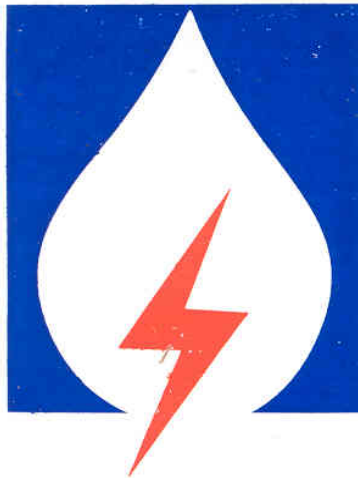


EMERGENCY PREPAREDNESS PLAN

FOR NATHPA DAM IN CASE OF UNPRECEDENTED
FLOODS, INCREASE IN SILT CONTENT, EARTHQUAKE,
NATURAL CALAMITY ETC.



SJVN Ltd

Revised on
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EMERGENCY PREPAREDNESS PLAN FOR NATHPA DAM

1. INTRODUCTION

The Nathpa Jhakri Hydroelectric Project (1500 MW) is under operation since October, 2003/May, 2004. This is a run of the river project constructed on river Satluj and contains 4 nos. underground Desilting chambers, each of size 525 x 27 x 16.5m to eliminate silt particles of 0.2 mm (one of the largest underground complex) and 27.392 km long, 10.15m diameter concrete lined, circular Head Race Tunnel and 301 m deep, 21m/18m diameter Surge Shaft. Three pressure shafts which bifurcates near Power House, feeding six Francis Turbines, each of 250 MW capacity. A 982m long Tail Race Tunnel conveys the water to an Outfall Structure on the left bank of river Satluj, through which the water is finally discharged into river Satluj (at present) and shall be diverted into the Head Race Tunnel of Rampur Hydroelectric Project (412 MW) after commissioning .

The Satluj River originates near Rakas Tal in Tibet and is fed by Lake Mansarowar at an altitude of 4570m. After traveling about 300km in Tibet, it enters into Indian Territory near Shipkala. In India, it travels for about 10-15km before the Spiti river joins it at Khab. Spiti is the main tributary of Satluj river. The Spiti River originates from Kunjam-La (El. 4550m) and after traveling for 130km through cold desert of Spiti valley, joins Satluj river at Khab (El.2549m). Baspa is another important tributary of the river Satluj in its upper courses. Satluj River leaves Kinnaur district in the West near Chauhra and enters Shimla district.

The total hydropower potential of Satluj river basin as estimated is 9728.25 MW out of which 5515.75 MW is being harnessed through projects that are either under operation or in construction stages.

The main hydroelectric power plants and dams on river Satluj under operation / implementation / construction upstream and downstream of Nathpa dam are:

A. Upstream of Nathpa dam -

1. Khab Hydro Electric Project, Kinnaur District (P)- under DPR
2. Karcham Wangtoo Hydroelectric Project, Kinnaur District (BC)- under construction
3. Baspa Hydroelectric Project, Kinnaur District (C)- under operation
4. Bhaba Hydel Project, Kinnaur District (C)- under operation

B. Downstream of Nathpa dam

1. Sorang Hydropower Project, Kinnaur District -under construction
2. Ghanvi-I, Shimla District, -under operation
3. Ghanvi –II, Shimla District , under implementation
4. Rampur Hydroelectric Project, Shimla-Kullu District - under construction
5. Luhri Hydroelectric Project, Shimla, Kullu, Mandi Districts. - under implementation
6. Kol Dam -under construction
7. Bhakra Dam -under operation

2. REASONS FOR EMERGENCY

1. Unprecedented floods , rise in silt content of water, cloud burst or any other natural calamity
2. Earthquake may affect any part of Dam, Landslides may cause obstruction to the flow creating lakes, possible failure of a dam, sudden release of stored water from upstream dams and failure of any underground structure due to geological reasons etc.

