CHENAB VALLEY POWER PROJECTS PVT. LTD.

(A Joint Venture of NHPC Ltd., JKSPDC & PTC India Ltd.)

KWAR HYDROELECTRIC PROJECT

(540 MW)

JAMMU & KASHMIR

UPDATED DETAILED PROJECT REPORT

EXECUTIVE SUMMARY

DECEMBER 2016

Copyright © 2015 CVPP

KWAR HYDROELECTRICPROJECT, (540 MW)
JAMMU & KASHMIR

FOREWORD

The Detailed Project Report of Kwar Hydroelectric Project has been prepared by CVPP in five volumes as below:

Volume I	-	*Engineering*
Volume II	-	*Cost Estimates & Project Planning*
Volume III	-	*Hydrology*
Volume IV	-	*Site Investigations & Geology*
Volume V	-	*Construction Materials*

***Volume** I comprises of engineering details of the project and includes chapters on project summary, stage development of Chenab basin, salient features, hydrology,optimization studies, power studies, site investigation &geology, design of civil engineering & hydro-mechanical equipment, power plant, electrical &mechanical equipment, estimate of cost environment and ecological aspects and economic evaluation.*

***Volume** II comprises of construction methodology and equipment planning, construction materials, construction programme& project schedule, infrastructure and construction facilities, project organization, project costs and analysis of rates and use rate of machinery.*

***Volume** III comprises of hydrology analysis.*

***Volume** IV comprises of site investigations carried out and geology of major components; and*

***Volume** V comprises of details of construction materials.*

*In addition to above, an **Executive Summary** has also been prepared.*

Field Investigations, collection of data from various agencies and subsequent preparation of Detailed Project Report has been completed with the cooperation extended by the State & Central Govt. agencies/departments. Co-operation of the various departments of J&K Govt. necessary for carrying out field works and for preparation of DPR, proved to be of great help for the completion of this Detailed Project Report.

EXECUTIVE SUMMARY

TABLE OF CONTENTS

APPENDIX – A – INDEX

Sr. No.	Aspect	Directorate/ Division/ Dept.	Date of Clearance
1	Inter State Aspects	PA(N), CWC	31.10.2012
2	Hydrology - Water Series	Hydrology(N), CWC	27.06.2013
3	Instrumentation Aspects	Instrumentation Dte., CWC	24.10.2013
4	Hydrology - Design Flood & Diversion Flood	Hydrology(N), CWC	01.11.2013
5	Glacial Lake Outburst Flood	FE&SA, CWC	06.02.2014
6	Power Potential Studies	HPA, CEA	16.12.2014
7	Power Evacuation Aspects	SP&PA, CEA	05.01.2015 16.03.2015
8	Geological Aspects	GSI	15.06.2015 17.10.2016
9	Annual Energy Generation	HPA, CEA	22.01.2016
10	E&M – Design Aspects & BOQ	HE&TD, CEA	29.01.2016 25.05.2016
11	Construction Power Aspects	HPA, CEA	09.02.2016
12	Pondage Aspects (IWT Angle)	HPP&I, CEA	10.02.2016
13	Foundation Engineering & Seismic Aspects	FE&SA, CWC	30.03.2016
14	Site Specific Design Earthquake Parameters	NCSDP / FE&SA, CWC	07.10.2016
15	Legal Aspects	Legal Div, CEA	10.10.2016
16	Construction Material & Geotechnical Aspects	CSMRS, MoWR	19.10.2016
17	Hydel Civil Design Aspects	HCD, CWC	19.10.2016
18	Dam Design Aspects	CMDD, CWC	20.10.2016
19	Gates Design Aspects /HM	Gates & Design (N&W) CWC	24.10.2016
20	Plant Planning/ Construction Machinery Aspects	CMC, CWC	27.10.2016
21	Cost Estimate of E&M Works	HPA-I, CEA	27.10.2016
22	Cost Estimate of Civil & HM Works	CA(HWF), CWC	31.10.2016
23	Quantities of Civil & HM Works	TCD, CEA	31.10.2016
24	Construction Schedule and Phasing of Civil & HM Cost	TCD, CEA	10.11.2016 11.11.2016
25	Phasing of Total Hard Cost	HPA-I, CEA	11.11.2016
26	Financial & Commercial Aspects	F&CA, CEA	15.11.2016

CHAPTER –1

PROJECT SUMMARY

CHAPTER – 1
PROJECT SUMMARY

1.0 INTRODUCTION

Kwar H.E. Project is one of the four projects on river Chenab in Distt. Kishtwar, J&K entrusted to NHPC for detailed investigation and preparation of DPRs by Central Electricity Authority (CEA) in August, 2004. These projects have been included in the ranking studies done by CEA and pre-feasibility reports (PFR) have been prepared by WAPCOS under 50,000 MW hydro initiative by the Hon'ble Prime Minister.

After detailed discussion during various meetings under CEA and Ministry of Power (MOP), Govt. of India it was decided that low tariff hydroelectric schemes should be taken up for detailed investigation and preparation of DPRs. CEA had classified the schemes into A-1, A-2 and A-3 categories. The classification of schemes are based on decision taken during the meeting held by Secretary (Power) on 23.03.2004 as under.

- Scheme to be directly taken up for implementation in central sector**-"A-1" Category.**
- Schemes for which PFR have been prepared by those agencies which are also involved in execution of the projects (e.g. NHPC, NEEPCO etc.). Such agencies could be offered projects for making DPRs- **"A-2" Category.**
- The projects for which PFRs have been prepared by those consultants who are not involved in implementation of the projects (e.g. WAPCOS). The preparation of DPRs of such projects can be offered to other agencies –**"A-3" Categories.**

Kwar H. E. Project has been given to NHPC under "**A-2" category.**

As per pre-feasibility report prepared by WAPCOS , Kwar H.E. Project, a run-of-river scheme located in Tehsil Kishtwar, Distt. Kishtwar (erstwhile Doda district)

of J&K envisages construction of a concrete gravity dam 68 m high across river Chenab at village Kandni, a 4.3 Km long HRT of 12.0 m dia., one no surge shaft of 25 m dia, four no. pressure shafts 90 m long & 5.4 m dia, a surface powerhouse at right bank of river Chenab near village Kwar to accommodate 4 units of 80.00MW each and a tail race channel of 75 m length of size 12.0m for discharging the water back into the river course.

The stage-I clearance of the project was obtained from Ministry of Environment & Forest (MOEF), Govt. of India by NHPC in the month of March, 2005 as per layout decided by WAPCOS. However when detailed survey and investigation works were taken up by NHPC, it was found that layout of the project needed some modifications based on ground survey as well as feasibility of the project. Subsequently request has been made by NHPC during December, 2005 for stage-II clearance from MOEF.

Features of the project have been slightly modified vis-a-vis proposal of WAPCOS. Dam location has been shifted downstream, power house was also brought adjacent to dam site and dam height (from deepest foundation) has been increased from 68m to 109m, surface powerhouse has been changed to underground powerhouse.

1.1 POWER POSITION – PRESENT AND FUTURE

Power is a critical infrastructure for economic development and improving quality of life. Since independence power generation has taken great strides and increased almost 200 times from a mere 1362 MW in 1947 to 2,78,733MW as on Sep'2015. The demand for power has primarily been fuelled by the fast track industrialization and growing commercial use of energy. But despite outstanding achievements in terms of capacity addition, the supply has not been able to keep pace with the demand. The major concern for Indian economy is to cope up with the increasing power demand vis-à-vis supply. Apart from this (energy & peak shortage), issues like adverse hydro: thermal mix, grid instability, frequency fluctuation etc. are other major concerns affecting the power sector of the country.

Hydro share percentage in the total installed capacity which peaked to 50.62% during 1963 stands only at about 15.2% presently. Considering the fact that hydro-power is renewable, pollution free, environment friendly, has decreasing trend in tariff and inherits several technical advantages, it becomes the most sought after alternative form of power and energy security for the future.

As per the estimate by CEA, hydro-power-potential has been assessed during the period 1978-87 as 84044 MW at 60% load factor corresponding to about 1,50,000 MW of installed capacity. Against this, only 41,997 MW of hydro potential has been developed till Aug'2015. Out of the total assessed hydro-power potential, Chenab basin contributes 5932 MW at 60% load factor.

Recognizing the importance of hydro-power, Govt. of India has taken several initiatives over last decade or so for accelerated development of hydro-power. These include Hydro Policy of 1998, Ranking Studies by CEA, three stage clearances for hydro projects, 50000 MW hydro initiative, preparation of DPRs of low tariff hydro power stations etc.

1.2 THE NEED

Over the years demand for power has outpaced its supply which has become a major concern for the Indian economy. Energy and peak demand shortages in the country during 2014-15 (Sep' 2015) stand at 3.2% and 3.2% respectively.

Another important concern is the excessive dependence on conventional resources for power generation. Out of total installed capacity of 278733 MW, 194199 MW (70%) is being contributed from thermal sources, 42283MW (15.2%) from hydro- power, 5780MW (2.1%) from nuclear sources and 36470 MW (13%) from renewable sources. Thus there is less percentage of hydro-power in the system than the optimal level (40%).

In view of inadequate power supply position, other technical constraints arising out of excessive dependence on thermal power and multiple techno-economical-

environmental superiority offered by hydro-power, it makes perfect case for capacity addition of hydro-power through its accelerated development.

Based on the capacity addition programme, anticipated power requirement of the region in the year 2014-15 to 2020-21 is as under:

Power Position of Regional Grid

(Without Kwar H E Project)

Northern Region		12th Plan			13th Plan			
		2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Installed Capacity	**MW**	71031	78426	83220	87692	92566	93587	93587
Peak availability	**MW**	47642	54137	55817	58817	62086	62771	62771
Peak requirement	**MW**	51977	54329	60934	65686	70276	75238	80620
Peak Surplus(Deficit)	**MW**	-4335	-192	-5117	-6869	-8190	-12467	-17849
Peak Surplus(Deficit)	**%**	**-8.3%**	**-0.4%**	**-8.4%**	**-10.5%**	**-11.7%**	**-16.6%**	**-22.1%**
Energy availability	**MU**	311589	354540	365058	384675	406055	410534	410534
Energy requirement	**MU**	332453	355794	422498	454897	485914	519260	555214
Energy Surplus(Deficit)	**MU**	-20864	-1254	-57440	-70222	-79859	-108726	-144680
Energy Surplus(Deficit)	**%**	**-6.3%**	**-0.4%**	**-13.6%**	**-15.4%**	**-16.4%**	**-20.9%**	**-26.1%**

Thus from the above projected power & energy shortages for Region, the need for 540 MW Kwar H. E. Project assumes significance.

1.3 CHENAB BASIN

Kwar H.E. Project is located on river Chenab which originates in Lahaul and Spiti area of Himachal Pradesh. After flowing through Pangi valley in Himachal Pradesh, the river enters into the Paddar area of Doda district of J&K. The river flows between steep cliffs and lower hills before entering Pakistan. Important tributaries include Marusudar, Bhut nallah, Bichlari etc. The drainage area of Chenab basin within the Indian territory is to the tune of 22681 Km^2 and is generally rocky as almost entire river flows through Himalayan ranges. The river Chenab is perennial and has comparatively better distribution of water flows because of substantial snowfall and rainfall during the winter months and continuous flow of water from a number of glaciers.

Due to the above features, the river has a high hydro- potential.

1.3.1 Hydroelectric Potential of Chenab Basin

As per the studies done by CEA, the total hydro-power potential of Chenab basin is estimated at 5932 MW at 60 % load factor (corresponding to 11318 MW of installed capacity). Major hydroelectric projects executed /under execution/ under investigation so far in the basin are as under-

Scheme	**River**	**Capacity**
Salal (Stage-I & II)	Chenab	690 MW
Sawalkot	Chenab	1856 MW
Baglihar (Stage-I & II)	Chenab	900 MW
Ratle	Chenab	850 MW
Dulhasti	Chenab	390 MW
Dulhasti-II	Chenab	550 MW
Kwar	Chenab	540 MW
Kiru	Chenab	624 MW
Kirthai -I	Chenab	390 MW
Kirthai -II	Chenab	930 MW
Barinium	Chenab	240 MW
Bursar	Marusudar	800 MW
Pakal Dul	Marusudar	1000 MW

1.4 THE PROJECT

1.4.1 Background

Kwar H.E. Project is one of the four projects on river Chenab in Distt. Kishtwar, J&K entrusted to NHPC for detailed investigation and preparation of DPRs by CEA in April, 2004.

The stage-I clearance from MOEF of the project was obtained by NHPC in the month of March, 2005 as per layout decided by WAPCOS. However when detailed survey and investigation works were taken up by NHPC it was found that layout of the project needs some modification based on ground survey as

well as feasibility of the project. Subsequently request has been made by NHPC during December, 2005 for stage-II clearance from MOEF.

Main components of the project are as under:

- A 109 m high (above deepest foundation), 195 m long (at top) Concrete gravity dam.
- U/s & D/s coffer dams (rock fill with central clay core).
- 1 no. 9.5 m dia. horse shoe shaped diversion tunnel of length of 685m.
- Reservoir with gross storage of 27.167 M.cum at FRL & 9.16 M.cum at MDDL and having reservoir area at FRL 0.8 Km^2.
- 4 nos. Power Dam Intakes with gate arrangement.
- 4 nos. 5.65 m internal dia underground circular steel lined penstocks/pressure shafts with vertical length varying from 54 m to 93 m and total length (excluding vertical) varying from 108 m to 182 m.
- An underground power house of cavern size 140.00 m x 23.30 m x 50.0 m to accommodate 4 units of 135 MW each.
- 2 nos. 9.50 m dia horse shoe shaped concrete line TRT's of lengths 2786 m and 2963 m.

The proposed site for the construction of dam is located near village Padyarna, in Distt. Kishtwar. The average river bed level at dam site is about EL 1290m. Corresponding to an FRL of 1385.0 m, the gross storage of the reservoir is 27.167 Mcum and area under submergence is 0.8 Km^2 .

Underground powerhouse is proposed on the right bank of the river near village Padyarna. The water from the reservoir would be taken to powerhouse through pressure shafts/ penstocks and discharged through tail race tunnels (TRT) back into the river course.

1.4.2 Topography & Physiography

The project area lies in the inner lesser Himalayas which encompasses steep, rugged terrain. The prominent geomorphic features include U- and V-shaped

valleys, interlocking spurs, ridges, saddles and river terraces. The narrow valleys bounded by high ridges open out in their upper glacial parts. Slopes are very steep due to which the rockfall occurs at certain points often under the effect of gravity. The altitude of the area varies from about 1250m to very high mountains. There are plentiful of grazing lands on the upper reaches of high mountains. A number of meadows and pastures on the uplands are well known. The vegetation is dominated with conifers. The local/ Gujjar population have extended their settlements in forests at high reaches.

Rocks are strongly folded at certain places and are mainly composed of granite, gneiss, schist, quartzite and phyllite. Some hot springs along river course have been observed in the area from where the water is emerging from the earth in its natural form.

1.4.3 Drainage

The river Chenab enters Kishtwar at Sansari in Paddar area of J&K from Himachal Pradesh. It is joined by major tributary Bhut nallah at Arthal (EL 1785 m). Subsequently it is joined by the largest tributary Marusudar river at Bhandarkot (EL 1100 m). Further down the river is joined by its tributaries Bichlari and Ans river on its right. From its origin in Baralacha pass in Lahul Spiti (Himachal Pradesh) to Akhnoor (Jammu), the river traverses about 585 Kms and drops by 5340 m. The local area drained by the river up to international border with Pakistan is 22681km^2 out of which 4662 Sqm are under glaciers.

1.4.4 Hydrology

The catchment area of river Chenab up to dam site of the project is estimated as 10325 km^2. It lies between Latitude 32^0 06'N to 33^0 39' N and Longitude 75^0 55' E to 77^0 48' E. Average annual rain fall is 838 mm at Benzwar/1000 mm for the entire basin.

1.4.5 Geology and Seismicity

Geologically the project area lies within inner lesser Himalayan belt under Kishtwar group of rocks. All the project components viz. dam & powerhouse are

housed in competent gneissose granite except tail race tunnel and part of diversion tunnel, which lies in incompetent phyllite rocks.

The proposed concrete gravity dam (109 m above deepest foundation level) is placed in the 'U' shaped valley where the dam foundation and abutments shall be on strong granites. Interestingly, the bedrock is exposed along the river channel at dam site at many places which indicate very shallow overburden depth in the active river channel section.

Some open valley dipping joints are observed on the right bank at upper level drifts. Based on the drift logs stripping limit varying from 3.51m to 13.25m is proposed for right abutment to abut the dam with sound & fresh rock. Apart from this adequate grouting shall also be required considering shearing and fracturization of rockmass as observed in the drifts. However, shear seams/zones would be suitably treated with dental excavation/treatment and duly backfilled with richer grade of concrete during actual excavation of dam foundation and abutment.

Based on the drift logs and some engineering considerations, the stripping limit varying from 2.30m to 25.96m is proposed for left abutment to abut the dam with sound & fresh rock. The permeability values in the bedrock vary from 4 to 26 Lugeon. This necessitates provision of adequate grouting to minimize seepage path below dam foundation.

The water conductor system comprises 4 nos. pressure shafts/penstocks to feed powerhouse. All the structure viz. Intake, Pressure shaft etc, shall be housed in competent granites. However, in case of intake structure some stripping due to open joints may be required to abut the structure in sound rock.

Considering all geotechnical characteristics of rock mass, the pressure shaft is anticipated to negotiate through Class-I 10%, Class-II 50%, Class-III 30%, & Class-IV 10% as per RMR classification.

The underground powerhouse complex having installed capacity of 540MW consist 140m x 23.3m x 50m machine hall and 116m x 17m x 16m transformer hall caverns, connecting through bus bar gallery etc. An underground power house is proposed on right bank in a sub vertical rocky cliff.

Though, dry to moist conditions are observed in exploratory drifts on right bank, but deeper inside possibility of seepage in powerhouse is anticipated due to well jointed nature of rock and surface charging from nearby nalas through open joints. Thus, provision of suitable mitigation measures are foreseen to control seepage into the machine hall.

The powerhouse cavern, in general, shall be in good to fair class of rock with random pockets of poor rock.

The twin tunnels are anticipated to be mainly in phyllitic rocks (around 90%) however quartzitic bands within phyllite-quartzite sequence and intrusive granitic rocks may appear in the initial part from PH side. An old slide scar has been observed on right bank near the TRT outlet and slide material is lying at the river bed following the rock profile. As such broad estimation regarding the tunneling media has been made and the same has been classified as 50% in class III – Fair rock, 30% class IV – Poor rock and 20% class V – Very poor rock.

Considering the difficulties during excavation at various structures, adequate provisions of rock supports has been kept in the cost estimate.

This dam shall create a 6.7 km long reservoir up to outlet of TRT of Kiru Project. The full reservoir level (FRL) has been proposed at EL 1385M having 0.8 sq km area. Right bank of the river is almost rocky (80% touching rock) whereas left bank shall be touching partly overburden (50%) and partly rock outcrops (50%). Major part of the reservoir rim shall be in contact with bedrock comprising of gneissose granite and phyllite-quartzite sequence. The topography & river course is generally found structurally controlled. Overall, the reservoir rim appears to be safe from geo-environmental consideration (except some part of

rim on left bank near village Galhar) with no possibility of reservoir leakage. No economic mineral within reservoir periphery has been reported till date.

The project area falls in Zone-IV of Seismic Zoning map of India which corresponds to high seismically active area. Site Specific Design Earthquake Parameters study has been carried out by DEQ, IIT Roorkee, 2007. The PGA value recommended for MCE & DBE was 0.31g and 0.16g respectively based on above study. Further, Department has also suggested α_h=0.17 and α_v=0.11.

However, updated and modified report on Site Specific Design Earthquake Parameters study has been carried out by DEQ, IIT Roorkee, 2016 and the recommended PGA values for the MCE and DBE conditions are estimated as 0.50g and 0.28g for horizontal component and 0.33g & 0.19g for vertical component. The recommended values for α_h=0.16 and α_v=0.11.

Dam height being 109m i.e. greater than 100m, MEQ studies were undertaken within a radius of 50km of the dam site by Wadia Institute of Himalayan Geology (WIHG) as per NCSDP guidelines.

Accordingly, Six (6) Broad band seismographs were installed for continuous recording of six months from June 2015-Dec. 2015.

The site specific seismic design parameter study report along with the MEQ study report was submitted to NCSDP. NCSDP in its 31st meeting held on 23rd June 2016 approved the response spectra and seismic design parameters of the project.

1.4.6 Dam and Reservoir

Reservoir will be formed by construction of a 109 m high (from deepest foundation level) concrete gravity dam. Broad feature of the reservoir shall be as under-

Dam top	EL 1387 M
Full reservoir level	EL 1385 M

Gross storage up to FRL	27.167 M cum.
Gross storage at MDDL	9.16 M cum.
Type of Dam	Concrete gravity dam.
Deepest Foundation Level	El 1278 M
Height of Dam	109 M from deepest foundation level
Length of Dam at top	195 M

1.4.7 River Diversion Arrangement

River diversion arrangement comprises of one number diversion tunnel horse-shoe shaped of dia 9.5m and length 685m; and the upstream and downstream coffer dams. The proposed diversion arrangement is designed for a flood discharge of 1041cumec (return period of 1 in 25 years non-monsoon).

1.4.8 Water Conductor System

4 no. power dam blocks with one intake each have been provided to lead the water through 4 no, 5.65 m dia underground circular steel lined penstocks to the Power house and the water shall be discharged back to the river through 2 no 9.5 m dia horse shoe shaped TRTs of lengths 2786 m and 2963 m.

1.4.9 Power House Complex

The underground powerhouse is located on right bank of river Chenab near village Padyarna. It will have an installed capacity of 540 MW (4 generating units of 135 MW each). Power House cavern is 140 m x 23.30 m x 50 m and transformer cavern is 116 m x 17 m x 16 m.

1.5 POWER GENERATION

The power generation and the optimization of Kwar H.E. Project has been made based on long series of available hydrological data with the objective of maximum utilization of the available inflow within economical limits. The observed discharge data for the 90% dependable year have been used as the

basis for carrying out the optimization studies. The project shall generate 1975.54 MU power in 90% dependable year with 95% machine availability.

1.6 COST ESTIMATE AND FINANCIAL FORECAST

The project has been estimated to cost Rs. 4949.24 crores including IDC of Rs.532.21 crores at April 2016 price level. The unit cost of energy at Bus Bar (I^{st} Year), considering return on equity of 16.5% based on generation in 90% dependable year works out to Rs. 6.21 per unit at April 2016 price level.

The levelised tariff at Present Day Cost at April 2016 price level works out to be Rs.5.77 per unit considering 12% free power to home state & 1% free power towards Local Area Development Fund.

1.7 TIME SCHEDULE

The project is proposed to be completed in a period of 54 months after accord of Government sanction. Infrastructural facilities shall be developed concurrently with the process of obtaining various govt. clearances.

CHAPTER –2

SALIENT FEATURES

CHAPTER-2

SALIENT FEATURES

LOCATION

State	:	Jammu & Kashmir
District	:	Kishtwar
River	:	Chenab
Latitude	:	33° 21’ 01” N
Longitude	:	75° 53’ 39” E
Location of Dam	:	Near village Padyarna
Location of Power House	:	Right Bank Of River Chenab near village Padyarna
Nearest Rail head	:	Udhampur
Nearest Airport	:	Jammu

HYDROLOGY

Catchment area at diversion site	:	10325 Sq km
Design Flood (PMF)	:	10534 cumec
GLOF	:	620 cumec
Location of Catchment		
Latitude	:	32° 06' N to 33° 39' N
Longitude	:	75° 55' E to 77° 48' E
Average annual rainfall	:	838 mm
Average annual Yield	:	12949 Mcum
Maximum Temperature	:	43°C
Minimum Temperature	:	-0.5°C

RESERVOIR

Full Reservoir Level (FRL)	:	EL. 1385.0 m
Maximum Water Level (MWL)	:	EL. 1385.0 m
MDDL	:	EL. 1372.0 m
Gross storage at FRL	:	27.167 Mcum
Live Storage	:	9.16 Mcum
Reservoir area at FRL	:	0.8 Sq Km
Length of Reservoir	:	6.7 km

DIVERSION TUNNEL

No., Diameter & Shape	:	1 no., 9.5 m, Horse-shoe shape
Length	:	685 m
Diversion Discharge	:	1041 cumec (1 in 25 years, non-monsoon)
Invert Level at Entry	:	EL 1293 m

Invert Level at Exit	:	EL 1285 m
Diversion Tunnel Gate	:	2 Nos. Vertical Lift gate
Size of Opening	:	2 Nos. 3.94 m x 9.5 m
Gate Operating Platform Level	:	EL. 1336 m

COFFER DAMS

Type	:	Rock fill with central clay core
Top of upstream coffer dam	:	EL 1315.00 m
Top of downstream coffer dam	:	EL 1292.00 m

DAM

Type	:	Concrete gravity Dam
Dam Top	:	EL 1387 m
FRL	:	EL 1385 m
Dam height (above river bed level / deepest foundation level)	:	101 m / 109 m
Length of dam at top	:	195 m

SPILLWAY

Type	:	Orifice & Crest type
Design Discharge	:	10534 cumec
No of bays(Orifice type)	:	4 Nos. of Orifice Spillway of 9.5m x 13.8m at EL. 1330.0m
No of bays(Crest type)	:	1 No. of Crest Spillway of 9.5m x 17.0m at EL. 1368.0m.
	:	
Width of Orifice spillway block	:	64.0 m
Width of Crest spillway block	:	16.0 m

ENERGY DISSIPATION ARRANGEMENT

Type	:	Ski-jump bucket with preformed plunge pool

OUTLET FOR ENVIRONMENTAL RELEASE

Design Discharge

i) For lean period (Dec– mar.)	:	16.49 cumec
ii) For Peak flow period(Jun-Sep)	:	74.09 cumec
iii) Remaining four months	:	16.79 cumec
Size of Gate	:	2.6 m (W) x 2.0 m (H)
Crest Level	:	1369.90 m

CONSTRUCTION SLUICE

Nos. & Size of Opening	:	4 nos. 3.1 m x 5.0 m
Invert Level	:	EL 1300 m
Length	:	128 m

POWER DAM INTAKE

Number	:	4 Nos.
Design Discharge (Per Intake)	:	145.07 cumec
Size of Opening	:	5.65 m x 5.65 m
Invert Level	:	EL. 1359.20 m
C/L of Intake	:	EL. 1362.025 m
Trash Rack size	:	15 m x 32.70 m

PRESSURE SHAFT / PENSTOCKS

Pressure Shaft No & Type	:	4 nos. Underground circular steel lined
Dia.	:	5.65 m (Internal)
Vertical Lengths	:	PS-1=54 m, PS-2=67 m, PS-3=80 m, PS-4=93 m
Total Length (excluding vertical)	:	PS-1=182 m, PS-2=156 m, PS-3=131 m, PS-4=108 m
Design Discharge (each Penstock)	:	145.07 cumec
Velocity (Penstock)	:	5.78 m/s

POWER HOUSE COMPLEX

Type	:	Underground
Installed capacity	:	540 MW (4 x 135MW)
Type of Turbine	:	Francis vertical
Turbine Centre line	:	EL 1245.55 m
Power House Cavern	:	140 m x 23.3 m x 50 m
Control Room Cavern	:	40 m x 15 m x 28.8 m
Rated Head	:	103.1 m
Design Discharge (Per Unit)	:	145.07 cumec

SURGE ARRANGEMENT, TRANSFORMER/ GIS CAVERNS & DRAFT TUBE GATE HALL

Surge Arrangement	:	Combination of individual (gate) shafts and surge galleries
Size	:	4 Nos. shafts of size 5.4 m x 7.5 m and 2 Nos. galleries 10.4 m horse-shoe shaped and length 750 m each
Draft Tube Gate Opening Size	:	7 m x 7 m

Transformer Cavern		
Top Level	:	EL 1325.00 m
Bottom Level	:	EL 1310.00 m
Size	:	116.0 m x 17 m x16 m
Size of GIS Cavern	:	65 m x 15 m x16 m

TAILRACE TUNNEL

No. & Type	:	2 nos, Concrete Lined
Dia. & Shape	:	9.5 m, Horse –shoe shaped
Design discharge	:	580.28 cumec
Velocity	:	3.87 m/sec
Length-	:	
TRT-1	:	2786 m
TRT-2	:	2963 m
Adit to TRT	:	560 m , Portal at EL 1300.00 m

OUTLET STRUCTURE

Number	:	2 nos.
Invert Level	:	EL 1265.00 m
Weir crest level	:	EL 1266.50 m
Normal TWL(All units Running)	:	EL 1269.90 m
Min. TWL(One unit Running)	:	EL 1267.32 m
Max. TWL (At PMF)	:	EL 1291.80 m
Deck level of the structure	:	EL 1293.00 m

POTHEAD YARD

Type	:	Outdoor
Size	:	150 m x 35 m
Elevation	:	EL 1315.00 m

POWER GENERATION

Installed capacity	:	540 MW
Annual Energy Generation in 90% dependable year	:	1975.54 MU

COST ESTIMATE

Project cost	:	Rs.4949.24 Crores at April’2016PL
Cost of Generation at Bus Bar/Unit	:	Rs. 5.77

CHAPTER –3

ESTIMATE OF COST

CHAPTER - 3
ESTIMATE OF COST
(Equity upfront)

3.1 INTRODUCTION

A summary of the Cost Estimate, including direct and indirect charges for the Civil and Generation work is provided on page 5-6 under heading 'Abstract of Cost'. The proposed cash flow for the Project is provided in this Chapter.

3.2 BASIS FOR ESTIMATE

GENERAL

The Cost Estimate of Kwar H.E Project has been prepared broadly on the basis of "Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence", New Delhi, April 2012 (Revision 3.0) and "Guidelines for preparation of Project Estimate for River Valley Projects" (Second Edition, March 1997, CWC) Published by CWC, New Delhi. The experience gained during preparation of Cost Estimates of other projects has also been utilized to arrive at the realistic cost of the project.

I- WORKS

Under this heading, provision has been made for various components of the Project as detailed hereunder.

A- PRELIMINARY

Under this heading, provision has been made for surveys and investigations to be conducted to arrive at the optimum of the project components.

B- LAND

This covers the provision for acquisition of land and compensation for houses and other properties etc including expenditure incurred for the same till date.

C- WORKS

This covers the cost of Diversion Tunnel, Coffer and Concrete Dam, Plunge Pool for Kwar H.E. Project along with associated Hydro-mechanical Works.

J- POWER PLANT CIVIL WORKS

This covers the cost of project components viz Intake Structure, Pressure Shaft Penstock & PS Adit, Underground Power House, Tail Race Tunnel, Tail Race Tunnel Outlet, Pot Head Yard and other appurtenant works.

The quantities indicated in the estimates for C - Works & J-Power Plant Civil Works are calculated from the preliminary engineering drawings and as per experience of other on-going or commissioned projects. A provision of 5% has been made for contingencies and the work charged establishment.

The unit rates for various items are based on Central water Commission norms and worked out at current market rates. The details of items and the supporting analysis are given in Chapter-6 of Volume-II of DPR.

K- BUILDINGS

Buildings, both residential and non-residential have been provided under this head. Included under the permanent category are all those structures which will be subsequently utilized during the operation and maintenance of the project utilities. The costs are worked out on plinth area basis prevalent in the area for the type of construction involved.

O- MISCELLANEOUS

Under this head, provision has been made to cover the cost of the following miscellaneous works.

a) Capital cost of electrification, water supply, sewage disposal, fire fighting equipments etc.

b) Repair and maintenance of electrification, water supply, sewage disposal, medical assistance, recreation, post office, telephone and telegraph office, security arrangements, fire fighting, inspection vehicles, schools, transport of labour etc.

c) Other services such as laboratory testing, R&M of guest house and transit camps, community center, retrenchment compensation, photographic instruments as well as R&M charges etc.

P- MAINTENANCE DURING CONSTRUCTION AND Y-LOSSES ON STOCK

A provision of 1% and 0.25% of C-Civil works, J-Power Plants, K-Buildings & R-Communications has been made for maintenance of works during construction period and losses on stock respectively.

Q-SPECIAL TOOLS AND PLANT

This provision under this head has been made to cover the residual value of the equipment to be used for infrastructure works only i.e. capital cost of the equipment less the credit due to resale or transfer of equipment and life of machinery used in works. For this purpose, the provision for the machinery likely to be used in infrastructure works (like buildings, roads etc.) excluding inspection vehicles has been taken as 25% of their value and for inspection vehicles, 100% of the cost has been booked under this head

R-COMMUNICATION

Provision under this head covers the cost of construction/improvement of roads and strengthening of bridges. The road widths have been planned to cater to the anticipated traffic including movement of heavy trailers. The costs of roads and bridges are based on the present rate structure for the type of construction involved.

X-ENVIRONMENT AND ECOLOGY

Provision towards Bio-diversity Conservation, Creation of Green belt, Restoration of Construction Area, Catchment Area Treatment, Compensatory Afforestation etc. and Disaster Management Plan have been made under this head as per EIA & EMP report.

ELECTRICAL WORKS AND GENERATING PLANT

The cost of generating plant and equipment is based on average of awarded cost of last three NHPC's Projects awarded having similar rating and escalating the same at DPR price level. The prices of auxiliary equipment and services are based on prevailing market prices/costs incurred at other ongoing or commissioned projects. The switchyard equipments are based on prevailing market costs. Taxes, duties and transport to site are based on prevailing prices. Erection and commissioning charges have been estimated as experienced on similar installations in the country.

A provision of 1% contingencies covering variations in the quantity of equipment and services has also been made.

II-ESTABLISHMENT

Provision for establishment has been made as per "Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence", New Delhi, April 2014 (Revision 3.0) for Civil works and Generation works respectively.

III-TOOLS AND PLANTS

This provision is distinct from that under Q-Special T&P and is meant to cover cost of survey instruments, camp equipment and other small tools and plants. A provision of Rs. 2 crores has been provided as per new guideline.

IV-SUSPENSE

No provision has been made under this head as all the outstanding suspense are expected to be cleared by adjustment to appropriate heads at completion of the Project.

V-RECEIPTS AND RECOVERIES

Under this provision, estimated recoveries by way of resale or transfer of equipment used in infrastructure works, DG sets and transformers used for generation of construction power and temporary buildings are provided.

SECURITY

A separate provision of Rs. 75.22 crores has been kept as per the requirement of the project throughout the construction period.

3.2 CASH FLOW STATEMENT

The proposed cash flow at April' 2016 Price Level excluding interest during construction will be as follows:

Year	Civil Works	Electrical works	Security	Total
		(Rs. in Crores)		
Expenditure up to January-2018	164.39			164.39
1	458.74	.10	18	476.84
2	890.30	252.61	18	1160.91
3	1089.77	404.71	15.69	1510.16
4	653.11	279.93	15.69	948.73
4.5	18.16	104.04	7.84	130.04
Total	**3174.45**	**1104.38**	**75.22**	**4391.05**

3.3 ABSTRACT OF COST

S.No	Description	Amount (Rs. In Crores) (April'16 PL)
A	***CIVIL WORKS***	
1	**DIRECT CHARGES**	
	I - Works	
	A - Preliminary	18.91
	B - Land	87.05
	C - Works	1339.93
	J - Power Plant Civil Works	1251.00
	K - Buildings	80.09
	O - Miscellaneous	33.25
	P - Maintenance During Construction	27.42
	Q - Special Tools and Plants	1.61
	R - Communication	70.76
	X - Environment and Ecology	93.86
	Y - Losses on Stock	6.85
	TOTAL OF I - WORKS	3010.74
	II - Establishment	206.38
	III - Tools and Plants	2.00
	IV - Suspense	
	V- Receipt & Recoveries	-4.96
	TOTAL DIRECT CHARGES	**3214.15**
2	**INDIRECT CHARGES**	
	I - Capitalised Value of Abatement of Land Revenue (5% of Cost of Culturable Land)	0.18
	II - Audit & Accounts Charges (0.25% of I - Works)	7.53
	TOTAL INDIRECT CHARGES	7.71
	TOTAL CIVIL WORKS	**3221.86**
B	**ELECTRICAL WORKS**	**1041.38**
	TOTAL COST (CIVIL + ELECTRICAL)	**4263.24**
	SECURITY	**75.22**
	Expenditure incurred by NHPC Ltd	**52.59**
	TOTAL COST (CIVIL + ELECTRICAL+SECURITY)	**4391.05**
	INTEREST DURING CONSTRUCTION	532.21
	(AT DEBT : EQUITY = 70 : 30)	
	FINANCING CHARGES	25.98
	TOTAL COST INCLUDING IDC & FINANCING	**4949.24**

F/CEG/751/02/01

CHAPTER –4

HYDROLOGY

CHAPTER 4
HYDROLOGY

4.1 GENERAL

Kwar Hydroelectric Project is a run-of-river type development scheme, planned across Chenab river, near Padyarna village in Kishtwar district of Jammu region. The entire project area is located in a highly mountainous and difficult terrain of Kishtwar Tehsil. The project envisages construction of 109 m high concrete gravity dam across Chenab River. At Full Reservoir Level (EL 1385 m) the reservoir storage is 27.17 Mcum and reservoir surface area is 0.8 Sq.km. Length of the reservoir at FRL is around 6.0 km. Gross storage capacity at MDDL (i.e EL 1372 m) is 18 Mcum and live storage capacity is 9.16 Mcum.

4.2 RIVER SYSTEM AND BASIN CHARACTERSTICS

The Kwar Hydro Electric Project is proposed on the river Chenab. Chenab river is one of the three main rivers viz. the Indus, the Jhelum and the Chenab which drains the state of Jammu and Kashmir. It is formed of two streams (namely, the Chandra and the Bhaga) joining each other at Tandi (EL 2820 m) south of Keylong, the district head quarter of Lahaul and Spiti in the Himachal Pradesh State. The streams of Chandra and Bhaga originate respectively from the north and south faces of Baralacha pass at elevation 4891 m situated in the great Himalayas of Lahaul region of Himachal Pradesh.

The river flows in a general north-west direction before it is joined by the biggest of all tributaries, namely the Marau or the Marusudar River at Bhandalkot. The Marau or the Marusudar river, in turn is formed by the confluence of two major streams namely the Warwan and the Rin-Nai, rising in the glaciers on the slopes of Nunkun Peak of the Great Himalayas, and joins at Yurdu. The Chenab takes a great bend at Bhandalkot changing its north westerly course to a southerly course. Downstream of this Bhandalkot point, the river is generally known as Chenab, and

flows almost due south upto Thatri, where it is joined by Kal Nai on the left. The river then takes a great bend at Thatri changing its course from nearly southerly direction to almost westerly direction. The Niru Nakla joins the Chenab from the left bank at Doda. The Chenab continues to flow in a westerly direction till it is joined by its tributary Bichlari river on its right at Ramban. The famous Banihal Pass in the Pir Panjal range is located in the watershed line of this tributary. The river then runs in a south westerly course. Before it turns south below the famous Salal loop, the Ans River joins the Chenab river on its right below Kanthan village. The Chenab river basin is a part of Western Himalayas. At its upper part the basin is narrow and elongated while it broadens down along the lower part. The upper portion of the basin is characterised by rugged mountainous topography, whereas lower basin consists of low hills and aggradational plain. More than 10,000 sq.km. of the total catchment of Chenab in India remains permanently above snowline.

As about one third of catchment area of Chenab remains perpetually covered by snow and glaciers, the comparatively high flows between March to June are largely contributed by snow melting. High discharge in the river between July to September is further compounded due to monsoon precipitation. The minimum flow occurs during December, January and February.

The upper catchment is covered with glaciers. The snow line is considered at EL 4500 m. The catchment area of Chenab at Kwar is 10325 sq.km. The rainfed catchment area is 4692 sq.km whereas snowfed catchment area is 5633 sq.km. The catchment area of Chenab at Kwar lies between Longitude $75^{o}55'$ E to $77^{o}48'$ E and Latitude $32^{o}06'$ N to $33^{o}39'$ N. The proposed dam site lies at Longitude $75^{o}53'39"$ E and Latitude $33^{o}21'01"$ N.

4.3 WATER AVAILABILITY STUDY

Kwar H.E. Project is proposed at around 10 km u/s of Dul dam site of Dulhasti Power Station. Long term average 10-daily series has been developed at Dul dam

site for the period 1975-2012, which is based on daily discharge data at Benzwar from 1975-2003 and daily discharge data at Dul dam from 2004-2012. Considering uniform rainfall pattern, 10 daily average flow series has been estimated at proposed dam site by transposing the data of Benzwar and Dul dam site in catchment area proportion. The water availability study was submitted to CWC and has been duly approved by them. Average annual yield of CWC approved series (1975-2012) at Kwar dam site is 12949 Mcum.

4.4 RESERVOIR ELEVATION AREA CAPACITY CURVE

Reservoir elevation area capacity curve has been obtained on the basis of 1:10000 scale contour maps @ 10 m interval. The gross capacity of reservoir at proposed FRL (EL 1385 m) is computed as 27.167 Mcum. The reservoir will extend up to a distance of around 6 km upstream of the dam site and will have a surface area of 80 Ha at FRL EL 1385 m. Gross storage capacity at MDDL (EL 1372 m) is 18 Mcum and live storage capacity is 9.16 Mcum.

4.5 RATING CURVE

On the basis of observed G&D data sites and available cross sections, rating curves have been prepared at different locations**.**

4.6 DESIGN FLOOD

As suggested by CWC, the flood between Kirthai-1 and Kwar H.E.Project has been estimated using Flood Estimation report of CWC (Subzone-7) and routed flood of Kirthai-1 HEP has been added to this flood to estimate design flood at Kwar H.E.Project. PMF of 10534 cumec has been recommended for design and planning purposes by CWC.

4.7 GLACIAL LAKE OUTBURST FLOOD

It was suggested by CWC that as around 76 % area is under permanent snow, GLOF studies may also be carried out. Accordingly a GLOF study was carried out

and submitted to CWC in Nov 2013. In CWC clearance letter received vide 6/11/2009/FE & SA/94 dated 06.02.2014, it is stated that peak discharge of 620 cumec estimated at dam site, due to GLOF event, is in order.

4.8 DIVERSION FLOOD

The flood frequency analysis has been carried out for non-monsoon flood peaks (data base 1975-2012) for different working season by Log Pearson type-III distribution based on modified discharge data after discussions with IWC**.** The 7.5 months working period (i.e. 1st Oct to 15th May) has been decided for construction. 1 in 25 year non-monsoon flood at mean line is 1021 cumec for this period whereas maximum observed flood is 1041 cumec for this period. Maximum observed flood of 1041 cumec is recommended as Diversion flood by CWC.

4.9 RESERVOIR SEDIMENTATION

At Dulhasti Power Station, a sediment rate of 0.224 ham/sq.km/year has been adopted based on data observed at Benzwar site. The sediment data observed at Dul dam in later years shows comparatively lower sediment rate (0.151 ham/sq.km/year).

4.10 ANALYSIS OF TRANSIENT CONDITION FOR UPSTREAM & DOWNSTREAM WATERWAY

The hydraulic transient study for Kwar hydroelectric project has been carried out to ascertain the transient conditions in upstream waterway and downstream waterway occurring during operation of the power plant and especially to satisfy those stipulated in Indian Standards for total closing and/or opening of the turbine.

The detailed hydrological studies and hydraulic transient studies along with annexures and figures are compiled in **Hydrology volume, Volume-III** of DPR.

CHAPTER –5

GEOLOGY

CHAPTER – 5

GEOLOGY

5.0 INTRODUCTION

The 540MW Kwar HE Project is located on river Chenab near village Padyarna. The project is 10 km upstream of Dulhasti Power Station (Under operation by NHPC) in Kishtwar District of J&K on Kishtwar-Paddar Road.

Modifications in the layout were made by NHPC wherein dam site was shifted from Galhar to Padyarna & powerhouse was also brought contiguous to dam body to make the scheme more compact & viable. However, the TRT is extended upto tail of Dulhasti reservoir to harness complete head between Kwar and Dulhasti Projects.

Geologically the project area lies within inner lesser Himalayan belt under Kishtwar group of rocks. All the project components viz. dam & powerhouse are housed in competent gneissose granite except tail race tunnel and part of diversion tunnel, which lies in incompetent phyllite rocks.

5.1 FIELD INVESTIGATION

After taking over the project for DPR preparation, detailed investigation works have been carried out. The investigations include topographical survey, geological mapping, exploratory drilling (21 nos. of holes cum depth 1453.72m), and exploratory drifting in dam (7nos.,cum length 417.50m) and in Power house area (cum length 293.3m(old drift)+150.7m(new drift), geophysical explorations, laboratory and in-situ rock mechanic tests & construction material survey etc.

5.2 REGIONAL GEOLOGY

In the project area quartzite-phyllite sequence of Dul and Lopara Formation and Pias Granite as an intrusive body are exposed. The granite is intruded in the host rock of quartzite-phyllite sequence. In general, the foliation trends

NW-SE with moderate to steep dips in NE direction with folding attitude at the proposed dam site.

5.3 GEOLOGICAL EVALUATION OF MAIN CIVIL STRUCTURES

5.3.1 Dam

The proposed concrete gravity dam (101m above river bed level) is placed in the narrow 'U' shaped valley where the dam foundation and abutments shall be on strong granite. However, the phyllite-quartzite-phyllite sequence of rocks, which are exposed in the area lie above the dam top. The bedrock is exposed along the river channel at dam site at many places which indicate shallow overburden depth (5m to 7m) in the active river channel section. The bedrock profile has been considered at EL 1291m & 1280m at dam axis towards right & left side respectively from centre of river, based on present investigations. Overall the rock mass is dissected by 4 sets of joints along with random joint. Foliation is faintly developed in this rock and wherever it is observed, it shows downstream dips. Steep dips have been noticed near the river bank which might have been developed due to folding nature of strata.

Right Abutment

Right abutment is explored by drifts at three levels. All the drifts are driven through granite/ gneissose granite with intermittent shear seams/zones. Shearing/ shattering generally follow S-2 & S-3 joint sets. Random thick quartz bands are also noticed mainly in the lower drift. Irregular bands of phyllite appeared at the upper level drift, while amphibolite at the end of u/s cross cut of lower level drift. The rock is generally fresh, strong with moderately to widely jointed nature.

Right abutment may require large stripping at selective locations due to open clay filled joints to abut the dam with sound rock. Further, it may also require adequate grouting considering shearing and fracturization of rock mass as observed in the drifts.

Left Abutment

Left abutment is explored by drifts at three levels. As per drift data rock mass condition is relatively better than right bank. Normal stripping is proposed to abut the dam with sound rock however; it may require selective large stripping. Apart from this, adequate grouting may also be required considering shearing and fracturization of rock mass as observed in the drifts. The left bank slope in the downstream of dam site is of concern where a large slide scar cum subsidence zone is observed between elevations 1450 & 1370m. This feature has developed in scree and sheared material and have tendency of subsidence on charging of the ground. This may affect the dam toe location. As such, it is mandatory to provide proper protection works to safeguard the toe of the dam. Provision for slope treatment has been kept accordingly.

The foundation and the abutments of dam shall be placed exclusively in granite, but it shall require selective stripping for founding the dam in fresh and good rocks. Though the bed rock of granite is strong and competent but it may also require curtain grouting to minimize seepage path below dam foundation.

5.3.2 Plunge Pool Area

The plunge pool area encompasses bedrock of gneissose granite and phyllite. Plunge pool area is explored by a drill hole towards left bank (i.e. KDH-4) out of proposed two drill holes. The drill hole has gone entirely in granite/gneissose granite. Gneissose granite is competent, strong and widely jointed whereas phyllite is incompetent and thinly foliated in nature. Riverbed is occupied by riverine material (10m to 12m) as such; excavation of riverbed material and bedrock is required to attain the required level for plunge pool.

5.3.3 Diversion Tunnel

A 685m long 10m dia horse shoe shaped diversion tunnel has been envisaged on the left bank to divert the river water to facilitate construction of dam and its appurtenant structures. Diversion Tunnel will be housed partly in granite (from u/s side) and partly in Phyllite-quartzite sequence. Gneissose

granite rock is well exposed at inlet location however at outlet location phyllite-quartzite sequence is exposed at river level but overlooking slope is under overburden cover. Due to thick overburden in the outlet area a drill hole (KDH-5) is made to estimate thickness of overburden. The bedrock is encountered at 16.6m depth (El. 1312.14M). The overburden is constituted of slope wash material of phyllites and silty soil. The bed rock is light grey coloured, weak to medium strong phyllite/quartzitic phyllite. Part of tunnel is likely to be within granite/gneissose granite upto Ch. 270m (±) from inlet side and rest in phyllitic rocks. Foliation is feeble in granite but developed at places and have moderate to steep dips. Consequently, the phyllite-quartzite rocks, which are expected in a length of approx. 415m are relatively well foliated and weak in nature.

Apart from this, a shear zone has also been inferred within quartzite-phyllite sequence. A drill hole was made on DT alignment (KDH-6) to confirm the existence of shear zone. The hole was drilled on hill slope and the shear zone is encountered between 29m to 35m depth which confirms the apprehension. This shear zone is likely to encounter between Ch. 550m (±) to Ch. 570m (±) from inlet side. In view of weak nature of strata, it may pose difficult tunneling condition if the medium is charged. As such, such poor zones will require advance probing and concurrent rock support measures during excavation.

The diversion tunnel is anticipated to negotiate about 20% class II, 30% class III, 25% class IV and 25% class V rocks based on RMR classification.

5.3.4 Water Conductor System

The water conductor system comprises intake structure, 4 nos. pressure shafts, directly from intake to join the Power House.

All the structure viz Intake, Pressure shaft etc, shall be housed in competent granites. The intake structure is located on right bank very close to dam body. The area around proposed structure exhibits outcrops of granite however, some scanty talus material (slope wash) is also observed on the slope below El. 1350M (±). The overburden is insignificant however need to be removed to

expose the rock. Granite is hard, moderately jointed, slightly weathered with some open joints (filled with soil/clay) in the area.

To explore the subsurface geological conditions a drift with cumulative length of 50m (including X-cuts) is made in the proposed intake area. The drift has driven through granite/gneissose granite, which is strong & moderately to widely joint in nature. Shear seams/zones (few cms. to <50cm) are observed at places. Open joints with soil filling are also observed in the initial reach i.e., from portal to Ch. 4m in the main drift. The pressure shafts are expected to be in competent granitic rocks but wedge failures aided by sheared joints is foreseen due to shattered nature of rock and open joints filled with clay at the surface. Considering all geotechnical characteristics of rock mass, the pressure shaft is anticipated to negotiate through fair to good rock condition except random stretch of poor rock condition.

