BEFORE HON'BLE PUNJAB STATE ELECTRICITY REGULATORY COMMISSION,

AT CHANDIGARH

PETITION NO. 02 / 2020

IN THE MATTER OF:-

M/s Everest Power Private Ltd. ....Petitioner

Versus

1. **M/s Punjab State Power Corporation Ltd**
2. **M/s PTC India Ltd. ....Respondents**

FILING OF PETITION FOR BUSINESS PLAN INCLUDING CAPITAL INVESTMENT PLAN FOR CONTROL PERIOD FROM FY 2020-21 TO FY 2022-23 UNDER REGULATION 9 OF THE PUNJAB STATE ELECTRICITY REGULATORY COMMISSION (TERMS & CONDITIONS FOR DETERMINATION OF GENERATION, TRANSMISSION, WHEELING & RETAIL SUPPLY TARIFF) REGULATION), 2019.

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Date: 22nd January, 2020

Place: New Delhi

Everest Power Private Limited
New Delhi

Petitioner

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Most Respectfully Showeth:-

1. The Petitioner is **M/s Everest Power Private Ltd,('EPPL')**, a Company incorporated under the Companies Act, 1956, having its Registered office at 1st House, Bhumian Estate, Nav Bahar Road, Chhota Shimla, Shimla – 170002, (Himachal Pradesh) and Corporate Office at Hall A, First Floor, Plot No. 143-144, Udyog Vihar, Phase IV, Gurgaon – 122015, Haryana, and is a Generating Company within the meaning of Section 2 (28) of the Electricity Act, 2003. EPPL has developed 100 MW Malana- II Hydro Electric Project in District Kullu, in the State of Himachal Pradesh which was declared under commercial operation on 12.07.2012 (**'Project'**).

2. That the Respondent No. 1 is **M/s Punjab State Power Corporation Ltd ('PSPCL')**, a Company registered under the Companies Act, 1956 having its

Office at The Mall, Patiala-147001 (Punjab). PSPCL has been entrusted with the responsibility of generation and distribution of power in the State of Punjab.

3. The Respondent No. 2 is **M/s PTC India Ltd ('PTC')**, a Company incorporated under the provisions of the Companies Act, 1956 having its registered office at 2nd Floor, NBCC Tower, 15, Bhikaji Cama Place, New Delhi – 110066. PTC has a license to undertake the activity of inter-State trading in electricity, granted to it by the **Hon'ble Central Electricity Regulatory Commission ('CERC').**

BUSINESS PLAN INCLUDING CAPITAL INVESTMENT PLAN FOR THE CONTROL PERIOD FROM FY 2020-21 to FY 2022-23

4. Regulation 9.1 of PSERC MYT Regulations, 2019 specifies as under:

> *"9.1. The Applicant shall file the Business Plan including the Capital Investment plan for its Generation, Transmission, SLDC and/or Distribution businesses, as the case may be for approval of the Commission on or before 20th August of the year preceding the first year of the Control Period for a duration covering the entire Control Period."*

5. Further, Regulation 9.3 of the PSERC MYT Regulation, 2019 states that:

> *"9.3 The Business Plan for Generation Business shall contain among other things the following:*
>
> *(a) Capacity addition / reduction;*
>
> *(b) Availability forecasts;*
>
> *(c) Future performance targets;*
>
> *(d) Proposed efficiency improvement measures;*
>
> *(e) R&M of existing generation units/projects and any other new measures to be initiated for the Generation Business, e.g.; automation, IT initiatives etc.;*

(f) Capital Investment Plan based on the above;

(g) Man Power Plan."

6. Further, Regulation 9.7 of the PSERC MYT Regulation, 2019 states that:

> *"The Capital Investment Plan covering the entire MYT Control Period will be submitted in the following two parts:*
>
> *a) Ongoing schemes of the previous MYT Control Period (i.e. works / schemes which are under construction or where full payments have not yet been made). All spillover works will be included in this;*
>
> *b) Schemes to be taken up in the order of priority giving the schedule over the full MYT Control Period. In case it is likely to take more than 3 years, the likely date of completion should also be given. This will also include such schemes which were part of the Capital Investment Plan of the previous MYT Control Period but could not be started and which the Applicant considers necessary to take up during the present Control Period."*

7. From the above, it may be stated that Business Plan including Capital investment Plan is intended to give a comprehensive present picture of the Company, availability forecasts, future performance targets, proposed efficiency improvements measures, R&M of existing generation units/projects and any other new measures to be initiated for the Generation Business, e.g. automation, IT initiatives etc. Accordingly, EPPL is hereby filing the Business Plan including Capital Investment Plan for the MYT Control Period from FY 2020-21 to FY 2022-23, based on the available data for previous years and future projections which have been prepared assuming the generation targets and various other relevant assumptions.

8. The Business Plan for the MYT Control Period has been prepared considering the provisions of the Electricity Act 2003 and the Policies issued by the

Government of India namely the National Electricity Policy & Tariff Policy and also the PSERC MYT Regulations 2019. Some of the relevant key provisions of the same are briefly discussed below.

9. Pursuant to the Electricity Act 2003, it was emphasized that the national policies on various matters would provide the guiding framework for the power sector parameters. Electricity Act, 2003 has also de-licensed the Generators and freed them from requirement of any license. There is no provision in the Act for regulating a Generating Company, only its generation tariff is determined by the Appropriate Regulation Commission in the case of sale of power to distribution licensees on long term basis. However, Generators are required to meet the technical standards with respect to connectivity to the Grid and also, the hydroelectric, are required to obtain the Concurrence of the scheme from the concerned competent authority.

10. Electricity is an essential requirement for all facets of life. The availability of reliable and quality power is very crucial to sustain economic growth. The nation has set itself the target of providing electricity to all which is a daunting task requiring significant addition to generating capacity and also expansion of transmission and distribution network. Electricity Act also provides an enabling framework for accelerated and more efficient development of power sector.

11. Ministry of Power, Government of India has notified the National Electricity Policy in 2005 outlining the plan for rural electrification and increase in generation capacity with emphasis on the development of hydro power. The Act also enables Central Government to review or revise the National Electricity Policy from time to time.

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New Delhi

12. The Tariff Policy notified by the Government of India deals with various parameters w.r.t fixation of tariff such as providing ensuring availability of electricity to consumers at reasonable and competitive rates and ensuring financial viability of the sector & attracting investments and also providing for adequate return on investments. Policy also provides for uniform guidelines for fixation of tariff for SERC & CERC.

