHECK CLEAT	M.S.	20.	
14.	DOWEL PIN	M.S.	20.	
15.	BOLTS 16Ø	M.S.	20	

PART NO	DESCRIPTION	QTY	MATERIAL	REMARKS
AMENDMENTS No. DATE	SCALE 1:5(1:2) DIMENSIONS ARE IN mm GEN. TOL. AS PER IS: 2102	DRN.	SUPERITENDING ENGINEER IRRIGATION WORKSHOP & ERECTION DIVISION ROORKEE	
	ROPE CAGE ROLLER FOR DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT	AE		
		EE	DRG. No. BG/	
		SE	DATE -	SHEET No. - 1 No. OFF SHEETS - 1







NOTE-

COPIED FROM DRG. NO. Y.B.G.D 25 G43 OF OF IRRIGATION WORKSHOP CIRCLE DESIGN DIVISION KANPUR

A WASHER MAY BE PLACED AT THE BOTTOM OF SPRING IF REQUIRED FOR INITIAL SETTING

PART NO	DESCRIPTION	QTY	MATERIAL	REMARKS
24	RIBS 16mm THICK	8	M.S	
23	LOCKING PLATE	4	M.S	
22	FLAT 31X25	8	M.S	
21	GREASE NIPPLE	4	M.S	
20	HEX. HD. BOLT Ø10X20LONG	8	M.S	
19	HEX. HD. BOLT Ø19X83 LONG	16	M.S	
18	KEY PLATE 6X84X32	4	M.S	
17	STRENGTH PLATE 6X90 SQ	4	M.S	
16	WASHER 3mm 100 O.D.	8	BRONZE	
15	ROLLER PIN	4	M.S	
14	BUSH 80mm LONG	4	BRONZE	
13	ROLLER	4	M.S	HELICAL SPRING MADE OUT OF NO. 4 S.W.G. SPRING STEEL WIRE CLOSED END COILS SQUARED BY GRINDING MEAN DIA. 1.5" FREE LENGTH 3.128" PITCH 0.444" DEFLECTION ABOUT 1/4" AT 180 LBS. LOADING.
12	COMPRESSION SPRING	4	M.S	
11	NUT Ø25	4	M.S	
10	WASHER 3mm FOR 25mm BOLT	4	M.S	
9	BOLT Ø25X 180 LONG	4	M.S	
8	PLATE 30X68X60	4	M.S	
7	LEVER ARM PLATE 12X508X105	8	M.S	
6	HEX. HEAD SCREW Ø10, 20 LONG	8	M.S	
5	KEY PLATE 6mm	4	M.S	
4	FULCRUM PIN	4	M.S	
3	FULCRUM PLATE 200X155X80	4	M.S	
2	PLATE 528X134X20	4	M.S	
1	PLATE 828X265X20	4	M.S	

SCALE 1:2.5

DIMENSIONS ARE IN mm. GEN. TOL. AS PER IS 2102

DETAIL OF COUNTER GUIDE FOR DAKPATHAR & ASAN BARRAGE OF YAMUNA HAYDRO PROJECT

DRN	
AE	
EE	
SE	

SUPERITENDING ENGINEER
IRRIGATION WORKSHOP & ERECTION DIVISION ROORKEE

DRG. No. BG/

DATE

SHEET No. - 2

No. OF SHEETS - 2

Index Map showing location of existing and proposed dam/ barrage on Yamuna river

Satellite Map of Asan Barrage

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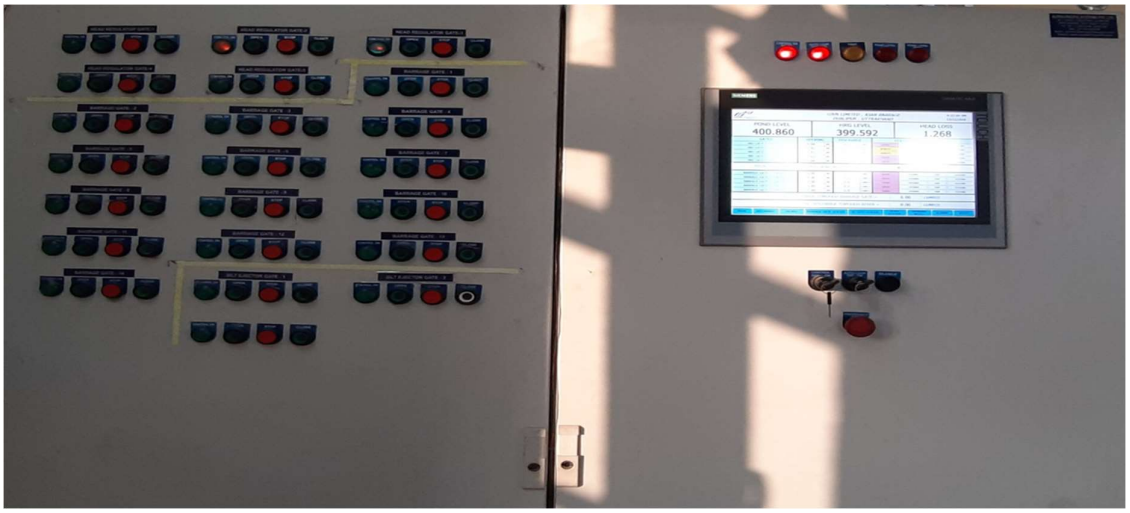
Appendix-V