5.3.5 Power House Complex

The powerhouse complex is adjoining to dam body on right bank and shall be located under a cover of around 200m mainly in granites. Irregular bands of phyllite are seen in P/H drift & drill hole KDH-12, while amphibolite is seen within granite in the old and new power house drift as well as in drill hole KDH-15 &17, which indicates that these two units have intertounging relationship with granite and may occur randomly within granite. A new drift of 150.7m length has been made from ± RD 50m of old P/H drift to explore the subsurface geological conditions around new alignment of P/H cavern. The rock mass (granite) encountered in the drift are hard and competent to accommodate the large caverns. In all 4 sets of joints dissect the rock mass. Out of these, foliation (S-1), across foliation (S-2) & valley dipping (S-3) joints are more prominent. Foliation joint cut obliquely to the longer axis of the cavern. In order to minimize the adverse effect of orientation of joints, the longer axis of the cavern is realigned in N $090^{o.}$ Nevertheless intersection of some of the joint sets can lead to wedge formation and few of them may result in gravity fall or sliding failures from crown and side walls which need to be taken care. Suitable provisions have been kept accordingly.

Though, dry conditions are observed in new exploratory drift, but deeper inside possibility of seepage cannot be ruled out due to well jointed nature of rock and surface charging from nearby nallas through open joints. Further, the powerhouse cavern is placed adjoining to dam body, seepage from reservoir through well jointed granite rock is also apprehended. Thus, provisions of suitable mitigative measures are foreseen to control seepage into the machine hall. The powerhouse cavern, in general, shall be in good to fair class of rock with random pockets of poor rock.

5.3.6 Tail Race Tunnel

The water from the power house shall be discharged back into the river through 2 nos. horse shoe tunnels on right bank of 2.786 & 2.963km long, having 9.5m dia at normal TWL 1270M to harness the maximum head. Both the tunnels are 78m apart from centre to centre and aligned almost subparallel to river course with a kink near Phullar nalla.

Both the tunnels are anticipated to be mainly in phyllitic rocks (around 90%) however quartzitic bands within phyllite-quartzite sequence and intrusive granitic rocks may appear in the initial part from PH side (around 10%). To know the rock cover and subsurface geological conditions two drill holes i.e. KDH-11 & KDH-14 were drilled in Phullar nala and on TRT-2 alignment respectively. A thick shear/fracture zone (>20m) was encountered in drill hole KDH-11 beyond 41.35m depth (El. 1383.6M) and continued down to the end of the hole , while in drill hole KDH-14 also ,a shear/fracture zone of nearly 21m thickness was encountered between 52.5 (EL. 1301.3M) and 73.5m depth (EL.1280.3M). The shear zone intercepted in this drill hole may encounter in TRT nearly at Ch. 1.2km (approximate 30m zone) from upstream side if shear zone follows the bedding attitude. An old slide scar has been observed on R/B near the TRT outlet and the slide material is lying at the river bed following the rock profile. As the valley slide TRT is under the slide material, a drill hole was proposed to assess the rock cover above the alignment. The drill hole (KDH-16) drilled in slide debris on TRT-1 alignment has intercepted the bedrock at 42m depth (El. 1342.96M). The bedrock is light green to grey colored and weak phyllite. A thick sheared/crushed zone is

encountered between 51 and 55.5m depth. The cover over the tunnel varies from 72m to 398m over TRT-1 and 92m to 468m over TRT-2 respectively. The minimum cover of 72m (TRT-1) comes below Phullar nalla.

Owing to weak and laminated nature of rock (phyllite) and at places tunnel having aligned sub-parallel to the strike of rock formation coupled with superincumbent cover, the tunnel may experience squeezing condition at places. There are number of surface manifestations of shear zones, lineaments & master joints etc. within phyllite which can be considered as zone of weaknesses for tunneling. Further, there are apprehensions of encountering number of weak zones (around 40% of total tunnel length) intermittently along the tunnel route. As such, 50% tunneling may be considered in class-III (fair rock) and 30% in class IV & 20% in class V rocks

5.4 RESERVOIR

This dam shall create a 6.7km long reservoir upto outlet of TRT of Kiru Project. The full reservoir level (FRL) has been proposed at EL 1385M having 0.8sq km area. Right bank of the river is almost rocky (80 % touching rock) whereas left bank shall be touching partly overburden (50%) and partly rock outcrops (50%). Major part of the reservoir rim shall be in contact with bedrock comprising of gneissose granite and phyllite-quartzite sequence. A thermal spring has been observed within reservoir which indicates presence of some structural control along the river course. A landslide is observed on R/B near tail of reservoir. However, some stretches under slope wash material near Galhar village may result in sloughing after filling up of the reservoir. These issues will be addressed during EMP studies. Overall, the reservoir rim appears to be safe from geo-environmental consideration (except some part of rim on left bank near village Galhar) with no possibility of reservoir leakage. No economic mineral within reservoir periphery has been reported.

5.5 SEISMICITY

The project area falls in Zone-IV of Seismic Zoning map of India which corresponds to high seismically active area. Site Specific Design Earthquake Parameters study has been carried out by DEQ, IIT Roorkee.

As per updated report, the PGA value recommended for MCE & DBE conditions are 0.50g and 0.28g for horizontal and 0.33g MCE and 0.19g DBE for the vertical ground motion respectively. Further, Department has also suggested the design seismic coefficient for preliminary design of Dam as αh=0.17 and αv=0.12, which was approved by NCSDP in its 31st meeting held on 23rd June 2016. (Letter dated 07.10.2016 is appended as Annexure-XII).

Further, as suggested by GSI during the evaluation of DPR, MEQ studies by Wadia Institute of Himalayan Geology, Dehradun have been carried out to know the local seismicity of the area as well as to establish the presence of neo-tectonic activity. The study is now completed and the report was discussed with NCSDP. Further, NCSDP has suggested some modifications in the MEQ report, however, these suggestions will not have any impact on the approved seismic design parameters. The final updated report shall be submitted after getting approved by NCSDP.

5.6 CONSTRUCTION MATERIAL

For the construction of concrete dam, coffer dams, diversion tunnel, powerhouse and other allied civil structures of the project, 4 rock quarries and one impervious soil deposit have been selected for meeting the requirements. The requirement of coarse and fine aggregate has been estimated to be 21.9 lac.cum, whereas 0.69 lac.cum. of impervious soil, 3.0 lac.cum. of rockfill material, 0.13 lac.cum. of filter material and 0.19 lac.cum. of Riprap material shall be required for construction of coffer dams.

Based on the test results and keeping in view the available quantity, it is concluded that sufficient suitable construction material is available to meet the requirement of the project.

CHAPTER –6

POWER STUDIES

CHAPTER – 6
POWER STUDIES

6.1 POWER SUPPLY-DEMAND

6.1.1 ON ALL INDIA BASIS

The Power System in India has grown from small, isolated stations, serving limited consumers in and around large cities, into large regional Power Grids. The generating capacity installed in the country has already grown to 306358.25 MW by September 2016.

For the purpose of system planning and operation the country has been divided into the following five geopolitical regions: Northern, Western, Southern, Eastern and North-Eastern regional power grids and the transmission system are being progressively inter-connected for efficient operation of these five regional grids.

The objective of the system development is to evolve self-sufficient regional grid catering to the individual regional power demands. It is also aimed at achieving the maximum benefits from integrated operation, through a proper mix of thermal and hydro generation. The present power position in the five regional Grids as per "'Load Generation Balance Report (LGBR) 2016-17" published by CEA is shown in Table 6.1a and 6.1b.

6.1.2 ON REGIONAL BASIS

The Northern Region comprises the states of Punjab, Haryana, Himachal Pradesh, Delhi, UP, Uttarakhand, Rajasthan, Chandigarh and J&K. The Northern grid comprises the power system controlled by Electricity Boards/ Corporations of the above states.

The Northern Region has been experiencing acute power shortage during the last decade due to rapid industrialization, developing irrigation network & urbanization. It is obviously not possible to meet rapidly growing power demands of industry and agriculture from the existing power stations. Electrical energy being the basic ingredient for economic upliftment through industrial and agricultural development, power shortage has slowed down the wheels of progress and put a curb on all development activities in the region. Thermal and nuclear generation of power is not the right solution for meeting peaking power deficit in this region because of limitations imposed

by inadequate availability of coal and nuclear fuel, long distances over which fuel has to be transported through an overloaded railway system and higher cost of power generation from thermal and nuclear power plants.

Even considering the coordinated operation of existing hydro, nuclear and thermal stations, as well as benefits from on-going projects and also from the schemes cleared by CEA, the Northern region shall face power deficits by the end of 12th five Year Plan and is also expected to face further power deficits in the upcoming years.

The Power position in Northern region for 12th ,13th and 14th five Year Plans has been summarized in Table 6.2. In the table, the peaking and energy capabilities are taken for optimum condition. The benefits from all schemes that have been cleared by CEA have been included.

6.1.3 JUSTIFICATION FOR THE PROJECT

From the Table 6.1a for the year 2015-16, it is observed that the North Region had deficit in capacity of (-)7.1 % and energy peak deficit of (-) 4.8%.

Northern region has Hydro thermal mix ratio of 23:64 at present in comparison to overall scenario in the country vis-à-vis Hydro Thermal ratio stands at 14:70. The proposed Kwar Project would form an integral part of the Northern Grid to contribute in projected energy requirement. Besides, it will also provide peak capacity to the grid and helps in optimizing the generation from thermal stations which are forced to operate at poor load factor in absence of matching hydropower contribution.

6.2 SCHEME FOR WHEELING EVACUATING POWER

The responsibility of power evacuation system from Kwar Power Project as per present scenario remains with PGCIL to be connected to grid at 400 kV level.

6.3 AVAILABLE GENERATING CAPACITY IN REGION

The Total Installed Capacity in Northern Region as on Sep 2016 is 80862.58 MW. Out of this, 18376.78 MW is Hydel and the rest are thermal and nuclear and thus the Hydro Thermal mix is 23:64 which is better than the national average of 14:70.

6.4 FUTURE ENERGY REQUIREMENTS IN REGION

The CEA has forecasted the future load demand in their publication "18th Electric Power Survey (EPS) of India" The future load demand for the year 2022-23 has been projected on the basis of a scaling factor of 1.0243 for Northern Region.

From Table 6.2, in Northern region there will be peaking deficit of 1.6% and Energy deficit of 1.8% by the end of 2016-17. However, by the end of 2022-23, there will be peaking deficit of 30.1% and energy deficit of 36.5%.

6.5 POWER SUPPLY POSITION WITH & WITHOUT PROJECT

The Power supply position without Kwar hydro electric project is shown in Table 6.2. From the perusal of table 6.2, the power scenario in the northern regions without Kwar HE Project by the end of 2022-23 is summarized as below:

Region	Peaking Power(MW)	Peaking Power (%)	Energy(MU)	Energy (%)
Northern Region	-26667	-30.1%	-227443	-36.5%

Note: Surplus denoted by (+)

Deficit denoted by (-)

Kwar HE Project with an installed capacity of 540 MW, is one of the potential schemes in J&K and, as such, merits clearance at an early date so as to be taken up for execution immediately to obtain benefits by 2022-23. The need for Kwar Project has therefore been considered in the context of power storage particularly peaking capacity in Northern region and energy requirements of Northern region apart from other considerations. Kwar Project is planned as run of river scheme with live storage capacity of 9.16MCM. It is planned to generate 1975.54 MU in 90% dependable year i.e. 1996-1997.

Power supply position with Kwar HE Project in Northern region is as given in Table 6.3. In the study, forecasted Hydro and Thermal (Including Nuclear & renewables) power plants proposed to be added to the system are also

shown. Factors like slippage in commissioning of the units, unforeseen outages have not been taken into account. It is also assumed that all the TEC cleared projects would be available by the end of 13th plan.

From the perusal of tables 6.3, the power scenario in the region with Kwar Project by the end of 2022-23 is summarized as follows:

Region	Peaking Power (MW)	Peaking Power (%)	Energy (MU)	Energy (%)
Northern Region	-26324	-**29.7**%	-225248	-**36.1**%

Note: Surplus denoted by (+)

Deficit denoted by (-)

It is observed that in Northern region, by the end of 2022-23, there is a peaking deficit of (-) 29.7% and Energy deficit of (-)36.1%. From the growth of demand and anticipated installed generating capacity on the basis of schemes proposed for benefits under construction/consideration during 13th Five Year Plan period, It is observed that power supply position in the Northern Region would become all the more acute from the start of 13th Five Year Plan and serious power shortage will have to be faced unless additional schemes are taken up immediately and implemented to derive timely benefits. The most important sources of power development in the Northern Region are its abundant hydro resources located in Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

The power from this project would be fully absorbed in the Northern grid. It is in this context that Kwar H.E. Project is being proposed for immediate implementation.

Table: 6.1a

Actual Power Position for Year 2015-2016

Region	Energy				Peak			
	Requirement	Availablity	Surplus/ Deficit (-)		Demand	Met	Surplus/ Deficit (-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
Northern	340475	324009	-16,466	-4.8%	54474	50622	-3852	-7.1%
Western	346767	345967	-800	-0.2%	48640	48199	-441	-0.9%
Southern	288025	283494	-4531	-1.6%	40030	39875	-155	-0.4%
Eastern	124653	123646	-1007	-0.8%	18169	18056	-113	-0.6%
North-Eastern	14488	13735	-753	-5.2%	2573	2367	-206	-8.0%
All India	1114408	1090851	-23557	-2.1%	163886	159119	-4767	-2.9%

Table: 2.1b

Anticipated Power Position for Year 2016-2017

Region	Energy				Peak			
	Requirement	Availablity	Surplus/ Deficit (-)		Demand	Met	Surplus/ Deficit (-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
Northern	**357459**	**351009**	**-6450**	**-1.8%**	**55800**	**54900**	**-900**	**-1.6%**
Western	379087	405370	26283	6.9%	51436	56715	5279	10.3%
Southern	310564	320944	10380	3.3%	44604	40145	-4459	-10.0%
Eastern	151336	135713	-15623	-10.3%	21387	22440	1053	4.9%
North-Eastern	16197	14858	-1339	-8.3%	2801	2695	-106	-3.8%
All-India	1214643	1227894	13251	1.1%	176028	176895	867	0.5%

The data for the year 2015-2016 & 2016-2017 tabulated above is as per 'Load generation balance report and ' Published by CEA June 2016 on the website www.cea.nic.in

Table-6.2

POWER SUPPLY POSITION NORTHERN REGION

WITHOUT KWAR PROJECT

Northern Region	Unit	12th Plan		13th Plan					14th Plan
		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Installed Capacity	**MW**	79693	83353	87565	89820	93550	94309	95822	97446
Peak availability	**MW**	50622	54900	55622	57055	59424	59906	60867	61899
Peak requirement	**MW**	54474	55800	65686	70276	75238	80620	86461	88566
Peak Surplus(Deficit)	**MW**	-3852	-900	-10064	-13221	-15814	-20714	-25594	-26667
Peak Surplus(Deficit)	**%**	**-7.1%**	**-1.6%**	**-15.3%**	**-18.8%**	**-21.0%**	**-25.7%**	**-29.6%**	**-30.1%**
Energy availability	**MU**	324009	351009	356014	365182	380347	383433	389585	396188
Energy requirement	**MU**	340475	357459	454897	485914	519260	555214	594000	623631
Energy Surplus(Deficit)	**MU**	-16466	-6450	-98883	-120732	-138913	-171781	-204415	-227443
Energy Surplus(Deficit)	**%**	**-4.8%**	**-1.8%**	**-21.7%**	**-24.8%**	**-26.8%**	**-30.9%**	**-34.4%**	**-36.5%**
Power plant considered to be added in respective year of 12th, 13th , 14th and 15th plan.			1400 MW	500 MW	520 MW	444 MW	660 MW	850 MW	1000 MW
			Raj(U-7&8) NPCIL	Unchahar St-IV(U-6)	Tapovan vishnugad	Vishnugad Pipalkoti	Harduagang Exp-II	Ratle HEP	Pakal Dul
			100 MW	1320 MW	660 MW	180 MW	99 MW	171 MW	624 MW
			Sainj	Meja STPP	Chabra GT	Bajoli Holi	Singoli Bhatwari	Lata Tapovan	Kiru
Source:			330 MW	100 MW	800 MW	1320 MW		240 MW	
A. www.cea.nic.in(CEA reports)			Kishanganga HEP	Uhl-III	Parbati-II HEP	Tanda-II		Kutehr	
1. list of power projects for likely benefit during 12 th plan			660 MW	36 MW	44 MW	1000 MW		252 MW	
2.Thermal units programmed for commissioning during 2015-16			Prayagraj	Chanju-I	Tangnu Romai-I HEP	Tehri PSS		Devsari	
3. Thermal and hydro projects monitoring report.				76 MW	111 MW	206 MW			
4.Status of hydro electric projects under execution for 12th plan and beyond				Phata Byung HEP	Swara Kuddu HEP	Shahpur kandi			
				1320 MW	120	130 MW			
Status of projects under construction: other websites				Suratgarh TPS(U-7&8)	Vyasi UJVNL	Kashang-II&III			
				660 MW		450 MW			
				Chhabra TPP Extn.(U-5)		Shongtong Karcham			
				100 MW					
				Tidong-I HEP					
				100 MW					
				Sorang HSPL					
Total	**MW**		**2490.0 MW**	**4212.0 MW**	**2255.0 MW**	**3730.0 MW**	**759.0 MW**	**1513.0 MW**	**1624.0 MW**

1.The data for the year 2015-16 and 2016-17 has been taken from 'Load generation balance report 2016-17' Published by CEA on the

2. Peak availability for the year 2017-18 onwards have been estimated on the basis of ratio of Peak availability to Installed capacity for the year 2015-16.

3. Energy availability for the year 2017-2018 onwards have been estimated on the basis of ratio of Energy availability to Installed capacity for the year 2015-16.

4. Energy requirement and peak requirement for the year 2016-17 onwards upto 2021-22 is based on 18th EPS of India.

5. Energy requirement and peak requirement for the year 2022-23 onwards is based on scaling factor of increase in Energy and Peak requirement for the years 2015-16 to
2016-17 from the preceding year.

6. Micro/mini hydel projects under construction have not been considered in this study.

This is a statistical analysis based on various publications mentioned above and meant for study and planning purposes only.

Table-6.3

POWER SUPPLY POSITION NORTHERN REGION

WITH KWAR PROJECT

Northern Region	Unit	12th Plan		13th Plan					14th Plan
		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Installed Capacity	**MW**	79693	83353	87565	89820	93550	94309	95822	97986
Peak availability	**MW**	50622	54900	55622	57055	59424	59906	60867	62242
Peak requirement	**MW**	54474	55800	65686	70276	75238	80620	86461	88566
Peak Surplus(Deficit)	**MW**	-3852	-900	-10064	-13221	-15814	-20714	-25594	-26324
Peak Surplus(Deficit)	**%**	**-7.1%**	**-1.6%**	**-15.3%**	**-18.8%**	**-21.0%**	**-25.7%**	**-29.6%**	**-29.7%**
Energy availability	**MU**	324009	351009	356014	365182	380347	383433	389585	398383
Energy requirement	**MU**	340475	357459	454897	485914	519260	555214	594000	623631
Energy Surplus(Deficit)	**MU**	-16466	-6450	-98883	-120732	-138913	-171781	-204415	-225248
Energy Surplus(Deficit)	**%**	**-4.8%**	**-1.8%**	**-21.7%**	**-24.8%**	**-26.8%**	**-30.9%**	**-34.4%**	**-36.1%**
Power plant considered to be added in respective year of 12th, 13th and 14th plan.			1400 MW	500 MW	520 MW	444 MW	660 MW	850 MW	1000 MW
			Raj(U-7&8) NPCIL	Unchahar St-IV(U-6)	Tapovan vishnugad	Vishnugad Pipalkoti	Harduagang Exp-II	Ratle HEP	Pakal Dul
			100 MW	1320 MW	660 MW	180 MW	99 MW	171 MW	624 MW
			Sainj	Meja STPP	Chabra GT	Bajoli Holi	Singoli Bhatwari	Lata Tapovan	Kiru
Source:			330 MW	100 MW	800 MW	1320 MW		240 MW	540 MW
A. www.cea.nic.in(CEA reports)			Kishanganga HEP	Uhl-III	Parbati-II HEP	Tanda-II		Kutehr	Kwar HEP
1. list of power projects for likely benefit during 12 th plan			660 MW	36 MW	44 MW	1000 MW		252 MW	
2.Thermal units programmed for commissioning during 2015-16			Prayagraj TPP	Chanju-I	Tangnu Romai-I HEP	Tehri PSS		Devsari	
3. Thermal and hydro projects monitoring report.				76 MW	111 MW	206 MW			
4.Status of hydro electric projects under execution for 12th plan and beyond				Phata Byung HEP	Swara Kuddu HEP	Shahpur kandi			
				1320 MW	120	130 MW			
Status of projects under construction: Other web sites				Suratgarh TPS(U-7&8)	Vyasi UJVNL	Kashang-II&III			
				660 MW		450 MW			
				Chhabra TPP Extn.(U-5)		Shongtong Karcham			
				100 MW					
				Tidong-I HEP					
				100 MW					
				Sorang HSPL					
Total	**MW**		**2490.0 MW**	**4212.0 MW**	**2255.0 MW**	**3730.0 MW**	**759.0 MW**	**1513.0 MW**	**2164.0 MW**

1.The data for the year 2015-16 and 2016-17 has been taken from 'Load generation balance report 2016-17' Published by CEA on the website www.cea.nic.in

2. Peak availability for the year 2017-18 onwards have been estimated on the basis of ratio of Peak availability to Installed capacity for the year 2015-16.

3. Energy availability for the year 2017-2018 onwards have been estimated on the basis of ratio of Energy availability to Installed capacity for the year 2015-16.

4. Energy requirement and peak requirement for the year 2016-17 onwards upto 2021-22 is based on 18th EPS of India.

5. Energy requirement and peak requirement for the year 2022-23 onwards is based on scaling factor of increase in Energy and Peak requirement for the years 2015-16 to 2016-17 from the preceding year.

6. Micro/mini hydel projects under construction have not been considered in this study.

This is a statistical analysis based on various publications mentioned above and meant for study and planning purposes only.

CHAPTER –7

OPTIMISATION STUDIES

CHAPTER - 7

OPTIMISATION STUDIES

7.0 INTRODUCTION

Kwar H.E. Project is located on the right bank of the river Chenab in district Kishtwar of Jammu & Kashmir (J&K) state near Padyarna village utilizing inflow of the river Chenab for power generation. It is essentially a run off river scheme having small pondage with live storage of 9.16 Mcum between FRL 1385m and MDDL 1372m. The installed capacity of the project has been proposed as 540 MW comprising 4 generating units of 135 MW each driven by vertical axis Francis turbines with overall efficiency of generation as 92%. Project is a step towards the exploitation of available hydro potential in the Jammu & Kashmir (J&K) state.

7.1 AVAILABLE INFLOW

Inflow series of 37 years i.e. 1975-76 to 2011-12 has been considered for power potential studies The criteria of the 90% dependable inflow is applied for conducting power potential studies. The available inflow after releasing a mandatory outflow of 16.49 cumecs during lean flow period (Dec to March), 74.09 cumecs during peak flow period (June to September) and 16.79 cumecs for remaining four months (October, November, April and May) for environmental requirements has been considered.

7.2 90% DEPENDABLE YEAR

The year 1996-1997 works out as 90% dependable year. The full reservoir level has been fixed at EL.1385.0 m and and MDDL level has been fixed at EL. 1372.0m. Max. Tail water level (all units running) is El. 1269.90 m and Min. Tail water level (one unit running) is EL.1267.32 m . Rated net head is 103.1m.

7.3. INSTALLED CAPACITY

The power potential study has been carried out for different installed capacities from 400 MW to 800 MW with an increment of 20 MW, for a 90% dependable year, as

shown in Table 7.1. The studies indicate selection of 540MW as optimum installed capacity at a load factor of 43.02% and incremental load factor of 25.21%. Four no. generating units, each of 135MW has been proposed for the power house of this project.

7.4. ANNUAL ENERGY GENERATION IN 90% DEPENDABLE YEAR

The annual energy generation with 95% machine availability after considering the environmental releases of 16.49 cumecs during lean flow period (Dec to March), 74.09 cumecs during peak flow period (June to September) and 16.79 cumecs for remaining four months (October, November, April and May) in 90% dependable year 1996-1997 works out to be 1975.54 MU with an annual load factor of 41.76%. Power potential study in 90% dependable year with 95% machine availability is Table 7.2.

Availability of Units in KWH / KW for Incremental Installation Based on Energy of 90% Dependable Year

Table 7.1

Average Net Head (in m) 103.1 **Overall Efficiency** 92%

S. NO.	INSTALLED CAPACITY MW	No. of 10-D AVALABILITY	ANNUAL ENERGY MU	LOAD FACTOR %	INCREMENTAL ENERGY MU	INCREMENTAL ENERGY KWH/KW	LOAD FACTOR FOR ADDITIONAL CAPACITY %
1	400	10	1717.66	49.02%			
2	420	10	1766.62	48.02%	48.96	2448.00	27.95%
3	440	9	1814.36	47.07%	47.74	2387.00	27.25%
4	460	9	1858.52	46.12%	44.16	2208.00	25.21%
5	480	9	1902.68	45.25%	44.16	2208.00	25.21%
6	500	9	1946.84	44.45%	44.16	2208.00	25.21%
7	520	9	1991.00	43.71%	44.16	2208.00	25.21%
8	540	9	2035.16	43.02%	44.16	2208.00	25.21%
9	560	9	2079.32	42.39%	44.16	2208.00	25.21%
10	580	7	2119.79	41.72%	40.47	2023.58	23.10%
11	600	5	2147.15	40.85%	27.36	1368.14	15.62%
12	620	5	2171.63	39.98%	24.48	1224.00	13.97%
13	640	4	2190.96	39.08%	19.33	966.40	11.03%
14	660	3	2208.05	38.19%	17.09	854.74	9.76%
15	680	2	2219.53	37.26%	11.47	573.63	6.55%
16	700	2	2229.13	36.35%	9.60	480.00	5.48%
17	720	2	2238.73	35.49%	9.60	480.00	5.48%
18	740	2	2248.33	34.68%	9.60	480.00	5.48%
19	760	2	2257.93	33.92%	9.60	480.00	5.48%
20	780	0	2265.35	33.15%	7.42	370.99	4.24%
21	800	0	2265.35	32.33%			

Table 7.2

POWER POTENTIAL STUDY IN 90% DEPENDABLE YEAR WITH 95% MACHINE AVAILABLITY

YEAR 1996-1997

FRL (m)		**1385**	**MDDL(m)**		**1372**	**Rated Head (m)**		**103.10**	**Design Discharge (Cumec)**		**580.30**	**Overall Efficiency**	**92%**
INSTALLED CAPACITY (MW)			**540**	**Type of Turbine**		**Francis**	**No. of Unit**	**4**	**Average Peaking Hr. (Lean Period)**		**2.7**	**Firm Power (MW)**	**51.80**
Annual Load Factor			**41.76%**	**Load Factor of Monsoon Period**			**87.53%**	**Load Factor of Non-Monsoon Period**			**18.79%**	**Design Energy (MU)**	**1975.54**
PERIOD		**Total Inflow (Cumec)**	**Total Inflow (MCuM)**	**D / S Release for Env. Concern (cumec)**	**Available Inflow for Power Generation (Cumec)**	**Unrestricted Power with Total inflow (MW)**	**Unrestricted Energy with Total inflow (MU)**	**Unrestricted Power with Available inflow (MW)**	**Unrestricted Energy with Available inflow (MU)**	**Restricted Energy with available inflow (MU)**	**Energy with 95% M/c Availability (MU)**	**Peaking Hours**	**Spill in addition to D/S Release (cumec)**
	1-10	739.42	638.86	74.09	665.33	633.30	151.99	569.85	136.76	129.60	123.12	24.00	85.03
	11-20	981.95	848.41	74.09	907.86	841.03	201.85	777.58	186.62	129.60	123.12	24.00	327.56
Jun-96	21-30	977.01	844.13	74.09	902.92	836.80	200.83	773.34	185.60	129.60	123.12	24.00	322.62
	1-10	755.22	652.51	74.09	681.13	646.84	155.24	583.38	140.01	129.60	123.12	24.00	100.83
	11-20	745.18	643.84	74.09	671.09	638.24	153.18	574.79	137.95	129.60	123.12	24.00	90.79
Jul-96	21-31	760.43	722.71	74.09	686.34	651.30	171.94	587.84	155.19	142.56	135.43	24.00	106.04
	1-10	853.79	737.67	74.09	779.70	731.26	175.50	667.80	160.27	129.60	123.12	24.00	199.40
	11-20	834.43	720.95	74.09	760.34	714.69	171.52	651.23	156.29	129.60	123.12	24.00	180.04
Aug-96	21-31	798.54	758.93	74.09	724.45	683.94	180.56	620.48	163.81	142.56	135.43	24.00	144.15
	1-10	581.88	502.74	74.09	507.79	498.37	119.61	434.92	104.38	104.38	104.38	19.33	
	11-20	463.10	400.12	74.09	389.01	396.64	95.19	333.19	79.96	79.96	79.96	14.81	
Sep-96	21-30	399.34	345.03	74.09	325.25	342.03	82.09	278.58	66.86	66.86	66.86	12.38	
	1-10	345.35	298.38	16.79	328.56	321.35	77.12	305.73	73.37	73.37	73.37	13.59	
	11-20	208.95	180.54	16.79	192.16	194.43	46.66	178.81	42.91	42.91	42.91	7.95	
Oct-96	21-31	134.00	127.36	16.79	117.21	124.69	32.92	109.07	28.79	28.79	28.79	4.85	
	1-10	126.59	109.38	16.79	109.80	117.79	28.27	102.17	24.52	24.52	24.52	4.54	
	11-20	119.60	103.33	16.79	102.81	111.28	26.71	95.66	22.96	22.96	22.96	4.25	
Nov-96	21-30	105.14	90.84	16.79	88.35	97.84	23.48	82.21	19.73	19.73	19.73	3.65	
	1-10	96.72	83.57	16.49	80.23	90.00	21.60	74.66	17.92	17.92	17.92	3.32	
	11-20	92.01	79.50	16.49	75.52	85.62	20.55	70.27	16.87	16.87	16.87	3.12	
Dec-96	21-31	88.48	84.09	16.49	71.99	82.33	21.73	66.98	17.68	17.68	17.68	2.98	
	1-10	85.75	74.09	16.49	69.26	79.79	19.15	64.44	15.47	15.47	15.47	2.86	
	11-20	83.53	72.17	16.49	67.04	77.73	18.65	62.38	14.97	14.97	14.97	2.77	
Jan-97	21-31	82.09	78.02	16.49	65.60	76.39	20.17	61.04	16.11	16.11	16.11	2.71	
	1-10	80.61	69.65	16.49	64.12	75.01	18.00	59.67	14.32	14.32	14.32	2.65	
	11-20	75.67	65.38	16.49	59.18	70.41	16.90	55.07	13.22	13.22	13.22	2.45	
Feb-97	21-28	72.16	49.88	16.49	55.67	67.14	12.89	51.80	9.95	9.95	9.95	2.30	
	1-10	73.79	63.76	16.49	57.30	68.66	16.48	53.32	12.80	12.80	12.80	2.37	
	11-20	77.87	67.28	16.49	61.38	72.46	17.39	57.12	13.71	13.71	13.71	2.54	
Mar-97	21-31	80.45	76.46	16.49	63.96	74.86	19.76	59.51	15.71	15.71	15.71	2.65	
	1-10	84.56	73.06	16.79	67.77	78.68	18.88	63.06	15.13	15.13	15.13	2.80	
	11-20	98.38	85.00	16.79	81.59	91.54	21.97	75.92	18.22	18.22	18.22	3.37	
Apr-97	21-30	145.93	126.09	16.79	129.14	135.79	32.59	120.17	28.84	28.84	28.84	5.34	
	1-10	180.97	156.35	16.79	164.18	168.39	40.41	152.76	36.66	36.66	36.66	6.79	
	11-20	204.23	176.45	16.79	187.44	190.04	45.61	174.41	41.86	41.86	41.86	7.75	
May-97	21-31	260.65	247.72	16.79	243.86	242.54	64.03	226.91	59.91	59.91	59.91	10.09	
Total							**2541.45**		**2265.35**	**2035.16**	**1975.54**		

CHAPTER –8

DESIGN OF CIVIL ENGINEERING STRUCTURES AND HYDROMECHANICAL EQUIPMENTS

CHAPTER – 8
DESIGN OF CIVIL ENGINEERING STRUCTURES AND HYDRO-MECHANICAL EQUIPMENTS

8.1 INTRODUCTION

Kwar H.E. Project envisages utilization of 115 m head of Chenab river by construction of a concrete gravity dam near Padyarna village, an underground power station of 540 MW (4 units of 135MW each) on the right abutment of the dam adjacent to dam axis and 2 nos. tail race tunnels of lengths 2786 m and 2963 m.

Certain changes in structures sizes & layout has been made in the DPR (July 2012) as per various meetings / discussions held with CWC, GSI, CEA etc. during detailed scrutiny and examination. The following changes with respect to DPR (July 2012) have been incorporated:-

- Design flood value of 7600 cumec reviewed & revised to 10534 cumec.
- Change in diversion discharge from 1020 cumec to 1041 cumec as proposed by CWC.
- In order to avoid sediment deposition near intake and for effective and efficient sediment management, the following Spillway configuration, on the basis of Mathematical / Numerical Model Studies, has been adopted in consultation with CWC against that provided in the DPR submitted for appraisal during 2012:

Spillway	**Lower Spillway**	**Upper Spillway**
Type	Orifice	Surface
Width of spillway	64	16
Crest Level of Spillway	EL 1330.0 m	EL 1368.0 m
No. & Size of Openings	4 no., 9.5m(W)×13.8m(H)	1 no., 9.5m(W)×17m(H)
Discharge Capacity at FRL	10534 cumec	

- The Design discharge of 145.07 cumec has been considered as against 151.3 cumec for carrying out Power Potential Studies as suggested by CEA.

- Silt excluder arrangement below intake has been deleted as per discussion with CWC, considering the low level spillway.

As per Technical clearance received from CWC, the principal components of the project are:

A. A concrete gravity dam 101 m high above river bed level.
B. River diversion works comprising of 1 no, 9.5 m diameter horseshoe shape diversion tunnel with upstream and downstream cofferdams.
C. 4 nos. orifice type spillways with discharging capacity of 3221 cumec each and 1 no. crest spillway with discharging capacity of 884 cumec and corresponding gate control structures to serve for flood release.
D. One outlet for environmental releases, having discharging capacity of 16.49 cumec to 74.09 cumec and gate opening size of 2.6m(W) x 2.0m(H)..
E. 4 nos. Construction sluices, each 3.1 m wide and 5.0 m high with crest at EL.1300.0 m to serve for diversion flood during construction stage.
F. Water conductor system consisting of:
    i. 4 nos. Power Dam Intakes with gate arrangement.
    ii. 4 nos. 5.65 m dia. circular penstocks / pressure shafts, with vertical lengths varying from 54.0 m to 93.0 m, and total lengths (excluding vertical) varying from 108.0 m to 182.0 m.
    iii. 2 nos. 9.5 m dia. horseshoe shaped tailrace tunnels of lengths 2786 m and 2963 m, respectively.
    iv. 2 nos. downstream surge galleries of dia. 10.4 m and length 750 m.
G. An underground power house complex consisting of:
    i. A machine hall cavern with MIV of size 140 m x 23.3 m x 50 m.
    ii. A control room cavern of size 40 m x 15 m x 28.8 m.
    iii. A transformer cavern of size 116.0 m x 17 m x 16 m.
    iv. A GIS cavern of size 65 m x 15 m x 16 m.
H. An outdoor Pothead Yard of size 150 m x 35 m at EL.1315.0 m.

All these components are marked on the project layout plan (drawing no. NHKR-D-41-GA-002).

These are based on the data available from various field investigations carried out as detailed in Volume-IV.

8.2 LAYOUT OPTIMIZATION

8.2.1 Introduction

The pre-feasibility report of Kwar H.E. Project was prepared by WAPCOS as a part of 50,000 MW hydro initiatives by Hon'ble PM. The project is located upstream of Dulhasti project. The proposed FRL and Tail Water level of the project as conceived in PFR were EL 1362.0 m and EL 1275.0m respectively. In the PFR, the project was envisaged with a rated head of 74.0m and an installed capacity of 320 MW with annual energy generation of 1426.56 MU in a 90% dependable year.

8.2.2 Review of the Project

Kwar project is one of the four projects handed over by CEA to NHPC for detailed investigation and preparation of Detailed Project Report in August 2004. The Kwar Project as planned in the PFR envisaged construction of 68 m high concrete Dam above deepest foundation level across the river Chenab and the 4.3 Km long head race tunnel of 12.0m dia with surface power house on the right bank of Chenab river near Kwar village.

After handing over of the project to NHPC for preparation of DPR, the study of PFR revealed that many components such as desilting basin are missing and diameter of surge shaft provided was on lower side. Preliminary calculations indicated that project would require large size desilting basins and very large diameter surge shafts in geologically unstable terrain. Considering above, it was felt necessary to workout alternative layout to optimize and simplify the project components especially with respect to spillway, desilting requirement, surge shaft and head race tunnel.

The topography of the area was further studied to locate alternative dam site. After collecting preliminary site data and reconnaissance survey of the site, an alternative-II were studied.

Alternative I – As proposed in PFR; Alternative-II - Dam at Padyarna village and Power House on the right bank near Dam and TRT out fall near Kwar village as proposed in the PFR.

Desk studies of all the alternative proposal were carried out and comparison made in respect of installed capacity and merit of the various alternative vis a vis utilization of available head and it revealed that the layout envisaged in Alternative II seems attractive with respect to layout optimization, sizes of the project components and overall benefit. Thus, the layout as above i.e. Alternative II was been taken up for detailed investigation.

The results of further geological investigations carried out has revealed availability of limited zone of competent rock mass for housing underground power house and associated structures. This constraint necessitated some changes in the initial layout of the project, notable among them being replacement of power intakes with power dam blocks, layout and sizes of caverns of power house complex, and optimization in size and alignment of water conductor system and installed capacity. It is this revised layout that is presented in this report.

8.2.3 Conclusion

Desk studies of all the alternative proposals were carried out and comparison made in respect of installed capacity and merit of the various alternative vis-a-vis utilization of available head and it revealed that the modified layout envisaged in alternative II seems attractive with respect to geological setup, layout optimization, sizes of the project components and overall benefit.

The layout as above i.e. Alternative II, was taken up for detailed investigation in 2007. Since then, results of additional investigations have necessitated further

optimization of layout and sizing of the project components, which are presented and discussed in this DPR.

8.3 INDUS WATER TREATY ASPECT

The Kwar project is proposed on the Chenab river which is one of the western rivers covered in the Indus Water Treaty, 1960. The parameters of the project have been planned in accordance with the provision of the treaty. Following aspects of the treaty has been considered while fixing the project parameters.

8.3.1 Pondage

The Kwar project is situated downstream of the Naunut (Latitude 33°21'01" North and Longitude 75°53'39" East) and as such no storage could be provided as per the treaty. However, the pondage as mentioned in the run of the river plant in para 8 of Annexure D of the treaty has been proposed considering the following operation of the plant:

a) The volume of water received in the river upstream of the plant, during any period of seven consecutive days shall be delivered into the river below the plant during the same seven day period. and
b) Volume of the water delivered in the river below the plant in any one period of 24 hrs shall not be less than 50% and not more than 130% of the volume received above the plant during the same 24 hrs period.

8.3.2 Minimum Drawdown Level

The FRL of the project has been decided on the basis of tailrace level of upstream project (i.e Kiru Project). The MDDL has been fixed at EL 1372.0 m on the basis of reservoir area capacity curve thus providing pondage of 9.16 Mcum between FRL and MDDL.

8.3.3 Power Intake Level

The power plant is proposed to operate between head water level of EL 1385.0m and EL 1372.0 m. In order to keep the flow condition in the intake smooth and to avoid the vortex formation, water seal above the intake centerline has been provided as per IS guidelines. On the basis of this the centre-line level

of intake has been fixed at EL 1362.025 m, the size of opening being 5.65 m x 5.65 m.

8.3.4 Spillway Crest Level

In order to ensure passage of design flood discharge of 10534 cumec, the crest level of four nos. of orifice spillways have been kept at EL. 1330.0 m. In combination with 1 no. crest spillway with crest level at 1368.0m, the level of spillway crest would facilitate entry of silt-free water inside the water conductor system. The above parameters shall be optimized on the basis of model study. The proposed orifice spillway shall be used for dual purpose of sediment management and passing of design flood.

8.3.5 Free Board

The free board for the concrete gravity dam has been calculated as per the guidelines of IS 6512 and IS 10084. A free board of 2.0 m has been provided which is reasonable considering the height of the dam, reservoir length, wind velocity etc.

8.4 RIVER DIVERSION WORKS

8.4.1 Diversion Tunnel

For the construction of concrete gravity dam and appurtenant works, the river diversion is proposed to be carried out through 1 no.9.5 m diameter concrete lined, horse shoe shaped diversion tunnel located on the left bank of the river. The diversion tunnel has been designed for passing 1 in 25 years non-monsoon (1st October to 15th May) flood of 1041 cumec.

8.4.2 Coffer Dams

Rock-fill cofferdams with a central impervious core shall be provided. Axes of these coffer dams shall be located about 115.0 m upstream and 350.0 m downstream of the proposed dam axis. The top level of 23m high upstream and 14m high downstream cofferdams has been provided at EL 1315.0 m and EL 1292.0 m respectively.

8.5 THE DAM

8.5.1 General

The proposed concrete gravity dam with its top at EL 1387.0 m has a length of 195 m. The top width of the dam varies from 12.5 m to 14.6 m.

8.5.2 Dam Height

The full reservoir level of the project has been finalized based upon the tail water level of upstream project (i.e. Kiru Project). The dam site, at Padyarna village has exposed rock on both the abutments and the valley is relatively narrow. Considering the above, dam location has been kept at this site. Dam height of 101 m high above river bed level has been proposed. The height of dam above deepest foundation level is expected to be of the order of 109 m.

8.5.3 Type of Dam

Considering the shape of the valley, rock exposure on the abutments and relatively low depth of overburden in the river (7 to 10m), a conventional concrete gravity dam has been proposed. The spillway has been accommodated in the central portion of the concrete dam. The power intakes have been provided in separate power dam blocks in the right portion of the concrete dam.

8.5.4 Dam Arrangement

The proposed dam is concrete gravity dam across the river with dam top at EL 1387.0m. The bedrock level at dam axis is at EL ± 1283.0m. Initial 4-5m depth of rock is expected to be weathered and as such after accounting for removal of this portion of rock, the deepest foundation level has been proposed as EL. ±1278.0 m. Thus the height of dam above deepest foundation level is expected to be of the order of 109 m. Min. top width of dam is proposed to be kept as 12.5 m, which shall provide for carriageway of the road.

8.5.5 Reservoir

The full reservoir level has been kept as EL 1385.0 m. This level has been fixed keeping in view the TWL at the outlet of Kiru Project. The project is run of the

river scheme with pondage as per provision of Indus Water Treaty 1960. The gross storage capacity of the reservoir shall be 27.167 Mcum and the live storage at pre-sedimentation stage is 9.16 Mcum respectively.

8.5.6 Spillway

To pass the excess water from dam, spillway section has been provided. The overflow section of 64 m width comprises of four low level spillway blocks, with crest level at EL 1330.0 m, each of 16.0m width with 9.5 m clear waterway and discharging capacity of 3221 cumec each. The thickness of the piers shall be designed by FEM analysis & may be increased during detailed design stage. One no. crest spillway with crest level of 1368.0m is also proposed with opening size of 9.5m x 17m and discharging capacity of 884 cumec. With one gate inoperative, the remaining three bays with one no. crest spillway are capable of discharging the design flood of 10534 cumec. The height of each orifice spillway opening has been kept as 13.8 m. Each spillway has been provided with a hydraulically operated radial gate. Upstream of radial gate, stop-log gate has also been proposed in order to facilitate maintenance of radial gates.

8.5.7 Outlet for Environmental Releases

In addition to the spillways, an outlet for (mandatory) environmental releases has also been provided, with a discharging capacity of 16.49 to 74.09 cumec and size of gate opening as 2.6 m x 2.0 m.

8.5.8 Construction sluices

To facilitate construction of dam, 4 numbers construction sluices have been proposed with crest at EL. 1300.0 m. The size of each construction sluice is 3.1 m x 5.0 m. These construction sluices will cater for passing monsoon flood during construction. Each construction sluice has discharge capacity of 289 cumec at EL 1336.60 m.

8.5.9 Non Overflow Section

Out of total dam length of 195 m, five bays of spillway shall cover 80 m length. Remaining length of dam has been provided as non-overflow sections. On the left bank two number non-overflow blocks of 16.0 m width and 16.725 m width

have been provided. On the right bank, four power dam blocks of 15.0 m width each and one non-overflow block of 22.08 m width have been provided.

8.5.10 Stability Analysis

The preliminary stability analysis for over flow and non-overflow sections has been carried out in accordance with IS: 6512 for various load combinations and found within the permissible limits as per code. In-situ rock mechanics tests have also been conducted in the dam drifts for confirmation of parameters, and have been adopted in the design. Study for site specific Earthquake parameters has been completed by Department of Earthquake Engineering, IIT Roorkee which has been subsequently approved by National Committee on Seismic Design Parameters (NCSDP).

8.5.11 Energy Dissipation Arrangement

A ski jump type energy dissipation arrangement has been provided at downstream of spillway. Flip bucket of radius 44.0 m with invert level at EL. 1311.478 m and lip angle of 34° has been adopted. The lip has been provided at EL 1319 m. A preformed plunge pool with lowest bed level at EL. ±1262.0 m and of size 60.0 m x 60.0 m has been proposed. The energy dissipation arrangement will, however be optimized on the basis of hydraulic model studies before finalization of engineering designs.

8.5.12 Dam Instrumentation

As the project envisages a high concrete gravity dam, instrumentation shall be provided to monitor behavior of the dam during construction as well as operation stage. At this stage percentage provision has been made in the cost estimate for instrumentation. 7 numbers of drawings for instrumentation have been prepared and submitted with this updated DPR. Further detailing shall be carried out during detailed design.

8.6 POWER DAM AND INTAKE

4 nos. power dam blocks with one intake each have been provided to lead the water to the powerhouse. The invert of intake structure has been kept at EL.

1359.20 m, to keep the intake relatively silt free. Each intake structure has been provided with trash rack structure at its entry. The maximum permissible velocity through trash rack has been kept as 1.5 m/s. The top of power dam is at EL 1387.0 m.

8.7 PRESSURE SHAFTS AND PENSTOCKS

The water from each intake is carried by 5.65 m finished diameter penstocks and pressure shafts. Full length of penstocks / pressure shafts is proposed to be steel lined to take care of pressure rise in case of load rejection. After the lower vertical bend at bottom, each penstock / pressure shaft leads to a unit of 135 MW each. The space around steel liner shall be back-filled with concrete. To facilitate excavation and erection of steel liner, independent erection platforms have been proposed at the top of each pressure shaft, in addition to an adit and erection gallery at the bottom of the shafts.

8.8 POWER HOUSE

8.8.1 General

The underground powerhouse is located on the right bank of River Chenab near dam axis. The powerhouse complex comprises the following main feature:

- Power house cavern with four generating units & MIV.
- Control Room Cavern.
- Transformer cavern.
- GIS Cavern.
- Access Tunnel to PH and TC.
- Adit cum Cable Tunnel.
- Downstream surge arrangement.
- Outdoor Pothead yard.

The proposed powerhouse will have an installed capacity of 540 MW (4 generating units of 135 MW each). The units are spaced at a distance of 27.0 m centers. The turbine centerline is placed at EL 1245.55 m. The excavation level of the draft tube pit is at EL 1230.75 m. TRT outlet is proposed at EL 1266.50 m.

8.8.2 Layout of Power House Complex

Powerhouse cavern and other associated caverns/galleries have been provided inside the ridge at the right bank of Chenab River. The layout of the powerhouse complex is shown in Drawing No. NHKR-D-41-GA-005. The layout of individual caverns / galléries is discussed below:

8.8.3 Power House Cavern

Powerhouse cavern having width of 23.30 m consists of 112 m long machine hall housing 4 units placed at 27 m c/c. Service bay of length 28 m has been located at EL. 1258.65 m at one end of cavern, and an equipment gallery of length 30 m and size 10 m D-shaped has been provided at the other end (Unit-4), also at EL. 1258.65 m. The overall size of power house cavern is 140 m x 23.3 m x 50 m.

8.8.4 Control Room Cavern

Due to geological and topographical constraints, the Control Room has been located in a separate cavern aligned perpendicular to the main power house cavity. The size of cavern is 40 m x 15 m x 28.8 m, and the building itself has 5 levels (excluding roof). It is connected to the service bay of power house by means of an adit cum cable gallery of size 30 m x 6 m x 15.3 m.

8.8.5 Transformer cum Draft Tube Gate Cavern

Transformer cavern of size 116 m x 17 m x 16 m, has been proposed 54.45 m downstream of powerhouse cavern at EL. 1310.0 m. It is aligned parallel to the main power house cavern and is connected to it by means of an inclined cable cum escape gallery and 4 nos. inclined bus ducts. The draft tube gates shall be operated from the transformer cavern and hence, independent gate hoists are located towards the downstream wall of the cavern. An unloading bay has been provided at one end of the cavern and therefore, in this portion, the height of the cavern is raised accordingly. At the other end of the cavern, a gallery of size 26 m x 11.5 m x 10 m has been provided for housing equipment and providing connectivity to power house through escape cum cable gallery.

8.8.6 GIS Cavern

As in the case of control room cavern, the GIS cavern has been located separate from the transformer cavern, due to geological and topographical constraints. Aligned parallel to the transformer cavern, it is offset from it by 15 m. The overall size of GIS cavern is 65 m x 15 m x 16 m. At one end of the GIS cavern, the access to transformer cavern passes through it. At the other end, an adit cum cable tunnel provides connectivity to the pothead yard.

8.8.7 Access Tunnel to Power House and Transformer Cavern

A main access tunnel (MAT) of length ±610 m and size 8.0 m D-shaped with portal invert at EL 1310.0 m has been provided for permanent access to power house and control room caverns. Access to transformer cavern is by means of a branch tunnel of length ±310 m, which is connected to MAT at EL. 1292.726 m. The downstream surge gallery for TRT-2 is connected to access tunnel to TC at EL. 1310.0 m. Access to lower erection gallery for pressure shafts is provided through a tunnel of size 8.0 m, D-shaped, which branches out from surge gallery for TRT-2. Length of this tunnel is ±305 m. For excavating crown portion of power house, a construction adit of size 6.0 m x 6.5 m has been provided between the control room cavern and service bay end of power house cavern. For excavating crown portion of GIS and transformer caverns, an adit cum cable tunnel has been provided, as discussed below in 8.7.8.