13. It is also emphasized in the Hydro Policy of the Government of India that the ideal hydro thermal ratio of the generating capacity should be 40:60. Whereas presently, the same is around 20:80 only. Thus, there is an urgent need to encourage the development of hydro generating stations and also to fully utilise the available hydro capacity in order to reduce the skewed gap in the hydro thermal mix. The hydro power requirement is even much more in the state of Punjab where the hydro thermal mix is even less than 20:80.

14. EPPL which is supplying the power from its 100MW Malana – II HEP on long term basis for a period of 40 years to the State of Punjab through M/s PTC India Ltd, has prepared its Business Plan for the control period in light of the above regulatory background and as per the provisions of the PSERC MYT Regulations 2019.

15. EPPL is a special purpose vehicle for 100MW Malana – II Hydroelectric Project (Project) situated in district Kullu, Himachal Pradesh. The Project has achieved the commercial operation on 12th July 2012. The entire power generated by the Project after deducting the auxiliary consumption and free power to Government of Himachal Pradesh is being sold to Punjab State Power Corporation Limited (PSPCP) through PTC. Thus, the only source of revenues for EPPL is revenues from sale of power from the 100MW Malana – II Project. The tariff for the Project is being determined by Hon'ble PSERC as per the applicable PSERC Regulations.

16. The details as required under Regulation 9.3 are given in the following paras.

16.1. Capacity addition / reduction

The installed Capacity of the Project is 100MW and with 15% overload it can generate 115MW. There is no immediate plan for capacity addition / reduction of Malana II Hydroelectric Project.

16.2. Availability Forecast

The Power Plant will be available for generation during the Control Period. The plant is subject to regular preventive maintenance and sufficient mechanical, electrical & electronic spares are procured from time to time. Moreover, one set of casted runners have been replaced with forged runners, up gradation of SCADA system in the Power Plant & Substation has been carried out and new Excitation System has been installed. Further a dedicated team of efficient engineers & skilled man power is operating the Power Plant.

All efforts will be put together to reach the level of 100% Plant Availability Factor during MYT Control period 2020-21 to 2022-23.

16.3. Future Performance Targets

16.3.1. The design energy of the Project is 403.27 MUs per annum after considering the mandatory discharge. The Auxiliary consumption is estimated to be 1.3% of the design energy as per CERC (Terms and Conditions of Tariff Determination) Regulation, 2019. These assumptions and facts were also recognized by Hon'ble PSERC vide its order dated 27.11.2013 and consequential order dated 4.12.2014. It is also submitted that EPPL is required to pay free power royalty to Government of Himachal Pradesh @12% of the generation as per provisions of the Implementation Agreement (IA) for up to 12 years from the COD of the Project and @18% from 13th year from COD till 40th years.

16.3.2. In view of the above, EPPL's target generation details during the control period i.e. FY 2020-21 to FY 2022-23 are estimated as per following paras.

As per design energy which is 403.27MU's, the net saleable energy for Control period i.e. FY 2020-21 to FY 2022-23 are estimated as below:

Target Generation as per approved Design Energy

(In MU's)

Particulars	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**
Gross Generation	403.27	403.27	403.27
Less: Auxiliary Consumption @ 1.3%	5.24	5.24	5.24
Less: 12% Free Power to GoHP	47.76	47.76	47.76
Net Saleable Energy	350.26	350.26	350.26

It is submitted that the average actual Annual Gross Generation of last four years is 360.74 MUs. The difference between design and actual gross energy is majorly on account of low discharge. The details of gross generation of last four years are given below:

Financial Year	**Gross Generation (MU)**
FY 2015-16	352.98
FY 2016-17	371.73
FY 2017-18	368.88
FY 2018-19	349.37
Average Gross Generation Generation (MU)	360.74
1.3 % Aux. Consumption (MU)	4.69
Gross Energy at Ex - Bus (MU)	356.05
12% Free Power to GoHP at Ex Bus (MU)	42.73
Net Saleable Energy to PSPCL at Ex - Bus (MU)	313.32

Accordingly, EPPL revised its target of Annual Gross Generation to 360.74 MUs during the control period FY 2020-21 to 2022-23. The table depicting revised generation target is given below:

Particulars	FY 2020 - 21	FY 2021 - 22	FY 2022 - 23
Gross Generation	360.74	360.74	360.74
Less 1.3% Aux. Consumption	4.69	4.69	4.69
Less 12% Free Power to GoHP	42.73	42.73	42.73
Net Saleable Energy at Ex-Bus	**313.32**	**313.32**	**313.32**

It is also submitted that EPPL has already appointed a consultant to review the actually observed discharge data at the Project site to arrive at the optimum design energy as per the provisions of the applicable CERC regulations. Upon completion of this review, EPPL shall submit the report to the competent authority for revision of design energy of Malana-II 100 MW HEP. Consequent to approval of competent authority, the report/approval shall be submitted to the Commission for its perusal.

16.4. Proposed efficiency improvement measures

The efficiency of the Generating Units has been improved and optimized by designing one set of new forged runners and replacing casted runners. The efficiency of both the generating units (Unit-1 & 2) has increased by 7% at 100% load condition, and the Plant is generating maximum energy (115MW) with 15% overload. In addition, the man power deployed in the Power Plant for Operation & Maintenance is being trained regularly and the efficiency of all appurtenant machines and tools are being further optimized. All measures are being implemented to maintain the highest efficiency of the Power Plant.

16.5. R&M of existing generation units/project and any other new measures to be initiated for the Generation Business, e.g.; automation, IT initiatives etc.

It is submitted that EPPL has significantly reduced the Plant Downtime by taking Preventive Annual Maintenance regularly and minimizing duration of annual maintenance of the Power Plant and its appurtenant components. The repair & maintenance activities include works such as repair of any damages to the civil structures, Spillways, radial gate seals, hydraulic cylinders, replacement of worn out/depleted auxiliaries, Repair & replacement of mouth rings, nozzles, cleaning and tightening of electrical equipment, inspection & repair of firefighting equipment & HVAC system; maintenance of ropeways which are life line for Surge Shaft, Bonnet Gate and Adit-4 areas, upkeep & maintenance of approach & access roads, repair of damages caused by landslide, cloud bursts and heavy snowfall to the approach roads and project components. All these activities will be carried out as and when required for smooth operation of the Power Plant.