3. Advance Flood Warning Arrangement

In order to safeguard permanent structures of the Project against exceptional floods, elaborate flood warning system have been installed at Khab and Powari to safeguard the project components and for the safety of men and machinery employed at the project sites having telecommunication, wireless and satellite based data communication system along the course of river Satluj from the point where it enters India to enable data transfer on real time basis 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 El. 1495.75m. To deal with flash floods of large magnitudes, it is absolutely necessary that accurate & timely warning of heavy inflows into the reservoir are transmitted to control room at Nathpa, so that, sufficient time is available for proper assessment of flood and depleting the reservoir in anticipation of heavy inflows and timely operation of gates in the dam is resorted to.

The travel time of peak flow from gauging stations at Khab to the dam is around 6 hours and from Powari is 2 hours . Approximate time taken by an electrically operated Radial gate to open fully is about 16 minutes (32 minutes when operated by petrol engines during power failure), 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 and thus safeguard against overtopping of the dam in case of a flood

with magnitude higher than the design flood. Thus the decision regarding raising the gates will depend on the information on magnitude of incoming flood communicated by the warning stations. Based on this, the requirement of depleting the reservoir level and raising the dam sluice Radial gates shall be decided by the Engineer-In-Charge of gate regulation.

The reservoir of Nathpa dam covers a stretch of about 2.5 km. corresponding to FRL 1495.5m. In the past, the unprecedented flood of Aug.1, 2000, estimated at 6500 cumecs had caused extensive damage to the undergoing works in the project. The catchment of reservoir lies largely in Tibet with only 26% in India. The flood of the order of 4500 cumecs was also observed on 26th june, 2005 due to breach of artificial lake formed on Parechu river (in Tibet region). Since necessary measures had already been taken, no major damages occurred in NJHEP due to this flood . During the floods river carries a lot of silt, boulders, gravel, & trash etc. and the same settle or float in the reservoir. Also, river Satluj is mainly snow fed, therefore it becomes essential to monitor the river/reservoir levels particularly during the long spells of hot weather in summer season along with the discharge in the tributaries which are prone to flash floods.

On receiving information about the approaching flood or if the silt content shows a rising trend beyond the upper permissible limit, the power plant shall be shut down and intake gates shall be closed. The reservoir shall be depleted and all gates shall be lifted completely to allow free flow conditions. The rise of water level on upstream and downstream side of dam shall be monitored at regular interval (every fifteen minutes) during the flood. Thus in the event of flood, the gates may be required to be raised simultaneously or starting from the central sluice and moving outwards as per the requirement worked out based on magnitude of flood. Nathpa dam gates operation activity is very crucial during floods. So, operation schedule shall be followed strictly. Once the flood abates and silt concentration shows a downward trend close to upper limit, the reservoir shall be filled up again and power generation shall be resumed.

3. Action to be taken in case of Power House Shutdown due to unprecedented floods, earthquake, cloud burst, gate failure etc. (For various inflow flood discharges it is to be ensured that the maximum reservoir level would not go higher than El. 1495.75m)

Sr No.	Description	Action to be taken
1	If upstream water level is at or below FRL of 1495.50m and discharge is around 1000-1500 cumecs	It may be considered as Normal Flood condition and can be passed through dam sluices by opening the dam 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 gates shall be closed in phased manner as per the procedure given in Annex-II. The projects under execution downstream of dam shall be immediately informed as per the list attached as Annex-V
2	Reservoir level approaching MWL of 1495.75m , flood discharge in the range of 1500-3000 cumecs	A flood up to the magnitude of 3000 cumecs can be passed through dam sluices by opening all the dam Radial gates 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 NJHPS units. This is possible if advance warning of the flood about the magnitude of the flood is available about 3 hours in advance so that all the sluice gates can be opened and reservoir level is brought down to free flow level which is possible since the advance warning station at Khab and Powari are functional round the clock. 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. The projects downstream of dam shall be immediately informed as per the list attached as Annex-V.