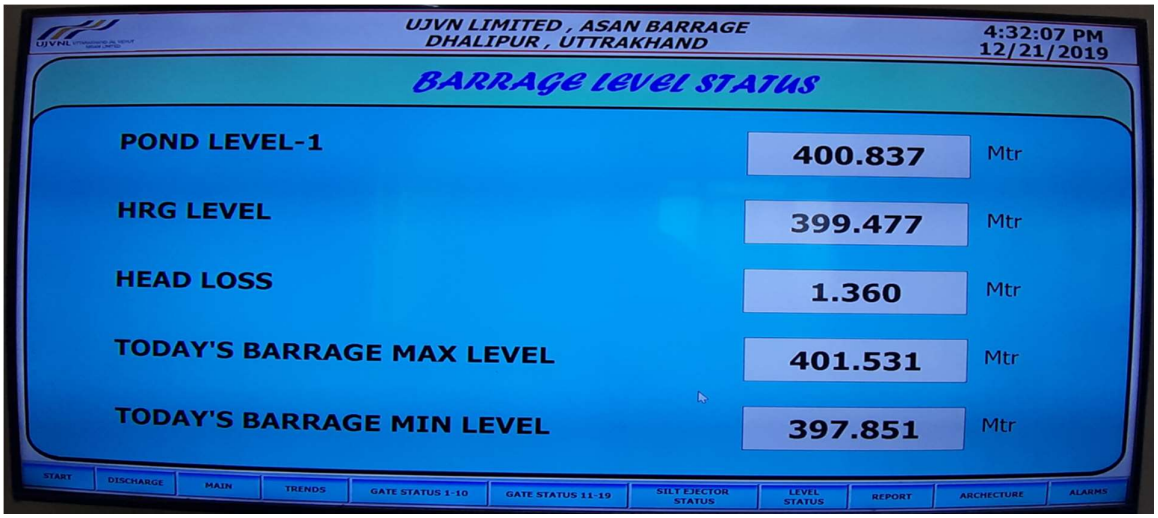
Appendix-V: Photographs

Spillway gates

Head Regulator



SCADA Panel



LED Display Screen of SCADA

Local Panel for gate operation

Barrage Gate before bottom seal replacement

Barrage Gate after bottom rubber seal replacement

De-silting work under sluice gate side before start of closure

De-silting work under sluice gate side after finishing closure work

D/S of Asan Barrage Channel bed Near Bridge No 2 before start of closure work

Channel bed Near Bridge No 2 after repair

Left Bank of Asan reservoir before start of closure work

Left Bank of Asan reservoir after completion of closure work

Laying of Concrete canvas over the bank of Power Channel

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Appendix-VI

Appendix-VI: Latest Design Flood review study

Government of India
Central Water Commission
Hydrology (DSR) Directorate
7th Floor (S), Sewa Bhawan,
New Delhi-110066
Email: hyddsr-cwc@nic.in

Subject: Review of Design Flood Studies of Asan Barrage under DRIP, Uttrakhand-Reg.

Design flood study report of Asan Barrage, Uttarakhand was received from DSR Directorate, CWC for examination/ vetting under DRIP, which has been examined and observations of this office are as under:

(1) Introduction

The Asan Barrage has been built across River Asan, a major tributary of River Yamuna in Dehradun district of Uttarakhand. The catchment area of Asan River up-to the barrage site is **685 sq km**. The maximum height & storage capacity of the barrage are **19.8 m** & **1.6 MCM** respectively. As per BIS: 11223 -1985 criteria, the barrages qualify for **100 year return period flood** as design flood and **SPF** as check flood. As reported by the consultant, the project was commissioned in **1967** and was originally designed for **4500 m^3/s** flood.

(2) Design Flood Studies

In absence of concurrent rainfall runoff data, the unit hydrograph of one hour duration was derived synthetically by the consultants using Flood Estimation Report for Western Himalayas-Zone-7. The one day storm event of **5th September 1995** observed at **Mukhim** has been adopted as the design storm with SPS depth of 50.06 cm. Loss rate of **0.5 cm/hr**, base flow of 0.05 $m^3/s/km^2$ have been adopted from FER for– sub zone 7. 12 hour rainfall distribution has been adopted from PMP Atlas of Ganga River Basin. The peak design flood has been worked out as **6921 m^3/s**.

(3) Observations

(i) The shape of the rising limb of the derived catchment response function does not appear to be in order. The same may be re-assessed and further computations be modified accordingly. This office has modified the computations and the recommended catchment response function is attached as annex-I.

(ii) As barrages qualify for design based on 100 year return period flood, same may be adopted as design flood and SPF may be considered as check Flood.

(iii) Maximum persisting due point temperature for the considered storm has been adopted for the second fortnight of September month. As the occurrence of storm is in the first fortnight, maximum persisting due point temperature and LAF computations may be modifies accordingly.

Contd -

6.3.17

(iv) The consideration of storm event of **5th September 1995** observed at **Mukhim** as storm for check flood appears to be generally in order. This office has slightly modified the transposition and maximum transposed storm depth works out to be 41.42 cm and with TAF, one day SPS depth works out as **58 cm** and same may be adopted as the storm depth for check flood.

(v) The catchment response function (i.e. Unit Hydrograph) plays an important role in the design flood computations and the short term concurrent observed discharge and rainfall data for few flood events is very useful input in derivation of such catchment specific response function. The project authorities may be advised to collect project specific short term concurrent observed discharge and rainfall data for few flood events for the derivation of the catchment response function.

(vi) The annual maximum observed flood peak data at the dam site may also be collected and used in the review of design flood for validation of design flood assessed by hydro-meteorological approach.

(vii) This office has slightly modified the design flood study using 100 year return period 24 hour duration rainfall 42 cm adopted from Isopluvial Maps. Storm duration has been adopted as 24 hrs and corresponding time distribution as given in PMP Atlas for Ganga River Basins has been adopted. Slightly modified catchment response function with a loss rate of 0.4 cm/hr, Areal reduction factor of 0.892 and base flow of 0.05 $m^3/s/sq.km$ from FER Sub-zone 7 have been considered in the analysis. The peak value of 100 year return period flood works out as **4442 m^3/s**. Further, considering one day areal SPS depth of 58 cm, loss rate of 0.3 cm/hr and other parameters same as adopted for 100 year return period flood analysis, the SPF has been worked out as **8056 m^3/s**. As the project was originally designed to carry **4500 m^3/s**, the same may be adopted as design flood in dam safety review of the project and a flood of **8056 m^3/s** may be adopted as check flood. The design flood hydrograph is enclosed with modified computations in brief at **Annex-I**.

This issues with the approval of Chief Engineer (HSO), CWC.

Encl: As above.