16.6. CAPITAL INVESTMENT PLAN

16.6.1. Regulation 9.7 of the PSERC MYT Regulation, 2019 states that:

> " *9.7. The Capital Investment Plan covering the entire MYT Control Period will be submitted in the following two parts:*
>
> *a) Ongoing schemes of the previous MYT Control Period (i.e. works / schemes which are under construction or where full payments have not yet been made). All spillover works will be included in this;*
>
> *b) Schemes to be taken up in the order of priority giving the schedule over the full MYT Control Period. In case it is likely to take more than 3 years, the likely date of completion should also be given. This will also include such schemes which were part of the Capital Investment Plan of the previous MYT Control Period but could not be started and which the Applicant considers necessary to take up during the present Control Period."*

16.6.2. Various equipment in the power station are subjected to very high stresses during the operation and by their basic design have lesser life than what is considered for the plant as a whole. The replacement of equipment's is needed at appropriate interval to ensure smooth and safe operation of the Power Plant. The proposal in this category belongs to such capital works, which are indispensable to operate generating station in a safe and smooth manner.

16.6.3. As regards the additional capitalization after cut-off date, Regulation 18.2 of PSERC MYT Regulations, 2019 specifies as under:

> *"18.2. The Capital Expenditure of the following nature actually incurred after the cut-off date may be admitted by the Commission. Subject to prudence check:*
>
> *a. Un-discharged/Deferred liabilities relating to works/services within the original scope of work;*
>
> *b. Liabilities to meet award of arbitration or for compliance of the order or decree of a court;*
>
> *c. On account of change of law;*
>
> *d. Any additional works/services which have become necessary for efficient and successful operation of the project, but not included in the original project cost; and*
>
> *e. In case of hydro generating stations, any expenditure which has become necessary on account of damage caused by natural (but not due to flooding of power house attributable to the negligence of the generating company) including due to geological reasons after adjusting for proceeds from any insurance scheme, and expenditure incurred due to any additional work which has become necessary for successful and efficient plant operation:*

Provided that any expenditure on acquiring the minor items or the assets like tools and tackles, furniture, air-conditioners, voltage stabilizers, refrigerators, coolers, fans, washing machines, heat convectors, mattresses, carpets etc. brought after the cut-off date shall not be considered for additional capitalization for determination of tariff w.e.f. the date of the start of first year of the control period".

The above said regulation allows the additional capitalization for the generating stations after cut-off date. EPPL proposes the capital investment schemes under above Regulation for efficient and successful operation of the plant.

16.6.4. Accordingly, EPPL is submitting its Capital Investment Plan for control period (FY2020-21 to FY 2022-23) for its 100MW Malana-II Hydroelectric Project in the following paras:

Part- A: Ongoing schemes of the previous MYT Control Period i.e. FY 2017-18 to FY 2019-20

16.6.4.1. Purchasing of Runners & nozzle Assembly :

As per the Order dated 30.07.2018, Hon'ble Commission has allowed Purchase of Runners & Nozzle Assembly of Rs. 5.50 Cr in FY 2017-18 & Rs. 5.50 Cr. in FY 2018-19 subject to submission of IIT Roorkee report before the actual expenditure on procurement of Runners is incurred in the respective years.

Two numbers of new forged runners (1 & 2) have been procured and successfully installed in FY 2018-19, and two more fully forged runners are expected to be delivered at site in FY 2020-21, which will be kept as spares. As directed by Hon'ble Commission the IIT Roorkee has already been submitted to the Hon'ble Commisssion.

The approximate cost of Runners being procured in FY 2020-21 has been estimated to Rs. 5.50 Crores excluding taxes.

16.6.4.2. LEFT ABUTMENT SLOPE STABILIZATION MEASURES

Due to excessive snowfall in the winters of 2018, the large trees along the left abutment above elevation El. 2545 m got dislodged in the month of March 2019. As a result, slope failure occurred about 50m upstream of the dam axis which caused extensive damages to the slope stability measures provided such as toppling of 5m high RCC wall, damages to the catch drain at EL 2570m elevation and retaining walls provided along the slopes. Slope stability measures were initiated immediately to contain further deterioration. The services of the consultant were hired to provide effective slope treatment which is being implemented till date. Copy of Consultant Report i.e. Aquagreen Engineering Management (P) Ltd. for Left Bank Upstream Slope Protection Works Construction Methodology is enclosed as **Annexure-1.**

It is further submitted that EPPL awarded work to Balaji Operation and Maintenance Services Pvt Ltd (BOMSPL) to execute the 5m high RCC wall from RD 25 to RD 58m which an amount of Rs. 0.40 Cr. Copy of the Work Order issued to BOMSPL is enclosed as **Annexure-2**. The remaining works (Construction of 5m high RCC wall from RD 58m to RD 90m and slope execution of stabilization works above the EL2545 with GEO-JUTE to be nailed with anchors) will be suspended from December 2019 to April 2020 due to extreme winter conditions; therefore the said work will spill over to FY 2020-21.

The approximate cost of left abutment slope stabilization has been estimated to Rs. 1.00 Crores.

16.6.4.3. UPGRADATION OF SCADA SYSTEMS IN POWER HOUSE AND CHHAUR SUBSTATION

As per the directives of Ministry of Power vide its notification dated 09.10.2018, all power stations are to be cyber security compliant and cyber security audit shall be carried out by the empaneled agency. Copy of the Letter from MoP dated 9.10.2018 is attached as **Annexure 3.**

As a compliance action, the services of CyberQ Consulting Pvt. Ltd. were taken for cyber security Audit of Malana-II 100 MW Power Plant. As per their suggestions upgradation of existing SCADA system including design, engineering and supply of compatible hardware, software and upgradation of operating system for 132/220 kV step-up Chhaur Substation and Malana – II power house is being implemented. A copy of the IT Security Audit Report of SCADA Network & IT Infrastructure of CyberQ Consulting Pvt. Ltd. is enclosed as **Annexure-4**. Accordingly, EPPL issued Purchase order to Andritz Hydro Private Limited for upgradation of existing SCADA system including Design, Engineer & supply of compatible hardware & software & Gradation of Operating System (windows 10) for Power House & Chhaur Sub-station are enclosed as **Annexure-5.** The estimated cost of the above works is around Rs. 0.70 Crs.

In view of the above, the year wise details of the expenses, which are expected to be capitalized during the control period i.e.FY 2020-21 to FY 2022-23 is tabulated below:

Ongoing schemes of the previous MYT Control Period i.e. FY 2017-18 to FY 2019-20

Amount in Rs.Crs.

	ADDITIONAL CAPITALIZATION				
S.N.	**Head**	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**	**Total**
1.	Purchase of Runners & Nozzles	5.50	-	-	**5.50**
2.	Left Abutment Slope Stabilization Measures	1.00	-	-	**1.00**
3.	Upgradation Of SCADA Systems In Power House And Chhaur Substation	0.70	-	-	**0.70**
	TOTAL	**7.20**	**-**	**-**	**7.20**

It is requested that Hon'ble PSERC may consider the above amount of Rs.7.20 Cr. towards additional capitalisation under various heads while approving the Capital Investment Plan. However, as above estimates are indicative only and actual expenses may vary.

