I A HYDRO ENERGY PVT.LTD

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I A HYDRO ENERGY CHANJU-I HEP (3X12 MW)

HP50MH0022

DISTRICT CHAMBA HIMACHAL PRADESH

EMERGENCY ACTION PLAN 2022-2023

I A Hydro Energy Pvt. Ltd.
Chanju-I Hydro Electric Power Plant
Vill. Kathwar P.O Bagheigarh Tehsil Churah Distt. Chamba
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I A Hydro Energy Private Limited

Emergency action plan for I.A Hydro Energy Private Limited dam was published in the year of 2017. This is the 03 revision of EAP plan as updated on March, 2022. Every effort has been taken to estimate the severity of flooding and inundation areas likely to be affected by I A Hydro Energy Private Limited Chanju-I HP50MH0022 in an emergency condition. These estimates are based on availability of primary and secondary data. Every effort has been made to foresee varied emergency possibilities and develop appropriate notification procedures for timely rescue and relief operations.

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1. Introduction

Chanju-I HEP 36MW has been envisaged as a run of river scheme on Chanju Nallah, a tributary of Baira river which in turn drains into the river Ravi, in Chamba Distt. Of Himachal Pradesh. The scheme is located upstream of the exiting Baira Suil HEP (198 MW). The nearest rail head is at Pathankot about 120 km from Chamba town. The project is located on Chamba-Kathwar road at about 77 Km from Chamba town. The projects involve the construction of gated weir across the Chanju Nallah at about 100m downstream of the confluence of the Chanju Nallah & Bhararu Nallah.

2. Purpose

The purpose of the Emergency Action Plan (EAP) is to identify emergency situation that could threaten I.A Hydro Energy Private Limited Chanju-I HP50MH0022 Barrage and to plan for an expedited, effective response to prevent failure of the Barrage and warn downstream of impending danger. This plan defines the notification procedure to be followed in the event of a potentially hazardous situation. The procedures are intended to protect lives and prevent property damage from an excessive release of water from the Barrage spillways or an uncontrolled outflow of water from the breached portion of the Barrage.

3. General Description of Dam

The project involves the construction of a gated weir across the Chanju Nallah at about 100m downstream of the confluence of the Chanju Nallah and Bhararu Nallah. The water conductor system comprises twin side intakes, twin feeder tunnels, twin desilting basins, twin connecting tunnels.

1. Location

State	:	Himachal Pradesh
District	:	Chamba
River/Stream	:	Chanju Nallah, a tributary of Baira Nallah and a sub-tributary of river Ravi.
Vicinity	:	Diversion weir on Chanju Nallah at about 100m downstream of Bhararu Nallah confluence and Power House on the right bank.

2. Geographical Co-ordinates of Project Area

Longitude	:	76°14'52"E
Latitude	:	32°44'14"N
Seismic Zone	:	**V**

Access distance from

New Delhi	:	670 km
State Capital Shimla	:	378 km
District Head Quarter, Chamba	:	70 km
Nearest Rail Head, Pathankot	:	197 km
Nearest Airport, Pathankot	:	197 km

3. Diversion Structure

Type	:	Gated weir (Barrage)
Average River Bed Level	:	El. 1426.00 m
Crest Level of Barrage Bays	:	El. 1427.00 m
Crest Level of Sluice Bay		El. 1426.00 m
Bridge Deck Level	:	El. 1442.00 m

4. Barrage Bays

No. of bays	:	4
Width of each Bay	:	6.5 m
Thickness of Piers	:	2.0 m
Clear width of Barrage Bays	:	26 m
Type and Height of Gate	:	Radial gate, 7.0 m

5. Under Sluice Bays

No. of under sluice bays	:	1
Width of each Bay	:	6.5 m
Thickness of Pier	:	2.0 m
Crest Level of Under Sluice Bays	:	El. 1426.00 m
Clear Width of under sluice portion	:	6.5 m
Type and Height of gate	:	Radial Gate, 7.0 m high

6. Reservoir

Full Reservoir Level (FRL)	:	El. 1440.00 m
Minimum Draw Down Level (MDDL)	:	El. 1432.75 m
Live Storage	:	60000 m^3

7. Energy Dissipation System	:	Hydraulic Jump Type Stilling Basin
Length of basin	:	47.5 m
Width of basin	:	39.5 m
D/s Floor Level	:	El. 1423.00 m

8. Power Intake

Type	:	Side Intake
No. of intakes	:	1
Size of Intake	:	2 bays each, vertical lift gate 1.90 m wide & 3.50 m high 3.75 m with 1.5 thick pier.
Invert Level of Intake	:	El. 1426.00 m
Top Lip Level	:	El. 1429.00 m
Minimum Draw Down Level (MDDL)	:	El. 1432.75 m

Design Discharge including 20% for sediment flushing.	:	16.85 x 1.2 = 20.22 m^3/s