Ravi Ranjan 02/03/17

(RAVI RANJAN)
Director

Director, DSR, CWC, New Delhi
No. 1/44/7/2017-Hyd(DSR)/45-46 Dated: 02.03.2017

Copy to: Director, HYD (N), CWC

UTTARAKHAND
100 - YEARS 24 - HOURS ISOPLUVIAL MAP (mm)

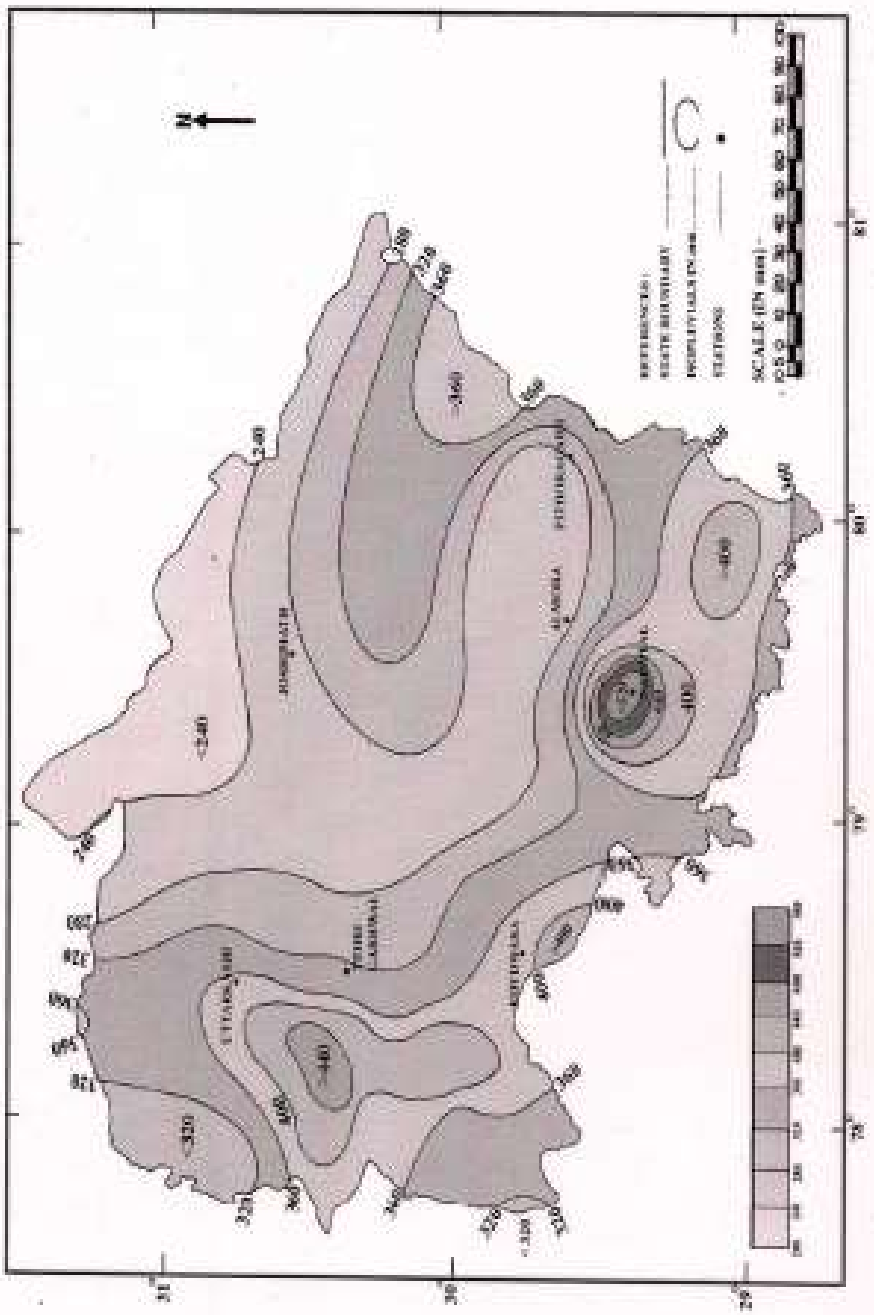
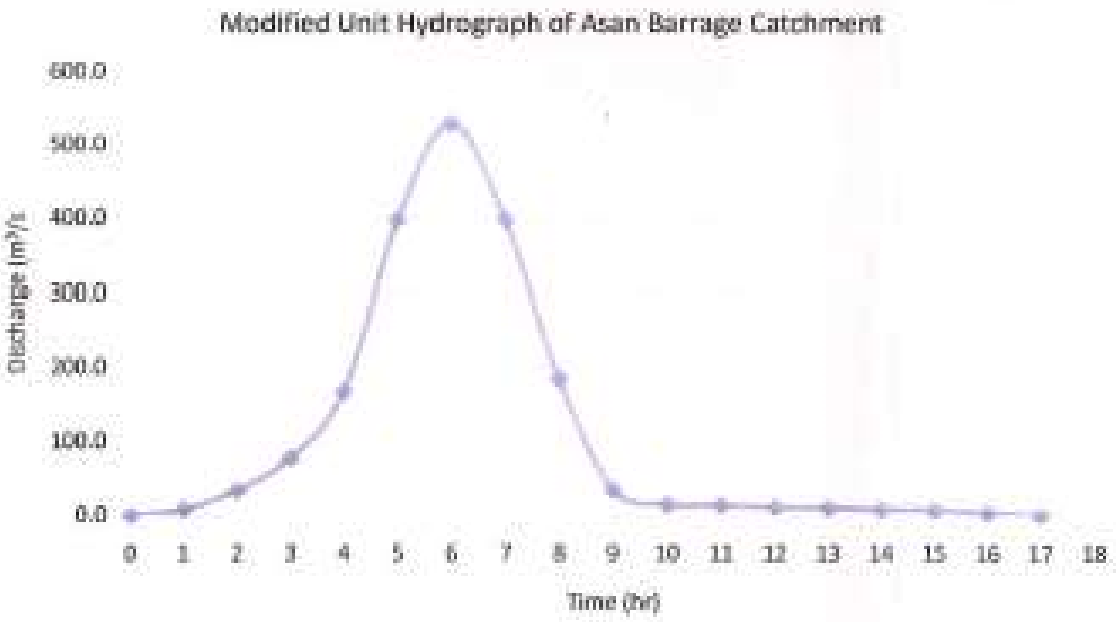