Part- B: Schemes/Works to be taken up over the MYT Control Period i.e. FY 2020-21 to FY 2022-23.

16.6.5. The details of the Schemes/Works which are to be taken-up by EPPL during the Control Period i.e. FY 2020-21 to FY 2022-23 are elaborated in in following paragraphs in the order of priority:

16.6.5.1. TOWARDS CONSTRUCTION OF CHUTE SPILLWAY:

a. EPPL intends to construct an ungated surface Spillway as per the directives and approval of the DOE, Govt. of Himachal Pradesh, in line with the thrust given by the Central Government for safe and smooth operation of all Hydro Electric Projects in view of the changing weather conditions & frequent incidents of excessive floods / cloud bursts in the upper catchment areas witnessed in past 2-3 years in Uttarakhand, Jammu & Kashmir and other parts of the Himalayan States. Such capital expenditure is admissible under the provisions of Regulation 14 (3) (viii) of the CERC (Terms and Conditions of Tariff) Regulations 2014. Relevant extracts of the same have been reproduced below:

> *"..........In case of hydro generating stations, any expenditure which has become necessary on account of damage caused by natural calamities (but not due to flooding of power house attributable to the negligence of the generating company) and due to geological reasons after adjusting the proceeds from any insurance scheme,* ***and expenditure incurred due to any additional work which has become necessary for successful and efficient plant operation;" (emphasis laid)***

Detailed Project Report on construction of additional un-gated surface Spillway, submitted to the Directorate of Energy (DOE) was accorded approval on 02.02.2018, which was submitted to the Hon'ble Commission for approval.

Hon'ble Commission in its order dated 30.07.2018 has decided that the amount of Rs. 15 Cr. will be allowed towards Construction of un-gated surface Spillway in the MYT Period i.e. FY 2017-18 to FY 2019-20. The copy of the letter of DoE dated 02.02.2018 along with DPR is enclosed herewith as **Annexure-6 & Annexure-7.**

It is submitted that, approval from Forest Department, district-Kullu was received for construction of additional Spillway on 31.10.2018, and subsequently online application was filed in MoEF & CC, New Delhi. The matter was subsequently referred to the Environment Appraisal Committee (EAC). EAC convened a meeting in this regard on 23.04.2019 for consideration of the proposal of EPPL. EAC has made recommendations to Ministry of Power for according the approval. Subsequently, EPPL was granted clearance by MoEF &CC on 5.08.2019 to commence the work. Copy of the clearance letter of MoEF & CC is enclosed as **Annexure-8**.

In view of monsoon period and ensuing winter season the works could not be initiated. Even though EPPL propose to undertake the construction of un-gated surface Spillway during the FY 2019-20. Considering the climatic condition at the project site, and without affecting the operation of the Power Plant construction of additional spillway is unlikely to be completed during 2019-20 and is expected to spill over to FY 2020-21 & FY 2021-22. Accordingly, EPPL shall claim the expenditure incurred under this head as and when the same is actually incurred as directed by Hon'ble Commission vide its Order dated 30.07.2018.

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16.6.5.2. CONSTRUCTION OF BRIDGE AND CULVERT ON ADIT-II & ADIT-I NALLAHS RESPECTIVELY

Due to frequent cloud bursts in the catchment areas of Adit – 1 & Adit – 2 Nallahs, the box culverts provided in these nallahs across the approach road to dam complex get choked due to enormous amount of debris & boulders transported down. As a result, the water of the nallahs overflow the box culvert and flows along the adjacent approach roads causing heavy damages & even wash outs of the entire road for considerable length. Recurring expenditures on cleaning the huge amount of debris and repairing the damaged roads is being incurred every year time and again. In last two consecutive years of FY 2017-18 and FY 2018-19 Rs. 0.11 Crs and Rs. 0.41 Crs were incurred for rectification works after the cloud burst respectively. As this approach road to dam is being utilized by the villagers residing in the adjoining villages, in the event of any damage to the road adjacent to these nallahs is putting enormous local and administrative pressure on EPPL for immediate rectification. Therefore, a RCC bridge with longer span is being designed and will be constructed across Adit- II Nalla, and a box culvert of adequate design length & height across Adit-I Nalla will be constructed for reliable and effective solution & avoid recurring expenditures.

Details of the proposed expense to be incurred towards construction of new bridge at Adit-II and Culvert:

(Amount Rs. in Cr.)

S.No	Particulars	FY 2020-21	FY 2021-22	FY 2022-23	Total
1	Bridge construction on Adit-2 Nallah.	0.65	-	-	**0.65**
2	Box Culvert at Adit-1 Nallah.	0.20	-	-	**0.20**
3	Box Culvert near DAM	0.20	-	-	**0.20**
	Total	**1.05**	**-**	**-**	**1.05**

Accordingly, the amount of Rs. 1.05 Cr. towards " Construction of New Bridge at Adit-II and Culvert" is expected to be incurred during FY 2020-21 (Rs. 1.05 Cr)

16.6.5.3. <u>TOWARDS CHANGE OVER OF POWER EVECAUTION SYSTEM FROM ADHPL TO HPPTCL CHHAUR BANALA 220 kV TRANSMISSION LINE:</u>

As per the decisions taken by the 31st Standing Committee, Malana II Power Plant will be an embedded project in the Chhaur - Banala 220 kV DC Transmission Line of HPPTCL. The Chhaur - Banala Transmission Line has been completed, and Malana II HEP has shifted from AD Hydro 220 kv transmission line to Chhaur- Banala 220 kv TL on 05-12-2019. The power is being evacuated by connecting the transmission line directly to the Chhaur Substation operated by EPPL. Construction of Gas Insulated Substation (GIS) of HPPTCL is likely to be commissioned during FY 2021-22 & afterwards the power of Malana – II will be evacuated through it. Copy of the minutes of the 31st Standing Committee meeting dated 02.01.2013 is enclosed as **Annexure 9.**

Therefore, interconnection of existing Chhaur Substation of EPPL with the GIS of HPPTCL will require additional equipment. In addition, Optical Fiber communication is to be laid down in the substation owned by EPPL to make the system compatible with that of HPPTCL.

Details of the proposed expense to be incurred towards procurement of material due to change in Power Evacuation System:

(Amount Rs. in Cr.)