9. Feeder Tunnels

Number	:	2
Design Discharge in each Feeder Tunnel	:	10.11 m^3/s
Type	:	D shaped (4.5 m X 3.5 m) with middle wall
Length of main twin Feeder tunnel	:	126 m

10. Desilting Chamber

Type	:	Underground hopper type
Number of Basins	:	2 Nos.
Size	:	B = 9.25 m
		D = 9.0 m
		L = 83.0 m
Side Slope of Hopper	:	1H : 1V
Average Discharge for each Basin	:	9.27 m^3/s
Average Flow-through velocity	:	0.16 m/s
Flushing Arrangement	:	Two no's of 0.7m dia flushing pipes.
Flushing velocity	:	> 5 m/s

11. Connecting Tunnels

Type	:	D-shaped, Concrete lined
Size	:	3.2 m x 3.2 m

	Length	:	41.0 m and 50.5m
12.	**Head Race Tunnel**		
	Type	:	D-shaped, concrete lined
	Size	:	3.2 m x 3.2 m
	Total Length (a)	:	4040.0 m
	Type	:	Circular-shaped,reinforced concrete lined
	Size	:	3.4m dia
	Total Length (b)	:	540.0 m
	Type	:	Steel lined pressure tunnel
	Size	:	2.3 m dia
	Total Length (c)	:	748m
	Total length of water conductor system (a+b+c)	:	5328m

An integral part of any hydroelectric development is the preparation of an Emergency Action Plan (EAP). The Chanju-I hydroelectric project EAP is prepared to meet the requirement of the Directorate of Energy, Government of Himachal Pradesh.

The Barrage is design to meet and exceed all standards for dam safety however the plan is developed in the interest of public safety when an unlikely emergency situation arises. The main hydroelectric power plants and dams in Ravi river basin under operation/ implementation/ construction upstream and downstream of Chanju-I HEP are:

A. Upstream of Chanju – I HEP:

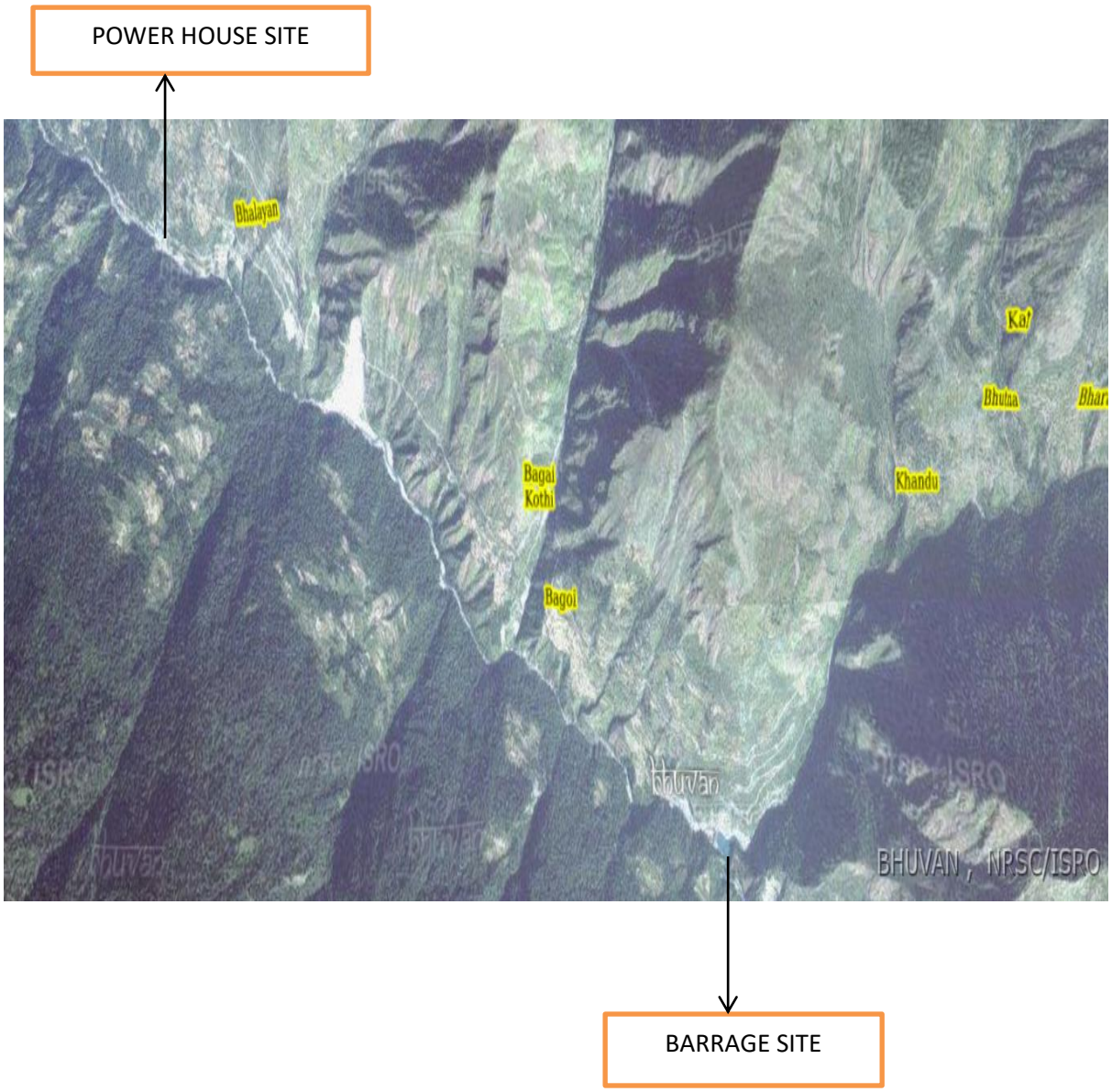
- Chanju - II Hydro Electric Project – under operation.
- Chanju - III Hydro Electric Project - under implementation