PLATE - XII

Time (Hour)	Adjusted Ordinates (m^3/s)
0	0.0
1	8.0
2	34.0
3	78.0
4	168.0
5	398.0
6	530.0
7	398.0
8	185.0
9	35.0
10	15.0
11	14.0
12	11.0
13	10.0
14	8.0
15	7.0
16	3.0
17	0.0



Annex-I

Computation of Rainfall Excess (100 year Rainfall)									
			100 year Point Rainfall			42	cm		
			ARF for the Asan Barrage			0.892	From FER Zone-7		
			100 year Areal Rainfall			37.46			
1st day	24 hr rainfall		37.46	cm					
	First bell (12 hour)		24.65	cm					
	Second bell (12 hour)		12.81	cm					
Time in hr	Time distribution coeff	Normalised Time distribution coeff	1st Bell Cum. Rain fall (cm)	1st Bell Incre mental Rainfall (cm)	1st Bell Loss Rate (cm)	1st Bell Rainfall Excess (cm)	2nd Bell Cum. Rain fall (cm)	2nd Bell Incre mental Rainfall (cm)	2nd Bell Rainfall Excess (cm)
1	10.9	17	4.08	4.08	0.40	**3.68**	2.12	2.12	**1.72**
2	17.8	27	6.59	2.51	0.40	**2.11**	3.43	1.31	**0.91**
3	23.6	36	8.84	2.25	0.40	**1.85**	4.60	1.17	**0.77**
4	29.3	45	10.98	2.14	0.40	**1.74**	5.71	1.11	**0.71**
5	34.8	53	13.04	2.06	0.40	**1.66**	6.78	1.07	**0.67**
6	40.1	61	15.02	1.98	0.40	**1.58**	7.81	1.03	**0.63**
7	44.7	68	16.75	1.73	0.40	**1.33**	8.70	0.89	**0.49**
8	49.1	75	18.39	1.64	0.40	**1.24**	9.56	0.86	**0.46**
9	53.4	81	20.01	1.62	0.40	**1.22**	10.40	0.84	**0.44**
10	57.6	88	21.58	1.57	0.40	**1.17**	11.22	0.82	**0.42**
11	61.8	94	23.15	1.57	0.40	**1.17**	12.03	0.81	**0.41**
12	65.8	100	24.65	1.50	0.40	**1.10**	12.81	0.78	**0.38**

Annex-I

Critical Sequencing of rainfall excess (100 Years)					
				Unit :	cm
Time	UG	Critical Sequencing		Reverse Order	
(hrs)	ORD	1st	IInd	1st	IInd
	(cumecs)	Bell	Bell	Bell	Bell
0	0.0				
1	8.0			1.10	0.38
2	34.0	1.24	0.46	1.17	0.41
3	78.0	1.58	0.63	1.17	0.42
4	168.0	1.66	0.67	1.24	0.46
5	398.0	1.85	0.77	1.33	0.49
6	530.0	3.68	1.72	1.74	0.71
7	398.0	2.11	0.91	2.11	0.91
8	185.0	1.74	0.71	3.68	1.72
9	35.0	1.33	0.49	1.85	0.77
10	15.0	1.24	0.46	1.66	0.67
11	14.0	1.17	0.42	1.58	0.63
12	11.0	1.17	0.41	1.24	0.46
13	10.0	1.10	0.38		
14	8.0				
15	7.0				
16	3.0				
17	0.0				

Annex-I

Critical Sequencing of rainfall excess (100 Years)					
				Unit :	cm
Time	UG	Critical Sequencing		Reverse Order	
(hrs)	ORD	1st	IInd	1st	IInd
	(cumecs)	Bell	Bell	Bell	Bell
0	0.0				
1	8.0			**1.10**	**0.38**
2	34.0	1.24	0.46	**1.17**	**0.41**
3	78.0	1.58	0.63	**1.17**	**0.42**
4	168.0	1.66	0.67	**1.24**	**0.46**
5	398.0	1.85	0.77	**1.33**	**0.49**
6	530.0	**3.68**	**1.72**	**1.74**	**0.71**
7	398.0	2.11	0.91	**2.11**	**0.91**
8	185.0	1.74	0.71	**3.68**	**1.72**
9	35.0	1.33	0.49	**1.85**	**0.77**
10	15.0	1.24	0.46	**1.66**	**0.67**
11	14.0	1.17	0.42	**1.58**	**0.63**
12	11.0	1.17	0.41	**1.24**	**0.46**
13	10.0	1.10	0.38		
14	8.0				
15	7.0				
16	3.0				
17	0.0				

Annex-I

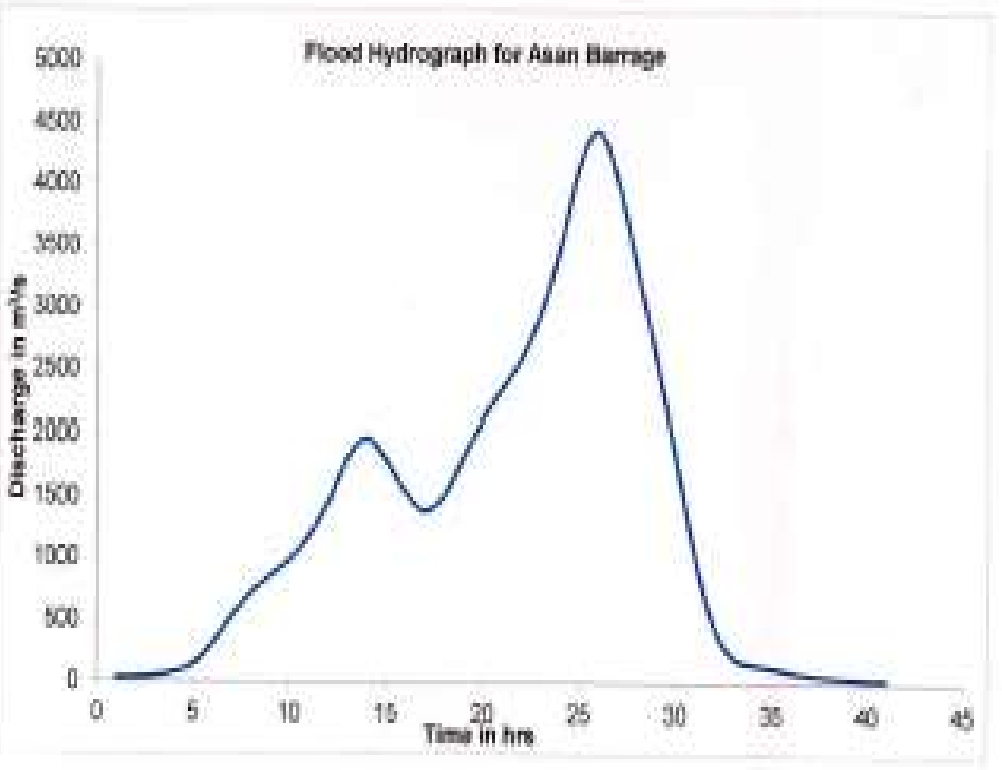
Computation of 100 year return period Flood