S.No	Particulars	FY 2020-21	FY 2021-22	FY 2022-23	Total
1	Optical Fiber Communication to make it compatible with HPPTCL	-	2.00	-	**2.00**
2	HPPTCL Ss Interconnecting equipment	-	1.00	-	**1.00**
3	Equipment Spares	-	0.05	-	**0.05**
	Total	**-**	**3.05**	**-**	**3.05**

Accordingly, the amount of Rs. 3.05 Cr. towards " Procurement of Material due to change in Power Evacuation System" is expected to be incurred during FY 2020-21.

16.6.5.4. Miscellaneous (towards procurement of Office Equipment; Tools & Tackles / Machinery and Computers).

EPPL propose to procure laptops, Computers, and propose to install and replace CCTV cameras at project site at various places on DAM, Power House Complex, Substation to further enhance the security in view of the notifications issued by Department of Energy, Govt. of Himachal Pradesh letter dated 28.02.2019 is enclosed as **Annexure-10**. During the FY 2020-21 to FY 2022-23. The expenses of Rs.0.21 Cr. *(Rs. 0.15 Cr. towards computers/laptops and Rs. 0.06 Cr. towards CCTV)* is likely to be incurred towards procurement Computers/Laptops and CCTV Cameras during Control Period FY 2020-21 to 2022-23.

It is further submitted that Safety Audit of the underground powerhouse carried out by M/s AEMPL recommended to provide smoke curtains and fire retardant doors at various locations to channelize the smoke in more effective manner in the event of any fire accident which will ensure the safety of the staff working inside the powerhouse. EPPL propose to procure the Smoke

Curtains, Fire Retaurdant Doors for the safety of manpower and effective smoke channelization in the event of fire in Power house. Also procurement of tipper for transportation of material to different locations of the Project and Fork Lifter for transporting heavy equipment to and fro from store and power house. The expenses of Rs.0.80 Cr. *(Rs. 0.20 Cr. towards smoke curtains, Rs. 0.05 Cr. towards fire retaurdant door, Rs. 0.25 Cr. towards tipper, and Rs. 0.30 Cr. towards Fork lifter) is likely to be incurred during the control period i.e. FY 2020-21 to FY 2022-23.*

Accordingly, the amount of Rs. 0.62 Cr. (Rs. 0.05 Cr. towards " Procurement of computers/laptops, Rs.0.02 Cr. towards CCTV cameras, Rs.0.20 Cr. towards smoke curtains, Rs. 0.05 Cr towards fire retaurdant door & Rs. 0.30 Cr towards fork lifter is expected to be incurred during FY 2020-21, Rs. 0.07 Cr. *(Rs. 0.05 Cr. towards Computers/laptops and Rs. 0.02 Cr.)* is expected to incurred during FY 2021-22 and Rs. 0.32 Cr. *(Rs. 0.05 cr. towards computer/laptops, Rs. 0.02 Cr. towards CCTV cameras and Rs. 0.25 Cr. towards tipper)* is expected to incurred during FY 2022-23.

16.6.5.5. LAND: LEASE CLAIMED BY GOVERNMENT OF HIMACHAL PRADESH:

It is submitted that 'Land held under lease' pertains to Forest Land diverted for the Project. No lease amount was either demanded by Government of Himachal Pradesh (GOHP) or paid by EPPL up to August 2014. GoHP subsequently raised demand for an amount of Rs.5.77 Crs. vide their letters dated 11.08.2014 & 27.08.2014 (excluding interest). The said demand has been raised in accordance with the provisions of the Himachal Pradesh Ceiling on Land Holdings Act, 1972 and Himachal Pradesh Village Common Lands Vesting and Utilization Act, 1974 and the Rules framed there under by the Government of Himachal Pradesh. The

Lease Rules were notified in 1993 i.e. prior to the signing of the PPA and PSA, and thereafter amended / replaced by Lease Rules 2011 and Lease Rules, 2013 wherein the lease rates were amended in each of the said amendments.

The demand for lease amounts to ₹ 5.77 Cr. from the period commencing from 19.11.2005 (being the date of accord of Forest Clearance) to 18.11.2014 towards lease rentals and ₹ 1.24 Cr. as an annual lease rental has been conveyed in the demand letter dated 27.08.2014 received from the Government of Himachal Pradesh on the basis of the Lease Rules 1993, Lease Rules 2011 and Lease Rules 2013, as prevailing at the relevant point of time. GOHP has also directed EPPL to enter into a Lease Agreement in this regard.

In the meanwhile, some hydro generating companies in Himachal Pradesh who had also received similar demands from the GoHP, had challenged the said demands on various grounds before the High Court of Himachal Pradesh. The Hon'ble High Court vide its Order dated 05.07.2017 has remanded back the matter to the GoHP with directions to first issue proper and complete notice to show cause, to the Petitioners, and thereafter, after calling for their response and according them an opportunity of hearing, decide the issue in accordance with law. The matter presently is being under consideration of GoHP and may be finalized any time.

It is also submitted that, EPPL has not so far paid any amount to GoHP in this regard and GoHP on its part, has not so far withdrawn or modified the above demand letters raised on EPPL for payment of lease charges.

The above said matter was also considered by Hon'ble PSERC while issuing the order dated 30.07.2018 approving the Capital Investment Plan for control period FY 2017-18 to 2019-20 and it was held by the Commission that any such expenses paid to GoHP towards lease rental shall be considered on merits when claimed as actual expenses by EPPL in subsequent years. In view of the above, EPPL hereby submit that EPPL shall approach Hon'ble Commission at the time of incurring the expenses actually towards lease rent.

16.7. In view of the above, the year wise details of the expenses, which are expected to be capitalized during the control period i.e. during FY 2020-21 to FY 2022-23 is tabulated below:

Schemes/Works to be taken up over the MYT Control Period i.e. FY 2020-21 to FY 2022-23.

(Rs. in Crore)

	ADDITIONAL CAPITALIZATION				
S.N.	**Head**	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**	**Total**
1.	Towards Construction of Chute Spillway	-	15.00	-	**15.00**
2.	Construction of New Bridge	0.65	0.20	0.20	**1.05**
3.	Procurement of Material due to Change in the Power Evacuation System	-	3.05	-	**3.05**
4.	Miscellaneous Expenses *(towards procurement of computers/laptops, CCTV Cameras, curtains,fire retaurdant door, tipper & fork lifter)*	0.62	0.07	0.32	**1.01**
	TOTAL	**1.27**	**18.32**	**0.52**	**20.11**

16.8. It is requested that Hon'ble PSERC may consider the above amount of Rs.20.11 Cr. towards additional capitalisation under various heads while approving the Capital Investment Plan. However, as above estimates are indicative only and actual expenses may vary.