8.8.8 Adit cum Cable Tunnel

An adit cum cable tunnel of size 6.0 m x 6.5 m and length ±275 m has been provided with portal invert at EL. 1305.0 m, near pothead yard. This tunnel meets the GIS cavern at EL. 1318.5 m, for facilitating excavation of crown portions of GIS and transformer caverns. After excavation, the same adit will serve as cable tunnel between GIS and pothead yard.

8.8.9 Downstream Surge Arrangement

Considering the length of the downstream waterway, provision of surge arrangement is required as per transient study. Tail race system comprises of 4 nos. draft tubes merging into 2 nos. tail race tunnels. The surge arrangement

consists of a combination of individual draft tube gate shafts, draft tubes and manifold and surge galleries, one for each TRT. The gate shafts are of size 5.4 m x 7.5 m, with bottom at EL. 1235.65 m and top at EL. 1310.0 m, opening into transformer cavern. The size of draft tube gate opening is 7.0 m x7.0 m. The surge galleries of length 750 m each are 10.4 m in diameter and Horse Shoe-shaped. Invert levels of the surge galleries are EL. ±1234.5 m at the bottom and EL. 1310.0 m at the top. The downstream surge gallery for TRT-2 is connected to access tunnel to TC and downstream surge gallery for TRT-1 open out with a separate portal at EL. 1310.0m. The maximum up-surge and minimum down-surge levels are EL. 1303.0 m and EL. 1246.40 m, respectively.

8.8.10 Outdoor Pothead Yard

An outdoor Pothead Yard is proposed to be accommodated on the right bank, in a bench of size 150 m x 35 m, at EL. 1315.0 m. An adit cum cable tunnel of size 6.0 m x 6.5 m and length ±275 m is proposed to connect the GIS cavern to pothead yard, with invert level at portal being EL. 1305.0 m. From the portal to pothead yard, a cable trench is proposed to be provided for a length of ±90 m.

8.9 TAIL RACE TUNNEL SYSTEM

The Tail Race system comprises of 4 nos. draft tubes merging into 2 nos. tail race tunnels. Shortly downstream of the merging points, the downstream surge galleries branch out from each TRT, as discussed above. The diameter of tailrace tunnel has been proposed as 9.5 m, to optimize tunnel hydraulics including downstream surge arrangement, and also to ensure stability of excavation of TRT. The lengths of the tunnels are 2786 m and 2963 m. To facilitate the construction of TRT, an intermediate construction adit of size 6.0 m x 6.5 m and length 560 m has been provided with portal invert at EL. 1300.0 m. The adit is proposed to be concrete lined in invert and shall be plugged later after completion of the project work.

8.10 TAILRACE OUTLET WORKS

Each tailrace tunnel opens into a tailrace outlet structure, with a common tail pool of varying length and an outlet weir. The outlet structure has been provided

with gate arrangement to isolate the unit from downstream side. The maximum tail water level is calculated to be 1291.8 m corresponding to PMF. The gate operation platform is proposed at EL. 1293.0m. The crest level of gate is at EL 1265.0 m and crest level of outlet weir is at EL. 1266.50 m.

8.11 HYDRO-MECHANICAL EQUIPMENTS

8.11.1 GENERAL

As per planning & layout of civil structures, following hydro-mechanical equipments are proposed for Kwar Hydroelectric Project: -

8.11.2 DIVERSION TUNNEL GATES AND HOISTS

For the purpose of closing diversion tunnels, two numbers fixed wheel type gates for opening size of 3.94 m wide x 9.50 m height have been envisaged at the inlet of tunnel. The gates shall have an upstream skin plate & upstream sealing. The sill of gate is located at EL 1293.00M. The gates are to be designed for water head corresponding to water level EL 1336.70M which is corresponding to mean annual flood. The deck level of the diversion tunnels has been fixed at EL 1338.00M.

The gates shall be operated by means of dedicated electrically operated rope drum hoists of capacity not less than 120T located on the hoist platform installed over trestles above the deck level. These gates are not envisaged to be kept in partial open condition and are meant for one time closure during lean season. During closure of DT gates water shall be passed through construction sluices and spillways. The diversion tunnel shall be plugged before the start of reservoir filling.

8.11.3 CONSTRUCTION SLUICE GATES AND HYDRAULIC HOISTS

In addition to the Diversion Tunnel, four numbers construction sluices are provided in the body of Dam. One number fixed wheel type gate for opening size of 3.1m x 5.0m has been provided in each sluice. The gates shall have an upstream skin plate & upstream sealing. The sill of the gate is located at EL 1300.00M. Sluice gates are capable of sustaining water loads up to FRL i.e. 1385.00M and designed to be lowered under unbalanced water head up to

1336.70M which is corresponding to mean annual flood. Each gate shall be operated by means of an independent double acting hydraulic cylinder of capacity not less than 125T Pull and 70T Push & a power pack located in the operation gallery. A watertight bonnet and bonnet cover is also provided at the top of groove in the gate operation chamber to avoid any ingress of water into the gallery.

Construction sluice shall be closed by lowering the gates in each groove for construction of concrete plug. Suitable sized air vent pipe shall be embedded in the downstream of gate of all four construction sluices for aeration purpose and to reduce hydrodynamic forces on the gate during operation. A monorail hoist of capacity not less than 15T shall be provided to facilitate erection of gates and hydraulic hoist system.

8.11.4 ORIFICE TYPE SPILLWAY RADIAL GATES & HYDRAULIC HOISTS

Spillways consist of four nos. orifice type bays of opening size 9.50 m x 13.80 m with crest at EL 1330.00M. Four submerged type radial gates for opening size of 9.50 m x 13.80 m shall be provided to control the discharge through the spillways. The radial gates shall be designed to sustain and operate against a head corresponding to FRL i.e. EL 1385.00M. Each gate shall be operated by means of two hydraulic cylinders, each of capacity not less than 330T, and a power pack. The gate operation shall be done from individual local control panels as well as from remote control system located at the dam control room (DCR), with provision of gate position indication in powerhouse control room.

Steel liner has been proposed to be provided underside of breast wall, in the piers and spillway glacis along the flow path from upstream of Stoplog to downstream of spillway radial gates to prevent erosion of piers and spillway glacis concrete resulting in damage of sill beams of spillway Stoplog and radial gates.

Two numbers trolley mounted mobile gasoline engine operated power pack capable of operating one gate at 1/4th of the normal rated speed is also envisaged.

One no. oil filter unit to purify the hydraulic oil, one unit contamination checking kit for checking of contamination level of the hydraulic oil & one no. low vacuum dehydration and degasification unit to remove water and gases from the hydraulic oil shall be provided to cater for hydraulic hoists envisaged in the HM equipment.

8.11.5 CREST TYPE SPILLWAY RADIAL GATES & HYDRAULIC HOISTS

Spillways consist of one number crest type bay of opening size 9.50 m x 17.00 m with crest at EL 1368.00M. One number crest type radial gate for opening size of 9.50m x 17.00m shall be provided to control the discharge through the spillway. The radial gates shall be designed to sustain and operate against a head corresponding to FRL i.e. EL 1385.00M. Each gate shall be operated by means of two hydraulic cylinders of 150T capacities each, and a power pack. The gate operation shall be done from individual local control panels as well as from remote control system located at the dam control room (DCR), with provision of gate position indication in powerhouse control room.

8.11.6 SPILLWAY STOPLOG & GANTRY CRANE

The inspection and maintenance of the Spillway Radial Gates (Orifice type as well as Crest type) shall be carried out by using one set of wheel type stoplog on the upstream side of these gates. The stoplog shall be fabricated in four units for opening size 9.50 m wide x 17.00 m high for Crest type Spillway Radial Gate. Except top unit, all three units shall be interchangeable. The same stoplog shall be used for inspection and maintenance of Orifice type Spillway Radial Gates also.

The stoplog shall have upstream skin plate and downstream sealing. The stoplog shall be designed for a head corresponding to FRL i.e. EL 1385.00M and shall be operated under balanced head condition. The top unit shall be provided with a filling–in-valve to create balance head condition. The stoplog units shall be kept over latches in the stoplog grooves. The stoplog units shall be operated by means of a gantry crane of 130T capacity and a lifting beam. Gantry rails (upstream rails on concrete girder and downstream rails on breast wall)

shall be provided at the deck level for movement of the gantry crane across spillway bays. Suitable cross travel shall also be provided in gantry crane to handle Stoplog units in bays/storage groove.

8.11.7 ENVIRONMENT RELEASE GATE AND HOIST

For environmental release of water, one number slide type regulating gate and one number slide type emergency gate for opening size of 2.60 m wide x 2.00 m height have been envisaged at the inlet. The gates shall have an upstream skin plate & upstream sealing. The sill of the gates is located at EL 1369.90M. The gates are to be designed for water head corresponding to water level EL 1385.00M. The deck level of the gate has been fixed at EL 1387.00M. A watertight bonnet cover is provided at the top of groove to avoid any ingress of water into the gate operation niche/chamber.

The gate shall be operational under any water head between elevations EL 1369.90M to EL 1385.00M. The gates shall be operated by means of double acting hydraulic hoists of 90T capacity and a common power pack located on the deck level. Suitable steel cover shall be provided at Deck Level EL 1387.00M to cover the gate operation niche/chamber

8.11.8 POWER INTAKE GATES, HOISTS, INTAKE BULKHEAD AND GANTRY CRANE, TRASH RACK & TRASH RACK CLEANING MACHINE

Four nos. power tunnel intakes are located on right bank to feed water to Pressure shaft/turbine units. Dedicated fixed wheel type gate for opening size 5.65 m wide x 5.65 m height shall be provided for each intake. The sill of the gates is located at EL 1359.20M. The gates are to be designed for a head corresponding to FRL i.e. EL 1385.00M. The gates shall have an upstream skin plate & upstream sealing. The gates shall be capable of lowering against unbalanced head corresponding to FRL i.e. EL 1385.00M. The gate shall be lifted under balanced head conditions created by crack opening of gate against U/S water level up to FRL i.e. EL 1385.00M. The gates shall be operated by means of dedicated rope drum hoists with lifting capacity not less than 90T installed on hoist supporting structure at Intake deck level at EL 1387.0 m.

For maintenance and inspection of intake gate, one set of slide type bulkhead made of 3 units for opening size 8.5m wide X 8.9m height has been proposed on the upstream side. The sill of the bulkhead is located at EL 1357.59 m and bulkhead shall be designed for corresponding to FRL i.e. EL 1385.0 m. The gate shall have upstream skin plate & downstream sealing. The top unit of stoplog shall be provided with filling in valve to create balanced head condition before lifting of the units.

The bulkhead shall be operated under balanced head condition by means of a gantry crane of 130 T capacity located on the intake deck and shall be lowered only for inspection and maintenance of the Intake gate embedded parts. The balance head shall be achieved by using filling-in-valve provided in the bulkhead.

It is proposed to provide steel liners in the lower bell mouth area of intake along the flow path from downstream of Intake bulkhead up to transition of pressure shaft to prevent erosion of concrete resulting in dislodging of sill beams.

On upstream face of the intakes, trash rack Inclined at 10 degree with vertical shall be provided. Each of four trash rack shall be for opening of size approximately 15.0m wide x 32.20 m vertical height and shall be fabricated in panels of suitable sizes. A total of four such screens are provided in the intake structure for complete covering of intakes.

The cleaning of the trash rack shall be done by means of trash rack-cleaning machine installed on the intake deck. The machine will be mounted on rail tracks running across the intakes. Suitable grapple arrangement shall also be provided with TRCM. Provision shall be made for suitable capacity trash removal trolley/vehicle.

8.11.9 PENSTOCK STEEL LINER

Four number pressure shaft of size 5.65 m fully steel lined take off from the d/s of Dam intake gate. Steel liner of diameter 5.65 m consist of transition, straight,

vertical and inclined ferrules, three inclined bends, one compound bends, thrust collar etc. for each lane, to feed four nos. turbines placed in the power house.

Steel liner shall be designed for internal pressure equal to static head plus the induced water hammer due to normal Wicket gate operation as well as for the external pressure as per IS: 11639 (Part 2). Accordingly the thickness of liner shall be adopted and provision of stiffeners shall be made.

8.11.10 DRAFT TUBE GATES AND HOISTS

To isolate turbines from the tailrace tunnels to cater to the inspection / maintenance requirements of turbines, one number fixed wheel type gate having skin plate on tail race side & sealing on turbine side has been provided in each of the four draft tubes. The clear opening of the gate is 7.0 m wide $\times$ 7.0 m height. The sill of the gate shall be located at EL 1235.65M. The gate shall be designed for water levels corresponding to TWL EL 1270.00M corresponding to all four units are running, and checked for TWL EL 1291.80M corresponds to PMF. The gates shall be capable to be lowered under unbalanced condition. The raising of gates shall be under balanced head created by operation of filling in valves provided in the gates.

Each gate shall be operated by means of dedicated rope drum hoists with lifting capacity not less than 125T installed on hoist supporting structure at deck level 1310.00M.

8.11.11 TRT OUTLET GATES AND ROPE DRUM HOISTS.

Each tailrace tunnel is provided with a gate of opening size 9.5 m wide x 9.5 m height at the outlet. Wheel type gate suitable for the above opening is provided to isolate the tunnel/generating unit from tail water. The sill of the gate is located at EL. 1265.00M. The gate shall have skin plate and sealing on the riverside. The TRT gates shall be capable of lowering against unbalanced head corresponding to EL 1291.80M which is corresponding to PMF with turbine units closed. The opening of the gates shall be under balanced head creating by crack opening of the gate. These gates shall be suitably designed to sustain a water head in the river at EL 1291.80M.

Each gate shall be operated by means of a dedicated rope drum hoist with lifting capacity not less than 125T installed on hoist supporting structure at Deck EL 1293.00M.

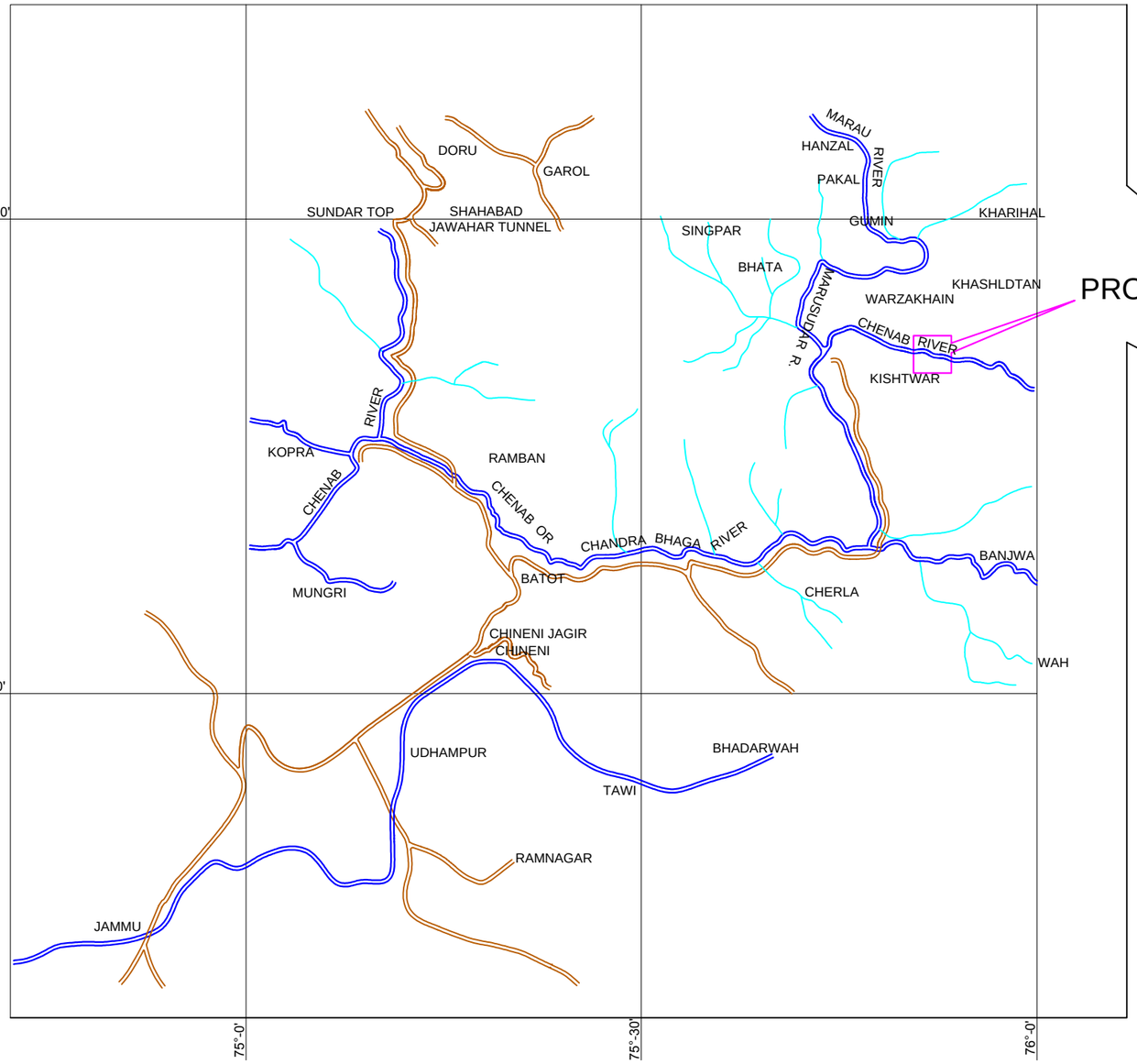
8.11.12 INSTRUMENTATION AND AUTOMATIC RESERVOIR MONITORING AND CONTROL SYSTEM

One complete set of microprocessor based remote control system shall be provided in dam control room for the operation of spillway radial gates and Environmental release gates. The programmable reservoir monitoring and control system shall include all necessary instrumentation like water level measuring instruments, gate position indicators, transducers, terminals, contacts, cabling etc. The status indications shall also be made available in the powerhouse control room. The communication system shall be bridged through fiber optic cable.

One uninterruptible power supply to provide back up (minimum 30 minutes) to the system in case of failure of main power supply to equipments shall also be provided.

8.11.13 DIESEL GENERATOR SET

One number 500 KVA, three phase synchronous type 415 volts, 50 Hz diesel generator sets with acoustic enclosures has been envisaged for the emergency operations of the HM equipments at the dam site. The diesel generating sets shall be suitably located to provide back-up supply to gate operating equipments and to computerized control system in case of power failure.



PROJECT LOCATION MAP

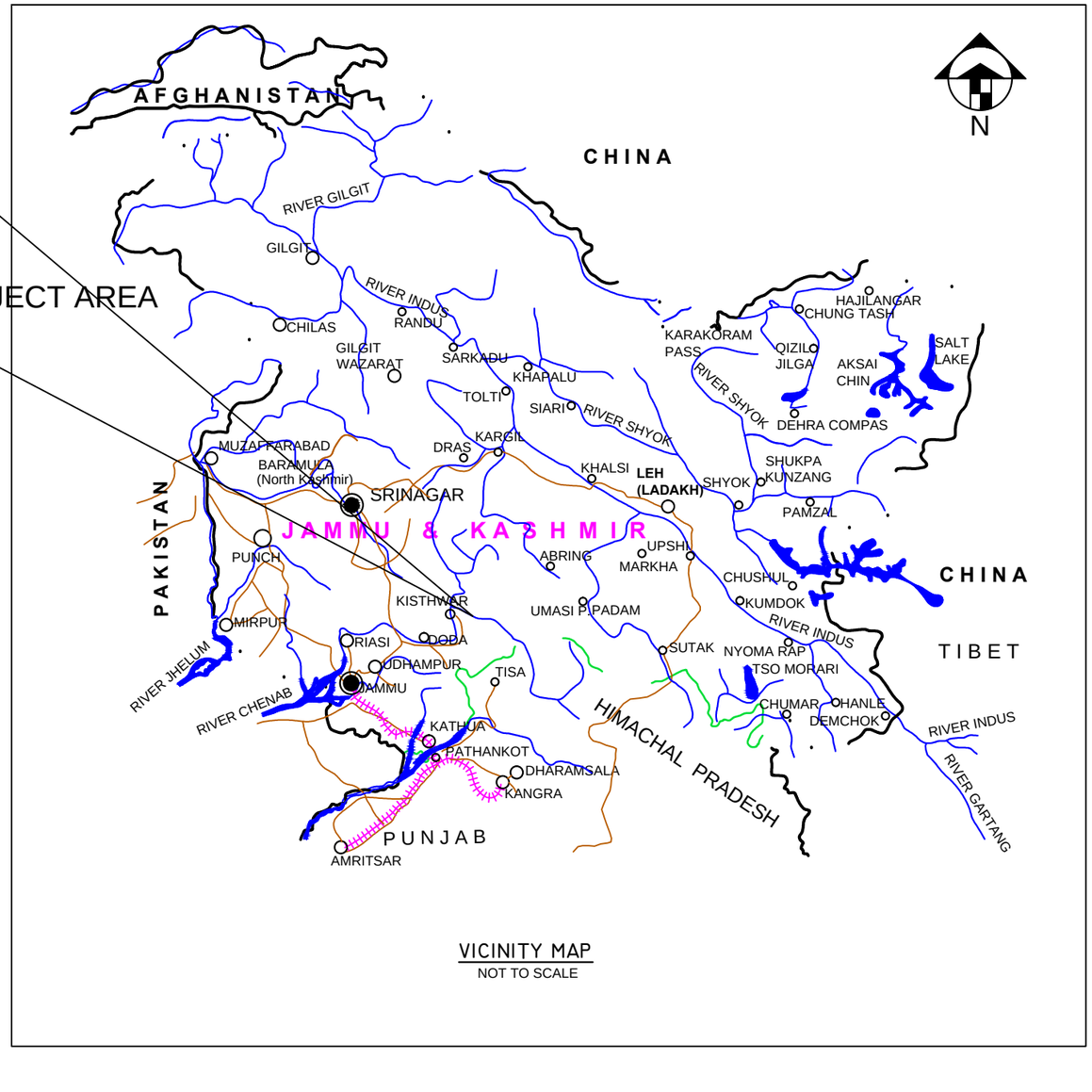
LEGEND

RIVER

METALLED ROADS

NALA

0 7.5 15 22.5 KM.



VICINITY MAP

NOT TO SCALE

LEGEND

1. INTERNATIONAL BOUNDARY.
2. STATE BOUNDARY
3. RIVER
4. ROAD
5. CAPITAL
6. OTHER TOWNS, VILLAGES

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

NHPC LIMITED

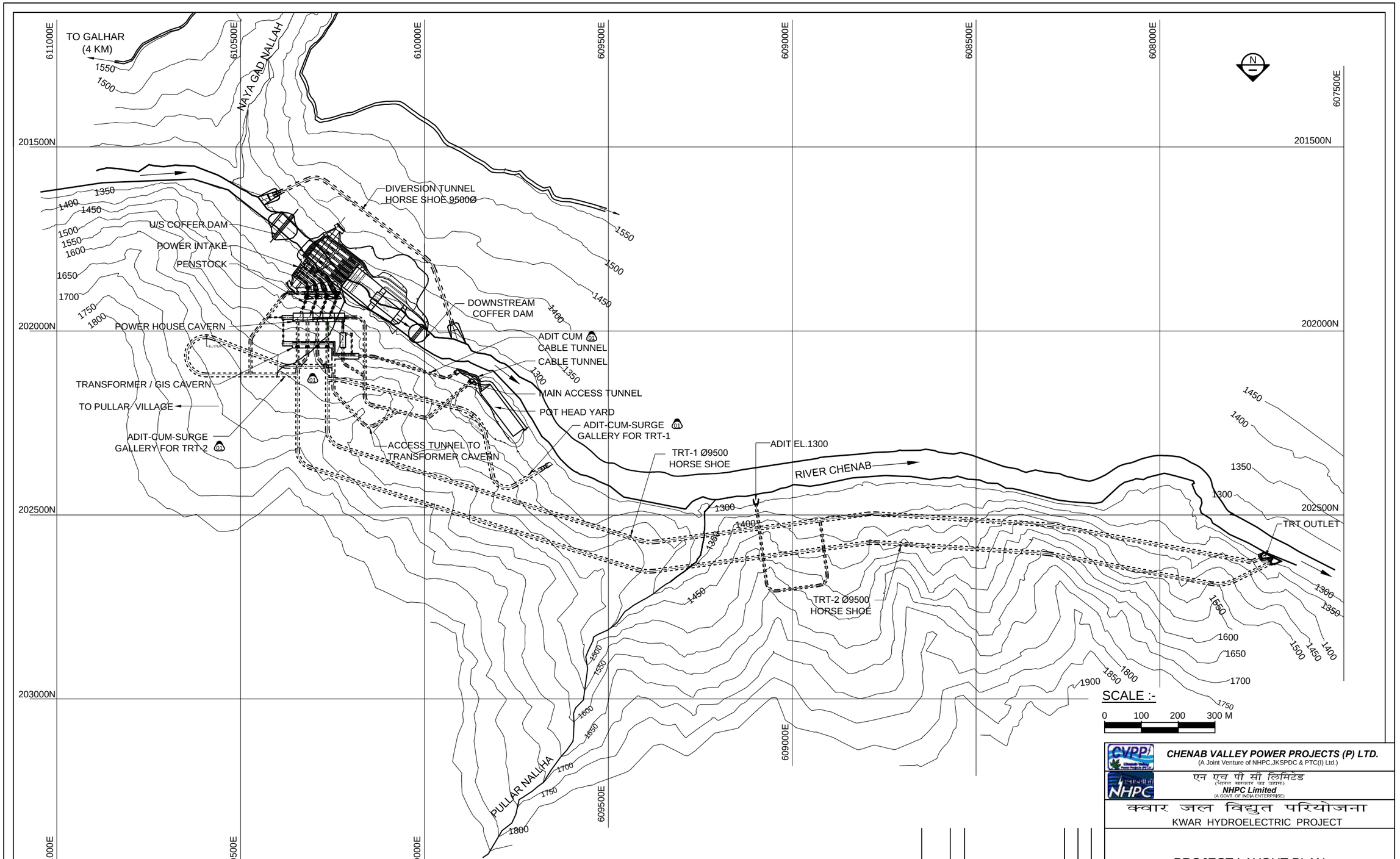
KWAR HYDROELECTRIC PROJECT (J & K)

INDEX PLAN

PREPARED BY	SUBMITTED BY	APPROVED BY
SUSHIL ALMADI Executive D/Man	Ajay Singh, Assistant Manager(Geo)	P.K. Gupta, Chief(Geo)

DATE JUNE 2012

NHKR-D-41-GA-001



NOTES :-

1. ALL DIMENSIONS ARE IN MM. AND LEVELS AND RDS ARE IN METRES.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

DATE		REVISION OR ISSUES	BY.	CH.	APP
NOV.2016	01	ISSUED FOR UPDATED DPR			
JUN.2012	00	FOR DPR PURPOSE ONLY			

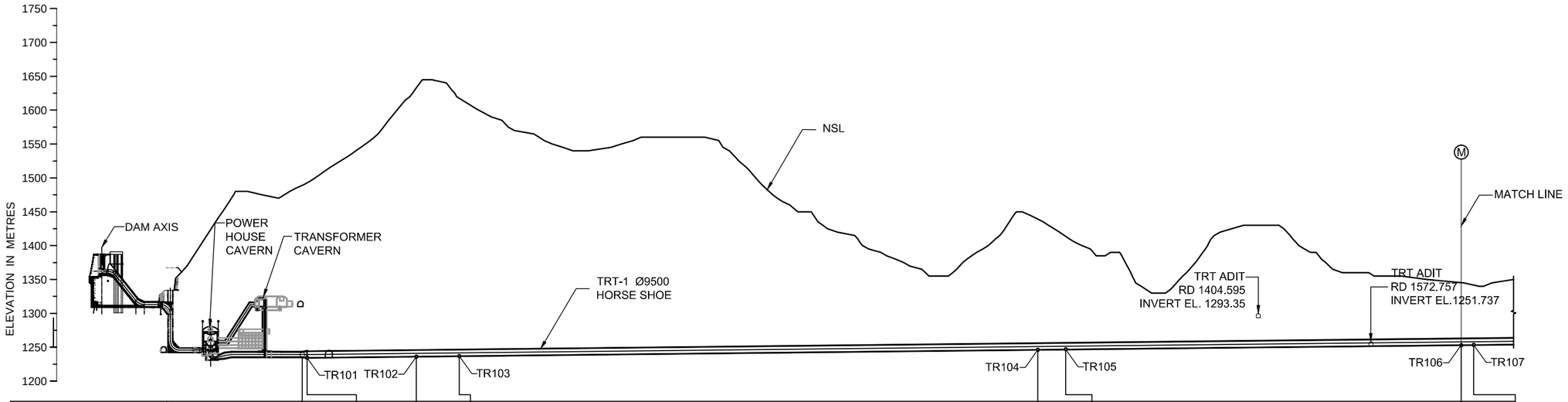
CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

क्वार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

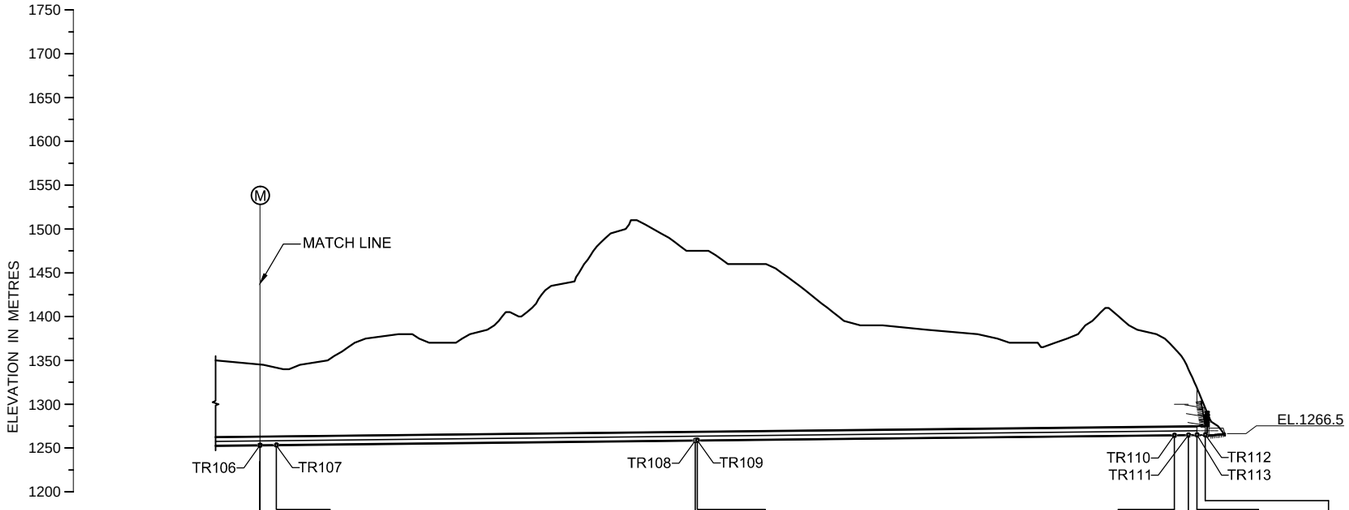
PROJECT LAYOUT PLAN

DRAWN उदेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN.2012	DRG. NO. उद्देख संख्या	NHKR	D 41 GA 002 01	



NATURAL SURFACE LEVEL		1463.594	1493.269	1632.843	1617.655	1439.17	1413.93	1345.35	
TUNNEL INVERT LEVEL		1235.65	1234.40	1236.17	1236.87	1246.30	1246.76	1253.20	
PARTIAL LENGTHS			161551	63429	855201	41119	584701	18516	
CUMULATIVE LENGTH			161551	224980	1080181	1121300	1706001	1724517	
SLOPE					SLOP 1 IN 91				
CURVE DATA				R50000		R95000		R95000	

LONGITUDINAL SECTION THROUGH WATER CONDUCTOR SYSTEM - I



NATURAL SURFACE LEVEL		1345.35	1341.78	1475.00	1475.00	1363.74	1340.31	1318.34
TUNNEL INVERT LEVEL		1253.20	1253.41	1258.68	1258.71	1264.72	1264.89	1265.00
PARTIAL LENGTHS		18516	478368	2409	544749	15938	9800	9500
CUMULATIVE LENGTH		1724517	2202885	2205294	2750043	2765981	2775781	2785281
SLOPE								
CURVE DATA		R95000		R20500		R25000		

LONGITUDINAL SECTION THROUGH WATER CONDUCTOR SYSTEM - I

NOTES -:

1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

SCALE-:

0 70 140 210 M.

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

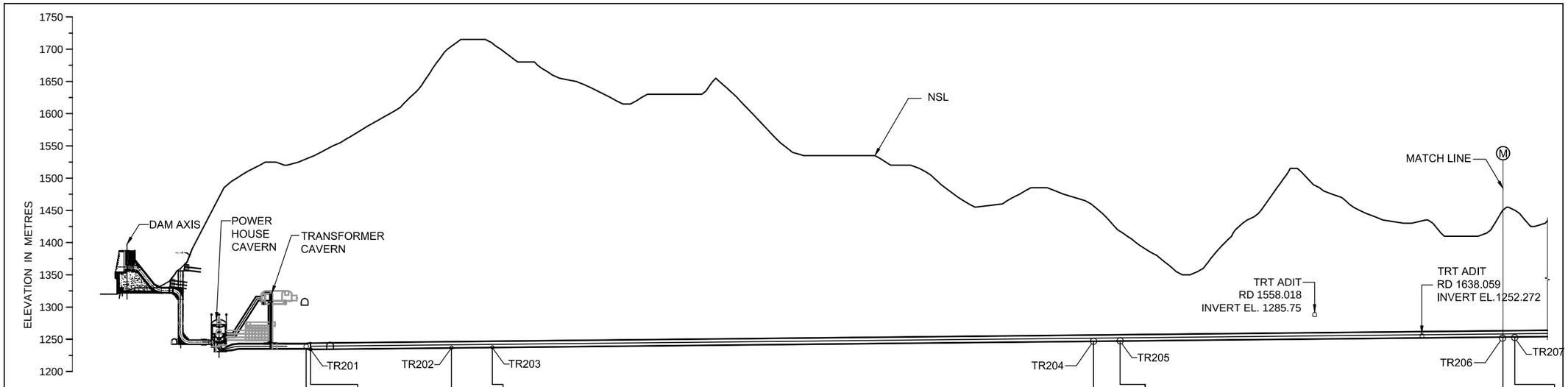
कवार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

WATER CONDUCTOR SYSTEM
L - SECTION THROUGH TAIL RACE TUNNEL-I

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV-16	01	SECTION REVISED & ISSUED FOR REVISED DPR			
JUN-12	00	FOR DPR PUPOSE ONLY			

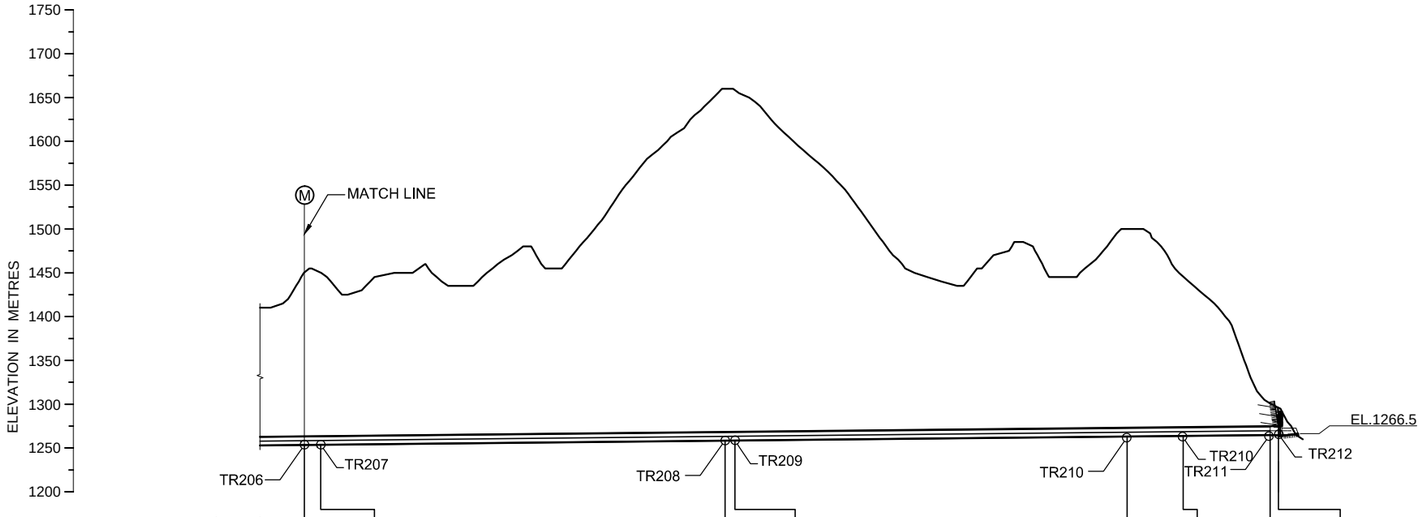
DRAWN उद्रित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन

DATE दिनांक	DRG. NO. उद्रेख संख्या						
JUN-2012	NHKR	D	41	GA	003	01



NATURAL SURFACE LEVEL		1529.987	1532.854	1704.418	1709.423	1456.957	1417.643	1450.458
TUNNEL INVERT LEVEL		1235.65	1234.40	1236.66	1237.32	1246.99	1247.41	1253.57
PARTIAL LENGTHS			218503	63430	932878	41218	594222	18523
CUMULATIVE LENGTH			218503	281933	1214811	1256029	1850251	1868774
SLOPE					SLOPE 1 IN 97			
CURVE DATA				R50000		R95000		R95000

LONGITUDINAL SECTION THROUGH WATER CONDUCTOR SYSTEM - II



NATURAL SURFACE LEVEL			1450.458	1450.260	1660.000	1658.665	1500.000	1445.000	1300.000
TUNNEL INVERT LEVEL			1253.57	1253.76	1258.55	1258.67	1263.31	1263.97	1265.00
PARTIAL LENGTHS			18523	461769	11163	448002	63935	99210	9500
CUMULATIVE LENGTH			1868774	2330543	2341706	2789708	2853643	2952853	2962353
SLOPE									
CURVE DATA			R95000		R95000		R100000		

LONGITUDINAL SECTION THROUGH WATER CONDUCTOR SYSTEM - II

NOTES -:

1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

SCALE-:

0 70 140 210 M.

NOV-16	01	SECTION REVISED & ISSUED FOR REVISED DPR			
JUN-12	00	FOR DPR PUPOSE ONLY			
DATE		REVISION OR ISSUES	BY.	CH.	APP.

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

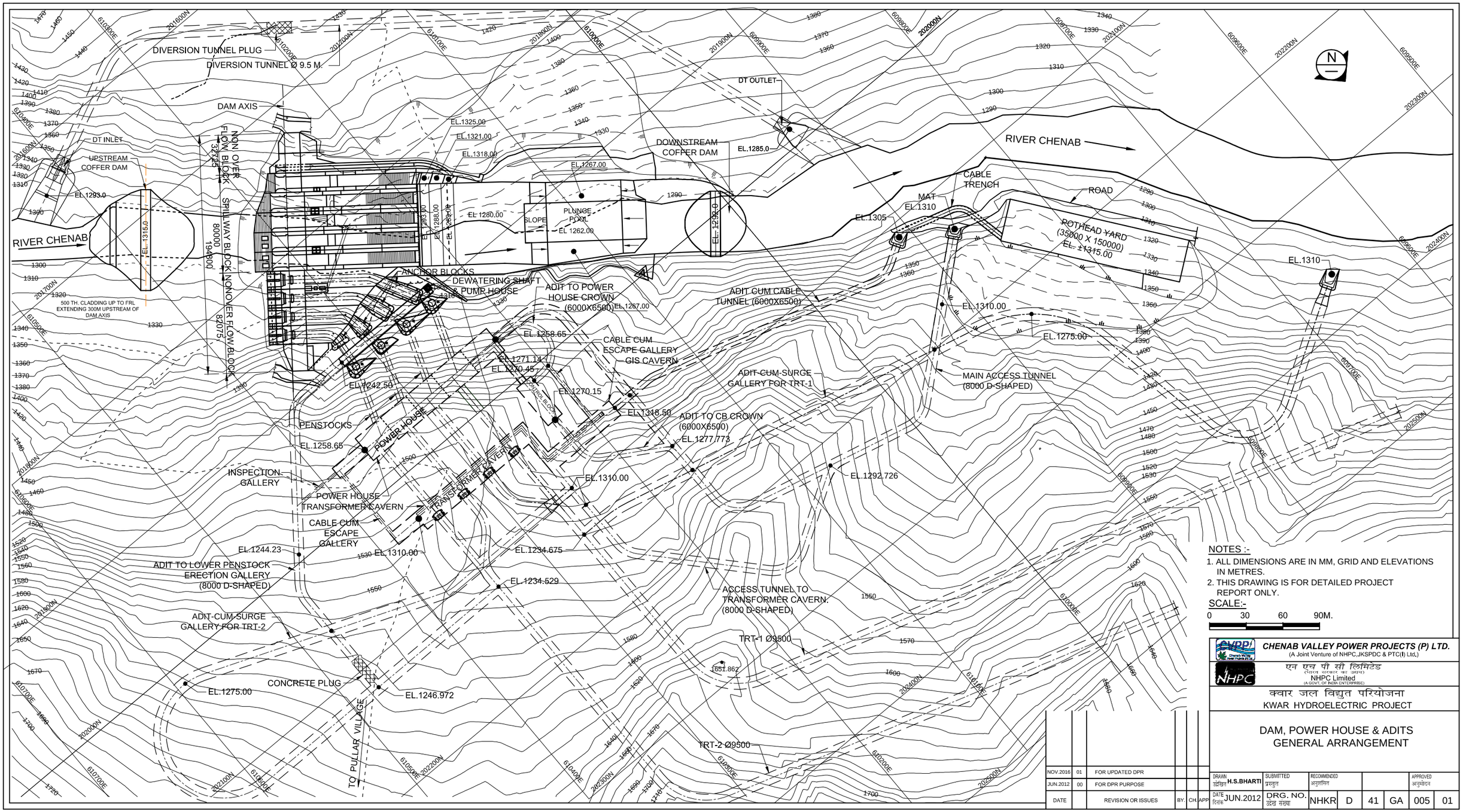
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

कवार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

WATER CONDUCTOR SYSTEM
L - SECTION THROUGH TAIL RACE TUNNEL-II

DRAWN उद्रित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन

DATE दिनांक	DRG. NO. उद्रेख संख्या						
JUN-2012	NHKR	D	41	GA	004	01



NOTES :-

1. ALL DIMENSIONS ARE IN MM, GRID AND ELEVATIONS IN METRES.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

SCALE:-

0 30 60 90M.

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

एन एच पी सी लिमिटेड
(ISO/OHSAS 9001:2008)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

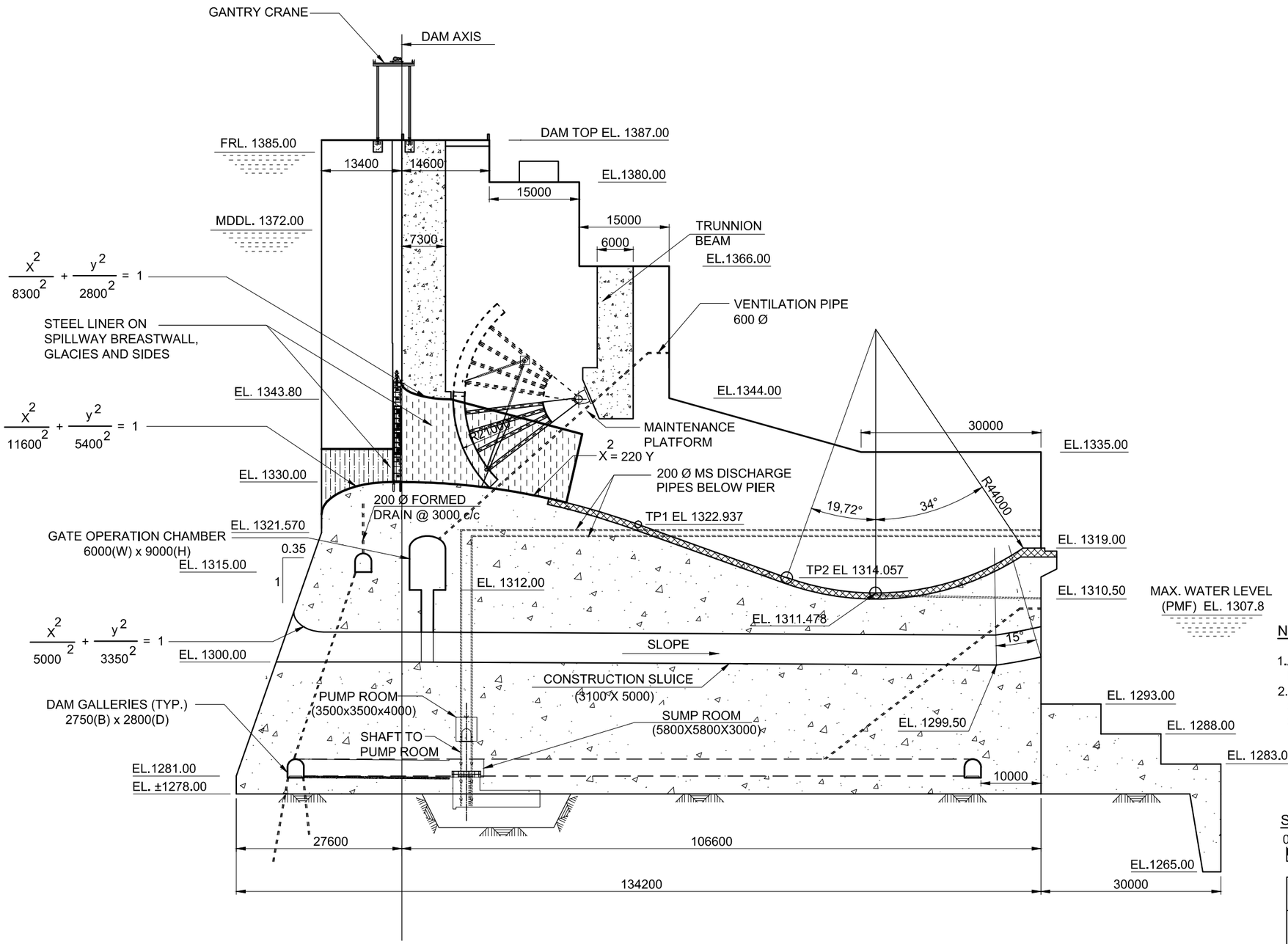
क्वार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

DAM, POWER HOUSE & ADITS GENERAL ARRANGEMENT

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV.2016	01	FOR UPDATED DPR			
JUN.2012	00	FOR DPR PURPOSE			

DRAWN उदहिका	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
H.S.BHARTI				

DATE दिनांक	DRG. NO. उदेव संख्या					
JUN.2012	NHKR	D	41	GA	005	01



NOTES-

1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
2. THE CONFIGURATION OF SPILLWAY & CAPACITY SHALL BE OPTIMISED ON THE BASIS OF MODEL STUDY.

SCALE:-

0 7.5 15 22.5 M

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

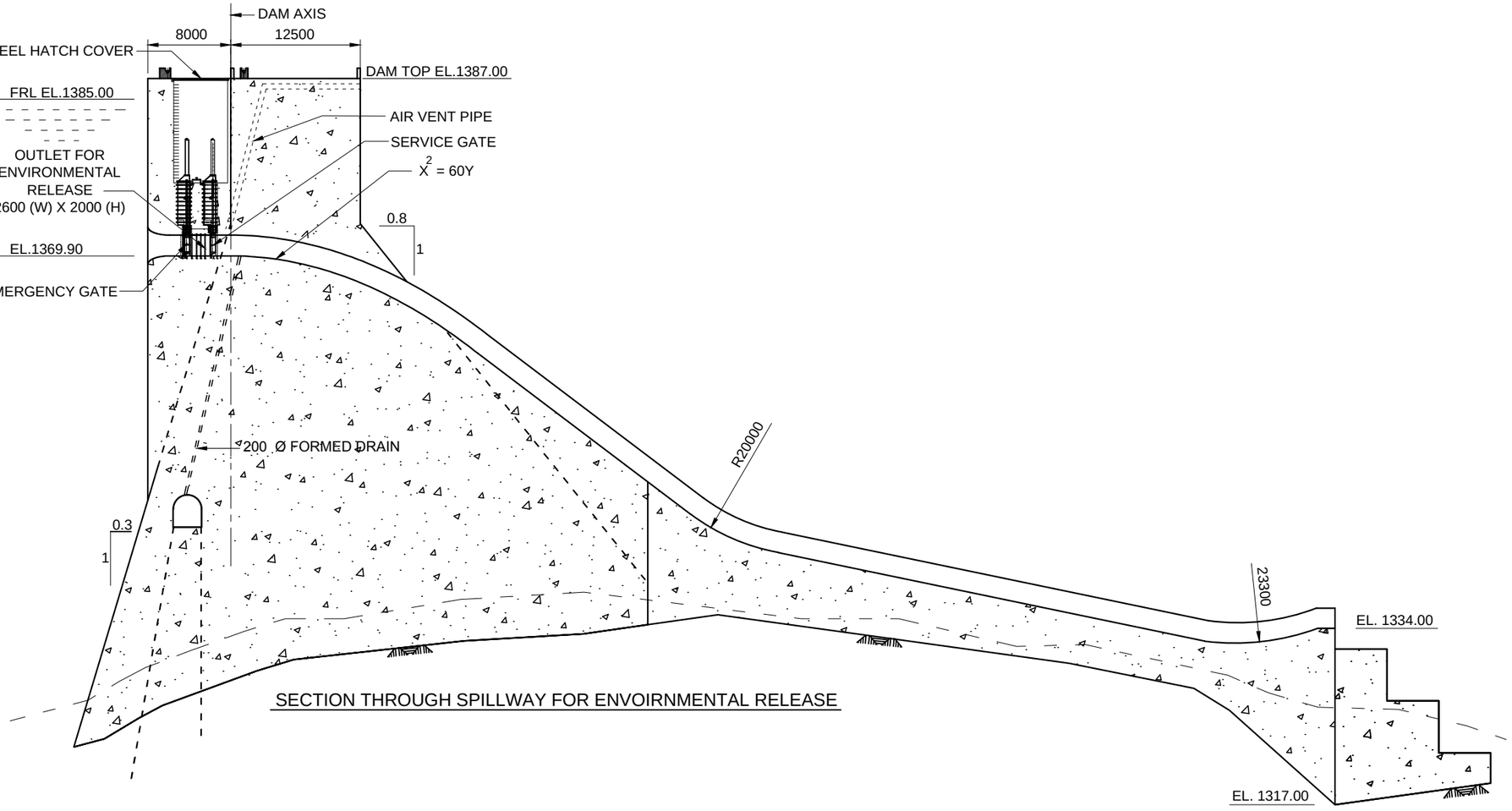
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

कवार जलविद्युत परियोजना (जम्मू एण्ड कश्मीर)
KWAR HYDROELECTRIC PROJECT (J & K)

DAM
ORIFICE SPILLWAY SECTION

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV 2016	01	ISSUED FOR UPDATED DPR			
JUN.2012	00	ISSUED FOR DPR			

DRAWN उत्तेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN. 2012	DRG. NO. उद्देश संख्या	NHKR D 41 GA 007 01		



SECTION THROUGH SPILLWAY FOR ENVOIRNMENTAL RELEASE

NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

SCALE:-

0 5 10 15M.