		Rainfall Excess in cm																										
Time	U.G	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total	Base	Flood Hydr.
(hr)	(m^3/s)	0.38	0.41	0.42	0.46	0.45	0.71	0.91	1.71	0.77	0.67	0.63	0.46	1.10	1.17	1.17	1.24	1.53	1.74	2.11	3.68	1.85	1.66	1.58	1.24	BSRO	Flow	Ordinate
0	0.0	0.0																								0.0	34.3	34
1	3.8	3.0	0.0																							3.0	34.3	37
2	34.0	12.9	3.5	0.0																						16.2	34.3	50
3	78.0	29.6	13.9	3.4	0.0																					46.9	34.3	81
4	140.8	63.8	22.8	14.3	3.7	0.0																				113.8	34.3	148
5	398.0	151.2	85.5	32.8	15.6	3.9	0.0																			232.4	34.3	307
6	530.8	201.4	163.2	70.6	35.9	16.7	6.7	0.0																		493.4	34.3	528
7	698.8	151.2	213.3	167.2	77.2	38.2	24.3	7.3	0.0																	682.6	34.3	717
8	185.0	70.7	163.2	222.4	183.1	82.3	55.4	30.9	17.0	0.0																831.6	34.3	866
9	35.0	15.3	75.9	167.2	243.8	195.0	119.3	71.0	38.5	6.2	0.0															950.8	34.3	984
10	35.0	3.7	14.4	77.7	183.1	259.7	282.6	152.9	134.2	76.2	5.6	0.0														2161.7	34.3	1170
11	34.0	3.3	6.2	14.7	85.1	195.8	378.5	365.2	289.0	66.1	22.8	5.0	0.0													1621.6	34.3	1656
12	31.0	4.2	5.7	6.3	16.1	90.7	282.6	682.3	686.6	129.4	52.3	21.4	3.7	0.0												1779.1	34.3	1813
13	30.0	3.8	4.9	5.9	6.9	17.2	121.4	262.2	911.0	309.5	122.8	48.1	11.6	0.8	0.0											1936.0	34.3	1970
14	8.0	2.0	4.1	4.6	6.4	7.4	24.9	168.4	686.6	408.3	266.7	108.8	31.9	12.4	9.4	0.0										1766.6	34.3	1801
15	7.0	2.7	3.3	4.2	5.1	6.9	10.7	31.9	318.2	326.5	355.1	250.7	77.3	25.8	10.8	9.6	0.0									1507.3	34.3	1542
16	3.0	1.1	2.9	3.8	4.8	5.4	8.9	13.7	68.2	142.5	266.7	333.9	183.1	184.8	91.3	39.8	9.9	0.0								1253.0	34.3	1287
17	0.0	0.0	1.2	2.9	3.7	4.9	7.8	12.7	25.8	27.9	124.0	250.7	263.8	407.8	190.6	91.3	42.2	10.6	0.8							1483.0	34.3	1517
18			0.0	1.3	2.2	3.9	5.1	10.9	24.1	11.6	25.5	116.6	183.1	583.9	465.7	196.6	96.9	45.2	13.9	3.0						1783.3	34.3	1820
19				0.0	1.4	3.4	5.7	9.1	18.9	10.8	10.1	22.1	93.1	417.8	620.1	465.7	208.3	103.7	30.2	16.9	0.0					2078.2	34.3	2113
20					0.8	1.5	3.0	7.3	17.2	9.5	9.4	9.5	36.1	283.3	465.7	620.1	493.5	223.4	115.7	71.7	29.4	0.0				2117.4	34.3	2152
21						0.0	2.1	6.6	13.8	7.7	7.4	8.8	6.9	38.5	216.5	465.7	657.2	529.3	292.3	164.6	125.1	34.8	0.0			2557.0	34.3	2591
22							0.0	2.7	12.8	6.2	6.7	6.9	6.4	16.5	91.0	216.5	493.5	704.9	492.3	334.5	287.0	62.9	13.3	0.0		2923.5	34.3	2958
23								0.0	5.2	5.4	5.4	6.3	5.1	15.4	17.6	91.0	229.4	529.2	522.2	439.8	618.2	144.3	58.4	12.6	0.0	3453.5	34.3	3488
24									0.0	2.3	4.7	5.0	4.6	12.1	16.4	17.6	43.4	249.1	892.5	1118.2	1466.6	310.8	139.1	31.7	9.9	4131.5	34.3	4166
25										0.0	2.0	4.6	3.7	11.0	12.9	16.4	18.6	46.0	321.9	899.8	1950.4	716.3	278.9	133.3	42.2	4408.2	34.3	4442
26											0.0	1.0	3.2	8.8	11.7	12.9	17.4	38.0	69.9	393.4	1466.6	980.3	660.7	283.4	96.7	3995.0	34.3	4029
27												0.0	1.4	7.7	9.4	11.7	13.6	18.6	38.1	73.9	480.8	716.3	870.8	628.8	208.3	3296.4	34.3	3331
28													0.0	3.3	8.2	9.4	12.4	14.6	24.4	71.7	128.0	342.3	660.7	837.4	493.3	2566.5	34.3	2601
29														8.0	5.7	8.2	9.9	13.3	19.1	29.5	95.2	64.8	307.1	628.8	657.2	1796.7	34.3	1831
30															0.0	3.3	8.7	10.6	17.4	23.2	31.5	22.8	58.1	292.9	493.3	986.0	34.3	1021
31																0.0	3.7	9.3	13.9	21.1	40.5	25.9	24.9	55.3	226.4	424.0	34.3	458
32																	0.0	4.0	12.2	16.9	36.8	20.4	23.2	23.7	49.4	180.5	34.3	215
33																		0.0	5.2	14.8	39.4	18.5	18.3	22.1	18.8	126.9	34.3	161
34																			0.0	6.3	25.8	14.8	16.6	17.6	17.4	98.2	34.3	132
35																				0.0	11.8	15.0	13.3	13.8	13.6	65.7	34.3	101
36																					0.0	3.6	11.8	12.6	12.4	42.3	34.3	76
37																						0.0	3.0	11.1	9.9	29.0	34.3	60
38																							0.0	4.7	8.7	13.4	34.3	48
39																								0.0	3.7	3.7	34.3	38
40																									0.0	0.0	34.3	34