B. Downstream of Chanju – I HEP:

- Trench weir of Baira Suil Hydroelectric Project -under operation
- Chamera-I Hydroelectric Project -under operation
- Ranjit Sagar - under operation

4. Description of the Downstream Inundation Areas

An inundation mapping is used to depict areas that could potentially flood if dam fails. As the FRL of our Barrage is EL. 1440.00 m and in case of our barrage failure there will be no flood hit area in the downstream. Further it is intimated that there is no habitation along the downstream of the Chanju Nallah till it entered in Baira Suil river only the Power house structure of Chanju-I and trench weir structure of Baira Suil are situated on the bank of this Chanju Nallah which are safe for any flood level. Thus there is no hazard to any public or any agricultural land etc.



5. Responsibilities

The person identified in this EAP with primary responsibility for emergency response are listed below:

5.1 Control Room Operator/ Shift Incharge (Barrage Complex) – The Control Room Operator located at Barrage site will be responsible for making immediate decisions regarding operations of the barrage during an emergency, in co-ordination with the Resident Engineer (Barrage Complex).

5.2 System Control Centre Operator/Shift Incharge (Power House Complex)- The System Control Center (SCC) Operator, IAHE located inside powerhouse building of Chanju-I HEP must ensure that all key IAHE persons to be notified are contacted as soon as possible. Decisions on emergency response are the responsibility of the key personnel noted in this document. The primary responsibility of the SCC is to manage the notification process. This involves co-coordinating all communications and recording activities of all involved personnel.

5.3 Barrage Incharge (Barrage Complex) – The Barrage Incharge will be responsible to deploy resources as required to prevent or delay the incident. This involves coordination with engineers, consultants and contractors. He will also coordinate with the Dispatch Engineer regarding immediate decisions for operation of the dam. The Barrage Incharge will also decide if/when to recommend facility of evacuation. In addition the Barrage Incharge, together with the Dispatch Engineer will determine action with regards to the operation of the hydroelectric plant.

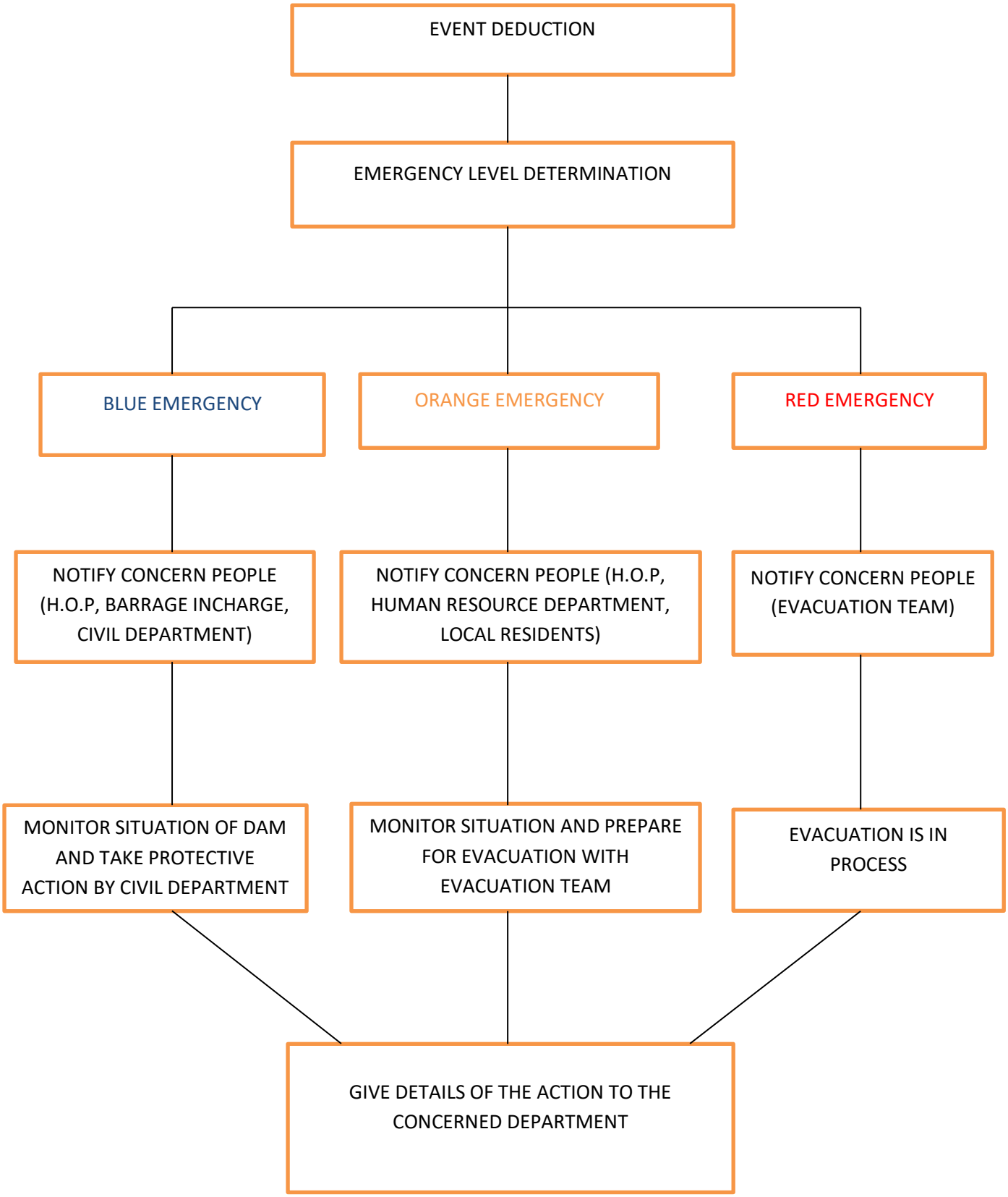
5.4 Power House Incharge (Power House Complex) – The Dispatch Engineer will be responsible to take corrective actions to ensure integrity of the IAHE grid system.