Sr No.	Description	Action to be taken
3	Reservoir level above FRL between 1495.50 – 1495.75 , flood discharge in the range of 3000-4500 cumecs	<p>In case a discharge of the order of 4500 cumecs is released by upstream dams or due to flash flood etc. in the tributaries, the same can be passed through dam sluices by resorting to flood routing. It is presumed that silt load will be above the permissible limits as detailed in Para 4 for operation of NJHPS units.</p> <p>All the sluice gates can be opened and reservoir level brought down to free flow level as per the procedure given in Annex-I. 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, & Defence Department etc. asking people not to venture into river banks below HFL mark.</p>
4	Reservoir level above FRL between 1495.50 – 1495.75 , flood discharge in the range of 4500-6500 cumecs	<p>A flood of the magnitude of 6500 cumecs can be passed through dam sluices 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 NJHPS units.</p> <p>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, projects downstream, Civil Authorities & Defence Department as per the list attached as Annex-V etc. and people living near HFL mark asked to be ready for evacuation.</p>

Sr No.	Description	Action to be taken
5	Reservoir level above FRL 1495.75 and still rising after opening of all the Radial gates , discharge above 6500 cumecs- Overtopping imminent -	In case information regarding flood of the magnitude more than 6500 cumecs is received from Khab or other warning stations, flood upto 6500 cumecs can be passed through dam sluices 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 Nathpa dam complex 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, Defence department etc. as per the list attached as Annex-V asking people living near HFL mark asked to be ready for evacuation .
6	Earthquake	Nathpa dam has been designed for DBE value of 0.29g for Max. Sluice section. After the earthquake, the visual inspection of dam body & galleries 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 dam 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 SJVN staff to safer places shall be taken by the project authorities.
7	Abnormal Instrument Readings	In case Instruments placed in the main civil structures of the project show abnormal readings, the same would be critically examined by the design department. After the analysis of the abnormal readings, remedial measures would be suggested by the design department.

Sr No.	Description	Action to be taken
8	Failure of Sluice Radial gates	For normal conditions, one sluice gate has been taken to be inoperative and each gate can pass a discharge of 1300 cumecs. But in case of exceptional conditions when there is flood of the order of 6500 cumecs, all the five gates have been assumed to be in operative condition. The flood of the order of 6500 cumecs can be passed through dam sluices by resorting to flood routing when advance warning of the flood is available. The reservoir level is brought to free flow level by opening all the Radial gate in advance. However, if more than one gate is in-operative, matter is to be immediately taken up between field & design departments

4. 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 4000 PPM at Wangtoo, 6000 PPM at Powari and 7000 PPM at Khab

Sr. No.	Description	Action to be taken
1.	For silt value between 2000 - 3000 PPM at Wangtoo and 3000-4000 PPM at Powari.	The silt sample will be taken every two hours.
2.	For silt value between 3000 - 4000 PPM at Wangtoo and 4000-5000 PPM at Powari.	The silt sample will be taken every hour
3.	The silt value in river is above 4000 PPM at Wangtoo, 6000 PPM at Powari and 7000 PPM at Khab	The information regarding increase in silt from Khab shall be closely monitored and in case it exceed 7000 PPM the effect shall be felt after approx. six hours at Wangtoo (depending upon the incoming discharge). The information shall be immediately passed to Power House and Engineer 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

5. Manpower requirement in case of Emergency Shutdown of Powerhouse.

2 Executives, 4 Technicians, 3 Helpers
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- I. Two executives are 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.
- II. 1 technician and 1 helper minimum are required for closing SFT gates.
- III. 2 technician and 2 helpers minimum are required to operate intake gates.
- IV. 1 technician is required to operate Radial gates.

6. Checklist before Starting 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. Sholding water is not diverted into HRT.
- 3. Sufficient manpower is available to perform activities. If not available then call required no. of manpower.
- 4. Downstream projects have been informed about power house shutdown and amount of discharge to be released.
- 5. Communication facilities are in order.
- 6. Transportation facilities are available.
- 7. Adit no. 2 Gate is closed.