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

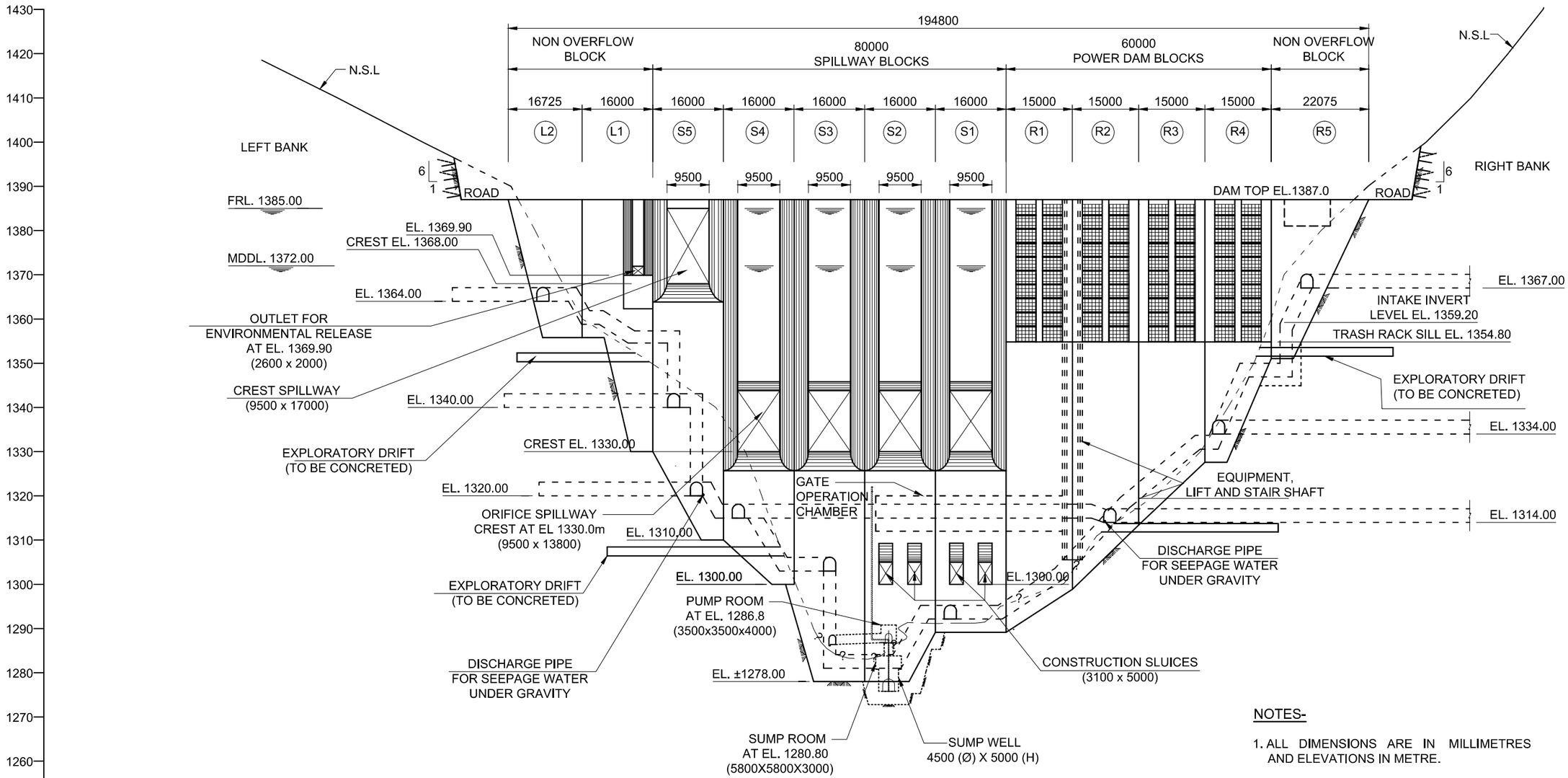
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

कवार जलविद्युत परियोजना (जम्मू एण्ड कश्मीर)
KWAR HYDROELECTRIC PROJECT (J & K)

DAM
OUTLET FOR ENVIRONMENTAL RELEASE

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV. 2016	01	ISSUED FOR UPDATED DPR			
JUN. 2012	00	ISSUED FOR DPR			

DRAWN उद्रेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN.12	DRG. NO. उद्रेख संख्या	NHKR D 41 GA 009 01		



NOTES-

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRE.

SCALE:-

0 10 20 30M.

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

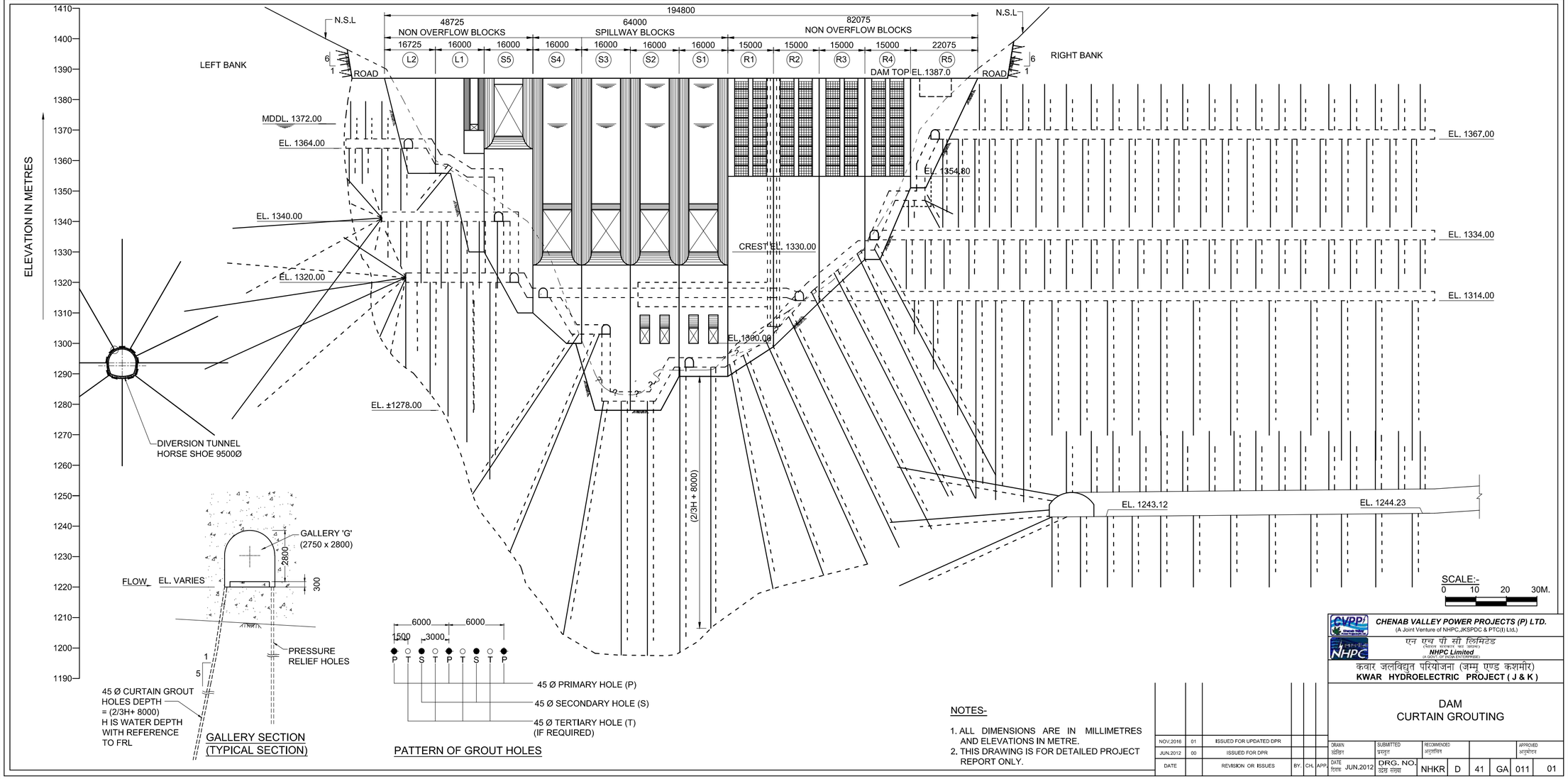
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

कवार जलविद्युत परियोजना (जम्मू एण्ड कश्मीर)
KWAR HYDROELECTRIC PROJECT (J & K)

DAM
UPSTREAM ELEVATION

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV. 2016	01	ISSUED FOR UPDATED DPR			
JUN. 2012	00	ISSUED FOR DPR			

DRAWN उद्रेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN.2012	DRG. NO. उद्रेख संख्या	NHKR	D 41 GA 010 01	



NOTES-

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRE.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

DATE		REVISION OR ISSUES	BY.	CHK.	APP.
NOV.2016	01	ISSUED FOR UPDATED DPR			
JUN.2012	00	ISSUED FOR DPR			

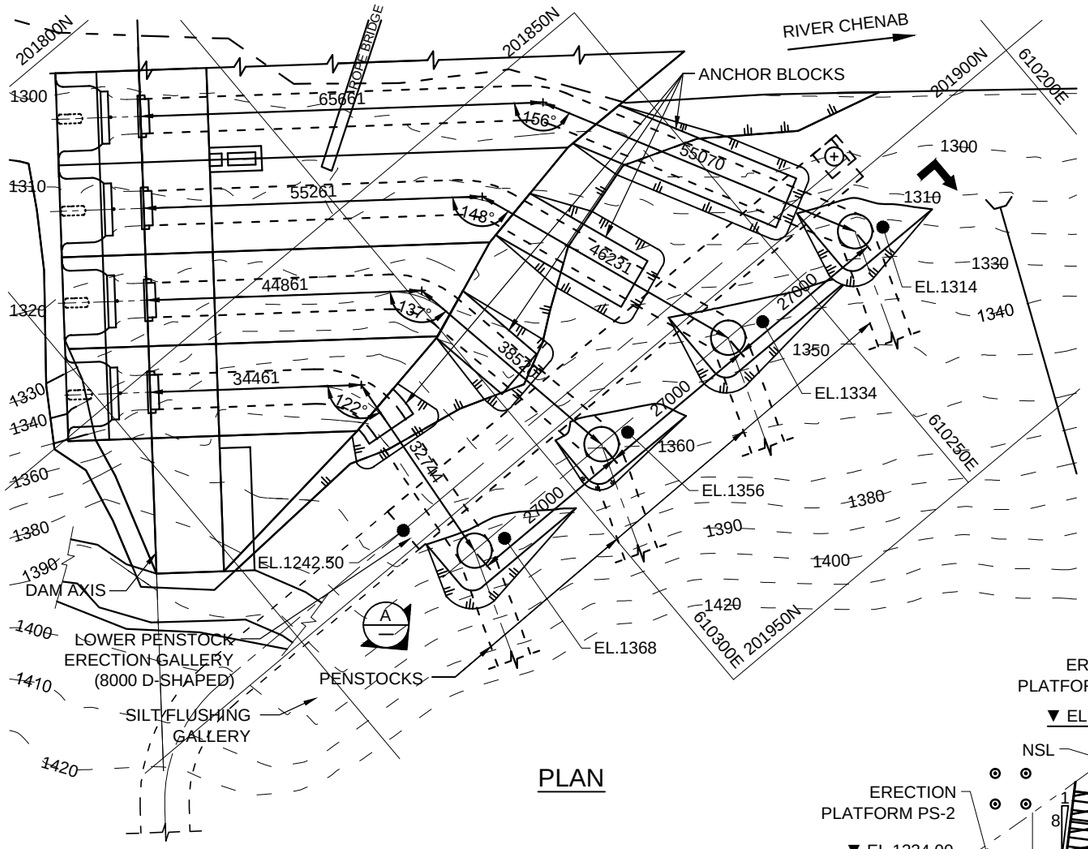
CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A MINI RATNA GOVT. OF INDIA ENTERPRISE)

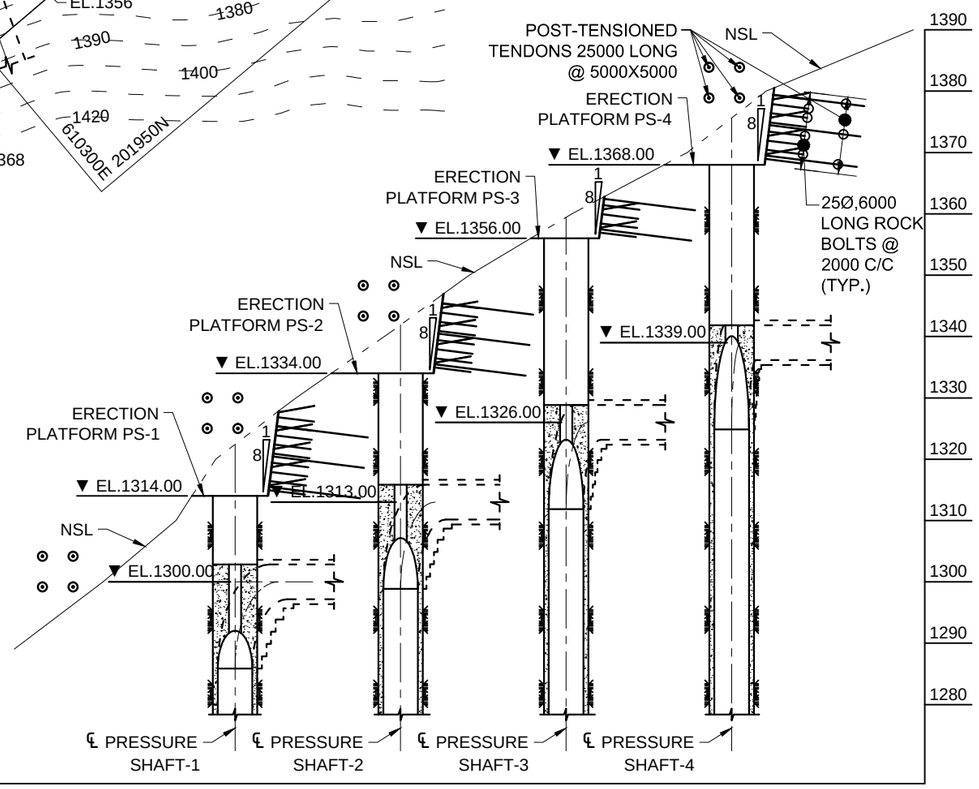
कवार जलविद्युत परियोजना (जम्मू एण्ड कश्मीर)
KWAR HYDROELECTRIC PROJECT (J & K)

DAM
CURTAIN GROUTING

DRAWN अंकित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदित
DATE दिनांक JUN.2012	DRG. NO. प्रेक्ष संख्या	NHKR	D 41 GA 011	01



PLAN



SECTION A

NOTES-:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS IN METRES.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.
3. POST-TENSIONED TENDONS SHALL BE PROVIDED DURING DETAILED DESIGN AS PER SITE REQUIREMENTS.
4. PRESSURE RELIEF HOLES AND CONSOLIDATION GROUTING SHALL BE PROVIDED AS PER SITE REQUIREMENTS.

SCALE-:

0 10 20 30 M

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

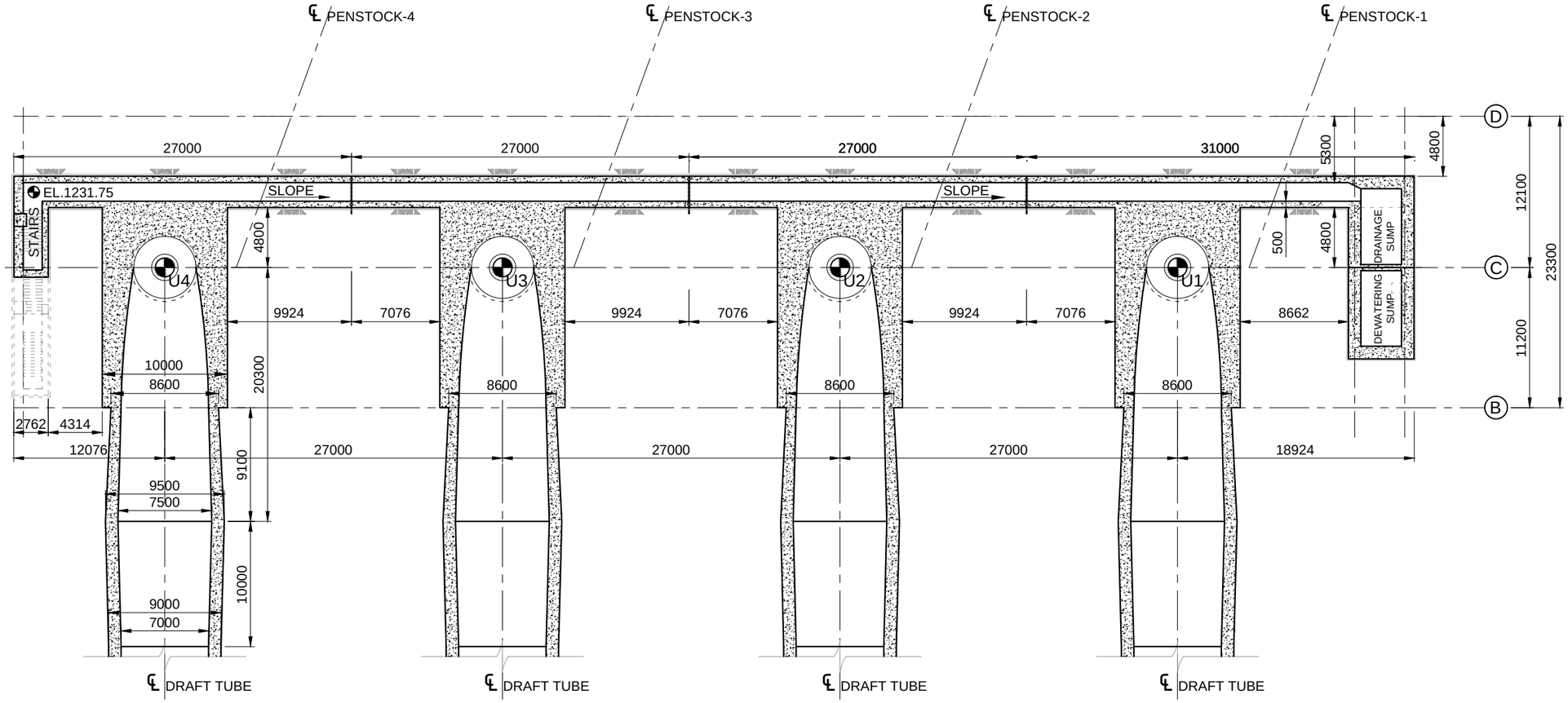
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

क्वार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

PENSTOCKS & PRESSURE SHAFTS ERECTION PLATFORMS GENERAL ARRANGEMENT

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV-16	00				
JUN-12	00	FOR DPR PURPOSE ONLY			

DRAWN उदेखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN.2012	DRG. NO. उद्रेख संख्या	NHKR	D 41 GA 021	00



PLAN AT EL.1232.25

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METERS.
2. THIS DRAWING IS FOR DETAILED PROJECT REPORT ONLY.

SCALE :-

0 4 8 12 M

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

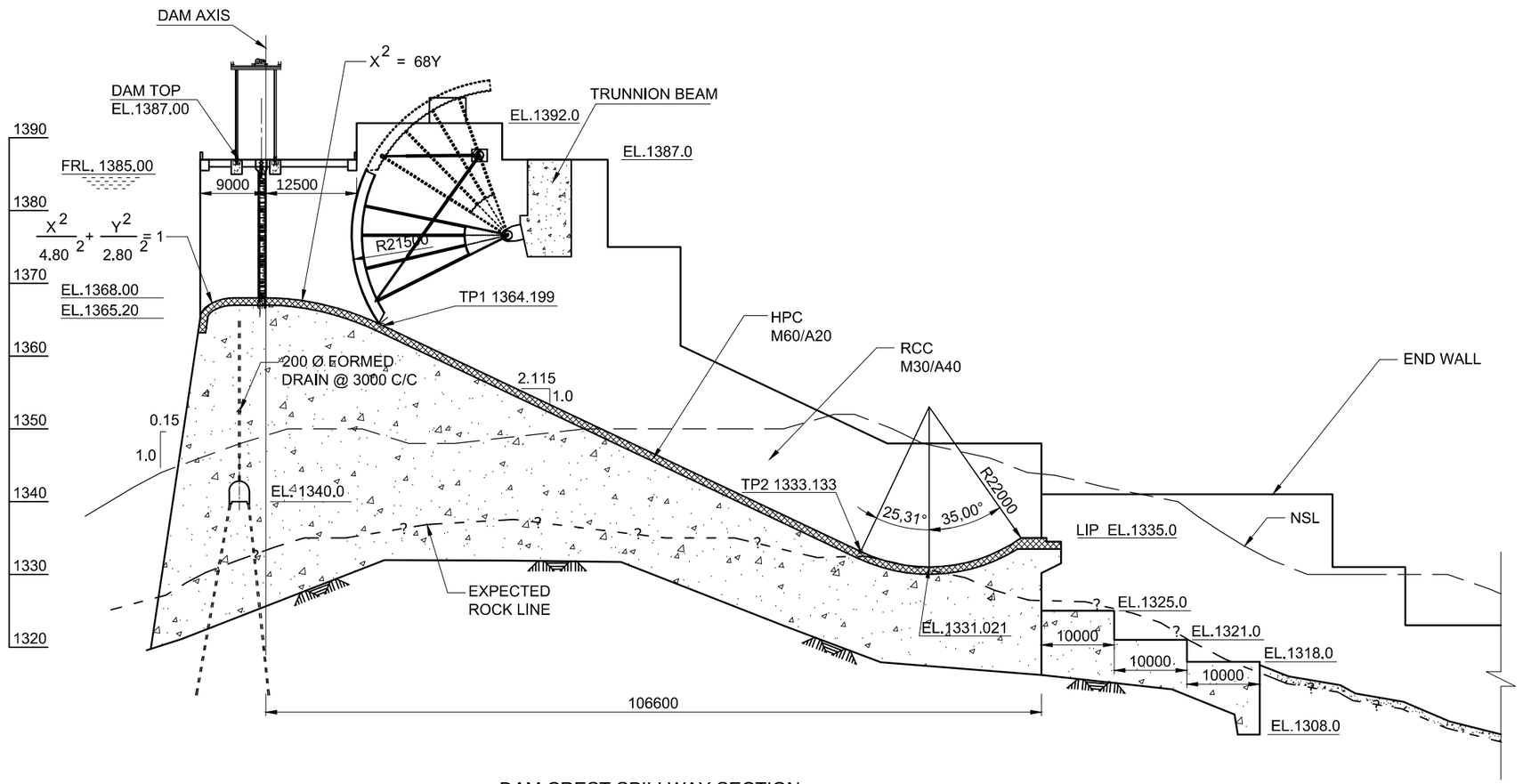
एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

क्वार जल विद्युत परियोजना
KWAR HYDROELECTRIC PROJECT

POWER HOUSE
PLAN AT EL.1232.25

DATE		REVISION OR ISSUES	BY.	CH.	APP
NOV-16		ISSUED FOR REVISED DPR			
JUN-12	00	FOR DPR PURPOSE ONLY			

DRAWN उद्देखित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक JUN-2012	DRG. NO. उद्देख संख्या	NHKR	D 41 GA 026 00	



DAM CREST SPILLWAY SECTION

NOTES:-

1. ALL DIMENSIONS ARE IN MILIMETRE AND ELEVATIONS IN METRE.
2. CONFIGURATION OF SPILLWAY & ENERGY DISSIPATION ARRANGEMENT SHALL BE OPTIMISED ON THE BASIS OF MODEL STUDY.

SCALE:-

0 7.5 15.0 22.5m

CHENAB VALLEY POWER PROJECTS (P) LTD.
(A Joint Venture of NHPC,JKSPDC & PTC(I) Ltd.)

एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A GOVT. OF INDIA ENTERPRISE)

कवार जलविद्युत परियोजना (जम्मू एण्ड कश्मीर)
KWAR HYDROELECTRIC PROJECT (J & K)

DAM
CREST SPILLWAY TYPICAL SECTION

DATE		REVISION OR ISSUES	BY.	CH.	APP.
NOV.2016	00	ISSUED FOR UPDATED DPR			

DRAWN उद्देशित	SUBMITTED प्रस्तुत	RECOMMENDED अनुशंसित		APPROVED अनुमोदन
DATE दिनांक NOV. 2016	DRG. NO. उद्देख संख्या	NHKR	D	41	GA	041	00

CHAPTER –9

POWER PLANT, ELECTRICAL & MECHANICAL EQUIPMENT

CHAPTER – 9

POWER PLANT, ELECTRICAL AND MECHANICAL EQUIPMENT

9.0 INTRODUCTION

Kwar H.E. Project envisages installation of four generating units of 135 MW each, operating under a rated design head of 103.1m placed in an underground power house located on river Chenab in Kishtwar district of Jammu & Kashmir state. The generation voltage is proposed to be 13.8 KV. This voltage will be stepped up to 400 KV voltage level by single-phase step up transformers.

The generator transformers are placed in a separate cavern downstream of power house cavern which shall be connected to its respective generators by isolated phase bus ducts. The transformers & bus reactors will be further connected to the Gas Insulated Switchgear placed in another separate underground cavern through 400 KV XLPE cables. Provision of 2 No. 400 KV outgoing line bays have been kept for evacuation of power from this project along with the provision of 3 No. single phase 41.67 MVAR, 400 KV bus reactors. 2 No. Outgoing 400 KV feeders from GIS shall be connected to pothead yard, located outside the power house through 400 KV XLPE cables. The 540 MW Power from Kwar H.E. Project would be fed to the Northern grid.

The Salient features of the Project are mentioned as per below:

Installed capacity	540 MW
No. & size of units	4 units of 135 MW
Type of Power house	Underground
Rated Design head	103.1 m
Maximum net head	110.0 m
Minimum net head	94.4 m
Type of Switchgear	400 KV Gas Insulated Switchgear

Turbine type	Francis
Speed of turbine	166.67 RPM
Generation voltage	13.8 KV
Transmission voltage	400 KV
GSU Transformer	55 MVA, 1 phase, 13.8/400/√3 KV
Overall efficiency of Unit	92%

9.1 MECHANICAL EQUIPMENTS

9.1.1 Turbines

The turbine would be of vertical shaft, Francis type, directly coupled to the generator. Each turbine would be designed for its rated output of 137.76 MW at rated net head of 103.1m in order to deliver rated generator output of 135 MW. The provision would also be made for 10% continuous overloading. The rated speed of turbine would be 166.67 rpm & the efficiency of turbine has been taken as 94.0%. The turbine characteristics would be selected such that the optimum efficiency falls close to the rated output of the unit.

The spiral casing would be of suitable cross-section fabricated from carbon steel plates. The stay rings would be of cast steel/fabricated welded to the spiral casing and would guide the water to the runner. The draft tube would be of fabricated structural steel, with adequate stiffening ribs. The runner would be integrally casted, made of stainless steel G-X5 Cr-Ni 13-4 material. The main turbine parts in the path of water i.e. the runner, top cover liners, bottom ring liners and wicket gates would be of stainless steel for improved resistance to wear. To counter the silt erosion effect, these items would have HVOF coating and in addition, provision of one set of spare runner, guide vanes, check plates and labyrinth would also be made. Bottom runner removal arrangement would be provided for repair and easy maintenance of runner.

9.1.2 Main Inlet Valves

Main inlet valve of butterfly type with a diameter of 4.6 m would be provided at the inlet of spiral casing of each turbine & connected to penstock on upstream side through matching piece for maintenance of turbines and for emergency isolation of the turbine in the event of governor failure. MIV would be housed in the Power house cavern with a 20 degree entry of penstock in Power house cavern.

9.1.3 Governor

The governor of each unit would be of the digital-hydraulic type with electronic speed sensing, electronic hydraulic transducer, oil-pressure actuator and an air-oil pressure (OPU) system. Speed, gate opening, gate limiter positioning etc will be indicated both on the governor cubicle and on the unit control board, to facilitate supervision of operation of the unit. The controls would include provision for emergency shutdown of unit in case of:

- Loss of pressure in the oil pressure vessel of the governor oil system.
- Excessive temperature rise in bearings.
- Excessive speed rise in the unit.
- Emergency closing of the MIV in case of excessive speed rise.
- Electrical faults.

9.1.4 Power House EOT Cranes

It is proposed to install two numbers EOT cranes with 220 ton main hook capacity each, auxiliary hooks of 45 ton & monorail of 10 ton capacity designed to travel the full length of the power house. Both the EOT cranes shall be used in tandem to handle the rotor. The capacity of EOT crane has been selected on the basis of preliminary assessment of rotor weight including weight of lifting arrangement & design margin. For handling the rotor, both of the powerhouse

EOT cranes would operate in tandem & shall be controlled by one cabin. Two monorail cranes shall be installed, one on each of the EOT cranes.

9.1.5 GIS Crane

One No. Electric overhead traveling crane of 10 Ton capacity would be installed in the GIS cavern for the erection & maintenance purposes.

9.1.6 Transformer unloading crane

Since the Transformer cavern is at higher elevation than Power house service bay level, one no. Electric overhead crane of 90/30T capacity would be installed in the draft tube gate cum transformer cavern. The crane would be used for loading, unloading & movement of transformers within the underground transformer cavern.

9.1.7 Auxiliary Systems of the Power Station

(a) Cooling Water System

Water for the closed loop cooling water system will be taken from the draft tube. This system would provide for the cooling of turbine and generator bearings, turbine shaft seal, generator transformer and other selected services. Necessary equipment/system will be included to provide silt free water for cooling requirements to minimize the damages due to silt.

(b) Fire Protection system

A complete fire protection system shall be provided for the powerhouse, Transformer cavern, GIS cavern, Pothead yard, Control block and other areas. Water for the fire protection system would be drawn from the tail race and stored in an elevated tank through pumps.

High velocity type mulsifier fire protection system along with nitrogen fire injection system shall be provided for GSU Transformers. MVWS spray shall be provided for cable galleries/tunnels and control room. Portable fire extinguishers

of different types shall also be provided at strategic points at all the floors of powerhouse, transformer cavern, GIS cavern and Pothead yard area for the protection in case of fire emergencies. Fire hydrants shall also be located at strategic points in Power House as well as other areas.

(c) Drainage and Dewatering System

A dewatering system would be provided in Power house with suitable number of pump motor sets arranged to dewater passages of the turbine and draft tube for each unit. A separate station drainage system, with suitable number of pump sets, would also be provided to drain and pump off miscellaneous inflows, and ground water seepage in the power house. Starting and stopping of the pumps would be automatic, controlled by level switches in the dewatering/drainage sumps.

Drainage system shall also be provided in pressure shaft bottom Adit, Main access tunnel, Transformer & GIS caverns. Provision of pumps for emergency drainage shall also be kept.

(d) Heating, Ventilating and Air conditioning System

Each powerhouse shall be provided with adequate ventilating and air conditioning system as required to maintain the control room, work areas, Power house cavern, Transformer cavern & GIS cavern at the selected temperature & humidity levels. The temperature and humidity levels would be selected to suit the requirement of equipment and plant staff.

(e) Oil Handling System

Oil handling system for transformer oil and lubricating oil will be provided with suitable piping, valves, tanks, purifiers etc. In addition, portable type oil purifiers will also be provided.

(f) Station Compressed Air System

Two Sets of high pressure (HP) compressed air system with operating pressure of 60 bars would be installed to meet the requirements of the governor oil system & operation of Main Inlet Valve (MIV).

Four sets of compressed air system with an operating pressure of 15 bars would also be installed for compressed air requirements for synchronous condenser operation mode of generating units.

Two Sets of low pressure (LP) compressed air system with operating pressure of 7 bars would be installed to meet the requirements of generator brakes, fire fighting system and station service air.

(g) Portable Water & Sanitary Service

Water from the cooling water system would be used to supply the plant's portable and sanitary water needs. The potable water would be filtered and chemically treated as required.

(h) Public Address and Surveillance System

A suitable public address and surveillance system like CCTV camera, personal identification system etc. will be installed in the Power house complex area to facilitate the communication and desired security in the power house area.

(i) Elevator

One no. Electric elevator will be provided in the Control block cavern. It will be designed for 16 persons and approximately load of 2000 Kg and have landings at all floors of the Control block cavern. One additional inclined type industrial escalator would also be provided between the passage/escape gallery from transformer cavern to the PH building and would be designed for 16 persons and approximately load of 2000 Kg.

(j) Workshop

A Mechanical workshop with machine tools as i.e. lathe, drills, grinder, welding machine, milling machine and general tools and work benches, etc. would be provided to carry out normal repairs of the equipment in each powerhouse.

(k) Testing Equipment

A test laboratory will be provided to carry out normal testing of the power house equipment. The laboratory will be equipped with custom made CTs, KW meters, HV test set, Oil testing set, Meggars, Relay testing set, rectiformers etc.

9.2 ELECTRICAL EQUIPMENTS

9.2.1 Generators

Each synchronous generator would be of direct driven, vertical shaft, salient pole type complete with air cooled stator, rotor, shaft, thrust and guide bearings, upper bracket, lower bracket and other components directly coupled to the turbine. It would be rated for a continuous output of 165 MVA (includes 10% continuous overloading), 50Hz at a power factor of 0.9 and rated voltage of 13.8 KV capacity. The provision of synchronous condenser mode of operation of generator would also be made along with the necessary associated equipments. The efficiency of the generator has been taken as 98.0%.

The stator and rotor would be transported in sections, so that the weight and size of the heaviest package is kept within transport limitations.

The generator would be semi-umbrella type in construction with thrust bearing cum lower guide bearing at the bottom & upper guide bearing at the top portion. Generator bearing arrangements would include an automatic high-pressure oil injection system, which would provide an oil film at the thrust bearings surface, to prevent damage during starting and stopping of the unit. A high-pressure oil system would also be provided for jacking up the generator rotor for maintenance purposes.

The windings of stator/rotor would be provided with class ‘F’ type insulation. The line terminals of the generator would be suitable for connection to the isolated phase bus conductors. The neutral side of the generator would be grounded through a resistor loaded distribution transformer in order to ground the star point.

The generators would be air cooled in a closed system designed to meet class ‘B’ insulation temperature limits with air-water heat exchangers mounted on the stator frame. Water based fire protection system shall be provided. Generator

protection shall be provided through latest technology numerical relays having necessary protections.

9.2.1 Static Excitation System

The Excitation system of the generator would be of the static type and shall include digital type voltage regulator, field suppression equipment and the associated accessories. The voltage regulation system would continuously and instantly respond to correct any change in the generator voltage and maintain it within its prescribed limits over the entire operating range of the generator. The excitation system shall be equipped with all type of limiters & protection system. The power for the excitation system would be obtained from a dry type excitation transformer, through tapoff bus duct connected directly to the generator voltage bus.

9.2.3 Bus Duct

Each generator would be connected to its step-up transformer by means of air insulated isolated phase bus ducts. The tentative current rating of the Bus duct is chosen in accordance with IS/International standards as 8000A . The isolated phase bus duct system would incorporate the required number of current and voltage transformers for protection and metering on line and neutral side of the generator. The bus would be provided with suitable lightening arrestors and surge protections. Required number of tap off duct shall be provided from 13.8 KV main isolated bus duct for connection to UATs, Excitation transformer's and LAVT/SAVT cubicles placed in the horizontal portion of the respective bus duct gallery.

9.2.4 Generator Step–Up Transformers

The step up transformers proposed would be single–phase units necessary to meet the transportation limitations to the project site. The transformers would be rated, 13.8/400/$\sqrt{3}$ KV, 55 MVA, 1ϕ, 50 Hz. The transformers shall be oil-

immersed with OFWF cooling & would be placed in separate transformer cavern. In order to meet contingencies due to failure of any of the transformers, one no. spare transformer would be provided. The transformers shall also be equipped with necessary protection equipment & relays.

9.2.5 Control, Monitoring and Protection System

Control, Monitoring and Protection system will be of fully automated type. It will be of the latest state of art available in the world market at the time of procurement. The power generating station would be centrally controlled from the central Control room/station which will be PC based computerized work stations.

Metering will include measurement of all standard quantities and recorders for constant monitoring of power generated and transmitted. Control would include all the necessary devices and schemes required to efficiently control the various systems of the plant, monitor the systems, their operation and identify points of trouble. The automatic control would include unit start/stop, synchronizing, emergency shut down etc. and joint control of the units. All protection, metering, control and plant supervisory systems will be seamlessly integrated.

Additionally, Unit controllers will be provided locally near each unit with provision for human machine interface, for the local control of units and its associated auxiliaries. On-line monitoring, plant supervisory and data acquisition system will be provided for monitoring and diagnostics need of plant for optimum and smooth operation.

9.2.6 Auxiliary Power Requirements

Power requirements of the Unit & Station auxiliaries would be provided through 2 No. 11 KV Switchgear boards, one placed inside power house cavern & other in the pothead yard. These 11 KV switchgears would be fed through 4 No. Station

auxiliary transformers, 2 Nos. 11 KV regional supply feeders & 2 Nos. Diesel generating Sets of 1000 KVA, 11KV rating.

The respective Station auxiliary transformers (SAT), each of 4000 KVA, 13.8/11 KV rating would be fed directly through tap-off bus duct connected to its respective 13.8 KV generator voltage bus.

Power requirements of the Station auxiliaries would be provided through Two (2) no. Station service boards (SSB's) which would be fed from 2 No. Station Service Transformer (SST) of rating 2500KVA, 11/0.415 KV. These SST's would be provided power from 11KV Switchgear placed inside power house cavern.

Power requirements of the Unit auxiliaries would be provided through their Unit Auxiliary boards (UAB) which would be fed from their respective dry type unit auxiliary transformer (UAT) rated 800 KVA, 11/0.415 KV. These UAT's would be provided power from the 11KV Switchgear placed inside power house cavern.

Two nos. Diesel generating Sets of rating 1000 KVA, 11KV to meet the start up power, emergency station supply and contingencies are proposed & would be connected directly to 11 KV Switchgear placed in the outdoor pothead yard area. Similarly, 2 nos. 500 KVA, 11 KV/415 V transformers for Dam area, 1 no. 400 KVA, 11 KV/415 V transformer for the pothead yard area & 1 no. 250 KVA, 11 KV/415 V transformer for TRT area shall also be provided. All these transformers would be fed from the 11 KV Switchgear placed in outdoor pothead yard area.

9.2.7 11 KV Switchgear

The 11 KV Switchgear system would comprise of two 11 KV switchgear boards, one placed inside the power house cavern & other in the outdoor pothead yard. These two boards would be inter-connected through 2 No. 11 KV XLPE cables. The 11 KV Switchgears would include all necessary protection equipment and relays.

11 KV Switchgear at power house would comprise of total 13 bays including 4 incoming feeders from SATs, 6 No. outgoing feeders for UATs & SSTs, one bus

coupler bay & 2 No. interconnection bays for its connection to 11 KV switchgear of pothead yard.

11 KV Switchgear at pothead yard would comprise of total 12 bays including two no. 11 KV regional supplies incoming feeders, two no. D.G. set supply incoming feeders. The 4 No. outgoing feeders would include 2 No. feeders for Dam area, 1 No. feeder for TRT area & 1 No. feeder for Pothead yard area. 1 No. bus coupler bay, 2 No. interconnection bays for its connection to the 11 KV switchgear of power house with 1 No. outgoing spare feeder would also be provided.

9.2.8 D.C. Supply System

A 220 volt DC System with two sets of 2000AH capacity battery bank would provide power for the control of switchgear, for the protection and control equipment, and for emergency lighting of the power house. The batteries would be provided with two battery chargers, each equipped with float and boost charging facility with all protective devices necessary to protect the system from damage. 220 V DC Distribution boards would be provided for feeding various types of 220 V DC loads.

A 48 V DC system with two sets of battery chargers & two sets of 500 AH capacity battery bank will be installed for the station communication and the PLCC system. 48V DC Distribution boards would be provided for feeding various 48V DC loads.

9.2.9 Illumination System

The Power plant lightning would comprise interior and exterior lights as appropriate for the entire power house area, transformer cavern & GIS building and pothead yard area. A separate emergency lightning system fed from the 220 V DC station battery system would be provided for essential locations e.g. control room, machine hall, GIS cavern, exits etc.

9.2.10 Equipment Grounding

The Power house, Transformer & GIS cavern and Pothead yard area would be provided with separate main grounding grids and the two grids will be interconnected. All non-current carrying equipment in the power house, transformer & GIS cavern and pothead yard would be grounded separately and connected to the main grounding grid. The grounding system would be designed to minimize the touch & step potential within acceptable safe limits.

9.2.11 Gas Insulated Switchgear (GIS)

In view of shortage of space at the power house site, it is proposed to install 400 KV Gas Insulated Switchgear (GIS). The 400 KV GIS shall be placed in an underground GIS cavern. The switching scheme proposed would incorporate 400 KV double bus arrangements to ensure reliability and flexibility in switching without interruption. The 400 KV GIS would be connected to the generator step up transformers through 400 KV XLPE cables. There would be total 8 nos. of GIS bays with four bays for generator transformers, one bay for bus coupler, provision of two bays for outgoing feeders & one bay for bus reactor. The GIS bays would have circuit breakers, isolators, C.T, P.T, Earthing switches, surge arrestors etc. The detailed characteristics and rating of the equipment would be established during the detailed design stage.

9.2.12 Bus Reactors

Provision of 3 No. single phase bus reactors, each of rating 41.67 MVAR, 400 KV, 50Hz has been kept & being placed in the underground transformer cavern. The reactors shall also be equipped with necessary protection equipment & relays.

9.2.13 400 KV XLPE Cable

400 KV GIS would be connected to single phase generator step up transformers placed in underground transformer cavern single-phase 400 KV XLPE cables. One No. spare cable for the above would also be provided. One No. reactor bay of 400 KV GIS would be connected to the single phase bus reactors placed in underground transformer cavern by single-phase 400 KV XLPE cables. Also feeder bays of 400 KV GIS would also be connected to the outdoor pothead yard through single-phase 400 KV XLPE cables. The spare cables would be provided, with sufficient slack at both ends for connection to any of the unit bays in GIS to any of the unit step up transformers/bus reactors & pothead yard feeder bay respectively. Therefore, total 23 No. single phase 400 KV XLPE cables (including two spare cables) with terminal kits would be provided.

9.2.14 400 KV Outdoor Pothead Yard

Two No. outgoing feeders would be provided in the outdoor potyard area. The outgoing feeders in pothead yard would have CVT, lightning arrestors, wave trap, gantry structures etc.

9.2.15 Power Line Carrier Communication Equipment (PLCC)

For purposes of transmission line protection, remote control, data and voice communication, transmission systems would have provision for installation of PLCC equipments. The PLCC equipment (panels) would be provided for each line for both sending & receiving ends by transmission line utility (i.e. PGCIL).

9.2.16 Power Evacuation System

The provision of total 2 nos. of 400 KV feeder bays have been kept. Space provision for one no. additional bay in Potyhead yard area and GIS cavern has also been kept.

CHAPTER –10

ECONOMIC EVALUATION

CHAPTER -10
ECONOMIC EVALUATION
(Equity upfront)

10.0 GENERAL

Kwar Hydro-Electric Project (540 MW) has been contemplated as a run off the river Scheme on the river Chenab in Distt. Kishtwar ,J&K, This project, has been estimated to cost Rs. 4949.24 Crores at April 2016 Price Level including Rs. 3221.86 Crores on Civil Works, Rs. 1041.38 Crores on Electrical Works, Rs. 75.22 Crores on Security and Rs. 532.21 Crores on IDC & Rs. 25.98 Crores on Financing Charges. Sale Rate of Energy generated at Powerhouse Bus Bars has been worked out as Rs. 6.21 / unit in 90% dependable year at April 2016 P.L.

10.1 ENERGY CONTRIBUTION FROM THE PROJECT

The energy generation of the project with an installed capacity of (4 X 135 MW) has been estimated at 1975.54 MU in a 90% dependable year.

10.2 PROJECT COST

The project has been estimated to cost Rs. 4949.24 Crores including IDC of Rs. 532.21 Crores and Financing Charges of Rs. 25.98 Crores at April 2016 Price Level.

10.3 FIXED AND RUNNING CHARGES

i) Interest rate

The interest rate of 10.55% has been considered for working out the financial return. The interest during construction has also been capitalized as 70% loan and 30% equity.

ii) Return on Equity

For working out the unit cost of energy, the return on equity has been taken at 16.50% as per CERC guidelines.

iii) Depreciation

In accordance with the current practice Depreciation has been charged as 4.90% of total cost excluding cost of land for initial 12 years and then the rest of the amount (90% of Total cost excluding cost of land – that booked during initial 12 years) has been booked uniformly for the balance life of the Project.

iv) Operation and Maintenance charges

According to CERC Guidelines, 2.0% of capital cost excluding cost of R & R has been considered for operation and maintenance charges during generation period.

10.4 UNIT COST OF ENERGY

The unit cost of energy generated at bus bar, considering 16.5% return on equity based on generation in 90% dependable year has been worked out as Rs. 6.21 per unit at April 2016 P.L.

The Levellised Tariff at Present Day Cost at April 2016 price level works out to Rs 5.77 per unit considering 12% free power to home state.

STATEMENT SHOWING IDC CALCULATION AT PRESENT DAY COST (APRIL 2016 PRICE LEVEL) (Equity upfront)

Rs in Crores

PRESENT DAY COST	**4391.05**		
EQUITY	**30%**	**HALF YEARLY INTEREST RATE**	**5.28%**
LOAN	**70%**	**FINANCING CHARGES**	**0.75%**

Years	**Hard Cost**			**Total Hard Cost**	**Financing Charges**	**Amount Equity**	**Receivable Loan**	**I.D.C**	**Loan Outstanding at the end of year**	**Amount Equity (for the year)**	**Receivable Loan**
	Civil	Electrical	Security								
Expenditure up to Zero date	164.39			164.39		164.39				164.39	
6	172.27		9.00	181.27		181.27				181.27	
12	286.47	0.10	9.00	295.57		295.57				295.57	
18	361.62	104.94	9.00	475.56		475.56				475.56	
24	528.68	147.67	9.00	685.35	25.98	368.00	343.34	9.06	352.40	368.00	352.40
30	555.61	202.80	7.84	766.26			766.26	38.80	1157.45		805.05
36	534.15	201.91	7.84	743.90			743.90	80.68	1982.03		824.58
42	462.24	170.22	7.84	640.30			640.30	121.44	2743.77		761.74
48	190.87	109.71	7.84	308.42			308.42	152.87	3205.06		461.29
54	18.16	104.04	7.84	130.04			130.04	129.37	3464.47		259.41
Total	3274.45	1041.38	75.22	4391.0500	25.9800	1484.7735	2932.2623	532.21	12905.1837	1484.77	3464.47

FC	**25.98**	**Crores**	**Equity**	**1484.77**
IDC	**532.21**			
Net cost of the project	**4949.24**	**Crores**	**Loan**	**3464.47**

KWAR H.E. PROJECT (540 MW)

Calculation of Energy Rate with Present Day Cost (April 2016 P. L.) (Equity upfront)

Annual Generation in a 90% dependable year	1975.54	Total cost including IDC	Rs. 4949.24 Crores	O&M Charges	2.50%	Interest rate on Loan	10.55%
Auxiliary Consumption	1.20%	Equity	Rs. 1484.77 Crores	Rate of increase of O&M Charges (compounded)	6.64%	nterest rate on Working Capital	12.80%
		Loan	Rs. 3464.47 Crores			Return on Equity	16.50%
		Cost of R & R	Rs. 36.08 Crores	Depreciation	4.90%	Discounting rate for LT-I	10.69%
Free power to home stat	13%			Maintenance Spares of O & M charges	15.00%	Minimum alternate tax	21.34%
Net saleable energy in M	1698.10	Cost of Land except Reservoir Land	Rs. 26.33 Crores			Corporate Tax	34.61%

YEAR	Outstanding Loan	ANNUAL FIXED CHARGES (Rs, in Crores) Interest on loan	Depre-ciation	Return on equity	Tax	O&M Charges	Interest on Working Capital: O&M for 1 month	Maintenance Spares	months Averag Billing	Interest	Total	Charges/Unit (Rs. per Unit) Total	Discounting Factor @ 10.69%	Discounted Tariff (Rs. per Unit)
1	2	3	4	5		6	7	8	9	10	11	12	13	14
1	3464.47	352.77	241.39	244.99	66.46	122.83	10.24	18.42	175.77	26.17	1054.60	6.21	1.0000	**6.21**
2	3223.08	327.30	241.39	244.99	66.46	130.98	10.92	19.65	172.86	26.04	1037.16	6.11	0.9034	5.52
3	2981.70	301.84	241.39	244.99	66.46	139.68	11.64	20.95	170.05	25.94	1020.29	6.01	0.8162	4.90
4	2740.31	276.37	241.39	244.99	66.46	148.96	12.41	22.34	167.34	25.87	1004.03	5.91	0.7374	4.36
5	2498.92	250.90	241.39	244.99	66.46	158.85	13.24	23.83	164.74	25.83	988.42	5.82	0.6661	3.88
6	2257.53	225.44	241.39	244.99	66.46	169.40	14.12	25.41	162.25	25.83	973.50	5.73	0.6018	3.45
7	2016.15	199.97	241.39	244.99	66.46	180.64	15.05	27.10	159.89	25.86	959.31	5.65	0.5437	3.07
8	1774.76	174.50	241.39	244.99	66.46	192.64	16.05	28.90	157.65	25.93	945.91	5.57	0.4912	2.74
9	1533.37	149.04	241.39	244.99	66.46	205.43	17.12	30.81	155.56	26.05	933.35	5.50	0.4437	2.44
10	1291.99	123.57	241.39	244.99	66.46	219.07	18.26	32.86	153.61	26.21	921.68	5.43	0.4009	2.18
11	1050.60	98.11	241.39	244.99	129.67	233.62	19.47	35.04	162.59	27.79	975.55	5.74	0.3622	2.08
12	809.21	72.64	241.39	244.99	129.67	249.13	20.76	37.37	160.98	28.05	965.86	5.69	0.3272	1.86
13	567.82	56.39	66.69	244.99	129.67	265.67	22.14	39.85	131.36	24.75	788.16	4.64	0.2956	1.37
14	501.13	49.35	66.69	244.99	129.67	283.31	23.61	42.50	133.26	25.52	799.53	4.71	0.2670	1.26
15	434.44	42.31	66.69	244.99	129.67	302.12	25.18	45.32	135.36	26.35	812.14	4.78	0.2413	1.15
16	367.74	35.28	66.69	244.99	129.67	322.18	26.85	48.33	137.68	27.25	826.06	4.86	0.2180	1.06
17	301.05	28.24	66.69	244.99	129.67	343.58	28.63	51.54	140.23	28.21	841.38	4.95	0.1969	0.98
18	234.35	21.21	66.69	244.99	129.67	366.39	30.53	54.96	143.03	29.25	858.20	5.05	0.1779	0.90
19	167.66	14.17	66.69	244.99	129.67	390.72	32.56	58.61	146.10	30.37	876.61	5.16	0.1607	0.83
20	100.96	7.13	66.69	244.99	129.67	416.66	34.72	62.50	149.45	31.57	896.72	5.28	0.1452	0.77
21	34.27	1.81	66.69	244.99	129.67	444.33	37.03	66.65	153.40	32.91	920.39	5.42	0.1312	0.71
22			66.69	244.99	129.67	473.83	39.49	71.07	158.27	34.41	949.59	5.59	0.1185	0.66
23			66.69	244.99	129.67	505.29	42.11	75.79	163.78	36.06	982.70	5.79	0.1071	0.62
24			66.69	244.99	129.67	538.85	44.90	80.83	169.67	37.81	1018.01	5.99	0.0967	0.58
25			66.69	244.99	129.67	574.62	47.89	86.19	175.94	39.68	1055.66	6.22	0.0874	0.54
26			66.69	244.99	129.67	612.78	51.07	91.92	182.63	41.68	1095.81	6.45	0.0789	0.51
27			66.69	244.99	129.67	653.47	54.46	98.02	189.77	43.81	1138.63	6.71	0.0713	0.48
28			66.69	244.99	129.67	696.86	58.07	104.53	197.38	46.08	1184.29	6.97	0.0644	0.45
29			66.69	244.99	129.67	743.13	61.93	111.47	205.50	48.50	1232.98	7.26	0.0582	0.42
30			66.69	244.99	129.67	792.47	66.04	118.87	214.15	51.08	1284.90	7.57	0.0526	0.40
31			66.69	244.99	129.67	845.09	70.42	126.76	223.38	53.83	1340.28	7.89	0.0475	0.37
32			66.69	244.99	129.67	901.21	75.10	135.18	233.22	56.77	1399.33	8.24	0.0429	0.35
33			66.69	244.99	129.67	961.05	80.09	144.16	243.72	59.90	1462.30	8.61	0.0388	0.33
34			66.69	244.99	129.67	1024.86	85.41	153.73	254.91	63.24	1529.45	9.01	0.0350	0.32
35			66.69	244.99	129.67	1092.91	91.08	163.94	266.84	66.80	1601.06	9.43	0.0316	0.30

			(A_1)	(B_1)
Note:	1. The charges per unit is exclusive of water cess, spares, incentive & Income Tax etc	215.9705	10.06	58.05
	2. MAT @ 20.01% has been applied for Ist 10 years during tax holiday after that corporate tax @ 30% on which 7.50% surcharge and 3% cess has been considered.	vellised Tariff (LT) in Rs.=(B)/(A)	LT-I	**5.77**

KWAR H.E. PROJECT, (April 2016 PRICE LEVEL)
UNIT COST OF ENERGY AT BUS BAR AT CURRENT PRICE LEVEL
(Based on 16.5% return on equity, 10.55% Interest on Term Loan, 0.75% Financing Charges and 12.80% interest on working capital)

1	Installed capacity			540	MW
2	Cost of the Project (Net) (Including Financing Charges @ 0.75% of Loan Amount)		Rs.	4417.03	Crores
3	Interest During Construction		Rs.	532.21	Crores
4	Total Cost of Project (Including IDC)		Rs.	4949.24	Crores
	a) Equity	30%	Rs.	1484.77	Crores
	b) Loan	70%	Rs.	3464.47	Crores
5	Annual Energy Generation			1975.54	MU
6	1.2% As Auxiliary Consumption of No. 5		1.20%	23.71	MU
7	Energy Available After Auxiliary Consumption			1951.83	MU
10	Free Power to Home State		13%	253.74	MU
11	Energy Available After Allowing Free Power			1698.10	MU
12	**Annual Fixed Charges**				
a)	Interest on Loan		10.55%	352.77	Crores
b)	Depreciation Charges		4.90%	241.39	Crores
c)	O&M Charges		2.50%	122.83	Crores
d)	Return on Equity		16.50%	244.99	Crores
e)	Minimum alternate Tax @		21.34%	66.46	Crores
	SUB-TOTAL			1028.44	Crores
f)	Interest on Working Capital		12.80%	26.17	Crores
I)	O&M Charges for 1 month		10.24		
II)	Maintenance Spares	15.00%	18.42		
III)	2 Months Average Billing		175.77		
	TOTAL		Rs.	1054.60	Crores
13	Sale Price at Bus Bar/Unit			6.21	Rs.
14	Levellaized Tariff			5.77	Rs.