5.5 Project Head/ Consultant - The Project Head of IAHE will be responsible and ensure over all activities in a coordinate manner to inform the nearby Police station and downstream projects and civil administration. In certain barrage incidents, the Project Head may deem if necessary to contact the Director and Managing Director.

6. Notification Flowchart

6.1 Description of Emergency Alert levels and Notification Type

Type of alert	Emergency Level	Situation	Actions to be taken
INTERNAL ALERT	BLUE	Existence of anomalies or events that are either harmless or might compromise to some structural or operational safety of the dam or dam observation system. The situation is stable or is developing extremely slowly. Events leading to such a slowly developing situation include the following: 1. Existence of minor foundation problems.	1. Issue watch condition notification with a BLUE emergency level alert. 2. Monitor situation closely. 3. Take corrective measure to solve the problem.
EXTERNAL ALERT	ORANGE	Situations with a high probability of dam failure, with the belief that it might not be possible to control the situation and might cause serious consequences downstream of the dam. Events leading to such a rapidly developing situation include the following: 1. Detection of severe anomalies in- dam structural elements, or- in dam operational elements. 2. Existence of severe foundation problems. 3. Occurrence of extremely large floods	1. Issue Failure Condition notifications with an ORANGE emergency level alert. 2. Take corrective emergency measures to solve the problem. 3. Warning -Population downstream of the dam to prepare for evacuation however there is no population to the downstream of the dam. 4. Mock drill of evacuation team. 5. Keep the ambulance and other vehicle ready.
EXTERNAL ALERT	RED	Situation of inevitable catastrophe described as follows: 1. Imminent dam failure because of flood waters overtopping the dam crest, or appearance of large flows through channels (piping) eroded through the embankment. 2. Dam failure in progress. No time will be available for analysis, decisions, and mitigation to be made before downstream impacts occur.	1. Issue Failure Condition notifications with a RED emergency level alert. 2. Issue the most severe evacuation warning. Focus on evacuating first those most at risk. 3. Immediate warning to all the quarter concern.


EVENT DEDUCTION
EMERGENCY LEVEL DETERMINATION
BLUE EMERGENCY
ORANGE EMERGENCY
RED EMERGENCY
NOTIFY CONCERN PEOPLE (H.O.P, BARRAGE INCHARGE, CIVIL DEPARTMENT)
NOTIFY CONCERN PEOPLE (H.O.P, HUMAN RESOURCE DEPARTMENT, LOCAL RESIDENTS)
NOTIFY CONCERN PEOPLE (EVACUATION TEAM)
MONITOR SITUATION OF DAM AND TAKE PROTECTIVE ACTION BY CIVIL DEPARTMENT
MONITOR SITUATION AND PREPARE FOR EVACUATION WITH EVACUATION TEAM
EVACUATION IS IN PROCESS
GIVE DETAILS OF THE ACTION TO THE CONCERNED DEPARTMENT

7. Emergency Identification

7.1 Potential Serious Situation

A Potential Serious Situation is defined as a hazardous condition at the barrage, which, if not attended to, may develop into an emergency situation. Listed below are examples of conditions, which could potentially lead to barrage failure if mitigative measures are not taken. Respective inspection checks are also listed.