Everest Power Private Limited
New Delhi

Capital Investment Plan for the Control period i.e. FY 2020-21 to FY 2022-23

(Amount Rs. in Crs.)

A	**Ongoing schemes of the previous MYT Control Period i.e. FY 2017-18 to FY 2019-20**				
S.N.	**Head**	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**	**Total**
1.	Purchase of Runners	5.50	-	-	**5.50**
2.	Left Abutment Slope Stabilization Measures	1.00	-	-	**1.00**
3.	Upgradation Of SCADA Systems In Power House And Chhaur Substation	0.70	-	-	**0.70**
	TOTAL (A)	**7.20**	**-**	**-**	**7.20**
B	**Schemes/Works to be taken up over the MYT Control Period FY 2020-21 to FY 2022-23.**				
S.N.	**Head**	**FY 2020-21**	**FY 2021-22**	**FY 2022-23**	**Total**
5.	Towards Construction of Chute Spillway	-	15.00	-	**15.00**
6.	Construction of New Bridge	0.65	0.20	0.20	**1.05**
7.	Procurement of Material due to Change in the Power Evacuation System	-	3.05	-	**3.05**
8.	Miscellaneous Expenses *(towards procurement of computers/laptops, CCTV Cameras, curtains,fire retaurdant door, tipper & fork lifter)*	0.62	0.07	0.32	**1.01**
	TOTAL (B)	**1.27**	**18.32**	**0.52**	**20.11**
	GRAND TOTAL (A+B)	**8.47**	**18.32**	**0.52**	**27.31**

Prayer:

It is therefore respectfully prayed that the Hon'ble PSERC may be pleased to:-

a) To admit the Petition seeking approval of EPPL's Business Plan including Capital Investment Plan, for Control Period from FY 2020-21 to FY 2022-23 in accordance with the PSERC MYT Regulations, 2019;

b) To approve the Business Plan including Capital Investment Plan for MYT Control Period for FY 2020-21 to FY 2022-23 as proposed by the Petitioner.

c) To pass any other order/s as the Hon'ble Commission may deem fit and appropriate under the circumstances of the case and in the interest of justice;

AND FOR THIS ACT OF KINDNESS, THE HUMBLE PETITIONER AS IN DUTY BOUND SHALL EVER PRAY.

Date:22nd, January, 2020

Place: New Delhi

Petitioner

Through

Counsel

Tarun Johri (Advocate)

Everest Power Private Limited
New Delhi

BEFORE HON'BLE PUNJAB STATE ELECTRICITY REGULATORY COMMISSION,

AT CHANDIGARH

IN

PETITION NO. ____/ 2020

IN THE MATTER OF:-

M/s Everest Power Pvt. Ltd. **___Petitioner**

Versus

1. M/s Punjab State Power Corporation Ltd.

2. M/s PTC India Ltd. **___Respondents**

SUSHMA GUPTA
NCT OF DELHI
R. No.-1187

AFFIDAVIT

I, VBV Satyanarayan, S/o Late V. Narayana Murty, aged about 33 years, working as Senior Manager of M/s Everest Power Pvt. Ltd, a Company registered under the provisions of the Companies Act, 1956, having its Corporate office at Hall A, First Floor, Plot No. 143-144, Udyog Vihar Phase IV, Gurgaon - 122015, do hereby solemnly affirm and state as under:-

1. I am the Senior Manager of M/s Everest Power Private limited, the Petitioner in the above matter and am duly authorised by the said Petitioner to make this affidavit on its behalf.

2. The statements made in the attached application are true to my knowledge and I believe them to be true.

3. There is no case pending in any court of law with regard to the subject matter of the petition.

NOTARIAL

SUSHMA GUPTA
NCT OF DELHI
R. No.-1187

DEPONENT

VERIFICATION:-

I,the Deponent above named, do hereby verify that the contents of the above affidavit are true and correct to my knowledge. No part of it is false and nothing material has been concealed therefrom.

Verified at New Delhi on this 22nd day of January, 2020.

DEPONENT

ATTESTED

NOTARY PUBLIC
NCT DELHI

SUSHMA GUPTA
NCT OF DELHI
R. No.-1157

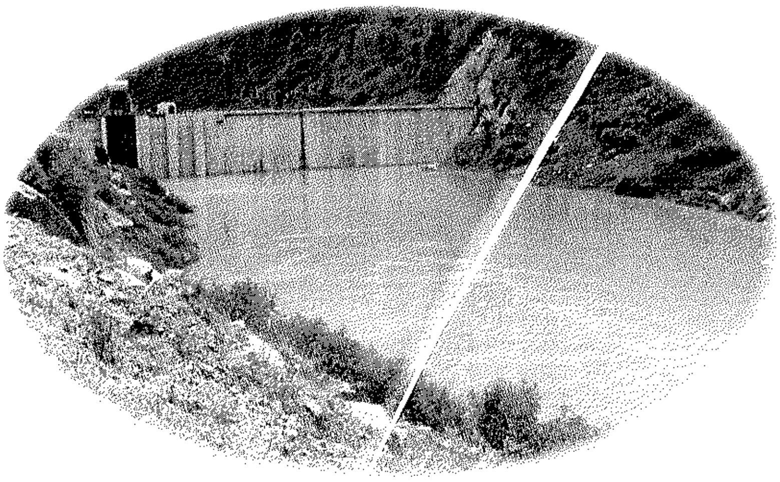
22 JAN 2020

Annexure - I

EVEREST POWER PRIVATE LIMITED

MALANA STAGE-II HYDRO ELECTRIC PROJECT

MALANA-II HYDRO ELECTRIC PROJECT (1.00 MW),
HIMACHAL PRADESH



DIVERSION DAM

LEFT BANK UPSTREAM SLOPE PROTECTION WORKS

CONSTRUCTION METHODOLOGY

May 2019

AQUAGREEN
Engineering Management (P) Ltd.

AQUAGREEN ENGINEERING MANAGEMENT PRIVATE LIMITED
143-144, UdyogVihar, Phase-IV, Gurgaon, Haryana, India-122017
Tel: +91-0124 4630800, Email:info@aquagreen.in. http://www.aquagreen.in/

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Contents

Everest Power Private Limited

1 Background:

Malana-II Hydroelectric Project (2 x 50MW) has been developed by M/s Everest Power Private Limited (EPPL). The plant has been commissioned in 2012 and in operation since then. The project comprises concrete gravity dam. At dam site, on the left bank, upstream of dam axis, a bench of 4m wide has been provided at EL.2545 (at top level of dam). Concrete cladding has been provided along the hill side of the bench for a length of about 35m from the dam axis with joints at regular interval. Slope failure occurred at about 25m u/s of dam axis from around EL.2580m which led to overturning of concrete cladding of 10m long (between RD.25m and RD.35m from dam axis) at EL.2545m. In view of this, a team of M/s AEMPL visited the site on 10th April 2019 to inspect the slide area and to suggest treatment measures.