Flood hydrograph

Unit : m3/s

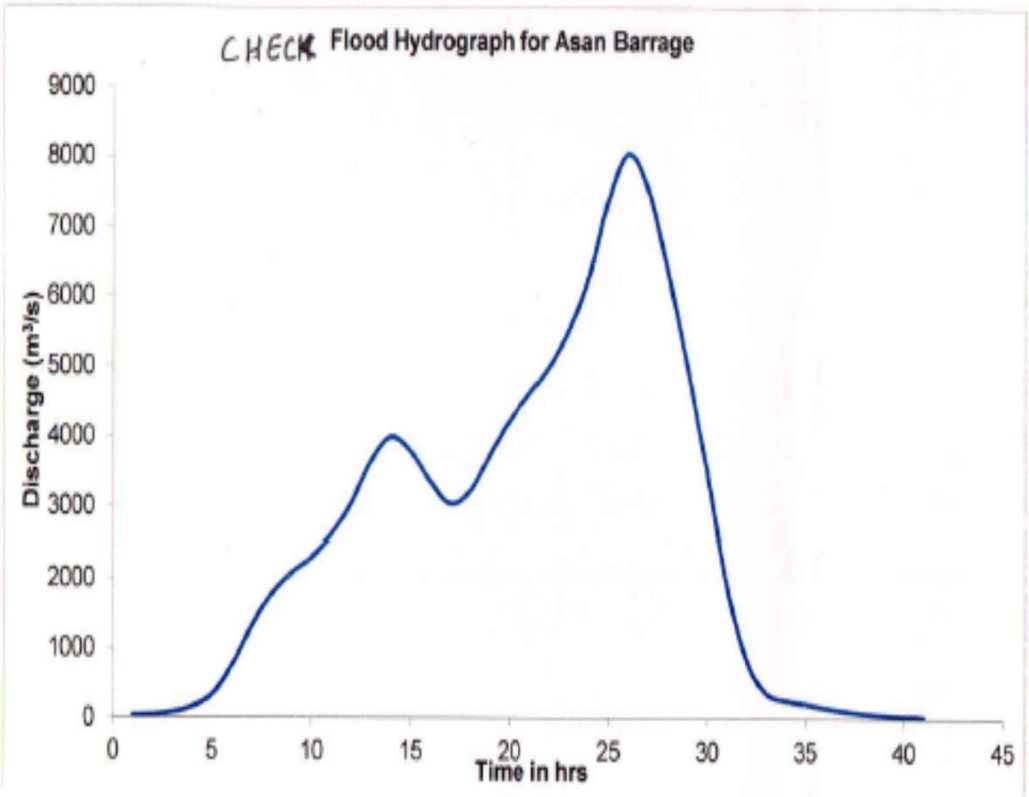
Time in Hours	Total Flood	Time in Hours	Total Flood
0	34	21	2591
1	37	22	2956
2	50	23	3488
3	81	24	4186
4	148	25	4512
5	307	26	4029
6	628	27	3331
7	717	28	2601
8	856	29	1831
9	984	30	1021
10	1178	31	458
11	1456	32	215
12	1813	33	161
13	1670	34	132
14	1601	35	101
15	1542	36	76
16	1387	37	60
17	1517	38	48
18	1820	39	38
19	2112	40	24
20	2352		



Flood hydrograph (SPF)

Unit : cumec

Time in Hours	Total Flood	Time in Hours	Total Flood
0	34	21	4983
1	42	22	5520
2	77	23	6267
3	158	24	7381
4	334	25	8056
5	750	26	7558
6	1322	27	6388
7	1787	28	5005
8	2080	29	3490
9	2300	30	1929
10	2613	31	845
11	3046	32	374
12	3641	33	272
13	3990	34	220
14	3788	35	164
15	3357	36	117
16	3045	37	84
17	3223	38	60
18	3732	39	41
19	4227	40	34
20	4616		



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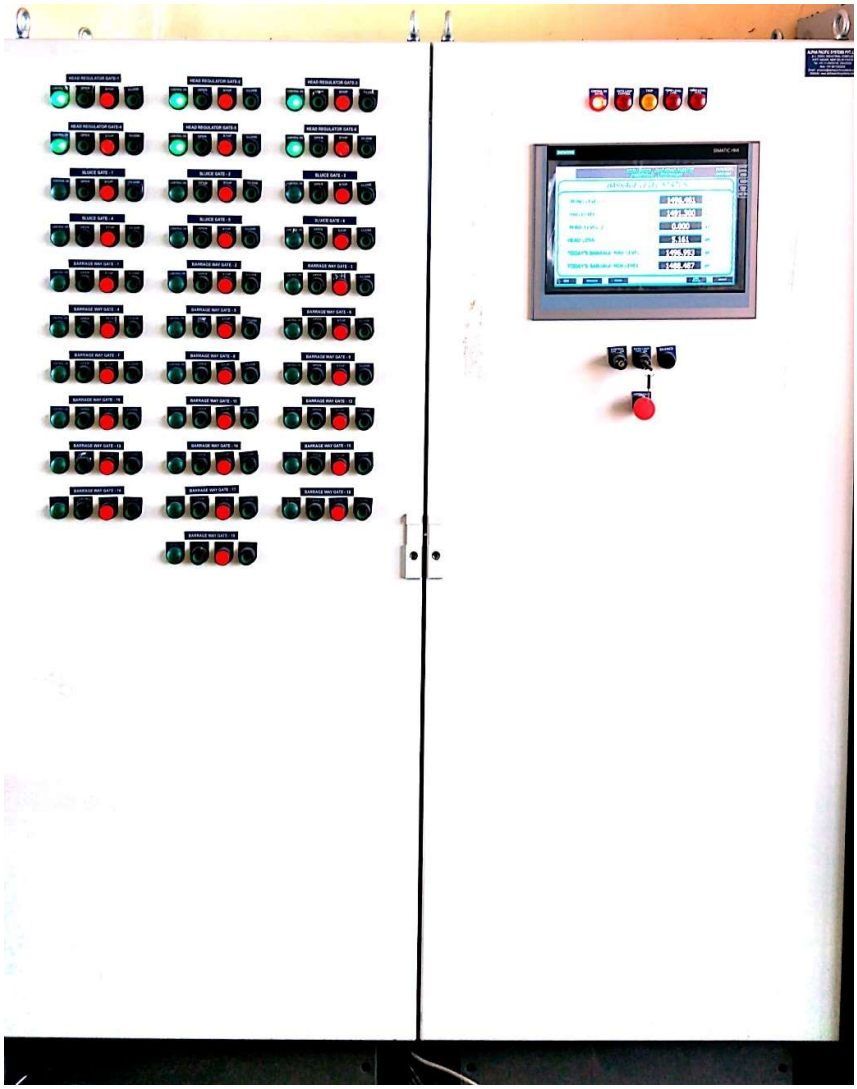
Appendix-VII