- **Excessive/increase amounts of seepage:**
  Check drains in the gallery for any abnormal increase in quantities of seepage.

- **Movement on the barrage crest:**
  Check for deflection on the barrage crest.

- **Spillway Obstruction:**
  Check spillway to ensure no blockage due to debris.

- **High inflows:**
  Check for water levels that are higher than normal reservoir levels.
  Check weather forecast for expected amounts of precipitation.
  Check for rapid rate of rise of water levels.

- **Widespread flooding:**
  Perform an aerial site inspection.

Rapid reservoir drawdown could also be a sign of a potential problem. This condition should be detected through continuous water level monitoring at **Control Room of Barrage complex and power house complex, IAHE.**

8. Barrage Failure

A **Barrage Failure** is defined as the failure of the barrage itself or its foundation, which results in large or rapidly increasing uncontrolled releases of water from the reservoir. It can be identified by the formation of a breach in the barrage or foundation. It is impossible to determine how long it will take for a complete failure to occur once a significant breach has formed. Once a significant breach has occurred regular updates of the warning will be issued as long as the threat exists.

9. Emergency Response

9.1 Technical Information

Response to any emergency arising out of a Barrage Incident or Barrage Failure will be greatly improved by having information in the hands of responsible persons in order to properly determine risks and possible outcomes. This information will allow the Control Room Operator, IAHE and the Barrage Incharge, IAHE to keep abreast of the prevailing hydrological condition and resulting rainfall/runoff patterns.

9.2 Access to the Site

Another important factor in responding to an emergency is access to the site. This access can be severely hampered during major storms. Such storms also cause floods creating a requirement to get to the site. This section provides information on gaining access to the site and the various methods available.

- **Vehicles**

IAHE has the following equipment at their disposal to travel to the site
• Four wheel drive SUVs
• Ambulance Van
• Loaders

Vehicles required during an emergency will also be available from IAHE.
Access to vehicle after hours will be available from the Barrage & Power House, IAHE.

- **Road Access**

Access to the Chanju-I Barrage complex is via the Bagheigarh-Chanju connecting with the state highway. The power house complex can be accessed by two roads one of which is through store/ workshop and the second one connects the Bhaled weir of Baira Suil HEP with the state highway.

- **Air Access**

Generally the only type of aircraft, which could be used in an emergency or non-emergency situation, would be helicopter. However, currently there is no helicopter landing facility near the Barrage or Power house complex.

10. Response during Darkness and Adverse Weather

10.1 Periods of Darkness

- ✓ High Mast light has been installed at Barrage site.
- ✓ Vehicles are equipped with emergency lighting (i.e. spotlights). In addition to the standby diesel generators at the Chanju –I barrage and power house complex.

10.2 Periods of Adverse Weather

- ✓ The response plan is unchanged in principle in periods of adverse weather. IAHE's emergency response teams are equipped to handle extreme working conditions resulting from adverse weather.

11. Impact on Communication Systems

- **Telephones** – The impact of the loss of power to the telephone system is expected to be minimal as the telephones used for communications are of Landline type which are battery operated & having self-phone- exchange inside the plant.

- **Walky Talky –** Power at the repeater sites is backed up by small, self-contained generating units. Walky talky units are generally used for in case of any emergency.

- **Data Transmission** – The impact of the loss of power is expected to be minimal as optical fiber cables shall be used for data communications which shall be backed by diesel gensets in case of power failure.

- **Cellular Phones** – The cellular phones have connectivity on all work sites of the project.

12. Advance Flood Warning Arrangement

Our Barrage is situated at the confluence, Chanju & Bhararu Nallahs. In order to safeguard permanent structures of the project against exceptional floods, flood warning system i.e. one check post has been installed at Charda along the upstream of Barrage & One check post has been installed at Jhakla about 04 KM upstream of Barrage Site to safe guard the project component & for the safety of man & machinery employed at the project site having telecommunication & wireless system which would also help in timely warning regarding impending flood.
For various inflow flood discharges it is to be ensured that the maximum reservoir level would not go higher than 1440.50 m. To deal with large flood of large magnitude, it is absolutely necessary that accurate & timely warning of heavy inflows into the reservoir are transmitted to control room at Barrage site, so that sufficient time is available for proper assessment of flood & depleting the reservoir in anticipation of heavy inflows & timely operations of the gates in the Barrage is resorted.
Approximate time taken by an electrically operated Radial gate to open fully is about 10 minutes. In case of power failure 1 no of DG Set is installed- (125KVA), so the amount by which the gates need to be raised can be calculated according to the magnitude of anticipated flood so as to deplete the reservoir in advance & the safe guard against overtopping of the Barrage in case of flood with magnitude higher than the design flood. Thus the decision regarding raising the gates will depend upon the information on magnitude of incoming flood communicated by the warning stations based on this, the requirement of depleting the reservoir level & raising the dam Sluice Radial gate shall be decided by the Barrage Incharge.
On receiving information about the approaching flood or if silt content shows a raising trend beyond the upper permissible limit, the power plant shall be shut down & intake gates shall be closed. The reservoir shall be depleted & all gates shall be lifted completely to allow free flow conditions. The rise of water level on upstream & downstream side of Barrage shall be monitored at regular interval (Every 10 minutes) during the flood. Thus in the event of floods, the gates may be required to be raised in definite sequence. Chanju-1 HEP gates operation activity is very crucial during floods. So, operation schedule shall be followed strictly. Once the flood abates & silt concentration shows a downward trend close to upper limit, the reservoir shall be filled again & power generation shall be resumed.