CHAPTER –11

CONSTRUCTION METHODOLOGY & EQUIPMENT PLANNING

CHAPTER - 11

CONSTRUCTION METHODOLOGY & EQUIPMENT PLANNING

11.0 GENERAL:

Kwar Hydroelectric Project is a run of the river scheme proposed to harness the hydel potential of Chenab River. The project is located in Kishtwar district of Jammu & Kashmir, envisaging utilisation of 102.5 m of rated head available between proposed Concrete Gravity Dam and the Powerhouse.

Construction methodology and selection of equipment has been planned with the aim to commission the project in a total period of four and half years (excluding infrastructural works). Major construction works shall start from 2nd month after necessary initial mobilization and the project shall be commissioned in 54th month. Available working season in a year in the project area shall be 12 months for all underground works and 9 months for surface works.

The project headquarter is located at Kishtwar which is about 240 kms from Jammu, the winter capital town of J&K. The dam site is about 40 kms from Kishtwar. The nearest rail head is Udhampur. The nearest domestic airport is at Jammu and the international airport is at New Delhi.

Since major works of the project are proposed to be executed through contract, some provisions of machinery like material trucks, tippers, trailers, motor grader, dozers, road rollers and other Q special T&P required for carrying out the infrastructural works have been made in the project estimate. Provisions for inspection vehicles, personnel carriers, ambulances and field workshop equipment have also been made in the estimate for infrastructural facilities.

Equipment planning for all the project components has been carried out in the upcoming pages and optimization studies have been conducted as if the works are to be executed under single package of Contract.

The construction methodologies for different components of the project are as under:

11.1 DIVERSION TUNNEL:

1 No., 685 m long, 9.5 m finished diameter, Horse-shoe shaped diversion tunnel on the left bank of river Chenab shall be excavated through drilling & blasting by heading & benching method. Excavated diameter of diversion tunnel shall be 10.3 m. The total time for excavation and concreting of Diversion tunnel shall be 13 months commencing from 2nd month including excavation and establishment of portals. Heading and Benching of D/T will be done from both the faces of the tunnel simultaneously. For the excavation of Diversion tunnel, equipment like 2-boom drill jumbo, 2.5 cum side dump loader & 20/25 t Multi-axle Rear dumpers have been proposed for deployment. Concreting shall be taken up in two parts i.e. Overt and Invert. The concreting and grouting shall be completed in 5.5 months. 2 nos. of 10m tunnel gantry have been proposed for concreting so that concrete in one gantry can be poured everyday in tunnel. 6 cum transit mixers and 60 cum/hr concrete pumps etc. have also been proposed to facilitate the concreting. As such total diversion tunnel would be completed in 13 months time.

11.2 COFFER DAM:

It has been envisaged that the coffer dams shall be constructed / repaired three times during entire construction period of the project. Construction of coffer dam with the placement quantity of rock fill materials shall be carried out in a period of 3.5 months including excavation & grouting etc. It is proposed to use the useful excavated muck from the Diversion Tunnel as well as abutment excavation in the construction of coffer dams. The equipment required for the construction of the Coffer Dams would be 20/25t rear dumpers, 2 cum Hyd. excavators, Dozers, Vibratory compactors etc.

11.3 CONCRETE GRAVITY DAM:

Abutment stripping of 101 m high & 195 m long dam will commence from 4th month and will be completed in 16th month. River bed excavation will be

completed in 2 months i.e. from 16th month to 17th month. 1.0/2.0 cum Hydraulic Excavator, 20/25t Rear Dumper, Air Tracks, Diamond Core Drills, Rock Breaker etc. will be used for dam excavation.

The concreting of 101 m high & 195 m long Concrete Dam will be started from 18th month. The concreting quantity below RBL shall be placed in 3 months commencing from 18th months with the help of tower crane of the capacity 10T@30 m radius. The remaining concreting quantity shall be placed in 25 months commencing from 20th month with the help of same tower crane used for concreting below RBL. One no. 38 cum/hr concrete pump shall also be deployed to supplement the concreting requirement. Batching & Mixing plants, Aggregate Processing Plants, Chilling plant, Ice plant etc (of suitable capacities) shall be used for production of aggregates and concrete placement. The U/s & D/s coffer dams will be constructed in the successive seasons till dam level reaches up to EL 1370m.

11.4 INTAKE STRUCTURE:

Four numbers of intakes have been proposed to convey the water from dam to powerhouse through 4 nos. pressure shafts/penstocks. Excavation of intake structures would be carried out in 2 months commencing from 6th month and completing in the 7th month. Excavation of intake portal would be carried out with 1.0 cum hydraulic excavators, 20/25t multi axle rear dumpers, wagon drills/crawler rigs etc.

Concreting of intake structure would be taken up from 43rd month and would be completed in 6 months (effective) by 49th month. Other equipment required for concreting purpose would be concrete pump, vibrators, 6 cum transit mixers etc.

11.5 PRESSURE SHAFT:

4 nos. steel lined pressure shafts, 5.65 m circular finished diameter, having max vertical length of 93 m max. And max. Total length (excluding vertical) 182.0m have been proposed for the four units to be installed at powerhouse. Since adits at bottom of the pressure shafts have been provided, the excavation of the vertical pressure shafts shall not depend on the

excavation/ concreting of intake structure and therefore it will be an independent activity. The excavation of vertical pressure shafts would be carried out manually through full sinking method taking both shafts at a time. The excavation of lower horizontal pressure shafts would be carried out from intake side by normal drilling and blasting method taking two shafts at a time with one set of equipment. The total period for excavation of pressure shafts (vertical & bottom) would be 8 months starting from 31st month, 9 months starting from 30th month, 11 months starting from 18th month & 13 months starting from 16th month for PS 1, PS-2, PS-3 & PS4 respectively. Steel liner erection and concrete back filling shall start from 30th month and end in 47th month in a period of 13 months.

11.6 POWER HOUSE:

4 X 135 MW (540 MW) underground power house located on the right bank of the river Chenab shall be fed by four penstocks.

The excavation of Powerhouse (140m X 23.3m X 50m) would be taken up after the excavation of construction adit to the powerhouse crown. This adit would further be extended throughout the length of the powerhouse. This excavation would take around 2 months. Further, this pilot tunnel would be widened upto 25.62 m width in two stages in 4 months.

Power house excavation would be carried out initially by benching of 3 meter from EL 1276 to EL 1273 in one month. Mucking would be carried out through adits to crown of power house.

Power house excavation would be subsequently carried out by constructing suitable ramps for benching down. Movement of equipment would be carried out through ramps. For excavation from El 1273 to El 1258.65, mucking would be carried out through adits to crown of power house in 6 months including removal of the ramps.

Suitable ramps would be prepared to come down below El 1246 and benching of the power house upto El 1237.3 would be carried out in 2 months. Mucking would be carried out through MAT.

After reaching the EL 1237.3, pit excavation would be carried out in 2 months. After the excavation of draft tube pit, MAT ramp would be removed in 1 month.

The excavation of power house cavern would require 13 months commencing from 12th month and completing in 24th month.

The equipment required for this purpose are 2 boom drill jumbo, 1.0/2.0 cum hydraulic excavator, 2.5 cum side dump loader, 20/25t multi axle rear dumpers, wagon drills/ crawler rigs, jack hammers, shotcrete machine, grout pump, concrete pump (38/60 cum/hr), vibrator, transit mixers etc. Batching & mixing plant, aggregate processing plant would meet the concreting requirement of power house.

11.7 TRANSFORMER CAVERN, GIS CAVERN & DT GATE HALL

The excavation of Transformer Cavern (116m X 17m X 16m) would be taken up after the excavation of construction adit to the Transformer Cavern crown. Construction adit to Transformer Cavern crown would be further extended to full length of the Transformer Cavern. Thereafter, it would be enlarged sideways to the full width of the Transformer Cavern.

The excavation of GIS cavern & DT gate hall (65m X 17m X 16m) would be taken up after the excavation of Transformer Cavern. Through this cavern pilot shafts of 3.0 m diameter would be excavated manually upto bottom. The pilot shafts would be excavated with Jack hammers & EOT/Gantry crane installed at the top of GIS cavern & DT gate cavern. The excavation of these four shafts would be taken up simultaneously. Time required for the excavation of Pilot shafts upto EL1242.30 would be around 3.0 months.

GIS & DT gate cavern would be benched down through these pilot shafts. Muck would be dozed through these pilot shafts & would be hauled through the TRT. The equipment required for this purpose are 2 boom drill jumbo, 1.0/2.0 cum hydraulic excavator, 2.5 cum side dump loader, 20/25t multi axle rear dumpers, tippers, wagon drills/ crawler rigs, jack hammers,

shotcrete machine, grout pump, concrete pump (38 cum/hr), vibrator, transit mixers etc.

The total time required for the excavation of Transformer cavern, GIS & DT gate cavern would be around 9 months.

11.8 TAIL RACE TUNNEL

2 nos. Horse shoe shaped 9.5 m finished diameter Tail Race Tunnels having maximum length of 2883 m shall convey 302.6 cumecs of design discharge. Excavation of the TRT would be carried out by heading & benching method. Excavated diameter of Tail race tunnel shall be 9.8 m. The total time for excavation of 732m for U/s of Tail Race tunnel - 1 shall be 12.5 months commencing from 14th month and 1212 m for D/s of Tail Race tunnel - 1 shall be 20 months commencing from 14th month. Similarly total time for excavation of 823m for U/s of Tail Race tunnel - 2 shall be 13.5 months and 1237 m for D/s of Tail Race tunnel - 2 shall be 20 months commencing from 13th month. Heading and Benching of Tail Race Tunnel will be done from three faces in both the tunnels. For the excavation of Tail Race tunnel, equipment like 2-boom drill jumbo, 2.5 cum side dump loader & 20/25 t Multi-axle Rear dumpers have been proposed for deployment. Concreting shall be taken up in two parts i.e. Overt and Invert. Concreting of TRT outlet portal. 2 nos. of 10m tunnel gantry in each TRT have been proposed for concreting so that concrete in one gantry can be poured everyday in each tunnel. 6 cum transit mixers and 60 cum/hr concrete pumps etc. have also been proposed to facilitate the concreting.

11.9 GIS & POT HEAD YARD

Excavation of GIS & Pot Head Yard would be carried out in a period of 6 months commencing from 27th month and completing in 32nd month. Concreting of the GIS & Pot Head Yard would be carried out in 10 months starting from 33rd month. The excavation & concreting of GIS & Pot Head Yard would be carried out with the help of 2 cum. hyd. excavator, wagon drills/ crawler rigs, 20/25 T multi-axle rear dumpers, 6 cum transit mixers, 38 cum concrete pump & B&M plant, aggregate processing plant etc.

Annexure -I

List of Equipment for Infrastructural Development of Kwar HE Project (540 MW)

Sl.No.	Description of equipment	No. of Equipment	Cost (Rs in Lacs)	Total Cost (Rs in Lacs)
1	Hydraulic Excavator, 1.0 cum.	1	50.00	50.00
2	Loader cum Excavator, 1.0/0.25 cum.	1	22.00	22.00
3	Front end loader 1.5 -2.0 cum	0	36.00	0.00
4	Crawler Dozer, 100 FHP	2	42.00	84.00
5	Wheel Dozer 200 FHP	0	80.00	0.00
6	Air Track/Wagon Drill	1	15.00	15.00
7	Jack Hammer/Pavement Breaker	6	0.35	2.10
8	Diamond Core Drill (Mechanical)	1	15.00	15.00
9	Diamond Core Drill (Hyd)	1	60.00	60.00
10	Compressed Air(cfm)	1200	0.0200	24.00
11	Rock splitter	0	10.00	0.00
12	Hyd. Rock breaker	0	18.00	0.00
13	Mobile Crane, 10 t Pick & Carry	1	10.00	10.00
14	Mobile Crane, 20 t (Rough terrain)	1	53.00	53.00
15	Fork Lift,8/10 t	1	12.00	12.00
16	Road Roller, 8/10 t	1	12.00	12.00
17	Concrete Mixer, 14/10 cft	3	1.50	4.50
18	Concrete Mixer, 28 NT	0	4.00	0.00
19	Dewatering Pump	LS	20.00	20.00
20	Tipper 4.5/6.0 cum.	4	10.00	40.00
21	Truck, 10 t	4	8.00	32.00
22	Low Bed Tractor Trailor, 30 t	1	40.00	40.00
23	Explosive Van, 10 t	1	10.00	10.00
24	Water Tanker/Sprinkler, 10 KL	2	10.00	20.00
25	Petrol/Diesel Tanker, 10 KL	1	10.00	10.00
26	Bus/Mini Bus	5	10.00	50.00
27	Car/MUV	2	6.50	13.00
28	Jeep (Petrol/Diesel)	13	4.50	58.50
29	Ambulance	2	9.00	18.00
30	Workshop Equipment	LS	20.00	20.00
31	Mobile work shop	1	15.00	15.00
32	Mobile Service Van	1	20.00	20.00
33	Fire Tender	2	22.00	44.00
34	Recovery Van	1	10.00	10.00
35	Pick up Van/L.C.V	3	7.00	21.00
36	Snow cutter Blower	0	50.00	0.00
37	Motorised winch 50hp	0	10.00	0.00
			Total	**805.10**

Annexure-II

EQUIPMENT LIST OF KWAR HE PROJECT, CONSTRUCTION STAGE

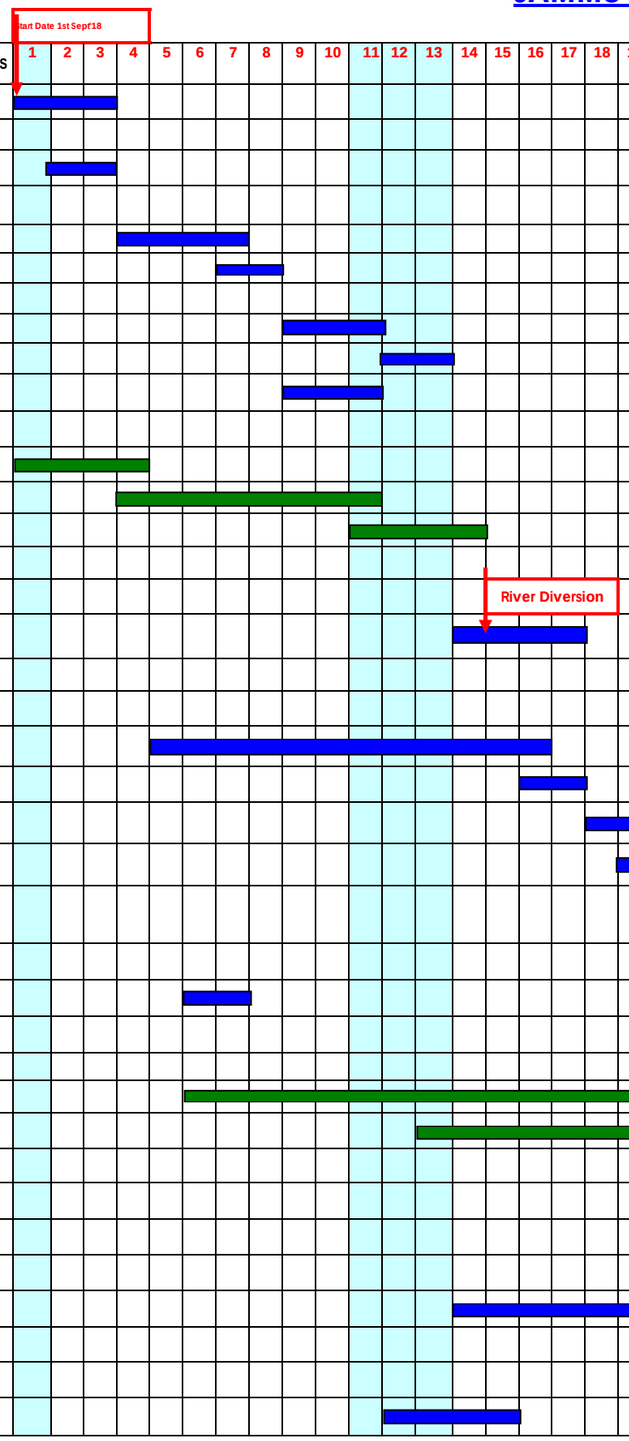
Sl. No.	Description of Equipment	Diversion Tunnel	Coffer Dam	Conc. Gravity Dam Quarry & APP	Plunge pool	Intake structure	Pressure Shafts	Power House, adit & access tunnels	D/S Surge Chamber and Transfor	Tail Race Tunnels & Pot head Yard	Misc. Works	Total no. of Equipment	Rate (Rs in Lakhs)	Total Cost (Rs in Lakhs)
1	Hyd. Excavator 1.0 cum.	2*	-	2	2	2*	2*	-	4	2	-	10	50.00	500.00
2	Hyd. Excavator 2.0 cum.	-	2	3	1	-	-	2	-	-	-	8	82.00	656.00
3	Laoder-cum Excavator 1.0/0.25 cum	-	-	1	-	-	-	1	-	-	-	2	22.00	44.00
4	Side Dump Loader 2.5 cum.	2*	-	-	-	-	2*	1	1*	4	-	5	75.00	375.00
5	Front end loader 1.5 cum	-	-	1	-	-	-	-	-	-	-	1	36.00	36.00
6	20/25 MT Multi axle rear dumper	6*	4	16	6	5*	6*	6	12	12	-	56	55.00	3080.00
7	Tipper 10 MT	-	-	4	-	-	2	2	-	-	-	8	10.00	80.00
8	Two Boom Drill Jumbo	2*	-	-	-	-	2*	1	1*	4	-	5	360.00	1800.00
9	Air Track / W. Drill / Crawler Drill	-	-	1	1	-	-	3	2	2	-	9	15.00	135.00
10	Jack Hammer / Pavement Breaker	2*	-	4	4	6	8*	2	2	4	-	22	0.50	11.00
11	Compressed Air (cfm)	250*	-	1000	1000	800	1000*	1800	800	1500	-	6900	0.0175	120.75
12	Tower crane 10T at 30 m radius	-	-	4	-	-	-	-	-	-	-	4	640.00	2560.00
13	Concrete buckets, 1/2cum	-	-	32	-	-	-	-	-	-	-	32	2.00	64.00
14	Flat Bed Truck	-	-	28	-	-	-	-	-	-	-	28	10.00	280.00
15	Concrete Pump 38 cum./hr.	-	-	1	1	-	2*	1	1	1	-	5	35.00	175.00
16	Concrete Pump 60 cum./hr.	1*	-	-	-	1	-	-	-	2	-	3	55.00	165.00
17	Transit Mixer 6 cum.	4*	-	3	2	4	4*	3	3	12	-	27	35.00	945.00
18	Crawler Dozer 300 F.H.P.	-	2	-	-	-	-	-	-	-	-	2	120.00	240.00
19	Crawler Dozer 200 F.H.P.	-	2	-	-	-	-	-	-	-	-	2	80.00	160.00
20	Crawler Dozer 100 F.H.P.	-	-	1	1*	-	-	2	-	1*	-	3	42.00	126.00
21	Crawler Dozer 70 F.H.P.	-		-	-	-	-	-	2	-		2	40.00	80.00
22	EOT/Gantry crane,20 T	-	-	-	-	-	-	-	1	-	-	1	20.00	20.00
23	Electric Winch, 10t	-	-	-	-	-	2	-	-	-	-	2	10.00	20.00
24	Rock Splitter	1*	-	1	-	-	-	1*	1	-	-	2	10.00	20.00
25	Hyd.Impact Breaker,Excavator mtd, 20 t	1*	-	1	-	-	-	1*	1	1*	-	2	60.00	120.00
26	Diamond Core Drill (Mechanical)	-	-	2	-	-	-	-	-	-	-	2	15.00	30.00
27	Diamond Core Drill (Hyd.) 300 M	-	-	1	-	-	-	-	-	-	-	1	60.00	60.00
28	Shotcrete Machine 6.0-12.0 cum./hr.	1*	-	2	-	-	2	2	2	1	-	9	25.00	225.00
29	Spraying Arms	-	-	-	-	-	-	1	1	1	-	3	40.00	120.00
30	Batching & Mixing Plant, 200 cum./hr.	1*	-	1	-	-	1*	1*	1*	1*	-	1	300.00	300.00
	Batching & Mixing Plant, 90 cum./hr.	1*	-	1	-	-	1*	1*	1*	1*	-	1	180.00	180.00
31	Aggregate Processing Plant 600 TPH	1*	-	1	-	-	1*	1*	1*	1*	-	1	900.00	900.00
32	Ice plant, 100TPD	-	-	1	1*	1*	-	-	-	-	-	1	100.00	100.00
33	Chilling plant, 425TR	-	-	1	1*	1*	-	-	-	-	-	1	425.00	425.00

EQUIPMENT LIST OF KWAR HE PROJECT, CONSTRUCTION STAGE														
Sl. No.	**Description of Equipment**	**Diversion Tunnel**	**Coffer Dam**	**Conc. Gravity Dam Quarry & APP**	**Plunge pool**	**Intake structure**	**Pressure Shafts**	**Power House, adit & access tunnels**	**D/S Surge Chamber and Transfor**	**Tail Race Tunnels & Pot head Yard**	**Misc. Works**	**Total no. of Equipment**	**Rate (Rs in Lakhs)**	**Total Cost (Rs in Lakhs)**
34	Hydraulic Vibrator alongwith excavator	-	-	1	-			-	-	-	-	1	60.00	60.00
35	Concrete Vibrator Electric / Pneumatic	L.S	-	L.S	-	L.S	L.S	L.S	LS	L.S	L.S	L.S	10.00	10.00
36	Grout Pump 20 kg/sq.cm	1*	-	2	-	-	2	1	1	1	-	7	12.00	84.00
37	Grout Pump 100 kg/sq.cm.	-	-	1	-	-	-	1	1	-	-	3	16.00	48.00
38	Mobile Crane 10 MT Pick & Carry	-	-	-	-	-	-	-	-	-	2	2	10.00	20.00
39	Mobile Crane 20 MT	-	-	-	-	-	-	-	-	-	2	2	70.00	140.00
40	Crawler crane 75MT	-	-	-	-	-	-	-	-	-	1	1	150.00	150.00
41	Vibratory Compactor 10 t	-	2	2*	-	-	-	-	-	-	-	2	30.00	60.00
42	Tunnel Gantry 10m dia.	2	-	-	-	-	-	-	-	-	-	2	75.00	150.00
43	Tunnel Gantry 9m dia.	-	-	-	-	-	-	-	-	4	-	4	60.00	240.00
44	Scoop tram, 1 cum	-	-	-	-	-	-	1	1	-	-	2	45.00	90.00
45	Dewatering Pump	L.S	L.S	L.S	-	L.S	L.S	L.S	LS	L.S	L.S	L.S	100.00	100.00
46	High Pressure water blaster	-	-	1	-	-	-	-	-	-	-	1	25.00	25.00
47	Ventilation System	L.S	L.S	-	-	L.S	L.S	L.S	LS	L.S	-	L.S.	200.00	200.00
48	Submersible Cutter Pump	-	-	-	-	-	-	-	-	-	1	1	150.00	150.00
49	Truck 10 T	-	-	-	-	-	-	-	-	-	10	10	10.00	100.00
50	Low Bed Tractor Trailor 30 T	-	-	-	-	-	-	-	-	-	1	1	40.00	40.00
51	Concrete Mixer 10/7 cft.	-	-	-	-	-	-	-	-	-	4	4	2.00	8.00
52	Concrete Mixer 28 NT	-	-	-	-	-	-	-	-	-	2	2	4.00	8.00
53	Hydra Lift	-	-	-	-	-	-	-	-	-	1	1	15.00	15.00
54	Explosive Van 10 T	-	-	-	-	-	-	-	-	-	2	2	10.00	20.00
55	Mobile Service Van	-	-	-	-	-	-	-	-	-	1	2	20.00	40.00
56	Water Tanker / Sprinkler 10 KL	-	-	-	-	-	-	-	-	-	3	3	10.00	30.00
57	Petrol/Diesel Tanker 10 KL	-	-	-	-	-	-	-	-	-	3	3	10.00	30.00
58	Bus/Mini Bus	-	-	-	-	-	-	-	-	-	6	6	10.00	60.00
59	Ambulance	-	-	-	-	-	-	-	-	-	3	3	9.00	27.00
60	Workshop Equipment	-	-	-	-	-	-	-	-	-	L.S	L.S.	150.00	150.00
61	Fire Tender	-	-	-	-	-	-	-	-	-	2	2	30.00	60.00
62	Recovery Van	-	-	-	-	-	-	-	-	-	1	1	10.00	10.00
63	Steel Rib Bending M/c	2*	-	-	-	-	-	-	-	2	-	2	5.00	10.00
64	Pick up Van/L.C.V	-	-	-	-	-	-	-	-	-	4	4	7.00	28.00
													Total	**16315.75**

KWAR HE PROJECT (4 x 135 MW)
JAMMU AND KASHMIR

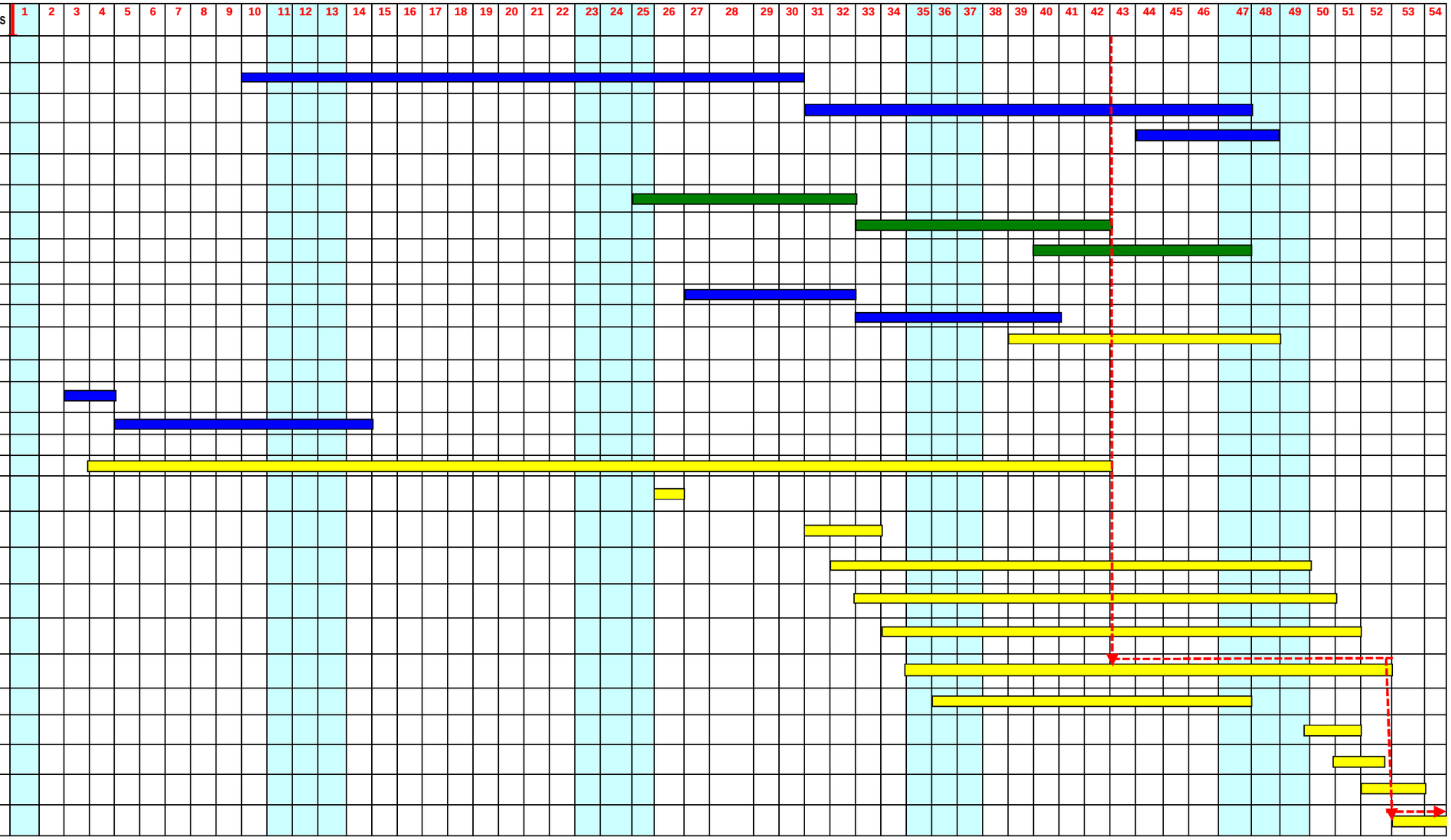
Start Date 1st Sept'18

Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
A	MOBILIZATION			3
B	DIVERSION TUNNEL			
1	Open excavation	cum	48000	2
2	Excavation of DT			
	Heading	m	685	4
	Benching	m	685	2
3	Concrete Lining			
	Overt	m	685	3
	Invert	m	685	2
4	Concreting of DT gate Structure	cum	7600	3
5	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	4
ii	Manufacturing, Testing and Supply	Job	%	8
iii	Erection			4
6	Diversion Tunnel Plugging	Job	%	1
C	COFFER DAM (U/S AND D/S)			
1	Rock fill/Impervious fill/Filler material	cum	350931	7
2	Reservoir filling	Job	%	1
D	CONCRETE DAM			
1	Common excavation/ Rock excavation	cum	498153	12
2	Riverbed excavation			2
3	Concreting upto River bed level EL 1286	cum	817500	2
4	Concreting above RBL EL 1286 upto crest level of under sluice gates			3
5	Concreting above EL 1305 upto crest level of spillway Radial gates Orifice Type			12
6	Concreting up to Dam Top			13
7	Common excavation/Rock excavation for Intake Structure	cum	79640	2
8	Concreting for intake structure	cum	78700	6
9	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	15
ii	Manufacturing, Testing and Supply	Job	%	24
iii	Erection of under Sluice Gates	Job	%	7
iv	Erection of Spillway Radial Gates	Job	%	12
v	Erection of intake gates	Job	%	10
E	PLUNGE POOL			
1	Excavation	cum	569298	17
2	Concreting of Plunge Pool	cum	51600	8
F	PRESSURE SHAFT			
1	Platform and arrangement of vertical shafts	Job	%	4



Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
2	Excavation of Adit to Lower Penstock, Erection Gallery through Adit cum Surge Gallery of TRT-2	m	220	3.5
3	Excavation of Lower Penstock Erection Gallery, Dewatering Shaft and Pump House	m	90	2
4	Excavation of Vertical and Bottom Pressure Shaft			
i	PS-1	m	141	8
ii	PS-2	m	165	9
iii	PS-3	m	187	11
iv	PS-4	m	205	13
5	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	12
ii	Manufacturing, Testing and Supply	Job	%	20
iii	Erection of Steel Liner PS-1	m	236	8
iv	Erection of Steel Liner PS-2	m	223	8
v	Erection of Steel Liner PS-3	m	211	8
vi	Erection of Steel Liner PS-4	m	201	8
6	Back fill Concrete			
i	PS-1	m	117	8
ii	PS-2	m	133	8
iii	PS-3	m	146	10
iv	PS-4	m	165	11
G	POWER HOUSE			
1	Open Excavation and Establishment of Portal of MAT	Job	%	2
2	Excavation of MAT to P/H	m	645	8
3	Excavation of Access Tunnel to Transformer Cavern through MAT	m	265	2
4	Excavation of Adit to P/H crown	m	100	2
5	Excavation of Adit to Control Block Crown through MAT	m	70+45	1
6	Excavation of P/H Cavern	cum	142043	13
7	Excavation of Control Room Cavern	cum	18051	4
8	Excavation of Transformer , GIS and Draft Tube Gate Cavern	cum	55037	9
9	Excavation of Draft Tube Gate Shaft	Job	%	6
10	Concreting of Draft Tube Gate Shaft	Job	%	6
11	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	12
ii	Manufacturing, Testing and Supply	Job	%	15
iii	Erection	Job	%	9
12	Concreting in service bay upto EOT level	Job	%	3
13	Concreting of Columns and Beams in Power House upto EOT level.	Job	%	7
14	Concreting of P/H	Job	%	18
15	Concreting of T/F Cavern	Job	%	10

Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
H	TAIL RACE TUNNEL			
1	Underground Excavation (Rock Class II to V)	cum	607200	21
2	Cement Concrete lining - M25/A40	cum	126600	14+3
3	Reinforced Cement Concrete - M25/A40	cum	10600	5
4	Hydro-Mechanical Works of TRT Outlet Gates			
i	Design & Engineering	Job	%	8
ii	Manufacturing, Testing & Supply	Job	%	10
iii	Erection	Job	%	8
I	GIS BUILDING AND POTHEAD YARD			
1	Surface Excavation	cum	210075	6
2	Concreting	cum	21715	8
3	Erection of Pothead yard Equipments	Job	%	10
4	Cable Tunnel			
i	Surface Excavation and Portal Preparation	Job	%	2
ii	Excavation of Cable Tunnel	m	320	10
J	E&M works of Power House			
i	Design & Engineering and Supply	Job	%	39
ii	Erection of EOT Crane in service bay	Job	%	1
iii	Extension of EOT Crane in Units	Job	%	3
iv	Unit-I - Erection, Testing and commissioning	Job	%	18
v	Unit-II -Erection, Testing and commissioning	Job	%	18
vi	Unit-III -Erection, Testing and commissioning	Job	%	18
vii	Unit-IV -Erection, Testing and commissioning	Job	%	18
viii	Erection of Transformers	Job	%	12
ix	Unit-I - Erection, Testing and commissioning	Job	%	2
x	Unit-I - Erection, Testing and commissioning	Job	%	2
xi	Unit-I - Erection, Testing and commissioning	Job	%	2
xii	Unit-I - Erection, Testing and commissioning	Job	%	2



LEGEND:

- Civil Works
- HM Works
- E&M Works
- Monsoon
- Critical Activity

CHAPTER –12

ENVIRONMENT AND ECOLOGICAL ASPECTS

CHAPTER - 12
ENVIRONMENT AND ECOLOGICAL ASPECTS

Kwar (540MW) H.E. Project, a run-of-river scheme is located on river Chenab in district Kishtwar of Jammu and Kashmir State. Kishtwar is the major township situated near the project site on a central plateau which is linked with other parts of the state by NH1B. The catchment area of the proposed project at the dam site is 10325 sq km. The terrain of the catchment is generally rugged and steep, with narrow valleys bounded by high ridges opening out in their upper glacial parts. The area observes sub-temperate climate. The influence of the monsoon is weak in the region. The basin receives precipitation round the year. Cold season precipitation from December to March occurs due to western disturbances leading to heavy snowfall during the winter season in the upstream portions. The catchment area is by and large snow bound for about two months during winter. For the remaining months, the lower reaches of the drainage area are free from the snow cover. The maximum and minimum temperature observed at Dul dam site is 43^0C and -1^0C, respectively.

The soils of Kishtwar region have been classified as Sandy skeletal, Loamy skeletal, Fine loamy, Course loamy and Loamy. Soil depth in general is moderately deep to deep varying up to 30 cm depth. However, at some places particularly in agricultural fields the depth is more. By and large, soils are immature containing large proportion of un-decomposed organic materials. Physico-chemical analysis of the soils reveals that the soils of the Chenab catchment at this particular area are not very fertile because it is deficient in most of the essential elements though the moisture and water contents are available in appreciable quantity. Generally, soils of this area are alkaline in nature. The microelements like zinc, iron, copper and manganese are also present in a quantity that can be considered as moderately sufficient in a mountainous soil. Overall the soils in the area are deficient in fertility level and categorize under medium range of fertility.

The various land use / land cover categories of the project area comprise of agriculture, forest, water bodies and other government land. Overall land requirement of the project is 136.35 ha for different components of project. Out of this 29.75 ha is forest land, 89.57 ha revenue (Govt.) land and 17.03 ha private land. Submergence at FRL (EL 1385m) is 55.25 ha, comprising of state land (river bed land). Execution of Kwar HE Project is likely to affect 5 villages viz. Bhagna, Semna Bhata, Ajna, Dichla and Galhar Bhata. Out of these, Galhar Bhata village shall be losing only the river bed land and any private land or property from this village shall not be affected. Therefore, it is not considered in the main affected villages. As per Census 2011, the total population in the four main project affected villages is 5705 spread over 1013 households with average household size of 5.6 and average sex ratio of 944.

During surveys, 63 PAFs with a total population of 350 from these 4 villages have been identified as affected families. Out of 63 PAFs, 19 belong to ST category and 44 belong to General category. The project affected population would be properly rehabilitated as per the R&R plan.

The major forest types and subtypes in the area, based on Champion and Seth (1968) classification, include Himalayan Moist Temperate forest (with two subtypes viz. Ban Oak forest and Moist Temperate Deodar forest), Western Himalayan Upper Oak-Fir forest, Western Himalayan Subalpine Fir forest and Dwarf Rhododendron scrub. The vegetation in these forest types is represented by species like *Quercus baloot, Quercus semecarpifolia, Salix alba* and *Aesculus indica* in Ban-Oak forests; *Cedrus deodara, Pinus wallichiana, Quercus semecarpifolia* and *Pinus gerardiana* in Moist Temperate Deodar forests; *Quercus floribunda, Quercus semecarpifolia, Abies pindrow and Picea smithiana* in Western Himalayan Upper Oak-Fir forests; *Abies pindrow, Picea smithiana* and *Pinus gerardiana* in Western Himalayan Subalpine Fir forest and *Rhododendron arboreum* and *Betula utilis* in Dwarf Rhododendron Scrub.

The floristic composition of the Kwar catchment/study area as per the EIA study comprises of 382 species distributed over 89 families with predominance

of Asteraceae followed by Lamiaceae and Fabaceae. During floral investigations, the presence of few rare, endangered and threatened species was also confirmed and presented in the EIA report. Most of these species were observed to inhabit higher altitudinal belts in the catchment area of the project. The RET species reported from the area include *Juglans regia, Ulmus wallichiana, Sassurea costus, Gentiana kurroo, Pinus gerardiana* and *Texus baccatta*.

Survey in the study area was undertaken to look for distribution pattern of wildlife. Some of the faunal species reported in area are yellow throated marten, rhesus macaque, jackal, porcupine, wild boar, fox, jungle cat, leopard, black bear, grass snake, garden lizard, house gecko, jungle crow, common myna, blue rock pigeon, red jungle fowl, black drongo, dove, bulbul, etc.

Project as well as study area does not fall within any National Park, Sanctuary, or Biosphere Reserve. The nearest protected area from the project is Kishtwar High Altitude National Park (KHANP). The southern boundary of KHANP is located at an aerial distance of about 10.50 km from project components and shall not be affected by project execution.

Based on the findings of Environmental Impact Assessment study, various Environment Management Plans have been prepared to mitigate the adverse impacts and to maximize the positive impact of the project construction on the environment. These management plans include: Biodiversity Conservation and Management Plan, Catchment Area Treatment Plan, Fisheries Management Plan, Solid Waste Management Plan, Public Health Delivery System, Energy Conservation Measures, Muck Disposal Plan, Landscaping and Restoration Plan, Air and Water Management Plan, Reservoir Rim Treatment Plan, Compensatory Afforestation Plan, Rehabilitation and Resettlement Plan, Environmental Monitoring Plan and Disaster Management Plan.

APPENDIX – A

Letters of clearances of DPR aspects by various Divisions / Directorates of CEA/CWC, GSI, etc.

CENTRAL WATER COMMISSION

Government of India
Central Water Commission
Irrigation Planning (North) Dte.

204 (S) Sewa Bhavan
R.K. Puram, New Delhi-66
Dated: Oct, 2012

Sub: Detailed Project Report (DPR) of Kwar Hydro Electric Project (4 x 140 MW = 560 MW) in Jammu & Kashmir.

Please refer CWC **UO No. 3/154/2012-PA(N)/1250-60,** dated **21.08.12** on the subject, vide which a Detailed Project Report (DPR) of **Kwar Hydro Electric Project (4 x 140 MW = 560 MW) in Jammu & Kashmir** has been forwarded to this office for examination.

Project Proposal-

The **Kwar Hydro Electric Project** is a run –of –river scheme located on river Chenab at village Kandni of the Kishtwar district of Jammu & Kashmir state. The project envisages construction of 109 m high, 195 m long concrete gravity dam and the water from the dam would be diverted to underground power house near village Padyarna downstream of the dam on right bank of Chenab River by means of 0.685 m long diversion tunnel for power generation. The underground Power House with an installation of 4 units of 140 MW each would operate under a rated head of 102.50 m for generating 560 MW of power. The Live storage of reservoir is 9.16 MCM and total estimated cost of the project is Rs. 4375.50 Crores at Jan 2012 price level.

The proposal has been examined from inter state angle and comments are as here under.

Comments –

1. The project is proposed on tributary of Chenab River, which is an international river between India and Pakistan. Therefore concurrence of MOWR (Indus Wing) from Indus Water Treaty considerations is required.
2. Inter-State aspect has not been discussed in project report. However, as seen from the index map available at the end of chapter of Executive Summary, Indian portion of sub-basin appears to be located entirely in J&K. Hence no inter-state aspect appears to be involved.

The Volume number I to V of DPR are returned herewith

This issue with the approval of CE (IMO).

Encl.- As above

30/10/12

(B.P.Pandey)
Director,
IP(N)Dte.

Director PA (N) Dte, CWC, Sewa Bhawan, R.K.Puram
CWC No. 7/2/7(J&K)5/2004/IP(N)/ 636 Dtd. 31/10/2012

भारत सरकार
केन्द्रीय जल आयोग
जल विज्ञान (उ) निदेशालय

कमरा नं. 507A(द), सेवा भवन
रा.कृ.पुरम, नई दिल्ली - 66.

विषय : Water Availability studies of KWAR HEP (560 MW) J&K.

संदर्भ :CWC U.O. No. 3/154/2012-PA (N)/1250-60 dated 21/08/2012.

उपर्युक्त सन्दर्भित पत्र का कृपआ अवलोकन करें जिसमें इस निदेशालय से उपरोक्त परियोजना सम्बंधी रिपोर्ट की टिप्पणी भेजने का अनुरोध किया है । इस सम्बन्ध में इस निदेशालय से टिप्पणी प्रेषित की जा रही है ।

संलग्न : यथावत

(जी.एल.बंसल) 27/6
निदेशक

निदेश्क, परियोजना मूलयांकन (उत्तर) निदेशालय, के.ज.आ.
फाइल संख्या: 1/J&K/34/2012/ज.वि.(उ) / 256

दिनांक: 27 /06/2013

June, 2013

No.1/J&K/26/2006/Hyd(N)/
Central Water Commission
Hydrology (North) Directorate

Subject:- Water availability studies of Kwar HEP (660MW) J&K.

FR is a Hydrology Report of Kwar HE Project (560 MW) in J&K received through Director, Project Appraisal (North), CWC vide CWC U.O. No. 3/154/2012-PA (N)/1250-60 dated 21/08/2012. The studies are examined and following observations are made:

Project Proposal:

Kwar H.E. Project is proposed as a run of the river type development across river Chenab in Doda district of J&K. Dam shall be located d/s to proposed Kiru HEP and u/s of Dulhasti HEP which is operational for last 10 years. The scheme envisages construction of a 97 m high concrete dam, with a gross storage capacity of 27.167 MCM. The permanent snow line is estimated at EL 4000m by the project authority. The total catchment area up to Kiru dam site is 10325 sqkm, out of which 7880 sqkm (76%) is snowfed area and remaining 2445 sqkm is rainfed.

Water Availability Studies:

Site specific data is not available. Gauge and Discharge site at Benzwar with catchment area of 10687 sqm (earlier maintained by CWC) is nearest to the proposed dam site and its data from 1975 to 2003 has been used in the studies. After year 2003 this site was closed.

Dulhasti H.E. Project is operational from last 10 year and discharge data at dam site Dul (catchment area=10500 sqkm) is also available from year 2003 onwards. To have a long term series at Kwar HEP, the discharge data at Dul dam site has been clubbed with Benzwar data.

Considering uniform rainfall pattern, 10-daily average flow series has been estimated at proposed Kwar dam site by transposing the data of Benzwar and Dul sites in catchment area proportion. Data gaps in 10-daily data are filled up by average values. The generated series has been subjected to internal and external consistency check. The series has also passed the t-test applied to check the homogeneity of the two data sets. Single mass curve of the estimated series depicts almost a straight line with a R^2 value as 0.99.
The 10-daily average flow series for the period from June, 1975 to May, 2012 is enclosed as Annexure-I and is recommended for planning and design purposes.

However, Project authorities are suggested to start collecting rainfall and discharge data at site which shall be useful to firm up the studies at later stage.

Design Flood Studies:

Design and diversion flood studies are under examination.