OPERATIONAL PROCEDURE FOR DAM SLUICE RADIAL GATES**(A) When the river inflow is less than design discharge of 383.88 cumecs:-**

- i. Maintain the reservoir level between El. 1494.00m and El. 1495.00m if the discharge is more than 100 cumecs and El.1495.50 m in case it is less than 100 cumecs.
- ii. All the Radial gates shall be fully closed.
- iii. In the case of sudden closure of Power House, release the excess discharge through central spillway automatic gates and Radial gates, if required.

(B) When the river inflow is between 383.88 cumecs and 600 cumecs:-

- i. Maintain the reservoir level between El. 1492.00m and El.1495.00m.
- ii. Release excess discharge through Radial gate nos. 1 and 2 in order to flush out silt from in front of Intake gate. The difference between the openings of two consecutive gates shall not be higher than 40% of the gate opening on lower side.
- iii. Alternatively, release the excess discharge through Radial gate no. 4 and 5. The difference between the openings of two consecutive gates shall not be higher than 40% of the gate opening on lower side.

(C) When the river inflow is more than 600 cumecs and silt is less than 4000 ppm:-

- i. Maintain the reservoir level between El. 1492.00m and El.1495.00m.
- ii. Release the excess discharge through Radial gate no.1 by partial opening i.e minimum gate opening of 85cm and maximum upto 2 mtrs.
- iii. If this gate opening is not sufficient to pass the surplus discharge, then open Radial gate nos. 2 partially by a minimum gate opening of 85cm and maximum of 2 mtrs. The difference between the openings of two consecutive gates shall not be higher than 40% of the gate opening on lower side.
- iv. Open Radial gate nos. 3, 4 and 5 partially one by one with a minimum gate opening of 85cm, if required.
- v. Increase the partial opening in steps of every 85cm in the same order i.e. starting from Radial gate no.3 as stated above, if required.

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

- i. Gradually start depletion of reservoir level by opening Radial gates and follow the procedure given in annex-II and ensure everything is in order as per checklist attached as annex-IV.
- ii. Central Sluice Radial gate in block No.6 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, any one or both of side sluices gates in the block No. 5 &7 shall be opened. Corner most sluice gates in block No.4 & 8 shall be opened next to them, if required.

The partial opening shall be increased (20%, 30% 40%----- 100%), as per the requirement, in the same order, if required to pass the high discharge.

Note- Please ensure during closing of Radial Gates that logs/boulders are not entrapped under the gate.

Annex- II

Sequence of Activities during Shutdown of Powerhouse

In case flood warning is received from warning station at Khab, Powari or increase in silt content in river Satluj is observed the information shall be immediately passed to Power House, downstream project authorities district administration, as per the list attached as Annex- and then follow the activities as given below.

- I. Gradually start depletion of reservoir level by opening Radial gates (the rate of depletion should not be more than 5 m/ hour).
- II. Close SFT gate of Chamber # 1 after shutdown of 1st machine.
- III. Close Intake gate of Chamber # 1 after shutdown of 2nd machine¹.
- IV. Close SFT gate of Chamber # 2 after shutdown of 3rd machine.
- V. Close Intake gate of Chamber # 2 after shutdown of 4th machine¹.
- VI. Close SFT gate of Chamber # 3 after shutdown of 5th machine.
- VII. Close Intake gate of Chamber # 3 after shutdown of 6th machine¹.
- VIII. Close SFT gate of Chamber # 4 after above operation are completed.
- IX. Wait for ½ an hour and reservoir level to go below 1488.00 before closing last Intake gate (This precaution is to be taken to avoid water surge to rise above through HRT and Intake Gate).
- X. Gradually decrease level to free flow condition² (the rate of depletion should not be more than 5 m/ hour).
- XI. Keep Radial gates open as long as the flood passes by and silt content in the river comes to the permissible level.
- XII. Keep the gates in dogging position if shutdown is carried out due to high flood (above 6500 cumecs) and leave the Dam premises.