Chanju nallah is a deep gorge and no habitants on its banks. Further this Nallah discharge to Baira Suil river a tributary of “Ravi river” & finally to Chamera Dam. Thus there is no hazard to any public or any agricultural land etc.

13. Action to be taken in case of Power House Shutdown due to unprecedented floods, earthquake and cloud burst etc.

Sr. No.	Description	Action to be taken
1.	If upstream water level is at or below the FRL 1440.00m and discharge is around 100-200 cumecs.	It may be considered as Normal Flood condition and can be passed through Barrage Sluice Radial gates as per the procedure given in Annex-I. Hourly silt samples are to be taken and in case the values exceed the permissible limits (please refer para no. 4), information must be passed to power house for closure of machines. Intake & SFT valves shall be closed in phased manner as per the procedure given in Annex-II. The projects under execution downstream of Barrage shall be immediately informed as per the list attached as Annex-V.
2.	Reservoir level approaching FRL of 1440.00 m & flood discharge in the range of 200-300 cumecs.	A flood up to the magnitude of 200 to 300 cumecs can be passed through one of the Radial gates or Barrage Sluice Radial Gate as per the procedure given in Annex-I. It is presumed that silt load will be above the permissible limit as detailed in Para 4 for operation of Chanju-I HEP units. This is possible if advance warning of flood about the magnitude of flood is available about 1 hour in advance so that all the gates can be opened and reservoir level is brought down to free flow level which is possible since the advance warning station at Charda and Jhakla are functional. Immediate information is to be conveyed to power house and generation in the power house shall be stopped before bringing down the water level below MDDL. Intake, SFT gates & TRT outfall gates shall be closed in phased manner as per the procedure given in Annex-II. The project downstream of Barrage shall immediately inform as per the list attached as Annex-V.

Sr. No.	Description	Action to be taken
3.	Reservoir level above FRL and discharge in the range of 300-650 cumecs.	In case the discharge is of the order of 450 cumecs is due to flash flood etc. in the tributaries the same can be passed through Sluice gate by restoring to flood routing. It is presumed that silt load will be above the permissible limits as detailed in Para 4 for operation of Chanju-1 HEP units. Immediate information is to be conveyed to power house and generation in the power house shall be stopped before bringing down the water level below MDDL. Intake & SFT gates and TRT outfall gates shall be closed in phased manner as per the procedure given in Annex-II. Immediate information shall be passed on to Civil Authorities, Warning stations, downstream project authorities and defense department etc.
4.	Reservoir level between 1439.50 – 1440.00 m and discharge in the range of 650-1000 cumecs.	A flood of the magnitude of 1000 cumecs can be passed through by opening the three gates i.e. Sluice Radial Gate and other Barrage Radial Gates by resorting to flood routing as per the procedure given in Annex-I. It is presumed that silt load will be above the permissible limits as detailed in Para 4 for operation of Chanju-1 HEP units. Immediate information is to be conveyed to power house and generation in the power house shall be stopped before bringing down the water level below MDDL. Intake & SFT gates and TRT outfall gates shall be closed in phased manner as per the procedure given in Annex-II. Staff working in the dam complex area would be asked to be ready for evacuation. Immediate information shall be passed on to Civil Authorities, Warning Stations and projects downstream, Civil Authorities & Defence Department as per the list attached as Annex-V etc.

Sr. No.	Description	Action to be taken
5.	Reservoir level above FRL 1440.00 and still rising after opening of all the Radial Gates & discharge above 2000 cumecs.	In case information regarding flood of the magnitude more than 2000 cumecs is received from Chanju Nala & Bhararu Nala, it can be passed through Barrage sluice radial gate & Barrage radial gates by opening of Radial gates as per the procedure given in Annex-I by resorting to flood routing. But in case the level is still rising after opening of all the gates it is an emergency situation and immediate information is to be conveyed to higher authorities and Power house. Instructions should be given to the manpower working at Chanju-1complex that after opening Radial gates fully and dogging them, closing all the intake gates, SFT gates and TRT outfall gates the complex should be evacuated and all the staff should move to safer place. Immediate Information shall be passed on to Civil Authorities, Warning Stations, projects downstream, Defense department etc. as per the list attached as Annex-V asking people living near HFL mark asked to be ready for evacuation .
6.	Earthquake	After the earthquake, the visual inspection of dam body & other civil structure etc. will be carried out and instrumentation readings will also be taken and the same shall be intimated to the design department. If instrumentation readings indicate earthquake of magnitude more than DBE, the information shall be immediately passed to Power House, Civil Authorities & Defence Department. If there appears to be any possibility any substantial damage or failure of Barrage due to earthquake, Immediate information shall be passed on to Civil Authorities, Warning Stations, projects downstream, Defence department etc. as per the list attached as Annex-V and people living near HFL mark asked to be ready for evacuation Necessary action to shift the Chanju-1 staff to safer places shall be taken by the project authorities.