ANNEXURE-I

Estimated 10-daily average flow series at KwarHEP Dam site CA= 10325 sqkm

Unit : cumec

YEAR	TEN DAILY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1975-76	I	552	921	1138	793	266	100	68	52	49	69	90	249
	II	578	1337	1455	678	214	86	64	54	61	58	114	593
	III	1094	1169	1045	344	130	71	60	56	60	71	226	556
1976-77	I	965	1117	1153	656	200	97	77	60	63	61	100	131
	II	684	1587	1039	353	127	91	71	60	68	71	95	156
	III	599	1583	734	282	108	86	67	62	60	85	116	345
1977-78	I	630	1739	1573	860	193	101	77	61	53	64	79	395
	II	852	1568	1104	484	138	85	76	57	58	66	175	658
	III	1469	1354	1001	286	124	79	70	53	55	88	179	816
1978-79	I	1095	1866	1604	464	198	106	79	65	60	38	147	308
	II	964	1541	1417	418	164	100	76	63	60	55	192	294
	III	1833	1587	1191	271	130	86	78	64	59	135	278	278
1979-80	I	401	1348	1584	304	183	90	70	61	56	59	83	276
	II	845	1720	1205	401	133	81	66	62	55	61	114	294
	III	1541	1295	889	187	100	79	61	58	59	74	164	395
1980-81	I	724	1350	1415	550	235	98	74	65	62	64	101	505
	II	903	1565	803	377	153	89	71	59	60	64	174	530
	III	1258	1230	876	272	113	81	63	57	64	82	265	721
1981-82	I	482	1089	1521	614	157	105	76	63	64	68	94	275
	II	530	1720	1303	321	128	91	70	61	60	66	131	216
	III	1385	1894	853	300	111	81	63	65	61	79	164	346
1982-83	I	566	896	1715	661	148	96	79	69	67	63	125	250
	II	940	1096	1265	594	128	86	73	67	65	69	125	386
	III	784	1535	758	275	114	81	67	62	61	82	197	427
1983-84	I	570	1074	1981	1189	308	108	77	62	60	67	112	252
	II	595	672	1479	722	206	97	71	65	54	72	114	308
	III	1178	1668	1533	427	124	83	68	62	107	87	159	620
1984-85	I	1199	1056	1283	700	126	96	77	61	68	67	77	186
	II	1097	798	1257	438	114	86	72	65	63	67	97	237
	III	1171	1096	1034	184	109	81	66	64	64	77	130	566
1985-86	I	748	1140	1259	754	234	95	77	69	61	70	96	254
	II	873	1323	1139	445	138	89	74	64	60	73	155	449
	III	979	1197	1035	301	105	80	71	62	60	93	212	287
1986-87	I	891	1378	1440	724	182	107	91	78	72	89	120	203
	II	966	1488	1319	350	158	103	91	75	71	89	119	212
	III	1606	1603	921	302	116	98	80	77	74	99	205	397
1987-88	I	761	1237	1103	968	265	120	93	79	68	123	140	401
	II	677	1217	1115	641	200	108	89	72	68	83	327	573
	III	966	1398	1229	468	136	99	87	69	63	120	379	619
1988-89	I	671	1600	1143	631	330	144	104	110	93	94	129	267
	II	931	1601	1048	561	215	124	93	101	94	96	155	426
	III	1725	1682	669	672	170	118	97	100	90	117	180	719
1989-90	I	1213	1005	1010	594	283	150	98	81	76	75	118	398
	II	959	1442	1167	594	208	131	90	80	83	89	164	917
	III	1027	1756	1040	400	173	112	80	80	81	102	221	843
1990-91	I	762	1723	1490	827	229	112	77	71	65	85	169	284
	II	748	1278	1068	556	177	105	68	68	64	96	143	440
	III	1833	1203	986	400	129	87	65	66	68	124	201	408
1991-92	I	935	1426	1059	891	215	121	82	68	65	68	123	291
	II	1100	1364	896	772	173	108	79	68	68	74	157	377
	III	1047	1290	931	365	142	93	75	65	67	99	236	475
1992-93	I	574	836	1053	826	248	140	92	83	71	69	105	409
	II	835	1122	905	421	200	128	86	77	74	82	141	423
	III	994	1287	922	309	162	108	82	72	65	89	232	599
1993-94	I	582	1400	894	706	238	121	99	71	51	59	169	313
	II	821	1214	762	515	205	107	91	59	48	86	140	322
	III	930	889	728	315	159	105	84	72	53	100	167	534

ANNEXURE-I

Estimated 10-daily average flow series at KwarHEP Dam site CA= 10325 sqkm

Unit : cumec

YEAR	TEN DAILY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1994-95	I	890	1175	511	642	233	95	68	49	47	49	74	234
	II	741	854	779	454	182	81	61	47	45	57	74	474
	III	1085	852	637	276	141	74	58	47	45	61	112	313
1995-96	I	644	1037	801	620	358	233	303	96	74	79	124	224
	II	1015	1082	872	446	326	158	101	89	74	68	139	274
	III	701	1446	659	388	272	122	99	81	75	123	282	401
1996-97	I	739	755	954	582	345	127	97	86	81	74	85	181
	II	982	745	834	463	209	120	92	84	76	78	98	204
	III	877	760	799	399	194	105	88	82	72	80	146	261
1997-98	I	803	552	587	424	205	127	111	90	68	95	194	389
	II	860	707	626	338	158	114	105	85	67	91	295	543
	III	473	781	709	271	137	110	96	79	71	143	295	702
1998-99	I	668	1149	894	794	576	211	167	106	82	79	169	219
	II	674	1165	861	812	337	186	151	98	75	85	184	274
	III	832	1008	745	551	233	177	123	92	75	108	250	368
1999-00	I	859	772	1427	879	291	177	138	82	69	72	91	252
	II	471	1083	1152	657	215	167	107	78	69	78	103	853
	III	591	1242	1218	437	184	155	94	72	70	86	121	1268
2000-01	I	552	821	1371	772	290	193	101	75	70	68	95	175
	II	626	987	932	526	229	145	88	72	70	68	112	296
	III	730	1349	944	360	219	125	80	70	67	79	131	451
2001-02	I	514	812	900	587	320	170	132	115	60	74	158	288
	II	849	1149	1107	469	213	151	130	114	61	99	203	648
	III	662	1185	824	393	192	139	122	74	68	141	228	675
2002-03	I	834	1291	1144	805	252	130	88	77	68	70	166	491
	II	968	1401	1144	458	220	112	81	76	65	68	191	728
	III	1103	1288	1193	329	174	95	79	71	64	94	299	828
2003-04	I	1224	1195	1157	649	171	109	100	100	102	78	142	174
	II	1120	1259	984	463	141	100	101	100	112	85	147	297
	III	1122	1332	725	362	130	103	100	89	79	99	175	399
2004-05	I	898	1124	804	544	199	91	72	75	82	95	100	206
	II	857	851	972	636	148	70	70	72	86	88	122	198
	III	668	783	652	240	110	76	69	70	82	103	184	196
2005-06	I	268	1274	1444	997	135	106	95	86	95	87	110	322
	II	430	1505	1115	289	113	96	96	103	92	88	108	647
	III	1548	1428	824	141	106	97	91	87	91	99	139	936
2006-07	I	558	1357	1551	392	148	119	91	72	50	76	163	499
	II	346	1084	1128	402	133	123	89	67	48	77	252	614
	III	726	1397	973	198	108	90	79	35	44	97	336	807
2007-08	I	504	1099	1109	762	153	97	68	58	54	71	80	211
	II	948	952	1099	424	116	84	65	59	53	76	308	465
	III	1280	1151	1036	292	103	77	60	60	60	74	240	499
2008-09	I	732	1237	1220	397	191	102	78	64	60	60	87	187
	II	1417	1091	925	210	147	93	74	59	59	69	108	261
	III	1141	1121	791	196	116	82	69	68	62	72	151	546
2009-10	I	794	946	1303	484	190	96	81	58	49	79	218	427
	II	503	1397	1237	254	150	99	76	61	64	80	175	365
	III	983	1219	795	196	114	88	69	57	70	114	195	590
2010-11	I	690	1243	2333	1217	205	122	75	63	51	62	96	517
	II	582	1580	1913	597	174	97	67	60	37	74	154	720
	III	1169	1930	1216	336	148	87	68	62	52	102	275	862
2011-12	I	904	1255	1301	980	244	103	77	65	56	64	138	392
	II	1211	1245	1065	778	154	93	67	57	55	60	125	283
	III	1566	1482	1012	362	124	81	61	53	72	83	162	451

(33) (6)

भारत सरकार
केन्द्रीय जल आयोग
यंत्रीकरण निदेशालय

कमरा न. 711 (द.), सेवा भवन,
आर.के. पुरम् नई दिल्ली

विषय:- कवार (Kwar) जल विद्युत परियोजना (560 MW), J&K के अनुपालन रिपोर्ट की जॉच (Examination of compliance report)

संदर्भ : 1. के.ज.आ.यू.ओ.सं 3/154/2012-PA(N)/1906 दिनांक 10.09.2013.
2. के.ज.आ.यू.ओ.सं Inst./1-151/2009/110 दिनांक 07.05.13

Reference is invited to the letter cited above vide which project authorities have submitted the compliance on the observations issued vide letter under reference (2) with regard to instrumentation aspects. The same has been examined and following suggestions are made:

1. Out of the three Strong Motion Accelerograph (SMA) provided in dam complex, one SMA may be deployed at suitable location for field monitoring of seismicity. It is suggested that facility for displaying earthquake intensity directly in Richter scale is made available with SMA.
2. Stress/strain meter may be provided at u/s face of dam to monitor silt load effect.
3. An array of Tilt meters at suitable spacing may also be provided along the height of dam at least in those blocks, where direct plumb lines have been provided.
4. It may be ensured that provision of instruments for monitoring deformation, stress etc. around underground rock excavation (tunnels/underground caverns) may be made typically at locations where geologic features such as a fault, shear zone, a highly jointed weathered rock zone or where higher stresses/deformation are likely to be encountered during excavation.
5. Provision for monitoring the observations, data analysis and its availability should be kept.

Keeping in view the above, DPR of Kwar HE Project (560 MW), J&K is cleared with respect to instrumentation aspects, subject to inclusion of compliance of above suggestion in the DPR.

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

24/10/13
(सुनील जैन)
निदेशक

निदेशक, परि० मूल्यांकन (उ०) केंद्रीय जल आयोग नई दिल्ली
यू.ओ संख्या यंत्री/1-151/2009/ 345 दिनांक 24 / 10 / 2013

भारत सरकार
केन्द्रीय जल आयोग
जल विज्ञान (उ) निदेशालय

कमरा नं. 507A(द), सेवा भवन
रा.कृ.पुरम, नई दिल्ली - 66.

विषय : Design Flood studies of KWAR HEP (560 MW) J&K.

संदर्भ : CWC U.O. No. 3/154/2012-PA (N)/2018 dated 19/09/2013.

उपर्युक्त सन्दर्भित पत्र का कृपआ अवलोकन करें जिसमें इस निदेशालय से उपरोक्त परियोजना सम्बंधी रिपोर्ट की टिप्पणी भेजने का अनुरोध किया है । इस सम्बन्ध में इस निदेशालय से टिप्पणी प्रेषित की जा रही है ।

संलग्न : यथावत

(जी.एल.बंसल) 1/11/13
निदेशक

निदेशक, परियोजना मूल्यांकन (उत्तर) निदेशालय, के.ज.आ.

फाइल संख्या: 1/J&K/34/2012/ज.वि.(उ) / 496 दिनांक: 01/11/2013

October, 2013

No.1/J&K/34/2012/Hyd(N)/
Central Water Commission
Hydrology (North) Directorate

Subject:- Design Flood Studies of Kwar HEP (560MW) J&K.

Water availability series of this project had been cleared during August, 2013. The compliance to the observations on design flood studies of Kwar HE Project (560 MW) in J&K received through Director, Project Appraisal (North), CWC vide CWC U.O. No. 3/154/2012-PA (N)/2018 dated 19/09/2013.The studies are examined and following observations are made:

Project Proposal:

The Kwar H.E. Project is proposed as a run of the river type development across river Chenab in Kishtwar district of J&K. Dam shall be located d/s to proposed Kiru HEP and u/s of Dulhasti HEP which is operational for last 10 years. The scheme envisages construction of a 97 m high concrete dam, with a gross storage capacity of 27.167 MCM. The permanent snow line is taken as EL 4500m by the project authority. The total catchment area up to Kwar dam site is 10325 sqkm, out of which 5633 sqkm is snowfed area and remaining 4692 sqkm is rainfed.

Design Flood Studies:

Since the height of the proposed dam is more than 30m, the design flood shall be PMF. The design flood studies for this project has been carried out as followed:

1. Channel routing of the flood hydrograph at Kirthai-I HE Project up to Kwar dam site
2. Flood hydrograph of the intermediate catchment has been added.
3. Resultant flood hydrograph after adding the above two

Channel routing of Kirthai-I flood hydrograph

In the design flood studies of Kirthai-I , 1- day PMP of 181 mm and 2- day PMP of 289 mm was adopted based on Baglihar HE Project and the design flood (PMF) of 9140 cumec for Kirthai- I HEP was approved during October,2012 .

The flood hydrograph of this u/s project Kirthai-I is routed by Muskingham's method up to dam site of Kwar HE Project. The river length is about 34 km, storage constant K is taken as 3.70 and channel storage constant X as 0.2 (varies between 0.15 to 0.25)

Since, the routing parameters are not fulfilling the criteria (K>t>2KX), the flood routing is done twice for K=2.0 & 1.70.

Flood hydrograph for intermediate catchment:

Synthetic Unit Hydrograph for this intervening rainfed catchment area of 770 sqkm has been derived based on the formulae given in CWC FER, Zone-7. Since the base period of UG is less than 24 hrs. 1-day PMP value of 181 mm (as adopted in Baglihar HE Project) is applied. Clock hour correction and temporal distribution has been adopted as per Baglihar Project. Snowmelt temperature as 2°C and base flow (@0.05 cumec per sqkm) are taken as per WMO formula and FER respectively.

Final resultant flood hydrograph at Kwar HEP:

The routed Flood hydrographs of Kirthai-I HEP and that of intermediate catchment are added to get the resultant PMF hydrograph at Kwar dam site. The peak of the hydrograph works out as 10534 cumec. Thus, PMF of 10,534 cumec is recommended for design and planning purposes. PMF hydrograph is enclosed as Annexure-I.

Diversion Flood Studies:

The proposed the construction period of 7.5 month is from 1st October to 15th May. Accordingly, non-monsoon flood peaks for the period from 1975-76 to 2002-03 at Benzwar and from 2003-04 to 2011-12 at Dul site are used in the study. These peaks have been transposed to Kwar dam site by Dicken's formula. These flood peaks are increased by 10% to make them instantaneous peaks. Flood frequency analysis has been performed and 1 in 25 years return period flood worked out as 1021 cumec by Log Pearson Type-III Distribution. Since, the highest observed non monsoon discharge for this period at Benzwar site is 1068 cumec which when transposed to Kwar dam site works out as 1041 cumec. Therefore, a diversion flood of 1041 cumec is recommended for the design and planning purposes.

However, Project authorities are advised to collect the short interval rainfall and discharge data at site for few flood events to update the studies at later stage.

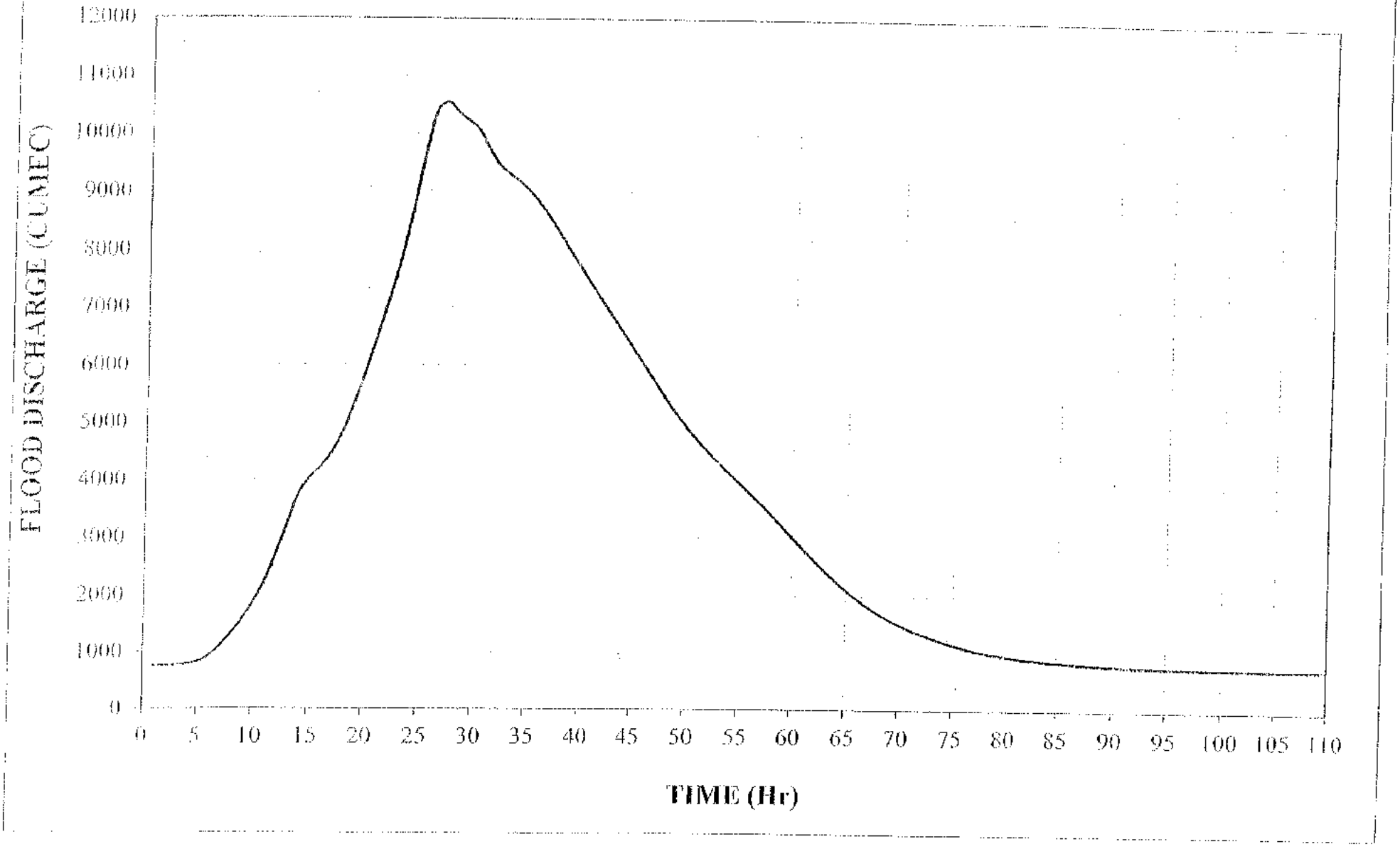
Annexure-I

PMF hydrograph at Kwar HE Project

TIME (in hour)	Total Flood at Kwar HEP (cumec)	TIME (in hour)	Total Flood at Kwar HEP (cumec)
0	758	55	3767
1	759	56	3586
2	765	57	3402
3	780	58	3208
4	819	59	3010
5	906	60	2812
6	1068	61	2619
7	1277	62	2434
8	1527	63	2260
9	1826	64	2101
10	2191	65	1956
11	2664	66	1825
12	3232	67	1708
13	3752	68	1603
14	4039	69	1508
15	4223	70	1423
16	4484	71	1346
17	4858	72	1276
18	5361	73	1212
19	5930	74	1154
20	6529	75	1104
21	7145	76	1059
22	7809	77	1020
23	8532	78	986
24	9504	79	957
25	10389	80	933
26	10534	81	911
27	10347	82	892
28	10203	83	876
29	10091	84	861
30	9993	85	847
31	9908	86	834
32	9771	87	823
33	9130	88	813
34	8944	89	805
35	8712	90	798
36	8447	91	793
37	8164	92	788
38	7879	93	784
39	7596	94	780
40	7317	95	777
41	7044	96	774
42	6774	97	771
43	6502	98	768
44	6225	99	765
45	5945	100	763
46	5665	101	762
47	5394	102	761
48	5130	103	760
49	4867	104	759
50	4611	105	759
51	4375	106	758
52	4259	107	758
53	4112	108	758
54	3940	109	758

Annexure-I

PMF Hydrograph at Kwar HE Project (J&K)



भारत सरकार
केंद्रीय जल आयोग
नींव अभियांत्रिकी एवं विशेष विश्लेषण निदेशालय
712 (द), सेवा भवन, रा. कृ. पुरम, नई दिल्ली - 110066
दूरभाष /फैक्सः 26101017 ई मेल: fesadte-cwc@nic.in
****

Sub: Glacial Lake Outburst Flood (GLOF) studies of Kwar HE Project, J&K -reg.

Ref: Chenab Valley Power Projects Pvt. Ltd. Letter no. CVPP/GM(KK)/Kwar/ Camp-Fbd/496 dated 25.11.2013

This is with reference to the report on GLOF study, in respect of Kwar HE Project, J&K, submitted to CWC for examination.

The report has been examined with respect to methodology, criticality analysis, breach simulation and attenuation pattern of GLOF Hydrograph. The tentative peak discharge estimated at dam site, due to GLOF event, is reported as 620 cumec for an assumed condition that the lake burst and 100 yr flood (5200 cumec) occur simultaneously at the dam site. The report is generally in order within the conditions/criterion, assumptions and limitations of the model parameters adopted in the study.

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

(Dr. B.R.K. Pillai)
Director

Director Hydrology (N), CWC, 507(S), Sewa Bhawan, R.K. Puram, New Delhi
No. 6/11/2009/FE & SA / ५५ dated: 6.2.2014

Copy for kind information to:

Director, PA (N), CWC, 407(S), Sewa Bhawan R.K. Puram, New Delhi-66

भारत सरकार
केंद्रीय विद्युत प्राधिकरण
जल विद्युत परियोजना मूल्यांकन प्रभाग (HPA Division)
सातवाँ तल, सेवा भवन (उ.), आर के पुरम, नई दिल्ली-110066

[आई. एस. ओ : 9001-2008]

-*-*-

विषय : Kwar H.E. Project in Jammu and Kashmir by M/s Chenab Valley Power Projects (Private) Ltd (CVPP) – Examination of DPR/ Power Potential Studies.

Reference may please be made to your letter No. 2/NHPC/57/CEA/07-PAC/4636-48 dated 27.07.2012 forwarding therewith Detailed Project Report of the above project. The revised power potential studies received vide CVPP letter No. CVPP/GM(Design)/2014/577 dated 1.09.2014 after approval of water flow series by CWC and subsequent compliances and discussion with M/s CVPP. Based on discussions M/s CVPP submitted Modified Power Potential studies vide letter dated 8.12.2014 proposing an installed capacity of 540 MW which has been examined in this Division.

As per DPR/ PPS Chapter/ Modified Power Potential Studies, Kwar H.E. Project has been proposed as a run-of-river development with an installed capacity of 540 MW to be located on right bank of river Chenab near Padyarna village in Kishtwar district of Jammu & Kashmir State. It has been proposed to construct a 109 m high (above deepest foundation), 195 m long (at top) Concrete gravity dam to create a reservoir with live storage of 9.16 MCM between FRL (1385 m) & MDDL (1372 m) and having submergence area of 0.8 km^2; u/s & d/s coffer dams (rock fill with central clay core); 1 no. 9.5 m dia. and 685 m long horse shoe shaped diversion tunnel; 4 nos. intakes with gated structure; 4 nos. 5.65 m dia underground circular steel lined pressure shafts/ penstocks with length varying from 108 m to 182 m; an underground power house to accommodate 4 units of 135 MW each and 2 nos. 9.50 m dia horse shoe shaped concrete line TRTs of lengths 2676 m and 2883 m. It is envisaged that the project shall generate 2075.37 MU power in 90% dependable year with 95% machine availability.

The 10-daily water flow series for 37 years (1975-76 to 2011-12) has been approved by CWC vide their letter dated 5.07.2013.

Following parameters/ criteria has been considered for carrying out power potential studies of Kwar HE Project :

10-daily water flow series	:	1975-76 to 2011-12
Hydrological year	:	June to May
90% Dependable year	:	1996-97
Environmental Releases through out year	:	9.5 Cumecs
FRL	:	1385 m
MDDL	:	1372 m
Live Storage	:	9.16 MCM
TWL (Normal)	:	1269.90 m
TWL (Min.)	:	1267.32 m
Head loss	:	7.7 m
Net Head (During Monsoon)	:	94.9 m
Net Head (During Non-Monsoon)	:	103.07 m
Design Discharge (Monsoon)	:	629.66 Cumec
Design Discharge (Non-Monsoon)	:	579.77 Cumec
Type of Turbine	:	Francis
Turbine Efficiency	:	94%
Generator Efficiency	:	98%

TG Efficiency	:	92.12%
Monsoon Period	:	June to September
Lean Season	:	December to March

Plant operation	-	Monsoon season:	As base load station
	-	Lean Season :	As peak load station for average 3.02 hours daily
	-	Non-Monsoon/lean :	As base/ peak load station on full/ partial load for varying period

After examination of above PPS/ inputs, an installed capacity of 540 MW as proposed by M/s CVPP is found to be generally in order considering plant load factor of 45.24% and average peaking duration of 3.02 hours diurnal full load generation during lean season (Dec. to March).

However, the installed capacity and energy benefits would need to be reviewed on account of following :

i). Any change in operating levels (FRL, MDDL, TWL) etc.
ii). Any change in reservoir operational pattern.
iii). Any change in water conductor system losses.
iv). Consequential change in design head.
v). Any change in environmental releases.
vi). Any change in pondage provisions.
vii). Any other aspect which gets derived during the detailed appraisal of DPR.

This issues with the approval of Member (Hydro), CEA.

(पी सी झिलोहा)
निदेशक एवं
ओफिसिएटिंग मुख्य अभियंता (एचपीए)

निदेशक (पी ए सी), के वि प्र

सं0 203/25/2014/एचपीए/ 428 दिनांक : 16 दिसम्बर, 2014

Copy to : 1. Director, Design (N&W), CWC (Room No. 428 (S), Sewa Bhawan, R.K. Puram, New delhi – 110016.

2. General Manager & Nodal Officer, Chenab Valley Power Projects (P) Ltd., 2nd Floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu – 180006 (J&K) (Fax No. 2477924, 2477835)

Copy for information to : Chief Engineer (PAO), CWC (Room No. 510 (S), Sewa Bhawan)

Government of India
Ministry of Power
Central Electricity Authority
System Planning & Project Appraisal Division
Sewa Bhawan, R. K. Puram, New Delhi-110066 [ISO: 9001:2008]
Website: www.cea.nic.in

CVPP/Comp Fbd/
9675/656
19/1/15

No. 9/18/2014-SP&PA/ 17-18 Date: 05.01.2015

Sh. Rajeev Sachdeva
General Manager & Nodal Officer
Chenab Velley Power Projects Pvt. Ltd.
2nd Floor,JKPCC Building
Rail Head Complex, Panama Chowk
Jammu-180012(J&K)

Subject: Submission of Updated Power Potential Studies for 540 MW Installed capacity-approval thereof

Please refer to your letter no. CVPP/GM (HQ)/Kwar/Camp-FBD/2014/650 dated 8th December, 2014 addressed to Chief Engineer (HPA), CEA on the above mentioned subject. You have submitted the revised chapter-9 "Power Plant, Electrical and mechanical equipment" along with the Single Line Diagrams. The same has been examined from power evacuation point of view and our observations / comments on the same are given below:

1. The above DPR envisages construction of 540 MW power plant in Doda District of Jammu & Kashmir on Chenab River. The Power house, housed in an underground cavern, comprises of four units of 135 MW +10% overloading each.

2. The power is proposed to be generated at 13.8 kV and stepped up to 400 kV through 13 nos. (one spare) 55 MVA single phase generator transformers. Power is to be transmitted from these transformers through isolated phase bus ducts to Gas Insulated Switchgear via 400 kV XLPE cables. Outgoing 400 kV feeders from GIS shall be connected to pothead yard located outside the power house through 400 kV XLPE cables for further transfer of power to the grid. The 540 MW Power from Kwar HEP would be fed to the Northern grid.

3. Double Bus switching scheme has been proposed at the 400 kV GIS switchyard. Provision of 4 nos. Generator Transformer bays, 1 no. of Reactor bay, 1 no. Bus Coupler bay and 2 no. 400 kV Line Bays has been made in the generation switchyard. Space provision for one no. additional bay in Pothead yard area and GIS cavern has also been kept.

4. Provision of 3 nos. single phase bus reactors, each of rating 41.67 MVAR, 400 kV, 50 Hz has been made at the 400 kV GIS generating switchyard and is be connected to GIS through XLPE cables.

5. Here, it may be noted that a composite transmission system with 400 kV HTLS conductor has been planned for evacuation of power from Kiru HEP (660 MW), Kwar HEP (540 MW) and Pakal Dul HEP (1000 MW). The system was discussed and agreed by 31st Standing Committee for Power System Planning of Northern Region. For evacuation of power from Kwar HEP, following evacuation system from Kwar HEP has been approved:

LILO of one circuit of Kiru HEP – 765/400 kV Kishtwar Pooling Station 400 kV D/c triple HTLS line (high capacity common corridor-II) from where the power will be further evacuated through Kishtwar-Gurdaspur 765 kV D/c transmission line.

The above stated switchyard provisions as mentioned in the DPR seem to be generally in order.

However, the project developer must ensure that the GIS switchyard and XLPE cable provided must be designed to handle 4000 Amps current

The above transmission plan is a conceptual plan and its updation / revision would be required based on the network topology and firm time schedule of the generation projects of Chenab basin.

6 Since these generating units rating is more than 50 MW, the developer must ensure that these machines are capable of operation in synchronous condenser mode.

7 Provision of mandatory environmental release as well as the details of the cost estimates for the 400 kV GIS switchyard and XLPE cable have not been furnished by the developer. The developer is requested to furnish the details for the same.

8. As per CERC Regulation, the project developer has to approach CTU for Grid Connectivity and seek long term open access (LTOA). Accordingly, transmission system planning for power evacuation from power plant of the project boundary i.e. Pothead Yard shall be taken up by CTU/CEA as per the procedure approved by CERC.

Kindly note that this letter is in super succession to our earlier letter no. 9/18/2014-SP&PA/2440-42 dated 17th December 2014 on the subject .

(Goutam Roy)
Director

Copy to: Chief Engineer (HPA), CEA
Director (PAC), CEA

Government of India
Central Electricity Authority
SP&PA Division
R.K. Puram, New Delhi -110066

[ISO: 9001:2008]

No. 9/18/2015-SP&PA/ 692 - 697

Date: 16.03.2015

Sh Rajeev Sachdeva
General Manager & Nodal Officer
Chenab Valley Power Projects Pvt. Ltd.
2nd Floor, JKPCC Building
Rail Head Complex, Panama Chowk
Jammu-180012(J&K)

Subject: Kwar H.E. Project (J&K) - Examination of Detailed Project Report reg.- Updated E&M Cost Estimate at December 2014 price level for 540 MW IC

Ref: (i). Chenab Valley Power Projects Pvt. Ltd. Letter no. CVPP/GM (HQ)/Kwar/Camp-FBD/24 dated 17th January 2015

(ii). CEA letter no. 9/18/2014-SP&PA/17-18 dated 5th January 15

Please refer to your above mentioned letter addressed to Chief Engineer (HPA), CEA on the subject vide which you have submitted the updated cost estimates for " Substation Equipment and Auxiliary Equipment and services for 400 kV GIS switchyard " i.e. Annexure-S (5) for examination.

In this regard, it is stated that the same has been examined and found to be generally in order.

(Goutam Roy)
Director

Copy to: Chief Engineer (HPA), CEA
Director (PAC), CEA

Annexure S(5)

KWAR HE Project (4 X 135 MW)

Cost estimates of Electro Mechanical Works

(Substation Equipment and Auxiliary Equipment and Service for Switchyard)

DEC - 2014 Price Level

Foreign equipment

S.No.	Item Particulars	Qty	Rate (Lakhs USD)	Amount (Lakhs USD)
1	GIS			
(a)	400 KV GIS	8 Bays	16.50	132.00
(b)	Spares @ 3%			3.96
2	XLPE CABLE			
(a)	400 kV XLPE Cable (400 sq mm Cu conductor) - From Transformer & Bus reactor to GIS	3200 m	200 USD/m	6.40
(b)	400 kV XLPE Cable (1600 sq mm Cu conductor) - From GIS to Pothead Yard	4500 m	430 USD/m	19.35
(c)	Transformer end Terminations	16 Nos.	0.30	4.80
(d)	GIS end Terminations	23 Nos.	0.30	6.90
(e)	Outdoor Type Terminations	7 Nos.	0.40	2.80
(f)	Spares @ 3%			1.21
	TOTAL			177.42

Government of India
Geological Survey of India

No. 514 to 17 / 6C/EPE/GSI/ND/2011 Date: 15-06-2015

From
The Director
LHIM & EPE Division, DGCO
Geological Survey of India
A -II, Pushpa Bhawan, New Delhi -110062

To
The Director (PAC)
Central Electricity Authority
Sewa Bhawan, R K Puram
New Delhi -110066,FAX: 26732395

Sub: DPR of Kwar HEP (560 MW), Jammu & Kashmir
Ref: Letter no..CVPP/GM (HQ)/Kwar/Camp-Fbd/282 dated 18.04. 2015
Sir,

With reference to above letter this is to state that the DPR of 560 MW Kwar Hydroelectric Project, J&K by M/s Chenab Valley Power Projects Pvt. Ltd may be considered cleared subject to the following conditions:

1. As and when completed, the results of the groutability test should be communicated to GSI for appraisal and incorporated in the final DPR.
2. the results of the MEQ studies, etc should be communicated to GSI for appraisal and incorporated in the final DPR.
3. The findings from the exploration/ investigations carried out after submission of DPR should be incorporated in the design with a copy to GSI.
4. As agreed upon, suitable treatment / protective measures may be made in the design for the steeply dipping (80^0) open joints (2-5cm) present beyond the stripping limit i.e. 12.85m on the left abutment and 13.85m on the right abutment.
5. At the present location of underground power house in granite, several intersecting shear zones are present at the crown level of cavern which will create instability leading to loose fall, over breaks, cavity formation, etc. The situation may further aggravate under wet condition. Therefore, as agreed upon, adequate support system / remedial measures like steel rib/ lattice girder beside rock bolts, shotcrete, grouting, may be kept in the design and incorporated in the DPR.
6. As agreed upon, suitable treatment / protective measures may be kept in the design to address likely seepage into underground Powerhouse cavern.
7. The status of monthly progress on balance explorations/investigations should be communicated.

All the suggestions of GSI (furnished as comments) and accepted/agreed upon by M/s Chenab Valley Power Projects Pvt. should be followed and incorporated in the revised/ final DPR.

The clearance may be considered withdrawn if the above conditions are not fulfilled and/or there is any change in any or all components of the proposed project.

Yours faithfully,

15.6.15

(Dr. J S Mehta)
Director

No..... / 6C/EPE/GSI/ND/2011 Date: 15-06-2015

Copy for kind information to:
(1) The Dy.D.G and Head Mission -IV,GSI CHQ, 27 JLN Road, Kolkata-700016
(2) The Dy.D.G. DGCO, GSI, A-II, Pushpa Bhawan, New Delhi- 110062
(3) The General Manager, Chenab Valley Power Projects Pvt. Ltd, 2nd floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu-180012

15.6.15

(Dr. J S Mehta)
Director

महानिदेशक शिविर कार्यालय
भारतीय भूवैज्ञानिक सर्वेक्षण
[illegible]
[illegible]
नई दिल्ली-110062

भारत सरकार
Govt. of India

Director General Camp Office
Geological Survey Of India
EPE & L.H.I.M. Division, A-II,
Pushpa Bhawan, Madangir Rd.
New Delhi-110062

No. [illegible] Dated: [illegible]

सेवा में,
[illegible]
[illegible]
[illegible]
[illegible]
नई दिल्ली – 110062

विषय: Final [illegible] DPR of Kwar HEP 560 MW, J&K.

संदर्भ: Letter No. [illegible]/CE/Design/2016/455, dated 23.06.2016

महोदय,

The conditional clearance to the DPR of Kwar HEP 560 MW project J&K was given vide the letter No. 514-17/ 6C/EPE/GSI/ND/2011, dated 15.06.2016. The clearance was subject to fulfilling of the following main conditions by the Project Developers :-

1. As and when completed, the results of the groutability test should be communicated to GSI for appraisal and incorporated in the final DPR.
2. As agreed upon, suitable treatment / protective measures may be made in the design for the steeply dipping [illegible] open joints (2-5cm) present beyond the stripping limit i.e. 12.85m on the left abutment and 13.65m on the right abutment.
3. At the present location of underground power house in granite, several intersecting shear zones are present at the crown level of cavern which will create instability leading to loose fall, over breaks, cavity formation etc. The situation may further aggravate under wet condition. Therefore, as agreed upon, adequate support system / remedial measures like steel rib/ lattice girder beside rock bolts, shotcrete, grouting, must be kept in the design and incorporated in the DPR.
4. As agreed upon, suitable treatment / protective measures may be kept in the design to address likely seepage into underground Powerhouse cavern.

[illegible] meeting [illegible] project site at [illegible] 2016 it was decided that since the height of the concrete gravity dam is more than 100m, developers will explore the dam site by two additional drifts of length 40m each to be excavated at El. [illegible] on both the abutments along with cross cuts of length [illegible] upstream [illegible] [illegible] the [illegible] and the stripping limits. The developers after complying with the laid down conditions have submitted the results to GSI for appraisal. The examination of the geological logs of [illegible]
[illegible]
[illegible]

conditions encountered. The project authorities were asked to review the stripping limits in the light of the geological data of these adits and drifts excavated at the dam site.

The project authorities have carried out a review of the stripping limit keeping in view the engineering considerations i.e. inclusion of superficial surface spillway and lowering of the crest of entire spillway for sediment management, the stripping limit for the left abutment worked out varies is related from 3 m to 2 m @2m to 2 m @20.98m R.L. the right abutment the stripping limit now proposed is 1.21m to 12.26m. Moreover the provision of consolidation/ curtain grouting of the abutment slopes have been done as per norms/ practice. In addition to this the treatment of foundation in weaker zones/ areas is to be taken care through Shastri's formula. The geological section along dam axis has been updated after incorporating the geological information collected from 3rd level adits.

The project site was visited on 23.09.2010. The dam site and the powerhouse are founded in the hard and compact gneissic granite. The exploration carried out at the project were examined and discussed with the project authorities.

Therefore, as all the stipulated requirement of geological appraisal for the 850 MW Kwar HEP have been fulfilled by the developers. The final clearance is granted with the condition that if there is a change in any components of the proposed project in future, the clearance will be treated as withdrawn.

सलाहेरिया
(अजीत सिंह)
निदेशक

No.NC ...../ 5-6/2010/GSI/NO/2009 Dated: 27.10.2010

प्रतिलिपि सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित:

1. [illegible]
2. [illegible]
3. Chief Engineer, Design & HOD & Nodal Officer, Chenab Valley Power Projects (P) Ltd., 3rd Floor, JKPCC Complex, Rail Head Complex, Parade Chowk, Jammu – 180012 (J&K).

(अजीत सिंह)
निदेशक

भारत सरकार
Govt. of India
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
जल विद्युत परियोजना मूल्यांकन-I प्रभाग
Hydro Project Appraisal –I Division
सेवा भवन, आर.के.पुरम, नई दिल्ली -110066
7th Floor, Sewa Bhawan(E), RK Puram, New Delhi 110066

विषय : कवार (Kwar) जल विद्युत परियोजना (4x135=540मेगावाट), जम्मू

Reference is invited to M/s CVPP letter no. CVPP/CWE/[illegible] dated 16.10.13 forwarding therewith revised chapter on Power potential [illegible] considering the environment releases as suggested in TOR issued by [illegible].

As per revised study the installed capacity of project has been retained at 540 MW [illegible] earlier by CEA letter no. 203/25/2014/HPA-I/28 dated 16.12.14. However [illegible] of the project has been estimated as 1975.54 MU.

Following parameter has been considered for carrying out power potential studies.

10-daily water flow series:	:	1975-76 to 2011-12
90% dependable year	:	1996-97
Environment releases :	:	74.09 cumec during [illegible]
	:	16.79 during non lean & non [illegible]
	:	16.49 during lean season
FRL	:	1385m
MDDL	:	1372m
Live Storage	:	9.16 M Cum
TWL (All units running)	:	1269.90 m
Head loss	:	7.7m
Net Head (during Monsoon)	:	94.9 m
Net Head (during non Monsoon)	:	103.1 m
Type of turbine	:	Francis

c/c

[illegible] Efficiency : [illegible] %

[illegible] Peaking Hours during lean : 2.7 Hours
[illegible]

[illegible] examination of Power Potential Studies, an installed capacity of 540 MW as proposed [illegible] CVPP is found to be generally in order, considering plant load factor of 43.0[illegible] % and [illegible] peaking duration of 2.7 hours during lean season (Dec to March). However, [illegible] installed capacity and energy benefits would need to be review on account of followings.

- [illegible] change in operating levels (FRL, MDDL, TWL etc).
- [illegible] changes in [illegible] operational pattern
- [illegible] changes in [illegible] for system [illegible]
- [illegible] change in design head
- [illegible]
- [illegible]
- [illegible] aspect which get covered during detailed appraisal of DPR.

This issues with the approval of Member(Hydro), CEA.

(श्रवण कुमार)
निदेशक (एचपीए-1)

[illegible] (पी. पी. सी.)

[illegible] 2015/एचपीए-1/ 62-63 दिनांक: [illegible]

[illegible] Batra, Chief Engineer & Nodal Officer, Chenab Valley Power Projects [illegible] Floor, JKPCC building, Rail Head complex, Panama Chowk, Jammu - 180012 [illegible] E-mail: [illegible]@gmail.com

Central Electricity Authority
Hydro Engg. & Technology Development Division
7th Floor, Sewa Bhawan,
R.K. Puram, New Delhi – 110066

ISO:9001-2008

Subject: DPR of Kwar Hydroelectric Project (4X135 MW), J&K- Examination of clarifications and revised E&M Chapter with drawings - reg

Please refer to M/s Chenab Valley Power Projects Pvt. Ltd. letter no. CVPP/CE (HQ)/Kwar/TEA/2015/1258 dated 18.01.2016 enclosing therewith clarifications to our comments sent vide letter No. 10/109/HE&TD/2015/1401-1402 dated 27.11.2015 on the above mentioned subject.

We have examined the clarifications furnished by developer and it is observed that there are no further comments subject to compliance of all our comments/observations and submission of the revised E&M Chapter and drawings incorporating our comments/observations. The developer may be further asked to submit updated BOQ also for our examination.

(पंकज गुप्ता)
निदेशक

मुख्य अभियंता (एच. ई. टी. डी.) 28/1/2016

Chief Engineer (HPA-I), CEA
File No. 10/109/HE&TD/2014-16/ 132 - 139 Dated: 21.01.16

Copy to: 1. Director (PAC), CEA
2. General Manager & Nodal officer, 2nd Floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu-180012(J&K)

Central Electricity Authority
Hydro Engg. & Technology Development Division
7th Floor, Sewa Bhawan,
R.K. Puram, New Delhi – 110066

ISO:9001-2008

Subject: DPR of Kwar Hydroelectric Project (4X135 MW), J&K- Submission of updated BOQ - reg

Please refer M/s Chenab Valley Power Projects Pvt. Ltd. letter no. CVPP/CE (HQ)/Kwar/2016/1385 dated 10.05.2016 enclosing therewith an updated copy of BOQ for our examination. The same has been examined and we have no further comments to offer.

(पंकज गुप्ता)
निदेशक

मुख्य अभियंता (एच. ई. टी. डी.)

24/5/2016

Chief Engineer (HPA-I), CEA
File No. 10/109/HE&TD/2014-16/714-716 Dated: 25.05.16

Copy to: 1. Director (PAC), CEA
2. General Manager & Nodal officer, 2nd Floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu-180012(J&K)

फोन: 011-26105978
फेक्स: 011-26108125

CVPP/Fbd/R-15
11/2/2016

भारत सरकार
Govt. of India
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
जल विद्युत परियोजना मूल्यांकन-I प्रभाग
Hydro Project Appraisal –I Division
सप्तम तल, सेवा भवन, आर.के.पुरम, नई दिल्ली -110066
7th Floor, Sewa Bhawan(N), RK Puram, New Delhi-110066

[ISO: 9001-2008]

विषय : कवार (Kwar) जल विद्युत परियोजना (4x135=540 मेगावाट), जम्मू और कश्मीर

Reference is made to M/s CVPPL letter no. CVPP/GM(HQ)/Kwar/850 dated 26.10.15 forwarding therewith revised cost estimate of construction power arrangement after updating at August, 2015 PL amounting to Rs. 22.97 Crores. The requirement of construction power is estimated as 6.6 MW and it will be arranged from Dulhasti HEP by extending to project site through 33 KV transmission line till the sub-station at Padyarna. The backup power will be arranged through 5 nos. DG sets of 1250 KVA each and 5 nos. DG sets on 100 KVA each.

Discussions were held in CEA and M/s CVPPL on 25.01.2016 submitted the revised cost of construction power arrangement amounting to Rs. 7.14 Crores at August, 2015 PL. The same has been examined and found to be in order. Cost of non works energy during construction period has also been estimated by this division amounting to Rs. 5.11 Crore at August, 2015 PL. The details of cost of construction power works and Non works energy are as under:

- Considering the magnitude of works, peak construction power requirement of 6.6 MW is found to be in order.
- Cost of construction power arrangement may be considered as Rs. 7.14 Crores at August, 2015 PL.
- Cost of non works energy during construction period may be considered as Rs. 5.11 Crores at August, 2015 PL.
- Generation tariff from DG sets comes to Rs. 14.76 / KWh and from Grid comes to Rs. 4.61 / KWh. Considering 80% supply from grid and 20% from DG sets, combined tariff of construction power (weighted average of tariff from DG sets and 33 KV Grid) comes out to Rs. 6.64 / KWh.

9.2.16
(श्रवण कुमार)
निदेशक (एचपीए-I)

निदेशक (पी. ए. सी.)

पत्रसं-दिनांक:203/25/2015/एच.पी.ए.-I/ 84 दिनांक: 9.02.16

Copy to :

1. Director Cost Appraisal (HWF), CWC New Delhi
2. Shri Sandeep Batra, Chief Engineer & Nodal Officer, Chenab Valley Power Projects Pvt. Ltd., 2nd floor, JKPCC building, Rail Head complex, Panama Chowk, Jammu -180012 (J&K). E-mail-: cvpppl@gmail.com

Annexure - A

August 2015 PL

Kwar HE Project (540 MW) - Cost of Construction Power works

S. No.	Description	Unit	Qty	Rate (in Rs Lakhs)	Amount (in Rs Lakhs)
I)	**Capital Cost**				
A)	**Electrification and Construction Power**				
a)	**Substations**				
1	33/11 kV receiving station at Kwar (2x6.3 MVA)	L.S.	1	235.91	235.91
2	33 Kv B.C. Bay (Bus Extension)	No.	3	10.22	30.66
3	11kV/415 V stations at different locations	Nos	20	6.32	126.40
b)	**Distribution systems**				
1	33 kV distribution systems	km	18	Already considered in the cost of Kiru HEP	
2	11 kV distribution systems	km	10	5.50	55.00
3	415 V distribution systems	km	30	4.70	141.00
B)	**R/M of Electrification**				125.00
	Total				**713.97**

Cost of Energy during construction period

S. No.	Description				
A)	**Total Energy required during constructin time**	**Unit**			**Details**
1	Peak requiremnet of constructin power	MW			6.60
2	construction period	Years			4.5
3	Working days in a year	Days			300.00
4	Load factor	%			60.00
5	Diversity Factor	%			40.00
6	Total Estimated Energy consumed during construction period (works + non works)	MU			51.32
B)	**Energy cost**				
	Tariff from DG set	Rs.			14.76
	Tariff from Grid	Rs.			4.61
	Total Energy cost from Grid (80% of total Energy)	Lakhs			1892.74
	Toatl Energy cost from DG sets (20% of Total Energy)	Lakhs			1515.01
	Total Energy charges	Lakhs			3407.75
C	**15% of total energy charges (Estimated cost of Non works Energy)**	**Lakhs**			**511.16**
	Cost of construction Power (Works + Energy)				
D	**Total cost of Construction Power (A+C)**	**Lakhs**			**1225.13**

Kwar HEP

A	**Depreciation :**			
	DG Set Capacity (kVA)			1250
	Rate of DG (per kVA) including Frieght ,Erection & Comm			9000.00
(i)	Cost of Equipment (Rs.)			11250000
(ii)	Life in Hours			30000
(iii)	Life in Years			15
(iv)	No. of Working Shifts			3
(v)	Annual Schedule Production Hours			3000
	Ownership Cost :			
(vi)	(a) Yearly Depreciation with refernece to life in years [0.9			675000.00
(vii)	(b) Yearly Depreciation with refernece to life in hours [0.9			1012500.00
(viii)	Average Yearly Depreciation			843750.00
(ix)	**Hourly Depreciation of Equipment [(viii)/(v)]**			281.25
B	**Repair and Maintenance :**			
(x)	**R&M Charges @120% of cost of Equipment**		120	450.00
C	**POL/ Energy Charges :**			
(xi)	BHP rating of Equipment			NA
(xii)	C1			NA
(xiii)	C2			NA
(xiv)	Diesel Consumption in litre per hour			242.55
(xv)	Cost of One Litre of Diesel			50.68
(xvi)	Cost of hourly fuel consumtion by Equipment [(xiv)*(xv)]			12292.43
(xvii)	Cost of 0.3liter/ hour fuel		265	79.50
(xviii)	**Sundry & Miscellaneous @10% of R&M Cha**		10	**45.00**
(xix)	**POL Charges**			**12416.93**
D	**Labour Charges :**			
		No.	Monthly Rat	Hourly Rate
(xix)	Foreman [No.*Monthly Rate*12/(	0.13	19500	30.42
(xx)	Operator [No.*Monthly Rate*12/I	1	15600	187.20
(xxi)	Mechanic [No.*Monthly Rate*12/	0.17	15600	31.20
(xxiv)	Electrician [No.*Monthly Rate*12/(	0.5	15600	93.60
(xxii)	Helper [No.*Monthly Rate*12/(v)]	1	7800	93.60
(xxiii)	Watchman [No.*Monthly Rate*12/(	0.17	7800	15.60
(xxv)	Supervisor [No.*Monthly Rate*12/(v)]			0.00
(xxvi)	Driver [No.*Monthly Rate*12/(v)]			0.00
(xxvii)	Beldar [No.*Monthly Rate*12/(v)]			0.00
(xxviii)	Direct Charge for Labour [(xix)+(xx)+(xxi)+(xxii)+(xxiii)+(x>			451.62
(xxix)	Indirect Charges @55% for semi skilled/ unsk		55	60.06
(xxx)	Indirect Charges @80% for skilled workers [0.		80	273.94
	Total Labour Charges			**785.62**
E	**Miscellaneous Supplies :**			
	Hourly Use Rate of Equipment			13933.80
	Hourly unit generation(kWh) cosidering P.F as 0.8			1000
	Unit Electricty rate per kWh			**13.93**

Kwar HEP

A	**Depreciation :**			
	DG Set Capacity (kVA)			100
	Rate of DG (per kVA) including Frieght ,Erection & Commi			7500.00
(i)	Cost of Equipment (Rs.)			750000
(ii)	Life in Hours			30000
(iii)	Life in Years			15
(iv)	No. of Working Shifts			3
(v)	Annual Schedule Production Hours			3000
	Ownership Cost :			
(vi)	(a) Yearly Depreciation with refernece to life in years [0.9			45000.00
(vii)	(b) Yearly Depreciation with refernece to life in hours [0.9			67500.00
(viii)	Average Yearly Depreciation			56250.00
(ix)	**Hourly Depreciation of Equipment [(viii)/(v)]**			**18.75**
B	**Repair and Maintenance :**			
(x)	**R&M Charges @120% of cost of Equipment**		**120**	**30.00**
C	**POL/ Energy Charges :**			
(xi)	BHP rating of Equipment			NA
(xii)	C1			NA
(xiii)	C2			NA
(xiv)	Diesel Consumption in litre per hour			26.24
(xv)	Cost of One Litre of Diesel			50.68
(xvi)	Cost of hourly fuel consumtion by Equipment [(xiv)*(xv)]			1329.84
(xvii)	Cost of 0.3liter/ hour fuel		265	79.50
(xviii)	**Sundry & Miscellaneous @10% of R&M Cha**		**10**	**3.00**
(xix)	**POL Charges**			**1412.34**
D	**Labour Charges :**			
		No.	Monthly Rat	Hourly Rate
(xix)	Foreman [No.*Monthly Rate*12/(	0.13	19500	30.42
(xx)	Operator [No.*Monthly Rate*12/I	1	15600	187.20
(xxi)	Mechanic [No.*Monthly Rate*12/	0.25	15600	46.80
(xxiv)	Electrician [No.*Monthly Rate*12/(	0.25	0	0.00
(xxii)	Helper [No.*Monthly Rate*12/(v)]	0.25	7800	23.40
(xxiii)	Watchman [No.*Monthly Rate*12/(	0.25	7800	23.40
(xxv)	Supervisor [No.*Monthly Rate*12/(v)]			0.00
(xxvi)	Driver [No.*Monthly Rate*12/(v)]			0.00
(xxvii)	Beldar [No.*Monthly Rate*12/(v)]			0.00
(xxviii)	Direct Charge for Labour [(xix)+(xx)+(xxi)+(xxii)+(xxiii)+(xx			311.22
(xxix)	Indirect Charges @55% for semi skilled/ unsk		55	25.74
(xxx)	Indirect Charges @80% for skilled workers [0.		80	211.54
	Total Labour Charges			**548.50**
E	**Miscellaneous Supplies :**			
	Hourly Use Rate of Equipment			2009.59
	Hourly unit generation(kWh) cosidering P.F as 0.8			80
	Unit Electricty rate per kWh			**25.12**

Weightage average tariff calculation

Tariff of 1250 KVA DG Set in Rs. =	13.93
Tariff of 100 KVA DG Set in Rs. =	25.12
Weightage average tariff of DG sets in Rs. =	14.76
Tariff from Grid supply in Rs. =	4.61
Weightage average tariff (with 80% grid power) in Rs.	6.64

CVPP/fbd/R-16
11/2/2016

49

Government of India
Central Electricity Authority
Hydro Project Planning & Investigation Division

(IS/ISO : 9001-2008)

710 (N), Sewa Bhawan,
R.K. Puram, New Delhi – 110066.
Telefax : 011-26195022
E-Mail: sharadaprasad1960@yahoo.com

Sub: Kwar HEP (540 MW) in J&K by M/s. Chenab Valley Power Projects (P) Ltd.