¹ one intake gate is to be closed after shutdown of 2 nos. machines after ensuring corresponding SFT gates have been closed.

² free flow condition is necessary to avoid silt deposition in dam reservoir and it helps in flushing silt deposited in dam reservoir.

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 5m /hour).
2. Crack open Intake Gate # 4 when reservoir level is above MDDL of 1474.00 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 # 4 when water level downstream of Intake and Reservoir level are balanced (this condition is necessary for smooth opening of Intake Gate).
6. Open SFT Gates of Chamber # 4 after opening Intake Gate # 4.
7. Inform Power House about opening of 1st Intake Gate (now two machines at Power House can be started).
8. Now open Intake Gate # 3, 2 & 1 and corresponding SFT gates (Two machines corresponding to each pressurized chamber can be started).
9. Inform power house after opening of each Intake Gates.
10. Maintain reservoir level as instructed.

Checklist for Power House Shutdown

Date-

Time -

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

Sr. No.	Description	Remarks	
		YES	NO
1	Downstream Projects have been informed	YES	NO
2	Sholding Inlet Gate is closed	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	Adit no. 2 Gate is closed	YES	NO
8	Alarm is Given by operating the Hooter	YES	NO
8	Before closing Intake gates it is Ensured that respective SFT gate is Closed.	YES	NO
9	Before Closure of last Intake Gate the Level of 1488 or below is achieved and at least half an hour has elapsed after complete shutdown of power house machines.	YES	NO

(Shift Incharge)
 Dam control room
 SJVNL Nathpa

Contact List - In Case of Emergency

ANNEX-V

Dam Control Room- 01786- 253238, 200359 (WLL), 253773 (Fax), 9816611368 (Airtel), 9418011368 (BSNL), EPABX- 3100,3101, Lift GVG- , SFT- Silt Lab- 3104

Power House Control Room- 01782- 234960, 275194, 9816075194, EPABX-4442

S.No	Name	Designation	EPABX		P&T/WLL		Mobile
			Office	Resi	Office	Resi	
1	Sh. N.C. Bansal	GM/HOP	4000	4500	275201	275275	9418057575
2	Sh. Sanjeev Sood	AGM (PH Operation).	4113	4613	275236	275145	9418475698
3	Sh. RK Gupta	Sr. Manager (I/c Nathpa)	3001	3501	253590	253363	9418075214
4	Sh. Jeta Ukkhal	Manager Dam (O&M)	3014	3014	253275		9418086861
5	Sh. Stayaban Sahoo	Dy. Manger(Elect Mtc)	3012				9418041576
6	Sh. Shiv Prasad	Dy. Mgr(Mech Mtc)	3023				9418035805

Other Important Numbers

1	Advance Warning Station Khab	01785-232760, 200046 (WLL)
2	Silt Lab Powari	9816003238, 9418060238
3	Sholding	9805011368, 01786- 200369
4	Kachrang Project	9816878714
5	Shorang Project	Sh. Varun Awasthi- 9805024399, Sh. Bhaskar Rana- 9805051399
6	Rampur Project	EPBX- 275056, 275057, 275812
7	Police Station Bhabanagar	01786-253455
8	Karcham Wangtoo	Karcham Dam- 01786-232413, 232415, Tapri- 9816507000, 01786-261381
9	Baspa Project	Kuppa Dam- 01786-242274, 9816943296, Power House- 9418014232, 9816805265
10	Bhaba Power House	9805053507
11	Ganvi Power House	01782-278439
12	Kol Dam	9816102327
13	DC Kinnaur	01786-222252
14	SP Kinnaur	01786-222270
15	SDM Office, Bhabanagar	01786-253201
16	HPSEB Substation Kotla	278291, 278267
17	HPSEB Substation (66 KV)	9805449025, 01786-200356
18	SDM Office, Rampur	01782-233002
19	DSP, Rampur	01782-234646
20	Police Station, Rampur	01782-233030