14. Action to be taken in case of Power House Shutdown due to increase in silt values above permissible level i.e. the silt value in river is above 2000 PPM

Sr. No.	Description	Action to be taken
1.	For silt value between 500 - 1000 PPM	The silt sample will be taken every 15 minutes.
2.	For silt value between 1000-1500 PPM	The silt sample will be taken 10 minutes.
3.	The silt value in river is above 2000 PPM	The information shall be immediately passed to Power House and Shift in-charge for preparation of shutdown of Power House. Radial Gate No. 1 and 2 shall preferably be opened first to flush out the silt and Intake & SFT gates shall be closed in phased manner as per procedure given in Annex-II

- **Manpower requirement in case of Emergency Shutdown of Powerhouse.**

1 Executive, 1 Engineer, 1 Technician, 1 Helper

- One executive is required to co-ordinate closing of Intake gates with shutdown of machines and to maintain or gradually deplete reservoir level by coordinating Radial gate operation and to communicate with power house to get status of machines and to inform status about gates operation.
- 1 Engineer is required for closing SFT valves from SCADA.
- 1 technician and 1 helper minimum are required to operate intake gates.
- 1 Engineer is required to operate Radial gates.

15.Checklist before Shutdown of Powerhouse

The checklist is enclosed as Annex-IV. Please ensure the following activities:

1. Power supply backup, D.G. in our case, is in order.
2. Downstream projects have been informed about power house shutdown and amount of discharge to be released.
3. Communication facilities are in order.
4. Transportation facilities are available.

16. DAM BREAK ANALYSIS

Dams are structures constructed across rivers to serve various purposes. Construction of dams has been in practice since a very long time. With the progression of time, various types of dams were constructed based on the location and prerequisite of society and designs were enhanced with the advancement of technology. The types of dam commonly found are:-

- Earthen/Rockfill dams.
- Concrete and Multi arch dams.
- Gravity Dams.
- Buttress Dams.
- Concrete, steel, timber & composite material dams.

With all the benefits, constructions of dams may prompt to tremendous problems on the failure of the dam structure. Dam failure is generally catastrophic and may occur due to many reasons such as piping through the structure, overtopping, design error, heavy rainfall generated runoff, earthquake, etc. There are total 13 causes of failure listed in Hydrologic Engineering Centre (HEC) research document. Whatever might be the reason, the results are devastating. On failure of a structure the energy stored behind the dam can cause a rapid and unexpected flood in downstream of the dam, resulting in loss of life and property. As a dam break possess high hazards, dam break analysis is considered very essential. Dam break analysis can be carried out by either Mathematical simulation using the computer or scaled physical hydraulic model.

There are two important parameters of dam breach analysis i.e. Prediction of reservoir outflow hydrograph and routing of that hydrograph through the downstream area. To predict reservoir hydrograph there are some fundamental steps to be followed such as prediction of breach characteristics which includes the shape and size of the breach and rate of breach formation, routing of reservoir storage and inflow through the breach.

16.1 Objectives:-

The following are the objectives of Dam Break Analysis:-
(i) Determination of outflow hydrograph and the peak discharge.
(ii) Estimation of dam breach parameters using appropriate empirical formulae.
(iii) Routing of peak discharge and prediction of hydrograph at different sections in downstream up to the point of consideration.
(iv) Mapping of Inundation levels.

16.2 Dam break modelling process

Generally, dam break modelling can be carried out by either

- Scaled physical hydraulic models.
- Mathematical simulation using computer.

A modern tool to deal with this problem is the mathematical model, which is most cost effective and approximately solves the governing flow equations of continuity and momentum by computer simulation. Mathematical modeling of dam breach floods can be carried out by either one dimensional analysis or two dimensional analysis.

In one dimensional analysis, the information about the magnitude of flood, i.e., discharge and water levels, variation of these with time and velocity of flow through breach can be had in the direction of flow.

In the case of two dimensional analyses, the additional information about the inundated area, variation of surface elevation and velocities in two dimensions can also be forecasted.