Reference is invited to HPP&I letter No. 7/16/HPP&I (I)/45-46 dated 04.02.2016 on the above mentioned subject, wherein it is mentioned that the pondage of 9.46 MCM has been proposed by the M/s CVPPPL between FRL 1385 m and MDDL 1372 m.

It is requested that, pondage of 9.46 MCM may please be corrected and read as **9.16 MCM**.

Yours sincerely,

Sharada
10/2/16

(Sharada Prasad)
Director (HPP&I)

Director, PAC (CEA).

No.: 7/16/HPP&I (I)/ 52 to 53 Dated: 10 Feb., 2016.

Copy to:

1. Chief Engineer (C), 2nd floor, JKPCC building, Rail Head Complex, Panama Chowk, Jammu-180012 **Fax- 0191-2479835**.

भारत सरकार
केंद्रीय जल आयोग
मृदा यांत्रिकी एवं विशेष डिजाइन निदेशालय
सेवा भवन (दू), आर के पुरम, न. दि. 110066
दूरभाष/फैक्स: 26101017 ; ई-मेल fesadte-cwc@nic.in

****

Sub: **Detailed Project Report (DPR) of Kwar Hydro Electric Project (560 MW), Jammu & Kashmir - Technical Examination regarding.**

Ref: Project Authorities letter nos (i) CVPP/GM (HQ)/KWAR/153 dated 07.08.2015
(ii) CVPP/GM (HQ)/KWAR/776 dated 07.10.2015
(iii) CVPP/CE(HQ)/KWAR/TEA/2016/86 dated 05.02.2016

The Detailed Project Report (DPR) of Kwar Hydro Electric Project, Jammu & Kashmir was submitted for technical examination. The DPR was examined and observations were issued vide this Directorate's letter no. 11/44/TE/2012/FE&SA/43-45 dated 28.01.2015. The project authorities, vide above referred letters, have submitted the compliance of this Directorate's observations.

This Directorate has no objection to the clearance of Kwar Hydro Electric Project, Jammu & Kashmir with respect to geological investigations related to foundation engineering and seismic aspects only, subject to fulfillment of the following conditions:

1. All the remaining/suggested investigations agreed upon shall be completed before finalizing the construction drawings and taking up construction activities, and results shall be considered for design/construction purposes.

2. The seismic design parameters approved by the National Committee on Seismic Design Parameters (NCSDP) shall be used for design purposes.

The compliance of above may be ensured before taking up detailed design/construction and shall also be intimated to this office. The clearance will be considered withdrawn if above conditions are not fulfilled

This issues with the approval of Chief Engineer (DSO).

(O. P. Gupta)
Director

Director P.A. (N), 4O7(S), CWC, Sewa Bhawan, R.K. Puram, New Delhi
CWC I.D. No. 11/44/TE/2012/FE&SA/ dated

Copy to:

1. Director, P&C Directorate, Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi-66

2. Sh. Sandeep Batra, Chief Engineer (HQ) & Nodal Officer, Chenab Valley Power Projects Pvt. Ltd (CVPPL 2nd Floor, JKPCC Building, Rail head Complex, Panama Chowk, Jammu-180012, (J&K) for compliance please

CVPP/Fbd/R-173
17-10-2016

Speed Post

भारत सरकार Government of India
केंद्रीय जल आयोग Central Water Commission
नींव अभियांत्रिकी एवं विशेष विश्लेषण निदेशालय F. E. & S. A. Directorate
आठवीं मंजिल (उ),. सेवा भवन् रा कृ पुरम् नई दिल्ली 110066
8th Floor (N), Sewa Bhawan, R.K. Puram, New Delhi-110066
दूरभाष /फैक्स Tel/Fax: 26101017 ई मेल /e-mail: fesadte-cwc@nic.in

*****

No. 2/2/2015 (Vol-I)/FE&SA/ 494 Dated: 07.10.2016

To,

Sh. Sandeep Batra,
Chief Engineer (HQ) & Nodal officer,
Chenab Valley Power Projects Pvt. Ltd,
2nd Floor, JKPCC Building, Rail Head Complex,
Panama Chowk, Jammu-180012 (J&K),
Email: sandeepbatra1967@gmail.com

Sub: Site Specific Design Earthquake Parameters for Kwar Hydro Electric Project, Jammu & Kashmir- reg.

Ref: Your office letter no. CVPP/CE (HQ)/Kwar/2016/53 dated 28.01.2016.

Sir,

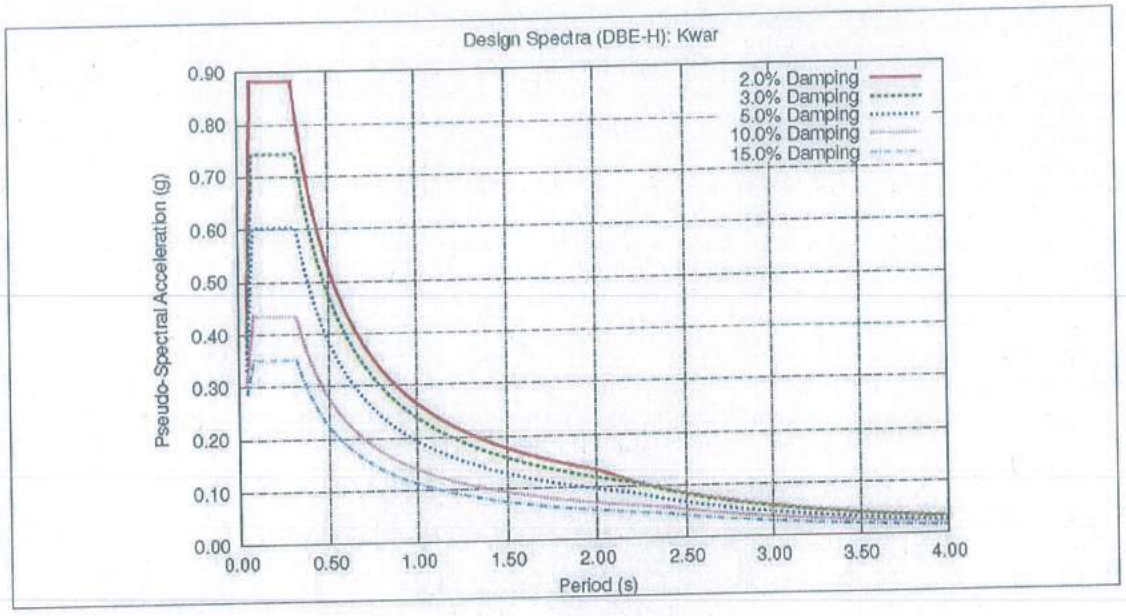
This is with reference to your aforesaid letter vide which the site specific seismic study report of the Kwar Hydro Electric Project, Jammu & Kashmir was submitted to the National Committee on Seismic Design Parameters (NCSDP).

The NCSDP has approved the aforesaid study report in its 31st meeting held on 23rd June, 2016, incorporating the revised seismic design parameters as submitted by IIT Roorkee (consultant).

Contd.....

The seismic design parameters of Kwar Hydro Electric Project, Jammu & Kashmir summarized in the Minutes of the NCSDP meeting are reproduced below:

(a) Response Spectra



(b) Other seismic parameters

Max. Credible Earthquake Magnitude	8	Horizontal distance to surface projection of fault (R_{JB}) (km)	5	Focal depth (km)	15
Horizontal seismic co-efficient (α_h)	0.16	Vertical seismic co-efficient (α_v)	0.11		
Strong motion duration (second)	8	Total duration (second)	42		
Report Reference	IIT Roorkee Report (EQ: 2015-12 (M); Project No. 6027/2014-15 (August-2015)]				

It is requested to do the needful for the safe design of Kwar HE Project components as per NCSDP's approval.

The above said approval of NCSDP is subject to submission of revised/updated MEQ studies report incorporating the compliance to the observations of the Committee by the project authorities by June, 2017, failing which the approval may be withdrawn. The observations made by the Committee on submitted MEQ study report is given as ***Annexure-I*** for needful compliance.

Yours faithfully,

Encl: As above

07/10/2016

(O P Gupta)
Director (FE&SA)&
Member-Secy (NCSDP)

Annexure-I

The observations made by the Committee in respect of submitted MEQ studies:

1 The array used for acquiring the MEQ data from the three projects is not well designed. All the stations are on southern side of Pakal Dul with only one station on the dam site itself. Similarly, the stations are falling on the SW of the projects Kiru and Kwar. The array may not cover spatially the MEQs occurring in the vicinity of these dam sites from the point of view of estimating the depths.

2 The objective of the study as given in the report are not falling in line with the objectives with which these studies are supposed to be carried out.

3 The seismicity as reported by IMD is shown to have magnitude ranges 1-2, 2-3, 3-4, 4-5 and 5-6, however, the Table is not representing the statement made in the text. There are no earthquakes less than 3 (which are called as microearthquakes) reported in the table 2 of the report which also is not required in such reports.

4 Please attach the Sushil, (2016) unpublished report as annexure to this report.

5 No justification has been given as to why only 13 earthquakes are located as given in Table 6, 14 are located as given in Table 7 while 178 events are reported to be recorded by the array.

6 No micro-earthquakes have been reported in this report in such a seismically active region

7 The report is badly written without understanding of objectives with which these micro-earthquake networks are to be deployed around HE projects for six months.

8 Fig 31, 32 and 33 are not relevant and serves no purpose.

9 The discussion and conclusions section says that total 13 earthquakes have been recorded during the six months period in the 50 km radius from the centre of Kiru, Kwar and Pakal dul project sites. These are not micro-earthquakes.

10 It is not given in the report that the computation of the magnitude and location of the events have been done using the software SEISAN, it could be elaborated a little more by giving the formulae used.

11 Since the study is on micro-earthquakes the events with magnitude greater than or equal to 1.0 need to be mentioned in Table 9.

General Point for new study.

Annexure-I

The Common observations made by the Committee in respect of MEQ studies:

- Proper references shall be made for historical earthquake data corresponds to the period before introduction of seismological instrumentation in the country (if indicated).
- Information on error bars in respect of epicentral parameters and focal depth; and distance between the earthquake epicenter and proposed dam site should also be indicated in the report.
- All the Phase data including the regional observatories considered for determining the hypocentral parameters of the micro earthquakes within a radius of 50km from the proposed dam site should be included in the Report.
- The data should be collected with objective to locate the events with good accuracy so that it may helpful in estimating the geometry of the seismogenic feature and the topography.
- Rock type of MEQ stations should be given in the report.
- Error in time and location considered in the study along with event locations should be listed.
- The seismic stations distribution should support the precise locations of local earthquake occurring nearby dam site.
- Peterson's curve showing the noise level of all seismic stations should also be included in the report.

Central Electricity Authority
(Legal Division)
*****

Subject : Kwar Hydro-Electric Project (4x140=560 MW) in J&K by M/s. Chenab Valley Power Projects (Pvt.) Limited.– Regarding.

Reference is invited to CVPPL/s letter no. CVPP/ CE (HQ)/ Kwar/ 2016/ 1283 date4d 15.02.2016 regarding review of Kirthai Hydro-Electric Project Stage-II (990 MW) in J&K by M/s. J&K State Power Development Corp. Ltd. The developer is requested to submit clearance from Ministry of Social Justice and Ministry of Home Affairs.

These may be considered as a condition for the accord of apraisal.

(Sandesh Kr. Sharma)
Chief Engineer (Legal)

1013-PAC
10-10-2016

Director (PAC), CEA
F.No. CEA/ 12/ 106/ 2012-Legal/ 1253 Dated the 10th October, 2016

Pls forward to CVPP
Amit Cehlot
13/10/16
DD-II / DDII
13/10. SSPT
May pls put up Finding

भारत सरकार
जल संसाधन मंत्रालय
केन्द्रीय मृदा एवं सामग्री अनुसंधानशाला

ऊलौफ पालमे मार्ग
हौजखास नई दिल्ली-16
दिनांक: 19/10/16

सं.:- यू0ओ0सं0 29/36/कवर/आर.एम.-I/सी.एस.एम.आर.एस./2012/675

सेवा में,
निदेशक (एच.पी.ए.-I)
केन्द्रीय विद्युत प्राधिकरण
एच.पी.ए.-I प्रभाग
सप्तम तल
सेवा भवन
आर. के. पुरम
नई दिल्ली-66

विषय: कवर जल विद्युत परियोजना, (660MW) जम्मू & कश्मीर की डी.पी.आर रिपोर्ट की मूल्यांकन स्थिति- संबंधी

संदर्भ: CEA letter No 203/1/200/HPA-I/457 dated 06.10.2016.

महोदय,

उपरोक्त विषय के संदर्भ में संलग्न पत्र आपको सूचनार्थ/आवश्यक कार्यवाही हेतु प्रेषित है ।

संलग्न: यथोक्त

17/10/16
(हसन अब्दुल्लाह)
निदेशक
केन्द्रीय मृदा एवं सामग्री अनुसंधानशाला

Government of India
Ministry of Water Resources, River Development and Ganga Rejuvenation
Central Soil & Materials Research Station

Olof Palme Marg, HauzKhas
New Delhi 110016
Fax No. 011-26853108
Phone: 011-26967985, 26961894

Subject: Appraisal status of DPR of Kwar Hydro Electric Project (560 MW), J&K

Reference: CEA letter No 203/1/200/HPA-I/457 dated 06.10.2016.

The Kwar Hydroelectric Project (560 MW) is proposed on River Chenab in Doda District of Jammu & Kashmir. The project envisages construction of concrete gravity dam, orifice type spillway and other appurtenant structures. M/s Chenab Valley Power Projects Pvt. Ltd. has prepared Detailed Project Report (DPR) for the proposed project.

CSMRS has already advised on concrete making materials, rock, soil and rock fill materials to project authorities through the following letters:

1. U.O.No.: 29/36/ Kwar /RM-I/ CSMRS/2013/67, Dated: 18/01 /2013 (Annexure-I)
2. U.O.No.: 29/36/ Kwar /RM-I/ CSMRS/2013/110, Dated: 06 /02/2014 (Annexure-II)

In view of the urgency, the DPR is cleared with condition that all the pending investigation shall be carried out not later than design/ pre-construction stage and the same should be submitted for review. The progress of all the pending investigation must be reported periodically.

Encl: As above

(Hasan Abdullah)
Director

Director (HPA-I), CEA, Sewa Bhawan, R.K. Puram, New Delhi-66

U.O.No.: 29/36/ Kwar /RM-I/ CSMRS/2013/ Dated: /10 /2016

Annexure - I

Government of India
Ministry of Water Resources
Central Soil & Materials Research Station

Olof Palme Marg, HauzKhas
New Delhi 110016
Fax No. 011-26853108
Phone011-26967985, 26961894

Subject: Observations on DPR Kwar Hydro Electric Project (560 MW),J&K

Reference: CWC U.O letter No 3/154/2012/PA(N)/1250-60 dated 21.08.2012.

The Kwar Hydroelectric Project (560 MW) is proposed on River Chenab in Doda District of Jammu & Kashmir. The project envisages construction of concrete gravity dam, orifice type spillway and other appurtenant structures.M/s Chenab Valley Power Projects Pvt Ltd has prepared Detailed Project Report (DPR) for the proposed project.

Rock :

1. GEOLOGICAL IDENTIFICATIONS OF ROCK TYPE ENCOUNTERED

Dam Area as per drill hole log of right bank: Granite/Gneissose Granite/Granite Gneiss, Fine grained light gray colored weak to moderately strong phyllite, medium strong to strong quartzite phyllite

Power House Area: White colored fine to medium grained, moderately strong & fresh quartzite, Granite/Gneissose Granite/Granite Gneiss, medium strong to strong quartzite phyllite bands

2. INVESTIGATIONS CARRIED OUT

Following rock mechanics laboratory tests has been carried out on representative samples of drill holes of Dam Area and Power House Area of Granite and phyllite rock, by ATES Delhi and CIMFR Dhanbad.

- Uniaxial Compressive strength (crushing strength)
- Determination of Grain density, water absorption and Bulk density
- Elastic parameters modulus of elasticity and Poisson's ratio
- Slake Durability Index
- Triaxial Strength Test

Detail reports of this are placed in annexure –IV &V of volume IV (A) of DPR.

- In-situ shear tests Concrete over Rock and rock over rock have been carried out by **M/S ATES, Delhi** in left (DL-1) and right Bank (DR-2) dam Site drift for determination of c and φ parameters of concrete to rock and rock over rock interface and detailed report are appended in annexure – VI of volume IV (A) of DPR
- In-situ test for modulus of deformation (Dilatometer Test 80 bar) have been carried out in the NX size drill hole at six suitable depths of right bank (DR-2) and left bank (DL-1) site drifts along dam axis to determine the design parameters like modulus of deformation, by **M/S ATES, Delhi** and detailed report are appended in annexure – VI of volume IV (A) of DPR
- Insitu stress measurement by hydraulic fracturing have been carried out inside three different orthogonal EX size drill hole at three different depths of old and new power house site drifts to determine the design parameters like insitu stress magnitude &

directions, by **M/S ATES, Delhi** and detailed report are appended in annexure – VI of volume IV (A) of DPR.

However, 13 nos. drill holes were probed at the locations of dam and power house area, for delineating the bed rock configurations and its quality. The brief summary of drill holes is given in Table 4.1.1.3 and 4.3.1.3 of DPR in volume-IV. The details of geological logs are appended in volume-IV of DPR. Above sub surface geological investigations indicated that the thickness of overburden materials, comprising sand, pebbles, cobbles and large boulders, overlying the bed rock may be of the order of 0.0 m – 26.0 m.. However, Geophysical investigations involving seismic refraction profiling was conducted for delineating the bed rock configurations and its quality in the proposed diversion tunnel outlet area in the left bank and at the right bank hill slope hosting the proposed powerhouse, besides, electrical resistivity sounding was also carried out in the proposed diversion tunnel area to determine the subsurface status regarding the groundwater condition, by **NHPC** and detailed report are appended in annexure – III of volume IV (A) of DPR. Further, MASW carried out at dam area for evaluating site specific earthquake design parameters for the project by **NHPC and** detailed report are appended in annexure – III of volume IV (A) of DPR.

3. ADDITIONAL SUGGESTIONS/INVESTIGATIONS SUGGESTED:

A. Laboratory investigations

Following rock mechanics laboratory tests on representative samples of drill holes of Dam Area and Power House Area of Granite and phyllite rock should be done before detail engineering design/construction stage

1. Tensile Strength test
2. P & S Wave Velocity, dynamic modulus etc.

Following rock mechanics laboratory tests on representative samples of drill holes of Dam Area and Power House Area of quartzite rock should be done before detail engineering design/construction stage.

1. Uniaxial Compressive strength (crushing strength)
2. Triaxial Strength Test
3. Determination of Porosity, Grain density, water absorption and Bulk density
4. Dynamic modulus
5. Deformation modulus and Poisson's ratio
6. Slake Durability Index
7. Indirect Tensile Strength (Brazilian)
8. P & S Wave Velocity etc.

B. Field investigations

Following insitu Tests should be done before detail engineering design/construction stage.

- Deformability of rock mass using plate load test/ Goodman jack in NX size drill holes should be carried out in powerhouse area.
- In-situ plate load tests for deformability of rock mass, .should be carried out nearest to foundation of dam site.
- Instrumentation programme should also be planned/made for monitoring of surface and underground structures.

Actual number, type, and location of tests should be decided in consultation with the designers, geologist and rock mechanics expert.

<u>Soil</u>

- It is proposed to have coffer dams during construction stage at upstream and downstream side of the main dam. The coffer dam consists of rockfill with central clay core. Top of the upstream coffer dam/ downstream coffer dam is at EL. of 1315

m and 1292 m and respective length is 115 m and 350m respectively. Two drill holes one in upstream coffer dam one in d/s coffer have been drilled and overburden of 10.95 m and 13.5 has been found. The permeability values of overburden of upstream coffer dam vary from $3.2X10^{-3}$ cm/sec to $3.7X10^{-3}$ cm/sec indicating that overburden is pervious.

- No investigation has been carried out for availability and suitability of material required for construction of coffer dams.
- Permeability values of overburden of upstream coffer dam vary from $3.2X10^{-3}$ cm/sec to $3.7X10^{-3}$ cm/sec indicating that overburden is pervious, therefore necessary precaution regarding seepage control may be taken up during construction.

Rockfill

1. From the DPR, it is observed that the required quantity of rockfill material (4.64 lakh cum) for the construction of U/s and D/s coffer dams of Kwar H.E.Project can be extracted from the quarries of KWR-1, KWR-2, KWR-3 and KWR-4.
2. It is mentioned in the DPR that the index properties viz. specific gravity, water absorption, impact value, crushing value, los-angeles abrasion value, soundness loss, flakiness index, elongation index and alkali aggregate reactivity potential of the fresh rock aggregates collected from the different drifts were got evaluated from the laboratories of DulHasti HE Project and NCCBM. Aggregate collected for evaluating above index properties is of mostly uniform size which is useful for concrete. However, the gradation of rockfill material varies from 0.475 mm to 1000 mm approximately. Therefore, both concrete (formed using aggregate) and rockfill material behaves differently under different loading conditions. No tests have been carried out on rockfill material for studying its behaviour under different field conditions.
3. Therefore, it is suggested to carry out the detail field and laboratory investigations of rockfill material to study and understand the stress-strain-volume change behaviour, evaluation of shear strength parameters and deformability & permeability characteristics of rockfill materials which are very important for the safe and economical design of rockfill structures.
4. For carrying out the above studies following field and laboratory tests have to be conducted on rockfill material.
    - Field grain size distribution test to evaluate an average prototype grain size distribution curve
    - Relative density test for determining the minimum and maximum densities
    - Large size triaxial shear test to study the stress-strain-volume change behaviour and evaluate the shear strength parameters i.e. angle of internal friction, Ø and cohesion, c
    - One dimensional compression test to determine deformability and permeability characteristics

Concrete

The requirement of coarse aggregate was estimated around 15.40 Lakh cum and fine aggregate around 7.7 Lakh cum. The total requirement after considering losses as per CWC guidelines works out to be 31.87 Lakh cum (i.e 1.38*23.1). To meet the requirement the project authorities have identified three Rock quarry (KWR-1, KWR-2& KWR-3) and excavated material from dam and power house (KWR-4). Project authorities have reported

total available quantity from all the quarries including excavated materials around 37.0 Lakh cum.

Coarse Aggregate:

Three samples each from all the three rock quarries and excavated materials were tested for its suitability and test results of all the representative samples are found to be suitable for wearing and non-wearing surfaces as per IS 383 -1970 (Reaffirmed,2002). The pertrography analysis results of all the samples indicating higher percentage of strain quartz and higher undulatory extinction angle. The mortar bar expansion as per ASTM C1260 test results of these samples also confirmed the presence of reactive minerals and all the samples showing potentially deleterious expansion. The project authorities have also reported the mortar bar expansion test results of 30 days for all the samples and are awaiting for the detailed test results. Hence, the project authorities are advised to send the detailed results of mortar bar expansion test for review at this stage.

Fine Aggregate:

The project authorities have proposed to use crushed sand from the rock-quarries and excavated material identified for coarse aggregate for this project. Comment will be offered after receiving the detailed test results of alkali silica reaction

Cement

Cement to be used shall be tested from time to time as per the relevant standards and test results should be checked for its conformity with relevant standards and manufacturers test report.

Supplementary cementitious material

In view of durability considerations of concrete, possibilities of using cement blended with supplementary cementitious materials such as fly ash, blast furnace slag etc, must be explored. These materials should also be tested before using in the project as per the relevant standards.

Water

Project authorities have tested one water sample from Chenab River and reported few parameters only. Hence the project authorities are advised to test the water sample seasonally and check for its conformity with the specification requirements given in IS: 456 before its use in the project.

Reinforcement:

The structural steel, reinforcing steel and high tensile steel which are to be used for different components of the proposed structure should be tested as per the relevant standards and checked for its conformity with relevant standards and manufacturer test certificate before use.

Murari Ratn

O/C 16/1/13 (MurariRatnam)
Director

Director, PA(M), Dte, CWC, SewaBhawn, R.K. Puram, New Delhi

U.O.No.: 29/36/ Kwar /RM-I/ CSMRS/2013/ 67 Dated: 18/01/2013

जारी किया
ISSUED
18/1/13

Tel: 011-26104203

CENTRAL WATER COMMISSION
Hydel Civil Designs (N&W) Directorate
******

8th Floor, Sewa Bhawan
R.K. Puram, New Delhi.

Sub: Kwar HE Project (4x135=540MW), J&K - Technical Examination of DPR –reg.

Ref:
i) CEA letter No. 2/NHPC/57/07-PAC/105-17 dated 29/05/2014
ii) CWC U.O No. 8/19/ 2012/HCD-N&W/1234-36 dated 10/10/2014.
iii) CVPP/GM(HQ)/Kwar/Camp-Fbd/594 dated 15/11/2014.
iv) CEA Lr. No.203/25/2014/HPA/426 dated 16/12/2014.
v) CVPP/CE(HQ)/Kwar/Camp-Fbd/432 dated 16/06/2015.
vi) CVPP/CE(HQ)/Kwar/1483 dated 30/08/2016.
vii) CWC U.O No. 8/19/ 2012/HCD-N&W/1297-1300 dated 09/09/2016.
viii) CVPP/CE(HQ)/Kwar/Camp-Fbd/401 dated 13/10/2016.

The DPR of Kwar HE Project (4x135=540MW - *revised*), J&K, was accepted by CEA for detailed examination in its review meeting held on 13.05.2014 based on the updated layout submitted by the Project Authorities vide their letter dated 01/01/2013 and the communication in this regard was received vide letter under reference (i). The DPR was examined and the comments pertaining to HCD components issued vide letter under reference (ii). The compliance in this regard was submitted by the Project Authority vide their letter under reference (iii). As per this letter, it was indicated that the mathematical model studies for sediment management / spillway configuration would be carried out by the Project Authority based on the spillway arrangement approved by CMDD (N&W),CWC. Accordingly, the numerical model studies have been carried out in CWPRS and the *Report on 2D Numerical Model Studies for Reservoir Sedimentation of Kwar HEP (J&K)* was submitted vide letter under reference (vi). The report was examined and the observations communicated vide letter under reference (vii). The compliance in this regard along with the revised numerical model studies have been submitted by the Project authority vide their letter under reference (viii).

The Power Potential Studies have been revised by CEA vide letter under reference (iv) and the installed capacity reduced from 560MW to 540MW.

The GSI clearance for the project has been issued vide letter under reference (v).

The DPR along with subsequent replies and submissions have been examined in detail and found to be generally in order subject to the following:

1) The design calculations shown in DPR and compliance submitted vide letter under reference (iii) are based on the earlier installed capacity of 560MW and corresponding rated head and discharge. This needs to be modified considering the revised Power Potential Studies and installed capacity of 540 MW approved by CEA, vide letter under reference (iv). The revised calculations & drawings shall be incorporated in the DPR prior to TEC.

2) The balance geological investigations as suggested by GSI (reference (v)) shall be completed. If some changes are found on the basis of the investigations, the same may be reported to this office and if need be the relevant design and drawings shall be modified on the basis of geological investigations.

3) As indicated by GSI (reference- v), due to the presence of several intersecting shear zones in the underground power house location, provision for additional support system like steel ribs, lattice girder etc. shall be made during detailed design stage.

4) The protective / preventive measures provided in the DPR for likely seepage in to the underground power house due to its close proximity to the dam, shall be reviewed based on the actual parameters, during detailed design stage.

5) Hydraulic model studies (physical) for the power intake shall be carried out for firming up intake profile and sediment deposition pattern in front of Power intake and reservoir as a whole, during detailed design stage.

6) There is no desilting basin in the water conductor system and the sediment management is proposed to be achieved by reservoir operation keeping in view the restriction on drawdown flushing as per IWT. Hence, various measures indicated for mitigation of erosion of underwater turbine parts as per reference (viii) needs to be adopted during the operation of the project.

7) Hydraulic transient analysis for the complete water conductor system shall be carried out during detailed design stage by adopting the actual machine parameters and load rejection / load acceptance criteria as specified by CEA. Design modifications, if any, shall be done accordingly.

8) Two/ three dimensional numerical model studies may be carried out for the underground Power House complex incorporating all the major interconnecting tunnels/adits during detailed design stage to study the stress and deformation pattern around the caverns, interaction between the caverns etc. so as to optimize the rock pillar width/depth proposed between various openings, cavern alignment and the rock support system provided in the DPR.

9) The Project Authority shall include all the comments and modifications suggested by this directorate in the concerned chapters/ drawings and accordingly it may be reflected in the BoQ and Cost estimate in the updated DPR.

IDF-I PAC 20-10-2016

This issues with the approval of Chief Engineer- Designs (N&W), CWC.

19/10/16

(T.K SIVARAJAN)
DIRECTOR

Director, PA (N), CWC, Sewa Bhawan, R K Puram, New Delhi
CWC U. O. No. 8 / 19 / 2012/ HCD–N&W/ 1350 dated: 19 /10/2016

Copy for kind information to:

i) Director (PAC) CEA, New Delhi.
ii) Director (HP&I) CEA 7th floor, Sewa Bhawan, New Delhi
iii) Director CMDD (N&W), CWC, New Delhi
iv) General Manager & Nodal Officer, CVPPL, 2nd Floor, JKPCC Building Rail Head Complex, Panama Chowk, Jammu-180012 (J&K) E mail: sachdevarajeev@gmail.com

P/s forward to HPA-I
20/10/16
DD-I/II

दूरभाष - 011-26102960

ईमेल आई.डी.:cmddnw@nic.in

भारत सरकार
Government of India
केन्द्रीय जल आयोग
Central Water Commission
कंक्रीट एवं चिनाई बांध अभिकल्प(उ. एवं प.) निदेशालय
C.M.D.D (North & West) Directorate, 8th Floor (S)
आठवाँ तल(द.),सेवा भवन, रामा कृष्णा पुरम, नई दिल्ली -110066

Sub: Technical Examination of DPR of Kwar Hydro Electric Project (Jammu & Kashmir) – Reg.

Ref: (i) Letter No. CVPP/CE(HQ)/Kwar/1528 dated 05.10.2016

(ii) Letter No. CVPP/CE(HQ)/Kwar/1524 dated 03.10.2016

(iii) CWC U.O No. 3/185/2012-CMDD(N&W)/544-48 dated 15.09.2016

Please refer to the letter under reference (i) and (ii) vide which project authorities submitted the reply for the letter mentioned under reference (iii).

Reply received from project authorities was examined and it is found that all the observations/ comments issued by this directorate have been suitably incorporated and are generally in order subject to the following:

1. Spillway and Ski-jump type energy dissipation arrangement (EDA) shall be tested for their efficiency on a physical model during pre construction stage.
2. Detailed dynamic analysis of the dam and spillway shall be carried out during pre construction stage.

This issues with the approval of Chief Engineer, Design (N&W), CWC

(शैलजा घोष)
निदेशक

Director, PA (N), CWC, Sewa Bhawan, R.K.Puram, New Delhi

No.3/185/2012/CMDD (N&W)/6549 Dated: 20-10-2016

Copy for kind information to:

1. Chief Engineer (HPA), CEA, Sewa Bhawan, New Delhi
2. Director, HCD (N&W), CWC, Sewa Bhawan, New Delhi
3. Director, PAC, CEA, Sewa Bhawan, New Delhi
4. Chief Engineer (HQ) & Nodal Officer, 2nd Floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu – 180012 (J&K)

Government of India
Central Water Commission
Gates Design (N&W) Directorate
*****

8th Floor (S), Sewa Bhawan
R.K. Puram, New Delhi- 110066
Phone No. 91-11-26100522
Fax No. 91-11-26100806

Date: 24th Oct. 2016

Subject: Technical examination of Detailed Project Report (DPR) of KWAR H.E. Project (4 x 135MW) Jammu & Kashmir.

Ref: 1. 3/154/2012/PA(N)/1250-60 dated 21.08.2012
2. CMDD, letter no.3/185/2016/CMDD(N&W)/476 dated 16.08.2016
3. CVPP/CE (HQ)/Kwar/camp-fbd/410 dated 20.10.2016

Apropos the subject cited above, the DPR of Kwar HEP was received from PA(N) Dte, CWC for examination of aspects related to gates and operating equipments vide letter under reference (i) above. Further as per telephonic discussion, the following updated documents were submitted by CVPP Ltd. vide letter under reference (3)-

1. Updated HM chapter (DPR).
2. Updated Quantity Estimate of HM Components (DPR Stage).
3. Copy of relevant civil drawings (3 nos.).
4. Copy of drawings of crest Spillway at 1368 level.
5. Copy of drawings of GA of spillway orifice Radial gate, Crest Radial Gate, stoplog, construction sluice gate and hoists.
6. Copy of drawings of GA of service & emergency gates for environment release.

Further observations/comments of this office are as under:

1. **Spillway stoplog gate:**
   i.The no. of units of stoplogs may be increased (preferably 6 to 7) and their height may reduced accordingly. Also arrangement may be provided for dogging of stoplog in false bays/ bridge deck etc.
   ii. Downstream skin plate may be provided.

2. **Crest type Spillway Radial Gates & Hydraulic Hoists:**
   i. Material for skin plate may be adopted as structural steel.
   ii. Vide clause no 6.4.3. of IS 4623, "the distance between c/l of crest and c/l of sill shall as small as possible in order to economize the height of gate and pier size". The sill elevation may accordingly be changed (preferably 0.3 m to 0.5m below crest) and subsequent design may be modified during detailed design stage. Also location of trunnion may be modified to optimize hoist capacity and pier size.

3. **Diversion Tunnel Gate:**
   Vide para 8.11.1.1 (Vol.1), it is mentioned that the diversion tunnel gate is meant for closure during lean season, and that it shall be operational under any water head between EL 1293.0 to 1337.5 m. The operating requirements shall be clearly indicated. During operation if the gate is to be kept in partial open position, features of regulating gate and embedded parts (top seal seat) may be incorporated. Vide para 8.11.1.1, it is stipulated that during closure of diversion tunnel, water level shall be controlled through construction sluice gates.

4. **Power tunnel Intake gates:**
   i. In the arrangement of intake gate, upstream skin plate & sealing is provided. This will reduce down pull but at the time of filing of penstock, there is a possibility of gate catapulting. Sealing arrangement and slot may be designed carefully at detailing stage.

ii. Instead of providing slide type bulkhead gate fixed wheel type bulkhead gate with individual rope drum hoist of suitable capacity (instead of gantry crane) shall be provided.
iii. The size of air vent pipe (300mm) may be increased suitably to match the actual air flow requirements.

5. **Environment release gate:**

Details of gate, intermediate supports for hoist stem etc. shall be reviewed and shown in the relevant drawing.

General Comments:

1. Deicing System: As the project is located at high altitude it may be confirmed any subzero conditions are considered in the design. For subzero condition, deicing arrangement for gates and hoisting arrangement may also be necessary. All these arrangements along with cost may be included in DPR.

2. The weight of various gates and their hoist capacities in Quantity Estimate of HM Components appears to be on higher side. The quantity estimate may be revised as per actual calculations during the detailed design stage.

3. Cost aspects are not examined in this directorate. These shall be examined by the Cost Appraisal Dte.

4. The details of structural components of gates, sealing arrangement, hoisting arrangement & capacity may be reviewed during the detail design stage.

Except for the above observations, the DPR from hydromechanical equipment point of view is found to be generally in order and there are no further comments to offer. A copy of the updated DPR chapter on hydromechanical components including the preliminary design calculation and the revised drawings may be submitted to this office for record.

This issues with the approval of Chief Engineer, Designs (N&W).

(Vaseem Ashraf)
Director

O/C

Director, PA(N), CWC, Sewa Bhawan, R K Puram, New Delhi
CWC U.O.No 11/2/2010 GD (N&W)/1884-89 dated 24/10/2016

Copy for kind information to:

1. **Chief Engineer (HPA), CEA, Sewa Bhawan, New Delhi.**
2. **Director, CMDD (N&W) Dte., CWC, New Delhi**
3. **Director, HCD (N&W) Dte., CWC, New Delhi**
4. **Director, PAC, CEA, Sewa Bhawan, New Delhi.**
5. **Chief Engineer (Designs) & Nodal Officer, 2nd floor, JKPCC Building, Rail Head Complex, Panama Chowk, Jammu-180012 (J&K).**

Director

CMPP|P69|R-189
28-10-2016

Government of India
Central Water Commission
Construction Machinery Consultancy Directorate
209 (S), Sewa Bhawan, R.K. Puram, New Delhi-66, Tel: 011-26100731, email: cmcdte@.nic.in

Sub: DPR of Kwar Hydro- Electric Project (560 MW), J&K- Reg.

This has a reference to the CA (HWF), CWC's letter no.10/13/91/CA(HWF)/447-57 dated 17/10/2016 inter-alia decision was taken on expeditious examination of the pending projects of J&K & H.P. In view of the high level decision taken on pending projects of J&K & H.P, the project has been examined broadly from plant planning angle and found to be considered conditional acceptance with subject to the satisfactory compliance of the following comments/suggestions at pre-construction/TEC stage.

I) Conventionally, CMC Directorate, CWC examine the project proposal from plant planning aspects, once the civil work quantities (BOQ) as submitted by the project authorities is approved by the TCD, CEA. As the project is under DPR/appraisal stage and civil work quantities are yet not approved by the TCD, CEA, hence, the project has been examined from plant planning angle based on the civil work quantities provided in the DPR and some discrepancies are observed as follows.

a) In coffer dam, earth filling has been proposed to be carried out by 1 no. of hydraulic excavator (2 cum) supported by 8 nos. of rear dumpers (25T). But, on analysing the calculated cycle time and loading time, 1 no. of hydraulic excavator can load only 4 nos. of dumpers so as to have optimal utilization.

b) Total 4 nos. of tower crane of 6T and 60 m for the concreting of Dam of 195m length and 109m high dam radius in 29 month including 2 month for concreting upto River bed level has been proposed, which seems to be difficult to operate. Instead of 6T and 60 m tower crane, 4 nos. of tower crane of 10t and 30 m radius may be deployed. Further, hourly concreting capacity of tower crane 10t and 30m radius is about 36 cum/hr, which will result in decrease in overall concreting time as compared to proposed concreting time.

c) Time taken for excavation and concreting of pressure shafts are found to be on higher side, which can be effectively optimize. Progress rate for excavation of horizontal pressure shaft of 5.65m dia is generally taken around 100m/month and concreting around 40m/month. Further, there are anomalies between lengths of pressure shafts provided in construction schedule and salient features.

d) Batching and mixing plant of capacity 300 cum/hr has been proposed at Dam Site. Instead of this, 1 no. of 200 cum/hr B&M Plant , 1 no. of 90 cum/hr Batching & Mixing Plant may be considered that will decrease redundancy and also concrete requirement of Diversion Tunnel can be catered easily.

e) Completion time of HM works and EM works may be reviewed, if they can be completed before proposed time period.

f) 50% Horizontal pull effect may not be taken in case of excavation by Wagon Drill. In case of open excavation, 80% excavation by Wagon Drill & & 20% excavation by Jack Hammer may be considered and one dozer with two excavators/loaders as supporting equipment may be considered in the analysis of the item rate.

Project authorities, if incorporate the above observations, it will result in reduction in duration of the activities by few months. Thus, overall project duration may be revised.

In case, if there is any significant variation observed in civil quantities by the TCD, CEA, then the project may require to be re-examined afresh from plant planning aspects.

II) As far as provision kept under subhead 'Q-Special T&P' is concerned, it is observed that a total provision of equipments worth Rs.1258.00 Lakh has been made in the sub head. In this regard, equipments worth Rs 805.10 Lakh have been found to be acceptable under "Q- Special T&P" on examining the list of equipments and accounting correct price, wherever required. The list of equipments is enclosed herewith for reference.

Encl: As above

o/c

27/10/2016

(Sureshwar Singh Bonal)
Director

Director, PA (N) Directorate, CWC, Sewa Bhawan, R.K Puram, New Delhi
CWC U.O. No. 21/JK/11/2016-CMC / 299-301 **dated:** 27/10/2016

Copy to:

1. Director, CA (HWF) Directorate, CWC, Sewa Bhawan, R. K. Puram, New Delhi for information & needful action.
2. General Manager (Civil), Corporate Office, JKSPDC, Exhibition Ground, Opposite J&K High Court, Srinagar, J&K-190009

Q spl T&P of KWAR Hydro Electric Project, J&K

Particulars	As proposed by Project Authority			As accepted by CMC Dte. from		
Sr. No.	Name of Euipments	Quantity	Unit rate (Rs. in lacs)	Amount (Rs.in lacs)	Nos.	Unit rate (Rs. in lacs)	Proposed cost charged to Q- special T&P* (Rs. in Lacs)
1	Hydraulic Excavator, 1.0 cum.	1	50.00	50.00	1	50.00	50.00
2	Loader cum Excavator, 1.0/0.25 cum.	2	22.00	44.00	1	22.00	22.00
3	Front end loader 1.5 -2.0 cum	1	36.00	36.00	0	36.00	0.00
4	Crawler Dozer, 100 FHP	2	42.00	84.00	2	42.00	84.00
5	Wheel Dozer 200 FHP with ripper	1	80.00	80.00	0	80.00	0.00
6	Air Track/Wagon Drill	2	15.00	30.00	1	15.00	15.00
7	Jack Hammer/Pavement Breaker	15	0.50	7.50	6	0.35	2.10
8	Diamond Core Drill (Mechanical)	1	15.00	15.00	1	15.00	15.00
9	Diamond Core Drill (Hyd)	1	75.00	75.00	1	60.00	60.00
10	Compressed Air(cfm)	2000	0.0200	35.00	1200	0.0200	24.00
11	Rock splitter	1	10.00	10.00	0	10.00	0.00
12	Hyd. Rock breaker (Mounted on 20 t excavator)	1	18.00	18.00	0	18.00	0.00
13	Mobile Crane, 10 t Pick & Carry	1	10.00	10.00	1	10.00	10.00
14	Mobile Crane, 20 t (Rough terrain)	1	70.00	70.00	1	53.00	53.00
15	Fork Lift,8/10 t	1	12.00	12.00	1	12.00	12.00
16	Road Roller, 8/10 t	1	12.00	12.00	1	12.00	12.00
17	Concrete Mixer, 14/10 cft	3	1.50	4.50	3	1.50	4.50
18	Concrete Mixer, 28 NT	1	4.00	4.00	0	4.00	0.00
19	Dewatering Pump	LS	20.00	20.00	LS	20.00	20.00
20	Tipper 4.5/6.0 cum.	8	10.00	80.00	4	10.00	40.00
21	Truck, 10 t	5	10.00	50.00	4	8.00	32.00
22	Low Bed Tractor Trailor, 30 t	1	40.00	40.00	1	40.00	40.00
23	Explosive Van, 10 t	1	10.00	10.00	1	10.00	10.00
24	Water Tanker/Sprinkler, 10 KL	3	10.00	30.00	2	10.00	20.00
25	Petrol/Diesel Tanker, 10 KL	1	10.00	10.00	1	10.00	10.00
26	Bus/Mini Bus	8	10.00	80.00	5	10.00	50.00
27	Car/MUV	2	5.00	10.00	2	6.50	13.00
28	Jeep (Petrol/Diesel)	20	4.50	90.00	13	4.50	58.50
29	Ambulance	2	9.00	18.00	2	9.00	18.00
30	Workshop Equipment	LS	20.00	20.00	LS	20.00	20.00
31	Mobile work shop	1	15.00	15.00	1	15.00	15.00
32	Mobile Service Van	1	20.00	20.00	1	20.00	20.00
33	Fire Tender	2	30.00	60.00	2	22.00	44.00
34	Recovery Van	1	10.00	10.00	1	10.00	10.00
35	Pick up Van/L.C.V	4	7.00	28.00	3	7.00	21.00
36	Snow cutter Blower	1	50.00	50.00	0	50.00	0.00
37	Motorised winch 50hp	2	10.00	20.00	0	10.00	0.00
			TOTAL	1258.00		TOTAL	805.10

फोन: 011-26105[illegible] फैक्स: [illegible]

भारत सरकार
Govt. of India
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
जल विद्युत परियोजना मूल्यांकन-I प्रभाग
Hydro Project Appraisal -I Division
सप्तम तल, सेवा भवन, आर.के.पुरम, नई दिल्ली-110066
7th Floor, Sewa Bhawan(N), RK Puram, New Delhi-110066

ISO [illegible]

Subject: Cost Estimates of E&M works of Kwar HEP (4x135=540 MW) in [illegible] by M/s Chenab Valley Power Project Pvt. Ltd.(CVPPL)- regarding

Reference is invited to M/s CVPP letter No. CVPP/CE(PD)/Kwar/[illegible]/16/404 dated 18.10.16 vide which they have submitted cost of E&M works of Kwar HEP (4x135=540 MW) for Rs.1064.53 crores at April, 2016 price level.

DPR of Kwar HEP (4x135=540 MW) was submitted by M/s Chenab Valley Power Project Pvt. Ltd.(CVPPL) vide their letter dated 27.07.2013 and the DPR was scrutinized for detailed examination by CEA on 29.05.2014.

Both the design and BOQ aspects of E&M equipments have been examined by HPA-II Division vide letter dated 29.01.2016 and 26.05.2016.

Based on the above, the cost of E&M Works has been examined in HPA-I Division and the matter was discussed with representative of M/s CVPPL.

The modified/ updated cost of E&M Works has been examined and the same is Rs.1141.38 Crores at April 2016 price level subject to finalization of Design Energy. Details of finalized cost of E&M Works is enclosed at Annex-I.

M/s CVPP may be requested to submit 6-monthly updated/revised cost estimates of estimated expenditure of E&M Works for examination in CEA (as per format enclosed at Annex-II) after finalization of zero date, construction period and [illegible] by the Authority.