2 Observations made during the site visit:

Observations made by the team during the site visit and the treatment measures are as follows:

During the site visit, it was observed that 3 modes of failures occurred at three different locations as detailed below:

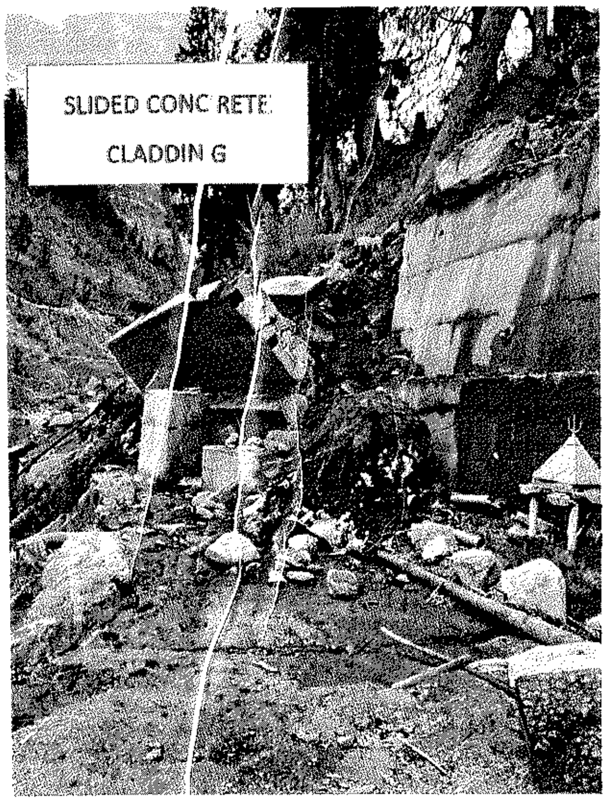
2.1 Location-1: Concrete cladding of 10m long has got overturned between RD.25m and RD.35m from dam axis:

Slope failure occurred at about 25m u/s of dam axis from around EL.2580m which led to overturning of concrete cladding of 10m long at EL.2545m (between RD.25m and RD.35m from dam axis). This cladding was not seen to be anchored into the soil whereas the adjacent cladding was anchored into the soil and was intact.

The concrete cladding which has overturned is of 5m high in two tiers each of 2.5m high.

Treatment Measures:

Initially, on the bench, at EL.2545m, vertical soil anchors of 32mm dia and 15m long have to be provided at 2m c/c staggered. All the empty spaces at EL.2545m (below existing concrete raft of the bench) shall be suitably filled with M10 concrete.

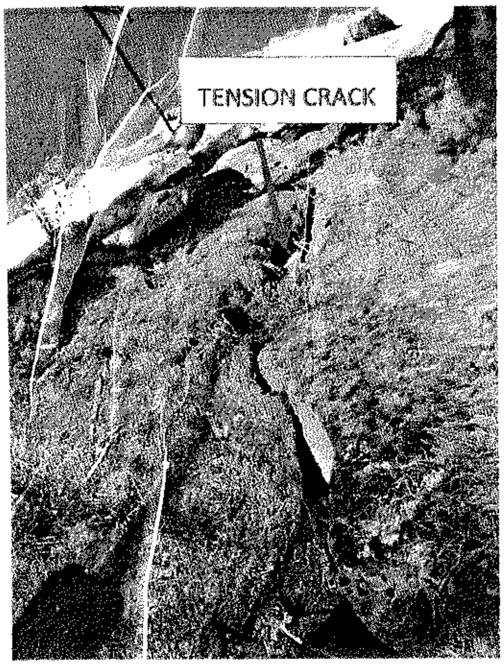


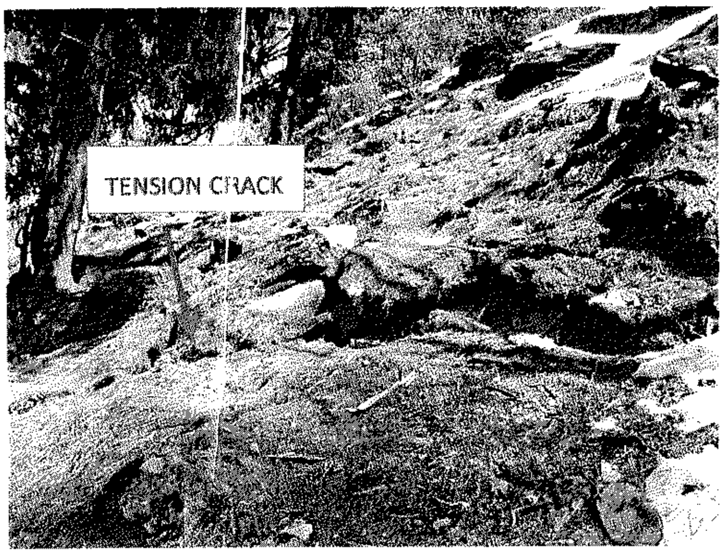
The concrete cladding which has failed due to overturning shall be removed. After cleaning, a new concrete cladding of 500mm thick at top and 750mm thick at bottom and 5m high shall be constructed covering full length between RD.25m and RD.35m as shown in the drawing. Prior to the construction of this wall, one row of soil anchors of 32mm dia and 10m long should be provided at 1m below the top of concrete cladding and 2 rows of soil anchors of 32mm dia and 12m long should be provided with one row at 750mm from bottom and another row at 1625mm from bottom row. Drainage holes of 75mm dia and 6m long should also be provided at 3m c/c staggered with inverter filter.

Exposed sloping surface to be provided with Geo-Grid/Geo-Jute nailed into the soil.

2.2 Location-2: Tension cracks occurred between RD.60m and RD.90m from dam axis:

Tension cracks have occurred on the left bank at around EL.2560m for a length of about 30m between RD.60m and RD.90m from the dam axis as marked in the drawing.


TENSION CRACK


TENSION CRACK

Treatment Measures:

In order to prevent water ingress into these tension cracks which may otherwise exerts hydrostatic pressure which can significantly lower the factor of safety of slip surfaces, these tension cracks shall be dressed and immediately filled up with clay after making V-notch (as shown in the drawing) on it along the length of crack. Filling of tension cracks with clay shall be done on priority prior to start constructing the cladded wall.