One dimensional analysis is generally accepted when valley is long and narrow and the flood wave characteristics over a large distance from the dam are of main interest. On the other hand, when the valley widens considerably downstream of dam and large area is likely to be flooded, two dimensional analysis is necessary. The basic theory for dynamic routing in one dimensional analysis consists of two partial differential equations originally derived by Barre De Saint Venant in 1871. The equations are:

i. **Conservation of mass (continuity) equation**

$$(\partial Q/\partial X) + \partial (A + A0) / \partial t - q = 0$$

ii. **Conservation of momentum equation**

$$(\partial Q/\partial t) + \{\partial (Q^2 /A)/\partial X\} + g\ A\ ((\partial h/\partial X) + Sf + Sc) = 0$$

where Q = discharge; A = active flow area; A0 = inactive storage area; h = water surface elevation; q = lateral outflow; x = distance along waterway; t = time; Sf = friction slope; Sc = expansion contraction slope and g= gravitational acceleration.

16.3 Conclusion

We have constructed a gated weir for which a Barrage formation has occurred having approximately stored 70000 cubic meter water which not in any way would cause harm to the downstream habitation and agricultural land. Since it is a Barrage and no dam break analysis has been done by us. We inspect our Barrage structure regularly.

As per our survey since Chanju gorge being a deep gorge and no habitation is there till it enters the Baira River only two structures are there one is Chanju-I Power station and other one is Baira Trench weir which is safe from any type of flood level.

ANNEX-1

- **OPERATIONAL PROCEDURE FOR DAM SLUICE & BARRAGE RADIAL GATES**

(A) When the river inflow is less than of 20 cumecs:-

- Maintain the reservoir level between El. 1439.50m and El. 1440.00m if the discharge is more than 19 cumecs maintains the reservoir level El. 1438.00 m.
- In the case of sudden closure of Power House, release the excess discharge through Sluice and Radial Gate.

(B) When the river inflow is between 20 cumecs and 30 cumecs:-

- Maintain the reservoir level between El. 1438.00m and El.1439.00m.
- Release excess discharge through Sluice Radial gate in order to flush out silt in front of Intake gate.
- If the discharge appears to be higher through the under-sluice gate, Radial gate No. 5 used to be opened, and then Gate No. 2 & 4 and at last Gate No. 3.

(C) When the river inflow is very high (flood conditions) cumecs and river silt is more than 4000 ppm:-

- Gradually start depletion of reservoir level by opening Radial gates.
- End Radial gate shall be operated first. It shall be initially raised/opened partially (minimum 10% of total opening height). If this opening is not sufficient to pass the surplus discharge, centre gate shall be opened. And if required other gates shall be opened in symmetrical manner.

Annex- II

- ## Sequence of Activities during Shutdown of Powerhouse

In case flood warning is received from warning station or increase in silt content in both side of Nala (Chanju Nala & Bhararu Nala) is observed the information shall be immediately passed to Power House, downstream project authorities district administration, and then follow the activities as given below.

1. Gradually start depletion of reservoir level by opening Radial gates (the rate of depletion should not be more than 5 m/ hour.
2. Close SFT valve 1 of Chamber # 1 after shutdown of 1st machine.
3. Close SFT valve 2 of Chamber # 2 after shutdown of 2nd & 3rd machine.
4. Close Intake gate of Chamber # 1 after 10 minutes of shutdown of 3 machines.
5. Close Intake gate of Chamber # 2 after 10 minutes of shutdown of 3 machines.
6. Gradually decrease level to free flow condition (the rate of depletion should not be more than 5 m/ hour).
7. Keep Radial gates open as long as the flood passes by and silt content in the river comes to the permissible level.
8. Keep the gates in dogging position if shutdown is carried out due to high flood (above 2000 cumecs).

Annex-III

- **Sequence of activities in case of starting Power House after Shutdown.**

1. Gradually increase reservoir level by closing Radial Gates (the filling rate should not be more than 2m /hour).
2. Crack open Intake Gate -2 when reservoir level is above the MDDL of 1433.00 m.
3. Make sure that the Intake gate is crack open and water is flowing through the Intake Gate.
4. Check water level downstream of intake gate.
5. Open Intake Gate -1 when water level downstream of Intake and Reservoir level are balanced (this condition is necessary for smooth opening of Intake Gate).
6. Open SFT valve of Chamber # 1 after opening Intake Gate # 1.
7. Open SFT valve of Chamber # 2 after opening Intake Gate # 2.
8. Inform Power House about opening of Intake Gates.
9. Maintain reservoir level as instructed.

Annex-IV

Checklist for Power House Shutdown

Before and during reservoir depletion in case of power house shutdown:

Sr. No.	Description	Remarks	
1	Downstream Projects have been informed	**YES**	**NO**
2	Inlet Gates is closed (20 min after the shutdown of plant)	**YES**	**NO**
3	Required No. of manpower are available.	**YES**	**NO**
4	Required No. of Vehicles are available	**YES**	**NO**
5	DG set is in Order	**YES**	**NO**
6	Communication facilities are in order	**YES**	**NO**
7	Alarm is Given by operating the Hooter	**YES**	**NO**
8	Before closing Intake gates it is Ensured that respective SFT valve is Closed.	**YES**	**NO**

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