BARRAGE CONTROL CONSOLE



Design Criteria

The Barrage operation shall be based on a strategy of balancing the Reservoir inflow and out flow by checking and comparing measurements taken at interval of 30 minutes. The specified measuring system shall provide the data (reservoir level, gate position and power channel discharge) to determine the three above-mentioned parameters by the main computer in the BCR (Barrage Control Room).

Barrage Control Console

It shall be designed to accommodate all control & automation devices like push buttons for manual operation of various dam components such as vertical lift gates, head regulator gates, silt ejector gates, level measuring devices, gate position devices, sump level controllers & display, Distributed Control System (DCS), processors, communication modules, networking modules, analog & digital input/ output modules, remote control panels for gates, all digital displays for Barrage monitoring, power supplies, indications, annunciation modules, system safety components, hooters etc as required and confirming to all applicable standards of dam & Hydro Electric power Plants.

Control console shall be capable for efficient & safely control of Barrage monitoring, controls, remote control panels & alarms, all level displays, gate position displays, radial gate remote controls with all controllers, power supplies, status displays, total discharge display, differential head display, alarms, annunciators etc complete as required for all dam components.

The Barrage control console shall be connected with various components of the Barrage through RTU's with networked redundant profibus/wireless communication link and industrial Ethernet via LAN.

MOTOR DRIVE POWER PANEL FOR HEAD REGULATOR, UNDER SLUICE & SPILLWAY GATES

Motor Drive Power Panel

The MDPP's for head regulator, under sluice & spillway gates are designed to operate the gates in efficient and fail safe manner as per applicable standards. The main feature is programmable movement & position control, redundant Profibus/ ethernet /wireless communication ability through RTU's with barrage automation & control system complete with all safety features. It has following modes of operations facility.

- Local control from barrage MDPP panel.
- Remote control from barrage control room.
- Auto loop control through barrage control & automation system

The gates are controlled through local control panel, remote control panel through RTU's and through the control system in auto loop control depending upon the water levels in the barrage. The main control and power devices are installed in the MDPP which shall be installed outdoor in open area near the gates. The MDPP are designed for IP-65 protection with double door construction.

The panels shall be designed to avoid full opening of the gates at once to avoid flooding in the river. The MDPP shall be provided with software controlled programmable travel device to enable the controlled opening of the gates. The operator shall be able to set the desired opening of the gates as per requirement. The gates shall open as per the set travel at once and stop thereafter. All indications shall be operated at 24 VDC. The local control panel should have lock and key operated selector switch for Remote/ Local selection. The local control panel will also have hooter of range at least 500 mtr which will haul during the operation of the gates to alert every one present at dam.

The panel shall be provided with electromagnetic brake power supply & automatic control system for brake operation. The brakes shall OPEN automatically on OPENING/CLOSING command of the gates. The Brakes shall also close on stopping of gates due to normal stop and/or due to any fault in the drive. The motor drive power panel shall work stand-alone if the communication of processor is failed to perform.

LEVEL MONITORING SYSTEM

Level Monitoring System

The following levels shall be monitored:

- Pond level.
- Power channel Level
- Differential level across trash rack.

All levels shall be displayed in the control room by means of digital display meter. All digital display meters shall be calibrated to indicate actual elevation of the levels.

The differential head of water shall be calculated. Rate of rise / fall in the differential head shall be calculated. Alarm shall be raised at a defined "HIGH" and "VERY HIGH" differential head with rising trend. The differential head shall also be displayed in the control room.

Unaffected by temperature, pressure, vapor, or extreme dust, radar technology can measure applications up to 100 meters (328 ft). Radar technology offers answers to these challenging conditions that other technologies can't handle.

The level monitoring instrument confirms to following specifications.

Measuring Principle:	RADAR Level Measurement
Frequency:	78 GHz FMCW
Range:	40 Meter
Analog output	4 to 20 mA
Accuracy	0.02 mA
Communications	HART, Optional: PROFIBUS PA (Profile3.0, Class B)
Power supply:	4 to 20 mA/HART, Nominal 24 V DC (max. 30 V DC) with max. 550

POSITION SENSOR

Position & Status monitoring:

The system shall be able to read & transmit the status data of the head regulator, under sluice, spillway gates by means of suitable transducers & transmitters. Only absolute value type angular/ rotary/laser encoders decoders transducers shall be used to read the actual status of the gates in millimeters. The actual opening of all the gates shall be displayed at all times locally near the gates and on the control console on at least 25 mm character size. The data shall also be logged in to the computer by means of barrage automation and control system. The system should be compatible with any industrial grade digital display to monitor the gate opening locally at any time. The position monitoring devices shall be connected to RTU's and to the automation system through industrial grade redundant profibus & ethernet/wireless communication systems to achieve highest level of data reliability.