Further M/s CVPP may be requested to submit the following:

i) Design Energy
ii) Type of Power House
iii) Type of Excitation System
iv) Project completion period

Revised Commissioning Schedule

This is not with the approval of Competent Authority

(डिम्पी)
निदेशक (पी.एस.पी.ए.-II)
ई-मेल- dimpa3[illegible]

Director (PSPA-II), Central Electricity Authority

पत्र सं. [illegible]: 2/3/2016/HPA-I/[illegible] दिनांक: 27.[illegible]

Copy for information to:
Chief Engineer and Head of Office, 5,2nd floor, JKPCC Building, Rail Head Complex, [illegible]
Chief Engineer, [illegible]

KWAR HE Project (4 X 15 MW)

ESTIPACT OF COST ESTIMATES OF ELECTRO MECHANICAL WORKS

Sl. No.	Description	Amount Rs. in Lakhs as on 24th Oct 2012	
			FOB (Turkey Port) Euro in Lakhs @ 1 Euro = Rs. 75.00
1	Preliminary (only cost of model tests)	20.00	
2	Generating Plant and Equipment		
	a) Generator, turbine and accessories-Annexure S-1)	4140.00	
	b) Auxiliary electrical equipment for power station - Annex S-2)	1758.00	
	c) Auxiliary mechanical equipment and services for power station - Annex S(3)	1239.00	
	d) Central Sales Tax on 2(a), (b) & (c) @ 2%	118.00	
	e) Transportation handling and insurance charges @ 6% of 2(a), (b) & (c)	541.80	
	f) Erection and commissioning charges @ 8 % of 2(a) (b) & (c) excluding spares	480.00	
	Sub-Total (Generating Plant and Equipment)	8516.80	
3	Substation Equipment and Auxiliary Equipment and Service for Switchyard		
	a) Substation equipment and auxiliary equipment and service for Switchyard - Annex S(4)	4778.00	
	b) Central Sales Tax @ 2 % on 3(a)	97.56	
	c) Transportation, handling and insurance charges @ 6% of 3(a)	286.68	
	d) Erection and commissioning charges @ 8% of 3(a) excluding spares	382.24	
	Sub-Total (Substation equipment and auxiliary equipment and service of Switchyard)	5544.48	
4	GIS & XLPE CABLE		
	a) 400 KV GIS & XLPE Cable - Annex S-3)		1111.11
	b) Customs Duty @ 29.60%	2463.11	
	c) Freight & Insurance @ 2% (Marine) of Item 4(a)	333.11	
	d) Freight & Insurance @ 6% (Inland) on 4(a), 4(b) & 4(c)	474.67	
	e) Erection & Commissioning charges @ 8% of 3(a) & 4(b) excluding spares	1.00	
	Sub-Total (GIS & XLPE Cable)	1.00	1111.11
5	Contingencies @ 1% on items 2, 3 & 4	1.00	
6	Taxes & Duties @ 0.5 % on 2, 3 & 4	1.00	
7	Sub-Total (Item 1 to 6)	1.00	1.00
8	Establishment (including in-house design and Engineering)	1.00	
9	Sub-Total (Item 7 & 8)	1.00	
10	Audit and account charges @ 0.25% on Item 7	1.00	
11	Bank Warranty @12.5 % on item 7	1.00	
12	EDC/W @ 1%	1.00	
13	Additional Charges (Miscellaneous)	1.00	
	TOTAL (in Rs. Lakhs)	1.00	

Central Water Commission
Cost Appraisal (HWF) Directorate

Room No. 522 (South),
Sewa Bhawan, R.K.Puram,
New Delhi-110066

Subject: DPR of Kwar (4x135= 540MW) Hydro--Electric Project, J&K – Regarding

PA(N), CWC had forwarded the above mentioned scheme vide their letter no. 3/154/2012/PA(N)/1250-60 dated 21.08.2012 for appraisal. The updated Civil & H-M works cost estimate amounting to Rs. 3284.29 Crores at April, 2016 Price level was submitted by Project authority on 27.10.2016 vide their letter dated 25.10.2016. In this regard, acceptability have been issued by the appraisal Directorates of CWC i.e. HCD (N&W), CMDD(N&W), Gates Design (N&W) and CMC Directorate subjected to incorporated / satisfactory compliance of the comments / suggestions /observations issued by them at pre construction /TEC stage by the project authority. CEA has also been reviewing the status of pending H.E.project on 18.10.2016 and minutes of meeting communicated to this directorate vide letter no. 18/1/2015-HPA-II/601 dated 21.10.2016.The correctness of quantities certificate have not been forwarded by the TCD, CEA. Therefore, DPR Cost Estimate of Civil works and HM works of the Project has been provisionally finalized of Rs. 3221.86 Crores at April, 2016 Price Level subjected to review at the pre construction /TEC stage. The cost has been finalized after considered the Works Tax @ 12.6% and BOCW cess @1%. Copy of EIA report and clearance certificate of MoEF has not been provided by the project authority.

The Cost Estimate of Civil works and HM works of the Project has been examined and provisionally finalized of Rs. 3221.86 Crores at April, 2016 Price Level subjected to review at the pre construction /TEC stage.

The provisions under B-Land and X-Environment and Ecology are provisional as they are subject to change based on final awards and acceptance of EMP report by MoEF.

The abstract of the cost is enclosed as Annexure.
This issues with approval of Chief Engineer, PAO, CWC.

Encl.: Annexure

31/10/16

(Arjun Singh)
Director
Mobile: 9711641227

Director, PA (N) Dte, CWC,
CWC, U O No 10/12/2012-CA (HWF)/ 4176-78 Dated 31-10-16

Copy to:
1. Director (PAC), CEA, Sewa Bhawan, R.K.Puram, New Delhi
2. Director, Thermal Civil Design Division, Sewa Bhawan, R.K.Puram, New Delhi

KWAR H.E. PROJECT, J & K (4 x 135)MW
ABSTRACT OF COST

S.No	Description	Amount (Rs. In Crores) (April'16 PL)
A	***CIVIL WORKS***	
1	**DIRECT CHARGES**	
	I - Works	
	A - Preliminary	18.91
	B - Land	87.05
	C - Works	1339.93
	J - Power Plant Civil Works	1251.00
	K - Buildings	80.09
	O - Miscellaneous	33.25
	P - Maintenance During Construction	27.42
	Q - Special Tools and Plants	1.61
	R - Communication	70.76
	X - Environment and Ecology	93.86
	Y - Losses on Stock	6.85
	TOTAL OF I - WORKS	3010.74
	II - Establishment	206.38
	III - Tools and Plants	2.00
	IV - Suspense	
	V- Receipt & Recoveries	-4.96
	TOTAL DIRECT CHARGES	**3214.15**
2	**INDIRECT CHARGES**	
	I - Capitalised Value of Abatement of Land Revenue (5% of Cost of Culturable Land)	0.18
	II - Audit & Accounts Charges (0.25% of I - Works)	7.53
	TOTAL INDIRECT CHARGES	7.71
	TOTAL CIVIL WORKS	**3221.86**

395

भारत सरकार
Government of India
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
तापीय सिविल अभिकल्प प्रभाग
Thermal Civil Design Division

विषय: Submission of KWAR H.E. Project (J&K): Submission of updated Civil BOQ- Reg.

May please refer to Chenab Valley Power Projects Pvt. Ltd.'s letter No. CVPP/CE(HQ)/Kwar/Camp-Fbd/419 dated 24.10.2016 vide which the updated Civil BOQ has been submitted to this division.

The quantities of civil works for projects being developed by Public Sector Undertakings or Central/State Government Organizations are not appraised in this Division as per present policy of CEA and the cost of Civil and HM works of the project is finalized by CWC based on quantities of civil works revised and submitted by Project Authorities after incorporating the observations of CEA/CWC/GSI on planning & design aspects in DPR drawings and revised certificate of correctness of quantities furnished by them.

However, for having uniformity in both Public and Private Sector Projects, the following issues may be taken care of while finalization of civil cost:

1. The over break in underground rock excavation has to be considered as 5% in class- II & class III types of rock and 10% in class IV & V types of rock.
2. Backfilling in over-breaks in ribbed portion of tunnels should be carried out with M-15 grade concrete.
3. In case of floor raft of power house, the estimated quantity of back-up concrete has been kept as 50% of the floor raft concrete which seems to be on higher side and may be taken into reconsideration for the BOQ.
4. The estimated extra quantity of concrete due to fractured hump b/w units has been kept as 2961 cubic meter (which is about 50% of estimated quantity) which may be reconsidered.
5. The wall thickness taken for the estimation of quantity of RCC at runner removal floor is 0.85 m which is almost double the actual wall thickness. So, the actual wall thickness may be considered in estimating the quantity of RCC.
6. The quantity of sand to be used in the grouting has been kept as 3.5% of the cement which doesn't seems to be correct. This may be reviewed and quantity of the cement and sand may accordingly be taken for the estimation.
7. Provision of cement bags for consolidation/ curtain grouting per meter length in dam has been considered as @4.0 bags/m. Whereas, generally 2 bags/m is considered in dam and 1.5 bags in Adit, Adit Portal, TRT and other tunnels in Class-IV and Class-V types of rock. The quantities of cement bags may accordingly be reviewed & corrected.

394

8. Provision of contact grouting should be as per IS: 5878 (Part-VII).
9. Fore poling and pipe roofing may be considered only for Class-V types of rock and not for Class-IV types of rock. The quantities of these items may accordingly be reviewed & corrected. Further, provision of fore poling and pipe roofing has to be considered in not more than 50% reach of tunnel in Class-V types of rock.
10. TRT lining thickness has been considered as 400 mm which is generally kept as 300mm maximum.
11. Concrete lining in Adit is generally be carried out only in invert portion of the Adit. However, it has been considered in crown and wall portion also. The same may be reviewed and corrected.
12. In Class-V types of rock, no rock bolting is generally being carried out. The same may be reviewed and corrected.
13. In Power House Cavern, thickness of shotcrete proposed for crown is 200 mm which seems to be on higher side. The same may be reviewed and corrected.
14. The dia of rock anchor proposed in power house cavern is 36 mm which also seems to be on higher side. The same may be reviewed and corrected.

The Copy of Certificate submitted by CVPP has been enclosed with this letter.

This for information and further necessary action please.

Encl: As above.

31/10/16

(नीरज कुमार)
निदेशक

निदेशक, पी.ए.सी. प्रभाग, के. वि.प्रा.
सं0.: 4/21/TCD-2007/Kwar/ 791-792 दिनांक:31/10/2016

Copy to:
Director, Cost Appraisal (HWF) Dte, CWC.

केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
तापीय सिविल अभिकल्प प्रभाग
Thermal Civil Design Division

Sub: Kwar H.E. Project (4 x 140 MW) in J & K: Construction Schedule and Phasing of Cost of Civil & HM Works –Reg.

The Project Authorities vide their letter no. CVPP/CE(HQ)/Kwar/Camp-Fbd/424 dated 26.10.2016 submitted updated Construction Schedule without revised construction methodology. Subsequently, revised Construction Schedule and phasing of cost of civil & HM works were submitted along with" Zero Date" i.e.01.01.2018 as mentioned in their letter of even no.455 dated 02.11.2016. However, "Zero Date" has been changed to 1st September, 2018 vide their letter of even no.466 dated 07.11.2016.

The cost of Civil & HM works is stated to be Rs.3221.86 Crores at April 2016 Price Level as cleared by CWC. The said cost and the construction schedule as finalized in TCD Division, CEA in consultation with the Project Authorities have been used for finalization of phasing of cost of civil & HM works of the Project. The said project being developed by a Public Sector Undertaking i.e. M/s CVPP Private Limited, a Joint Venture of M/s NHPC Limited & JKSPDC & PTC India Limited, only the basic hard cost of civil & HM works has been phased on half yearly basis over a construction period of 54 months with effect from the "Zero Date" i.e. 01.09.2018 as intimated by the Project Authority vide their letter no. dated 07.11.2016 as cited above.

1. The construction schedule has been finalized based on following considerations:

   - A pre-construction period of 18 months before "Zero Date" has been proposed for infra-structure works such as land acquisition, building, roads, bridges etc. Mobilization period of 3 months from the start of Zero Date i.e. 01.09.2018 has been considered.
   - A construction period of 54 months with effect from the "zero date" i.e. 1st September, 2018 has been proposed.
   - Power House is the Critical Activities of the project as shown in the Construction Schedule as well as the monsoon period of 3 months (July to September) is also highlighted in it.

2. Considering the construction schedule as finalized in TCD Division, the phasing of the cost of Civil & HM works submitted by the Project Authorities was examined and finalized based on following considerations:

- The Cost of Civil & HM works amounting to Rs.3221.86 crores at April, 2016 Price Level as finalized by CWC has been considered. Out of this, Rs. 111.80 crores is proposed to be spent till zero date i.e. 01.09.2018 and the balance amount of Rs. 3110.06 crores has been phased over a period of 54 months on half yearly basis which comprises of 9 blocks of 6 months each.

A copy each of construction schedule and phasing of basic cost of Civil & HM works the of the project as finalized in this Division are enclosed at **Annex-I** and **Annex–II** respectively for favour of information and further necessary action in the matter.

10/11/16
(नीरज कुमार)
निदेशक

मुख्य अभियन्ता, (एच.पी.ए-I), के0वि0प्रा0

सं0. 4/21/ कवार/2007/टीसीडी/ 820-22 दिनांक: 10 .11 .2016

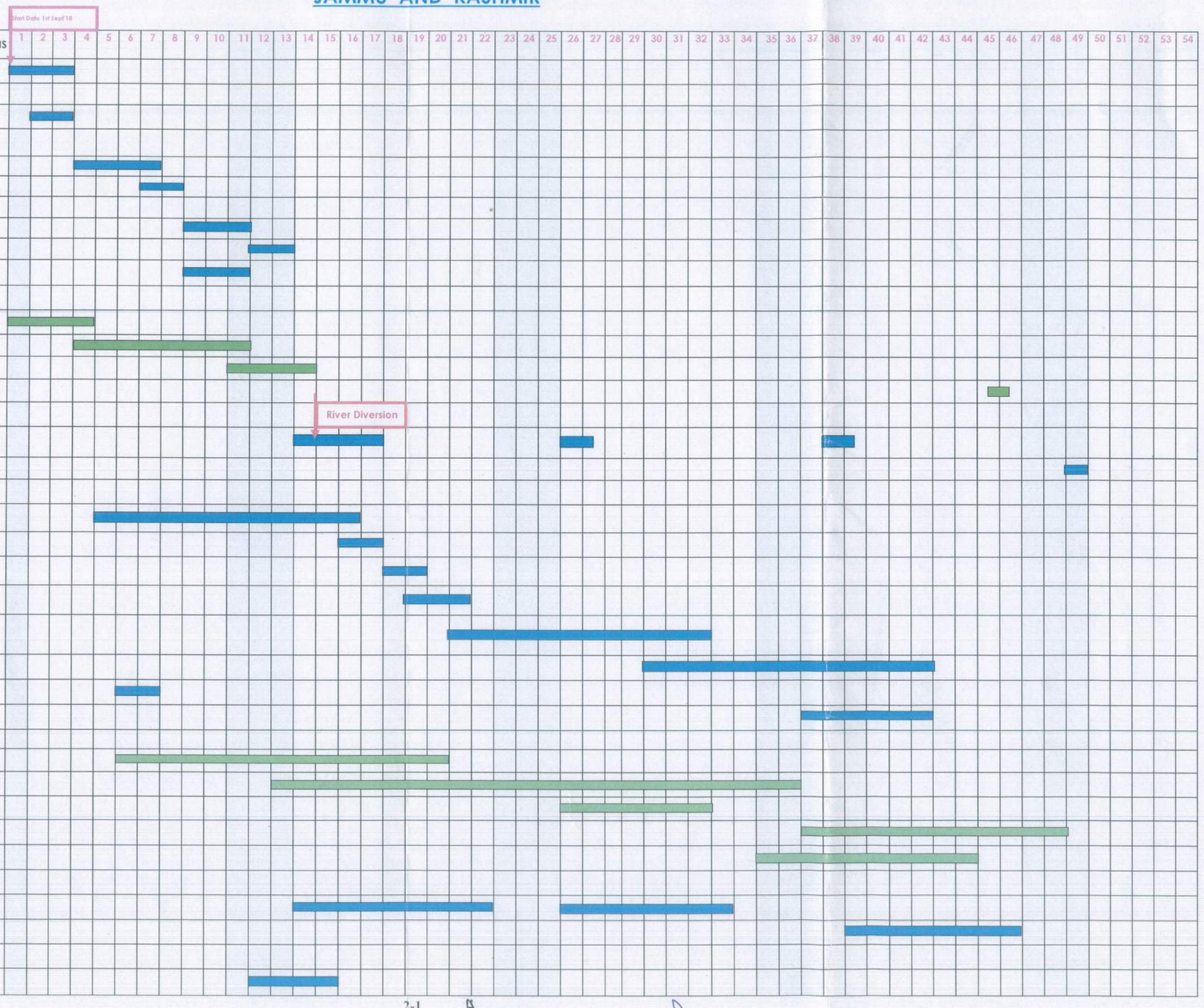
प्रतिलिपि: सूचनार्थ एवं कार्रवाई हेतु :

1. निदेशक (पी.ए.सी),के0वि0प्रा0 ।
2. Chief Engineer(HQ), 2nd Floor, JKPCC Building Rail Head Complex, Panama Chowk, Jammu-180012 (J&K).

KWAR HE PROJECT (4 x 140 MW)
JAMMU AND KASHMIR

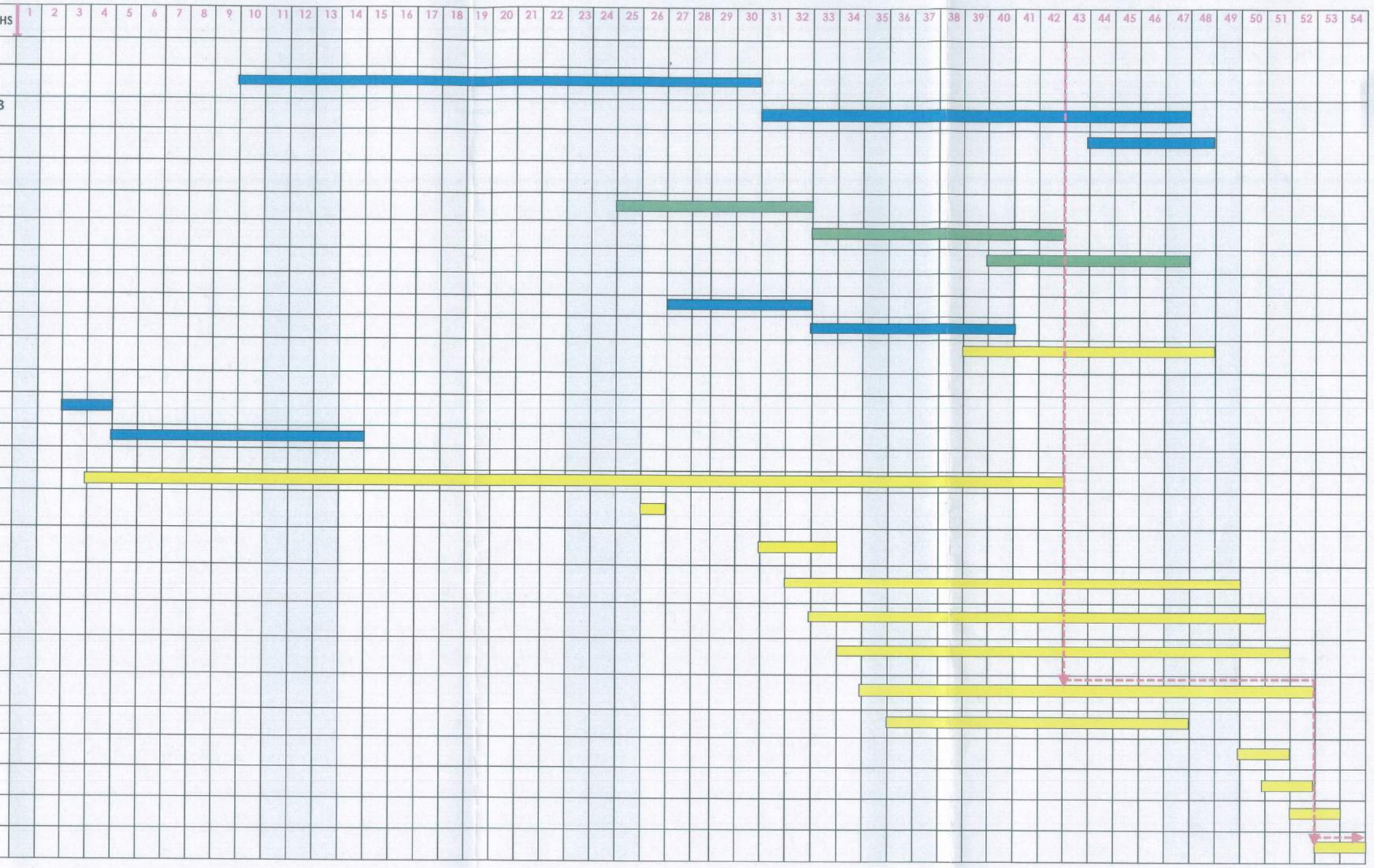
Annexure-1

Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
A	MOBILIZATION			3
B	DIVERSION TUNNEL			
1	Open excavation	cum	48000	2
2	Excavation of DT			
	Heading	m	685	4
	Benching	m	685	2
3	Concrete Lining			
	Overt	m	685	3
	Invert	m	685	2
4	Concreting of DT gate Structure	cum	7600	3
5	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	4
ii	Manufacturing, Testing and Supply	Job	%	8
iii	Erection			4
6	Diversion Tunnel Plugging	Job	%	1
C	COFFER DAM (U/S AND D/S)			
1	Rock fill/Impervious fill/Filler material	cum	350931	7
2	Reservoir filling	Job	%	1
D	CONCRETE DAM			
1	Common excavation/ Rock excavation	cum	498153	12
2	Riverbed excavation			2
3	Concreting upto River bed level EL 1286	cum	817500	2
4	Concreting above RBL EL 1286 upto crest level of under sluice gates			3
5	Concreting above EL 1305 upto crest level of spillway Radial gates Orifice Type			12
6	Concreting up to Dam Top			13
7	Common excavation/Rock excavation for Intake Structure	cum	79640	2
8	Concreting for intake structure	cum	78700	6
9	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	15
ii	Manufacturing, Testing and Supply	Job	%	24
iii	Erection of under Sluice Gates	Job	%	7
iv	Erection of Spillway Radial Gates	Job	%	12
v	Erection of intake gates	Job	%	10
E	PLUNGE POOL			
1	Excavation	cum	569298	17
2	Concreting of Plunge Pool	cum	51600	8
F	PRESSURE SHAFT			
1	Platform and arrangement of vertical shafts	Job	%	4



Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
2	Excavation of Adit to Lower Penstock, Erection Gallery through Adit cum Surge Gallery of TRT-2	m	220	3.5
3	Excavation of Lower Penstock Erection Gallery, Dewatering Shaft and Pump House	m	90	2
4	Excavation of Vertical and Bottom Pressure Shaft			
i	PS-1	m	141	8
ii	PS-2	m	165	9
iii	PS-3	m	187	11
iv	PS-4	m	205	13
5	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	12
ii	Manufacturing, Testing and Supply	Job	%	20
iii	Erection of Steel Liner PS-1	m	236	8
iv	Erection of Steel Liner PS-2	m	223	8
v	Erection of Steel Liner PS-3	m	211	8
vi	Erection of Steel Liner PS-4	m	201	8
6	Back fill Concrete			
i	PS-1	m	117	8
ii	PS-2	m	133	8
iii	PS-3	m	146	10
iv	PS-4	m	165	11
G	POWER HOUSE			
1	Open Excavation and Establishment of Portal of MAT	Job	%	2
2	Excavation of MAT to P/H	m	645	8
3	Excavation of Access Tunnel to Transformer Cavern through MAT	m	265	2
4	Excavation of Adit to P/H crown	m	100	2
5	Excavation of Adit to Control Block Crown through MAT	m	70+45	1
6	Excavation of P/H Cavern	cum	142043	13
7	Excavation of Control Room Cavern	cum	18051	4
8	Excavation of Transformer , GIS and Draft Tube Gate Cavern	cum	55037	9
9	Excavation of Draft Tube Gate Shaft	Job	%	6
10	Concreting of Draft Tube Gate Shaft	Job	%	6
11	Hydro-Mechanical Works			
i	Design & Engineering	Job	%	12
ii	Manufacturing, Testing and Supply	Job	%	15
iii	Erection	Job	%	9
12	Concreting in service bay upto EOT level	Job	%	3
13	Concreting of Columns and Beams in Power House upto EOT level.	Job	%	7
14	Concreting of P/H	Job	%	18
15	Concreting of T/F Cavern	Job	%	10

Sr. No.	PARTICULARS	UNIT	QTY.	MONTHS
H	TAIL RACE TUNNEL			
1	Underground Excavation (Rock Class II to V)	cum	607200	21
*2	Cement Concrete lining - M25/A40	cum	126600	14+3
3	Reinforced Cement Concrete - M25/A40	cum	10600	5
4	Hydro-Mechanical Works of TRT Outlet Gates			
i	Design & Engineering	Job	%	8
ii	Manufacturing, Testing & Supply	Job	%	10
iii	Erection	Job	%	8
I	GIS BUILDING AND POTHEAD YARD			
1	Surface Excavation	cum	210075	6
2	Concreting	cum	21715	8
3	Erection of Pothead yard Equipments	Job	%	10
4	Cable Tunnel			
i	Surface Excavation and Portal Preparation	Job	%	2
ii	Excavation of Cable Tunnel	m	320	10
J	E&M works of Power House			
i	Design & Engineering and Supply	Job	%	39
ii	Erection of EOT Crane in service bay	Job	%	1
iii	Extension of EOT Crane in Units	Job	%	3
iv	Unit-I - Erection, Testing and commissioning	Job	%	18
v	Unit-II -Erection, Testing and commissioning	Job	%	18
vi	Unit-III -Erection, Testing and commissioning	Job	%	18
vii	Unit-IV -Erection, Testing and commissioning	Job	%	18
viii	Erection of Transformers	Job	%	12
ix	Unit-I - Erection, Testing and commissioning	Job	%	2
x	Unit-I - Erection, Testing and commissioning	Job	%	2
xi	Unit-I - Erection, Testing and commissioning	Job	%	2
xii	Unit-I - Erection, Testing and commissioning	Job	%	2



LEGEND:

- Civil Works
- HM Works
- E&M Works
- Monsoon
- Critical Activity

KWAR H.E. PROJECT, J & K (540 MW)

Six Monthly Phasing of Cost of Civil and Hydro Mechanical works

Rs. In Crore

S. N.	Description	Amount (at April 2016 PL)	Expenditure made by CVPPL upto April,16	Expenditure to be incurred till zero date i.e Sept' 2018	Balance Expenditure	MONTHS									Total Balance Sum
						6	12	18	24	30	36	42	48	54	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	**A - Preliminary**														
	Basic cost	18.91	2.99	12.88	6.03	1.81	1.81	0.90	0.72	0.30	0.12	0.12	0.12	0.12	6.03
2.	**B - Land**														
	Basic cost	87.05	3.44	27.94	59.11	26.60	24.10	4.14	1.77	0.50	0.50	0.50	0.50	0.50	59.11
3.	**C - WORKS**														
A.	Diversion Tunnel														
	Basic cost	107.39		4.74	102.65	30.07	59.69	11.88						1.00	102.65
B	Coffer Dam														
	Basic cost	12.71			12.71			7.26		2.72		2.72			12.71
C	Concrete Dam														
	Basic cost	1097.00			1097.00	9.19	18.39	60.70	255.33	235.29	268.00	215.25	31.68	3.17	1097.00
D	Plunge Pool														
	Basic cost	122.84			122.84			10.07	10.07	10.07	12.59	40.01	40.01		122.84
4.	**J - POWER PLANT CIVIL WORKS**														
A	Pressure Shaft & Penstock														
	Basic cost	157.39			157.39		1.28	13.93	23.47	26.82	45.79	30.79	15.31		157.39
B	Power House & Power House Adit														
	Basic cost	271.85		10.19	261.66	10.94	21.87	37.18	39.13	76.16	51.45	22.91	1.00	1.00	261.66
C	Surge Arrangement														
	Basic cost	188.26			188.26	11.58	23.15	39.36	33.36	42.66	26.02	11.15	0.50	0.50	188.26
D	TRT														
	Basic cost	514.12			514.12		49.34	98.67	98.67	97.67	46.03	46.03	76.71	1.00	514.12
	Percentage														
E	TRT Outlet														
	Basic cost	41.89			41.89						12.89	27.10	1.89		41.89
F	Pot Head Yard														
	Basic cost	77.49			77.49	7.92	11.87	3.96		7.92	23.89	20.93	0.50	0.50	77.49
	Sub Total (C + J)	**2590.93**		**14.93**	**2576.00**	**69.69**	**185.59**	**283.02**	**460.03**	**499.31**	**486.67**	**416.93**	**167.60**	**7.17**	**2576.00**
5.	**K - Buildings**														
	Basic cost	80.09		0.60	79.49	27.82	23.85	19.87	7.95						79.49
6.	**O - Miscellaneous**														
	Basic cost	33.25	0.65	13.39	19.86	2.98	2.98	2.98	2.38	2.38	1.99	1.59	1.59	0.99	19.86

S. N.	Description	Amount (at April 2016 PL)	Expenditure made by CVPPL, upto April,16	Expenditure to be incurred till zero date i.e Sept' 2018	Balance Expenditure	MONTHS									Total Balance Sum
						6	12	18	24	30	36	42	48	54	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7.	P - Maintenance during construction Basic cost	27.42		0.10	27.32	1.16	2.26	3.19	4.78	5.04	4.42	4.21	1.69	0.57	27.32
8.	Q - Special Tools & Plants Basic cost	1.61		0.55	1.06	0.64	0.43								1.06
9.	R - Communication Basic cost	70.76		19.95	50.81	17.78	14.00	12.70	5.08	0.25	0.25	0.25	0.25	0.24	50.81
10.	X - Environment & Ecology Basic cost	93.86			93.86	14.08	14.08	11.26	11.26	11.26	9.39	9.39	7.51	5.63	93.86
11	Y - Losses on Stock Basic cost	6.85			6.85	0.29	0.56	0.80	1.19	1.27	1.11	1.05	0.42	0.14	6.85
12	**Total of I-Works**	**3010.74**	**7.08**	**90.34**	**2920.40**	**162.86**	**269.65**	**338.86**	**495.17**	**520.32**	**504.44**	**434.05**	**179.69**	**15.37**	**2920.40**
13	II - Establishment Basic cost	206.38	14.46	21.46	184.92	8.81	15.87	21.63	31.89	33.59	29.57	28.02	11.38	3.96	184.92
14	III - Tools and Plant Basic cost	2.00			2.00	0.11	0.18	0.23	0.34	0.36	0.29	0.30	0.12	0.07	2.00
15	V - Receipt and Recoveries(-) Basic cost	-4.96	-0.0018	-0.0068	-4.96						-1.24	-1.24	-0.99	-1.19	-4.96
16	INDIRECT CHARGES I - Capitalised value of abatement of land revenue Basic cost	0.18			0.18	0.08	0.08	0.02	0.01						0.18
17	II - Audit & Accounts charges Basic cost	7.53			7.53	0.42	0.69	0.87	1.28	1.31	1.10	1.12	0.46	0.24	7.53
18	Total Civil Works Basic cost	**3221.86**	**21.54**	**111.80**	**3110.06**	**172.27**	**286.47**	**361.62**	**528.68**	**555.61**	**534.15**	**462.24**	**190.87**	**18.16**	**3110.06**

केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
तापीय सिविल अभिकल्प प्रभाग
Thermal Civil Design Division

Sub: Kwar H.E. Project (4 x 140 MW) in J & K: Construction Schedule and Phasing of Cost of Civil & HM Works –Reg.

In continuation of this office's letter no. 4/21/Kwar/2007/TCD/820-22 dated 10.11.2016, it is to inform that as per summary of expenditure incurred by NHPC vide their letter no. NH/C&JV/JV 01/890 date 07/10/2014, the capital expenditure incurred (taken from audited account as on 31.03.2014) on Kwar and Kiru project is Rs. 104.92 crore. Further, as per CVPP's letter no. CVPP/CE (HQ)/camp- FBD/445 dated 31-10-2016, the amount of Rs. 52.33 Crore has been considered in Kiru HE project and the balance amount of Rs 52.59 crore shall be booked in the cost of Kwar H E Project. As this expenditure has already been incurred, so no phasing is required for this amount.

This is for information & necessary action, please.

11/11/16
(नीरज कुमार)
निदेशक

मुख्य अभियन्ता, (एच.पी.ए-I), के0वि0प्रा0

सं0. 4/21/ कवार/2007/टीसीडी/824-26 दिनांक: 11.11.2016

प्रतिलिपि: सूचनार्थ एवं कार्रवाई हेतु :

1. निदेशक (पी.ए.सी),के0वि0प्रा0 ।
2. Chief Engineer(HQ), 2nd Floor, JKPCC Building Rail Head Complex, Panama Chowk, Jammu-180012 (J&K).

भारत सरकार
Govt. of India
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
[ISO: 9001-2008]
जल विद्युत परियोजना मूल्यांकन-I प्रभाग
Hydro Project Appraisal-I Division
सप्तम तल, सेवा भवन, आर.के.पुरम, नई दिल्ली -110066
7th Floor, Sewa Bhawan(N), RK Puram, New Delhi-110066

Subject: Kwar HEP (4x140=560MW) H.P.-Half yearly phasing of expenditure regarding.

This has reference to CVPP of letter no.-CVPP/CE(HQ)/Kwar/Camp-Fbd/2016/457 dated 04.11.2016, please find enclosed herewith the phasing of estimated hard cost (at present day level) of Kwar HE Project as finalized in TCD Division (civil works) and HPA-I Division (E&M Works).

1. Gross installed capacity -560 (4x140MW)
2. Phasing of hard cost (at present day level) of the project is given at **Annex-I.**
3. Design energy of the project is 1975.54 MU.
4. Zero Date for main construction works- 1st Sept, 2018
5. Pre-Construction period of the project before 'Zero Date' has been considered as 18 months and the main construction period after 'Zero Date' has been considered as 54 months.
6. Project is proposed as underground power house with static excitation system.
9. Unit wise commissioning schedule of the project is given below:

Main PH		
1st Unit	-	51th month
2nd Unit	-	52nd month
3rd Unit	-	53rd month
4th Unit	-	54th month

It is requested that IDC & FC and tariff of the project may be calculated for inclusion in the Authority note for the concurrence of the project likely to be discussed on the Concurrence meeting.

Encl: as above

11.11.16
(श्रवण कुमार)
निदेशक (एचपीए-I)
ईमेल- dirhpa3@gmail.com

Chief Engineer (F&CA), CEA

No: 203/25/2016-HPA/ 724 Date: 11.11.2016

Copy for information to: Director (PAC), CEA

513

ANNEX-I

KWAR HEP(4X135=540 MW)- J&K
Phasing of Expenditure
(Rs. in Crores)

Year	Half Yearly	Present Day Cost (At April, 2016 PL)			
		CIVIL	E&M	Security Expenses	TOTAL
Expenditure incurred by NHPC		52.59	0.00	0.00	52.59
Expenditure made by CVPP upto April,2016		21.54	0.00	0.00	21.54
Expenditure to be made till Zero date (1.9.2018) from Apr 2016		90.26	0.00	0.00	90.26
Sub-Total :		**164.39**	**0.00**	**0.00**	**164.39**
1	I	172.27	0.00	9.00	181.27
	II	286.47	0.10	9.00	295.57
Sub-Total :		**458.74**	**0.10**	**18.00**	**476.84**
2	I	361.62	104.94	9.00	475.56
	II	528.68	147.67	9.00	685.35
Sub-Total :		**890.30**	**252.61**	**18.00**	**1160.91**
3	I	555.61	202.80	7.84	766.26
	II	534.15	201.91	7.84	743.90
Sub-Total :		**1089.76**	**404.71**	**15.69**	**1510.15**
4	I	462.24	170.22	7.64	640.30
	II	190.87	109.71	7.84	308.43
Sub-Total :		**653.11**	**279.93**	**15.69**	**948.73**
5	I	18.16	104.04	7.844	130.04
Sub-Total :		**18.16**	**104.04**	**7.84**	**130.04**
Grand Total		**3110.06**	**1041.38**	**75.22**	**4391.05**

(109)

CVPP/Pdd/R-208
16-11-2016

केन्द्रीय विद्युत प्राधिकरण
CENTRAL ELECTRICITY AUTHORITY
F & C A Division, E & C Wing
वि0 एवं वा0 मूल्यांकन प्रभाग, आ0 एवं वा0 स्कंध
SEWA BHAWAN, R. K. PURAM, NEW DELHI – 110 066
सेवा भवन, रा0 क0 पुरम, नई दिल्ली – 110066

ISO : 9001 – 2008
आईसओ: 9001 – 2008

विषय: Appraisal Note for CEA Appraisal of Kwar HEP (540 MW) in Jammu & Kashmir.

संदर्भ: PAC letter No.2/NHPC/57/CEA/07-PAC/936-75 dated 7.11.2016

This is reference to PAC letter dated 7.11.2016 for Appraisal of Kwar HEP (540 MW) in Jammu & Kashmir by M/s Chenab Valley Power Projects Pvt. Ltd. to be hold 15.11.2016 at 4:30 PM

The hard cost and other parameters forwarded by HPA Division-I vide their letter dated 11.11.2016 have been considered for computation of IDC and tariff. The Appraisal Note of F&CA Division, in respect of Kwar HEP for Appraisal of CEA , is enclosed herewith.

This issue with the approval of Member (E&C), CEA.

संलग्न : यथोपरि

प. बत्रा 15/11/2016
(Pankaj Batra)
मुख्य अभियन्ता

✓ निदेशक (PAC Directorate), के. वि. प्रा.
स0: 1/204/के वि प्रा/ आ एवं वा/वि वा मू/ 1138 दिनांक :11.11.2016
15

Copy to: मुख्य अभियन्ता (HPA-I), के.वि.प्रा.

Appraisal Note on F&CA aspects
Appraisal Meeting to be hold on 15.11.2016

1	Name of Project:	Kwar HEP		
2	Capacity(MW):	540 MW		
3	Name of Promoter:	M/s Chenab Valley Power Projects Pvt. Ltd.		
4	Location:	Kishtwar	District	
5	State:	Jammu & Kashmir		

A. Present Day Cost (at April, 2016 Price Level)
(Information based on HPA-I Division letter No.203/25/2016/HPA/724 dated 11.11.2016)

Sl. No.	ITEM	Foreign Currency Component				Indian Component Rs Crores	Total Cost Rs Crores	% of Total Cost
		Currency	Amount in million	Exchange Rate (@)	Equivalent Indian RsCr.			
1	Hard Cost				0.00	4391.05	4391.05	88.72
		US$			0.00	532.21	532.21	10.75
2	IDC				0.00	25.98	25.98	0.52
3	Financing Charges				0.00			
	TOTAL(Incl.IDC &FC)	Euro	0.00	0.00	0.00	4949.24	4949.24	100.00
		US$	0.00	0.00	0.00			
	Completion Cost Rs.crs/MW		9.17					

B. FINANCIAL PACKAGE SUMMARY

B1 Sl. No.	DEBT FINANCING Source/ Name of Agency	Currency	Amount	Exchange Rate (@)	Equivalent Indian Rs Cr	Interest Rate % (Fixed/ Floating)		
(a)	Foreign Debt	NIL				N/A		
(b)	Domestic Debt				3464.47	10.55%		70%
(i)	Rupee Term Loan	Rs	(b) Sub-Total =		3464.47	% of Total Cost		
								70%
	TOTAL DEBT (a) + (b)=				3464.47	% of Total Cost		

B2 Sl. No.	EQUITY FINANCING Source/ Name of Equity Partners	Currency	Amount	Exchange Rate (@)	Equivalent Indian Rs Cr	REMARKS	
(a)	Foreign Equity		NIL				
(b)	Domestic Equity	Rs	(b) Sub-Total =		1484.77	% of Total Cost =	30%
					1484.77	% of Total Cost	30%
	TOTAL EQUITY (a) + (b)				1484.77	DEBT : EQUITY RATIO	70:30
	DEBT+EQUITY (B1 + B2) =				4949.24		

B3 Sl. No.	FINANCING CHARGES ITEM	Up front Charges Rs Cr	Committ-ment Charg Rs Cr	Guarantee Fees Rs Cr	Others (if any) Rs Cr	Total Financing Charges(Rs Cr.)	REMARKS
	DEBT	25.98				25.98	0.75% of Debt
	Rupee Term Loan						
	TOTAL	25.98				25.98	

C. **OBSERVATIONS**

(i) The hard cost and phasing of expenditure has been taken as per HPA-I Division letter dated 11.11.2016
(ii) The hard cost is based on present day cost at PL April, 2016]
(iii) The project is proposed to be financed with a debt -equity ratio of 70:30
(iv) Gestation Period of the project is 54 months from zero date i.e. 1.9.2018 as per HPA I Division letter dated 11.11.2016
(v) The rate of interest as proposed by developer is @10.55% per annum for loan.
(vi) IDC & FC is based on deploying 30% of equity up-front.
(vii) Financing Charges adopted as proposed by developer 0.75% for loan.

D. **TARIFF ASSUMPTIONS-As per CERC Tariff Regulations, 2014**

1	Installed Capacity (4x156 MW)	540	2	Equity (%)	30.00%
3	Design energy MU	1975.54	4	Debt (%)	70.00%
5	Auxilliary power consumption	1.20%	6	Loan Repayment period	CERC Norms
7	Free power	13%	8	O&M charges (escalation @ 6.64%)	2.50%
9	Depreciation	CERC norms	10	Interest on loan	10.55%
11	Return on equity	16.50%	12	Interest on working capital	12.80%
13	Life of plant	35 years	14	Corporate tax	34.61%
15	Minimum Alternate Tax (MAT)	20.96%	16	Discounting factor	10.69%
			17	Maintenace Spares(% of O&M cost)	15.00%

E.

	Tariff (Rs./Kwh)	
	Ist Year	Levelised
With 13% free power as per CERC Norms	6.21	5.77

Note: This is only indicative tariff.

F. **Levelised tariff of other Hydro Power Projects recently cleared by CEA is enclosed as ANNEXURE**

ANNEXURE

Levelised Tariff of H E Projects recently cleared by CEA

S.No	Project Name Promoter Date of issue of TEC	Capacity MW	Cost/ MW Rs.Crs	Levelised Tariff (Rs/Kwh) Capacity Charge	 Energy Charge	 Total
1	Athirappailly KSEB – Kerala 31.3.2005	163	2.37	1.35	0.83	2.18
2	Rampur HEP SJVNL in HP 9.12.2005	412	5.69	0.87	0.9	1.77
3	Lata Tapovan HEP NTPC Hydro Ltd. 8.2.2006	171	4.63	0.58	0.7	1.28
4	Teesta HEP St –III Tista Urja Lt. 12.5.2006	200	4.75	0.96	0.86	1.81
5	Pakal Dul HEP M/s NHPC Ltd 03.10.2006	1000	5.09	1.3	1.24	2.54
6	Rammam HEP St- III NTPC 12.9.2006	120	5.28	0.92	1.07	1.99
7	Vishnugad Pipalkoti M/s THDC Ltd. 21.09.2006	444	4.71	1.02	0.94	1.96
8	Kotlibhel 1A M/s NHPC Ltd 03.10.2006	195	5.62	0.91	0.86	1.77
9	Kotlibhel 1B M/s NHPC Ltd 31.10.2006	320	5.65	1.2	1.14	2.34
10	Kotlibhel St – II M/s NHPC 30.11.2006	530	4.78	1.06	1.01	2.07
11	Loktak Down stream NHPC 15.11.06	66	8.64	0.71	1.22	1.93
12	Teesta St VI HEP Lanco Energy Pvt. Ltd 27.12.2006	500	6.57	1.2	1.1	2.3
13	Pala Maneri HEP M/s UJVN Ltd 23.02.2007	480	4.01	0.77	0.69	1.46
14	Rangit St. IV Jal Power Corp. Ltd. 06.07.2007	120	6.05	1.39	1.04	2.43
15	Lower Jurala APGENCO 24.07.2007	240	3.78	1.47	0.94	2.41
16	Pare HEP NEEPCO 24-09-2007	110	5.03			2.01
17	Dibang HEP NHPC 23-01-2008	3000	5.48			2.69
18	Gundia HEP KPCL 25-04-2008	200	5.6			2.67

ANNEXURE

Levelised Tariff of HE Projects recently cleared by CEA

S.No	Project Name Promoter Date of issue of TEC	Capacity MW	Cost/ MW Rs.Crs	Levelised Tariff (Rs/Kwh)		
				Capacity Charge	Energy Charge	Total
19	Singoli Bhatvari HEP L&T Uttaranchal 11.07.2008	99	6.73			2.63
20	Alaknanda HEP GMR Energy Ltd. 08.08.08	300	4.72			2.14
21	Rupsiabagar Khasiabara – NTPC Ltd. 16.10.2008	261	6.57			2.85
22	Demwe Lower – Athena Demwe PPL 20.11.2009	1710	7.51			3.37
23	Lower Siang – M/s Jaypee Arunachal Power Limited 16.02.2010	1600 (Ph-I) 2700 (Overall)	8.73 7.4			2.93 2.97
24	Teesta IV HEP M/s NHPC Ltd. 15.04.2010	520	6.91			3.14
25	Kuther HEP M/s JSW Energy Ltd 10.08.2010	240	7.49			3.77
26	Baglihar HEP Stage-II M/s J&K SPDC ltd 29.12.2010	450	4.70 (Without Mega) 4.46 (With Mega)			2.91 2.76
27	Sainj HEP HPPC ltd 29.12.2010	100	6.76			3.70
28	Panan HEP Himagiri H.E.P ltd 07.03.2011	300	6.10			3.36
29	Nafra HEP M/s SEW Nafra Power Corpn. Pvt. Ltd. 11.02.2011	120	7.07			3.69
30	Nayamjang Chhu M/s NJC Hydro Power Ltd. 25.01.2011	130	3.01 (Without Mega) 7.82 (With Mega)			3.92 3.82
31	Kolodyne HEP M/s NTPC 14.09.2011	460	1.26			5.83
32	Tawang-I HEP M/s NHPC 10.10.2011	600	7.98			3.25
33	Tawang-II HEP M/s NHPC 22.09..2011	800	7.98			3.54

ANNEXURE

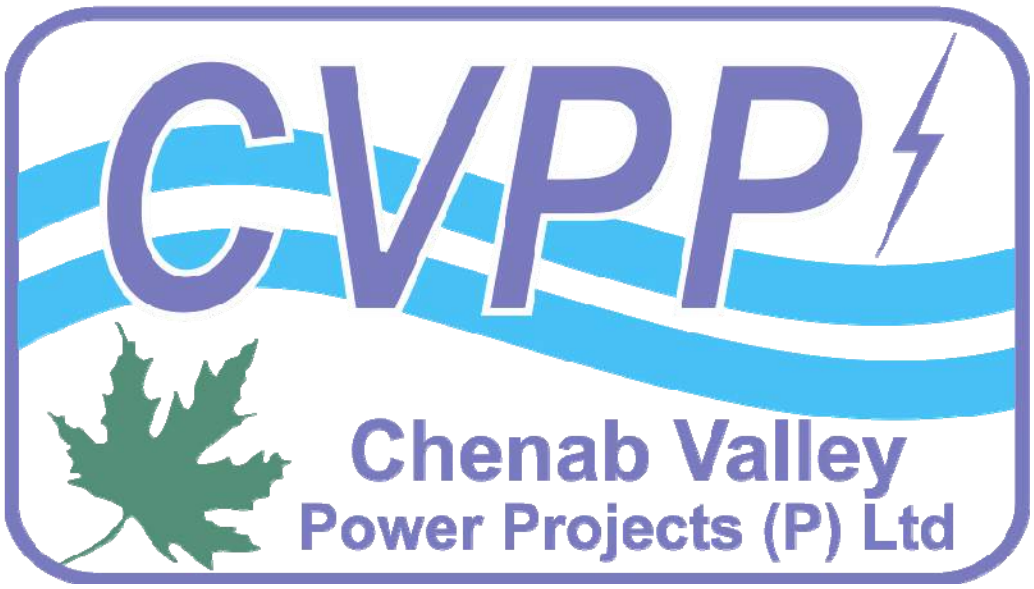
Levelised Tariff of hydro Projects recently cleared by CEA

S.No	Project Name Promoter Date of issue of TEC	Capacity MW	Cost/ MW Rs.Crs	Levelised Tariff (Rs/Kwh)		
				Capacity Charge	Energy Charge	Total
49	Kalai-II HEP M/s Kalai Power Pvt. Ltd. 8.1.2014	1.00	11.83			6.56 (CERC) *RoE @16.5%
50	Chango Yangthang M/s Malan Power Co. Ltd 31.03.2014	[illegible]	11.54			6.53(CERC) *RoE @16.5%
51	Diku HEP M/s Naga Mani Power pvt ltd 31.03.2014	96	11.83			7.37(CERC) *RoE @16.5%
52	New Ganderbal HEP J&K SPDC Ltd. 10.06.2014	93	10.39			4.74 (CERC) 4.34 (JKERC) without free power
53	Chhatru HEP M/s DCM Sriram Infrastructure Ltd 15.01.2015	118	11.00			7.05(CERC) *RoE @16.5%
54	Kynshi - I HEP M/s Athena Kynshi Power Pvt. Ltd. 28.01.2015	270	11.68			7.07(CERC) *RoE @16.5%
55	Heo HEP M/s Velcan Energy 16.04.2015	240	6.73			3.85(CERC) RoE @15.5%
56	Tato-I HEP M/s Siyota Hydro Power Ltd 04.06.2015 (Letter to be issued)	186	8.03			4.40(CERC) RoE @16.5%
57	Lower Kopili HEP APGCL	120	9.30			3.37(AERC) RoE @15.5%
58	Seli HEP Seli Hydro Electric Power Corp. Ltd.	400	10.30			5.85 (CERC) *RoE @16.5%
59	Kiru HEP Chinab Valley Power Projects Pvt. Ltd.	624	7.44			4.51 (CERC) *RoE @16.5%
60	Sach Khas L&T Hydro Power Ltd (meeting to be held)	99	12.70			8.36 (CERC) *RoE @16.5%
61	Loktak D/s HEP M/s Loktak Downstream Hydroelectric Corporation Ltd.	66	20.5			6.20 (RoE 15.5%) 6.06 (RoE 14%) with 1% free power
62	Kwar HEP Chinab Valley Power Projects Pvt. Ltd	540	9.17			5.77 (CERC) *RoE @16.5%

ANNEXURE

Levelised Tariff of HEP Projects recently cleared by CEA

S.No	Project Name Promoter Date of issue of TEC	Capacity MW	Cost/ MW Rs.Crs	Levelised Tariff (Rs/Kwh) Capacity Charge	Energy Charge	Total
34	TATO-II HEP M/s NHPC 22.05.2012	00	7.98			3.80
35	Vyasi HEP M/s UJVN Ltd 25.10.2011	20	7.80			4.63 (CERC) 4.19 (JERC)
36	Bajoli Holi HEP M/s GMRHP Ltd 30.12.2011	80	9.43			4.70 (CERC) 4.79 (HPERC)
37	Indira sagar (Polavaram) M/s APGENCO 21.02.2012	80	3.14			3.17 (CERC) 2.78 (APERC)
38	Shongtong Karcham HEP M/s HPPCL 16.08.2012	50	6.24			3.62 (CERC) 3.95 (HPERC)
39	Devsari HEP M/s SJVNL 07.08.2012	49	6.19			3.57 (CERC)
40	Ratle HEP M/s GVK Ratle 19.12.12	50	6.49			3.85(CERC)
41	Miyar HEP M/s Miyar Hydro Electric Power co 7.2.2013	20	9.38			5.50(CERC)
42	Hirong-II HEP M/s Jaypee Arunachal Power Limited 10.04.2013	00	10.33 with Mega			5.48(CERC)
43	Gongri HEP M/s Dirang Energy Pvt 4.02.2013	44	9.97			4.98(CERC)
44	Etalin-II HEP M/s Etalin Hydro Electric Power Co 12.07.2013	397	8.17			4.07(CERC)* * ROE-16.5%
45	Dagmara HEP-17X7.65MW M/s BHPC Dtas of meeting - 20.3.2013 (Letter to be issued)	30.05	22.51			13.01(CERC) without free power
46	Talong Londa HEP M/s GMR Londa Hydro Power Pvt. Ltd. 16.8.2013	25	9.66			5.54(CERC) * ROE-16.5%
47	Naying HEP M/s Naying DSC Power Ltd. 11.9.2013	300	9.30			4.73 (CERC) *RoE @16.5%
48	Siyom HEP M/s Siyom Hydro Power Pvt. Ltd. 17.12.2013	300	12.10			6.71 (CERC) *RoE @16.5%



Save Energy for Benefit of Self and Nation