BILL OF MATERIAL

S. No.	Items	Quantity
1	Main Control Panel	01 No.
2	Barrage Control Console	01 No.
3	Motor drive power panels (Local Control Panels) for Silt Ejector gates	03 Nos.
4	Motor drive power panels (Local Control Panels) for Head Regulator gates	05 Nos.
5	Motor drive power panels (Local Control Panels) for Spillway gates	14 Nos.
6	Radar Type Level Measuring Instrument	02 Nos.
7	Laser type Position Monitoring transmitter	10 Nos.
8	Control Cables	1 Lot
9	Communication Cables	1 Lot

MAIN CONTROL PANEL				
S. No.	**Name Of Items**	**Rating**	**Qty.**	**Make**
1	ILLUMINATING TYPE PUSH BUTTON GATE OPEN & CLOSE (GREEN) FOR 22 GATES		44	SIEMENS
2	NO Contact Blocks for I/L PB, KEY ACTUATOR & SILENCE PB		47	SIEMENS
3	Illumination Module for I/L PB	110V AC	44	SIEMENS
4	PUSH BUTTON STOP (RED)		22	SIEMENS
5	NC Contact Block for RED PB		22	SIEMENS
6	LED INDICATION LAMP AMBER (TRIP)	230V AC	1	SIEMENS
7	LED INDICATION LAMP RED (CONTROL ON)	24V DC	1	SIEMENS
8	LED INDICATION LAMP GREEN (CONTROL ON)	230V AC	22	SIEMENS
9	LED INDICATION LAMP RED FOR POND LEVEL LOW, HIGH & AUTO LOOP CONTROL	230V AC	3	SIEMENS
10	2 POSITION KEY ACTUATOR CONTROL ON/OFF & AUTO LOOP ON/OFF.		2	SIEMENS
11	SILENCE PUSH BUTTON BLACK		1	SIEMENS
12	EMERGENCY STOP PUSH BUTTON WITH 1NC BLOCK		1	SIEMENS
13	MCB DP 10KA	32A	1	SIEMENS
14	MCB SP 10KA	6A	3	SIEMENS
15	POWER SUPPLY I/P: 100-240V; O/P: 24VDC / 12.5A		1	SIEMENS
16	CPU 314C-2PN/DP 24DI/16DO/4AI/2AO		1	SIEMENS
17	SIMATIC S7-300, RAIL L=480MM		1	SIEMENS
18	S7 MICRO MEMORY CARD, 512KB		1	SIEMENS
19	SM 323, OPT.ISOLATED, 16 DI & 16 DO,24VDC		5	SIEMENS
20	CP 340 COMMUNICATION PROCESSOR		1	SIEMENS
21	FRONT CONNECTOR, 40PIN,SCREW CONT.		7	SIEMENS
22	SCALANCE 8 PORT Switch		1	SIEMENS
23	HMI 15 Inch		1	SIEMENS
24	RELAY BOARD 24V DC 8 CHANNEL		12	PHEONIX
25	PANEL SMALL TUBE LIGHT 230V AC		2	HAVELLS
26	PANEL DOOR LIMIT SWITCH		2	ESSEN
27	PANEL TOWER LAMP (R,Y,B) INBUILT BUZZER 230V AC		1	IDEAL
28	3 WAY POWER SWITCH SOCKET		1	DHEERAJ

LOCAL CONTROL PANEL (22 Nos.)					
S. No.	**Name Of Items**	**Rating**	**Unit Qty.**	**Total Qty.**	**Make**
1	MCCB TP 25KA, with T/M & O/L & S/C PROTECTION	40A	1	22	SIEMENS
2	POWER CONTACTOR TP AC3	16A	3	66	SIEMENS
3	Auxiliary contact blocks 1NO FOR CONTACTOR		6	132	SIEMENS
4	Auxiliary contact blocks 1NC FOR CONTACTOR		2	44	SIEMENS
5	PHASE LED INDICATION LAMP RED	230V AC	1	22	SIEMENS
6	PHASE LED INDICATION LAMP YELLOW	230V AC	1	22	SIEMENS
7	PHASE LED INDICATION LAMP BLUE	230V AC	1	22	SIEMENS
8	LED INDICATION LAMP OPENING & CLOSING (GREEN)	230V AC	2	44	SIEMENS
9	LED INDICATION LAMP TRIP & COM FAULT (AMBER)	230V AC	2	44	SIEMENS
10	THREE PHASE DIGITAL VAF METER		1	22	RISHABH
11	CT CL. 1.0	20/5A	3	66	RISHABH
12	CT SHORTING LINK		3	66	PHOENIX
13	THERMAL OVERLOAD RELAY FOR 3HP STARTERS	3.2-5A	1	5	SIEMENS
14	THERMAL OVERLOAD RELAY FOR 5HP STARTERS	5-8A	1	14	SIEMENS
15	THERMAL OVERLOAD RELAY FOR 7.5HP STARTERS	8-12.5A	1	3	SIEMENS
16	PUSH BUTTON OPEN & CLOSE (GREEN)		2	44	SIEMENS
17	NO Contact Blocks for Green PB & L/R SS		4	88	SIEMENS
18	PUSH BUTTON STOP (RED)		1	22	SIEMENS
19	NC Contact Block for RED PB		1	22	SIEMENS
20	L/R SELECTOR SWITCH 3 POS.		1	22	SIEMENS
21	MCB SP 10KA	6A	6	132	SIEMENS
22	PANEL SMALL TUBE LIGHT 230V AC		1	22	HAVELLS
23	PANEL DOOR LIMIT SWITCH		1	22	ESSEN
24	CONTROL TRANSFORMER 440V/230V	100VA	1	22	TTC
25	HOOTER 230V AC		1	22	VAISHNO
26	MCB DP 10KA	10A	1	22	SIEMENS
27	ETHERNET SWITCH 8 PORT		1	22	AIRPRO
28	Power Supply 24V DC/6.2A		1	22	SIEMENS
29	CPU 1211C DC/DC/DC, 6DI/4DO		1	22	SIEMENS
30	SB 1231; 1AI		1	10	SIEMENS
31	RELAY BOARD 24V DC, 2C/O, 8 CHANNEL		1	22	UL AUTOMATION