R.R.Masonry wall has been provided in two tiers at the toe of the slope (below the tension crack region) at bench EL.25 45m. This wall has already cracked and also got dislocated at some locations. Therefore, this wall shall be removed with caution at a maximum of 10m length at a time. A new concrete cladding of 500mm thick at top and 750mm thick at bottom and max. 5m high (the wall height is varying) shall be constructed at a rate of 10m covering full length between RD.35m and RD.90m as shown in the drawing. This wall shall be made curved in plan in such a way that the toe of the cladding is as close as possible to the existing overburden/soil. Please note that removal of existing damaged wall and replacement with concrete cladded wall with soil anchors shall be done at a maximum rate of 10m at a time. As brought out in previous section, prior to the construction of this wall, one row of soil anchors of 32mm dia and 10m long should be provided at 1m below the top of concrete cladding and 2 rows of soil anchors of 32mm dia and 12m long should be provided with one row at 750mm from bottom and another row at 1625mm from bottom row. Drainage holes of 75mm dia and 6m long should also be provided at 3m c/c staggered with inverter filter.

Open concrete lined drainage (300mm x 300m) shall be provided at 3 locations as follows:

i. Along the top of cladded wall
ii. At intermediate level
iii. At top, existing catch drain can be used after repairing wherever damaged

The drains should be sloping u/s and d/s from the crown of the slope and the rain water should be drained properly.

Exposed sloping surface to be provided with Geo-Grid/Geo-Jute nailed into the soil.

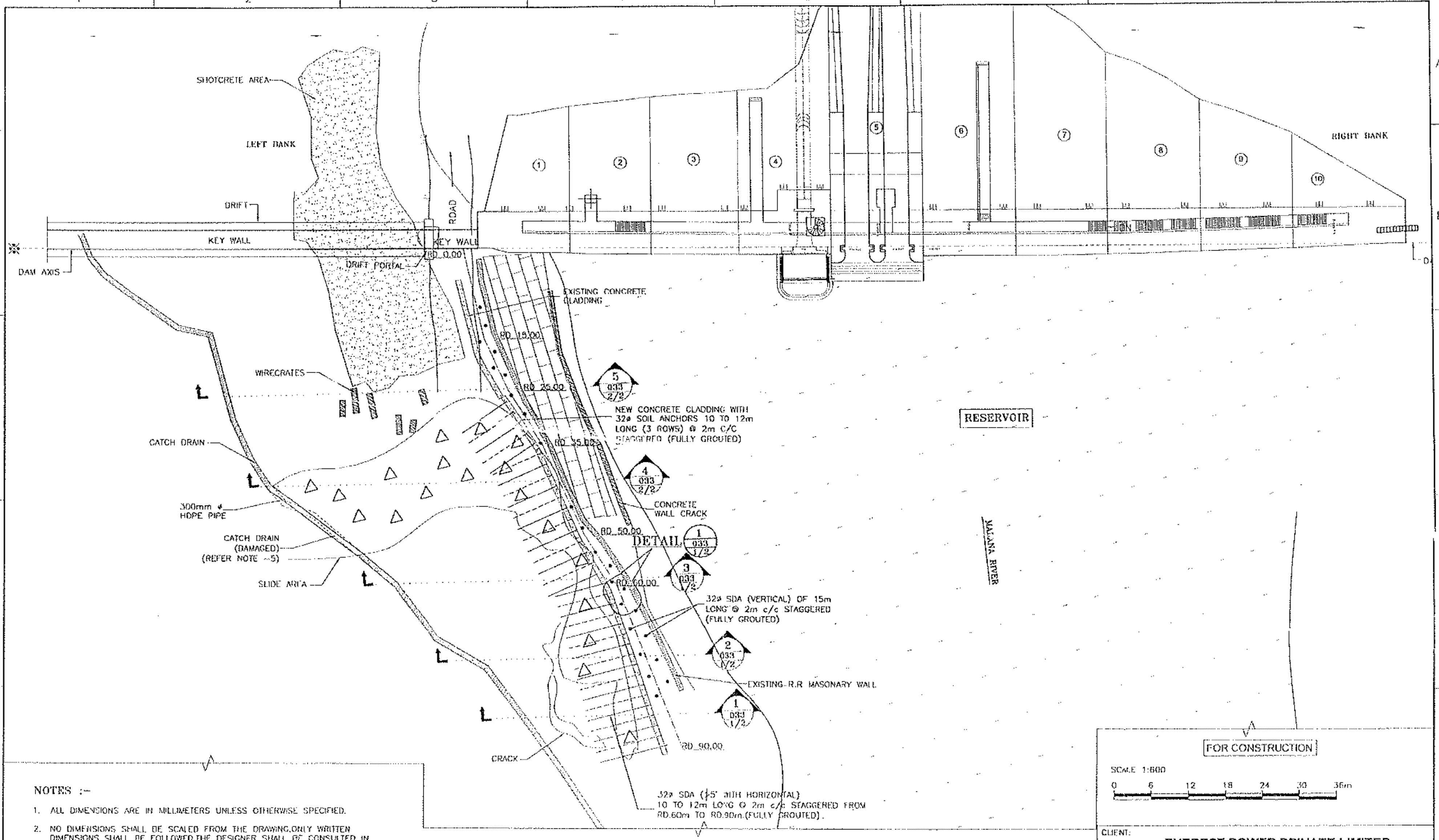
2.3 Location-3: Settlement of grid beams and concrete cladding between EL.2545m and EL.2535m:

As per the drawing issued for left bank slope protection works by the former design consultant, a bench/berm of 3m wide has been provided at EL.2535m. Along hill side of this bench, 500mm thick concrete cladding has been provided for a height of about 4m anchored with two rows of 32ϕ, 12m long self-drilling anchor @ 2m c/c. Also, slope protection with 250mm thick stone filling covered with PVC coated wire mesh in the form of grid with beams has been provided between EL.2545m and EL.2539m.

During the site visit, it was observed that the bench at EL.2535m has got settled along with 500mm thick concrete cladding and grid beam protection. Cracks could be seen in these settled concrete cladding. Due to this settlement, there is a cavity formed between the bottom of the concrete cladding and the bench at EL.2535m. This cavity has been packed with stones by the project O & M team. 300mm thick RCC concrete raft has also been provided along the bench at EL.2535m. Due to the aforesaid settlement, a cavity has formed below the raft. This cavity should be filled up immediately with M10 concrete.

During the site visit, the water level in the reservoir was at about EL.2530m. Condition of slope protection work below water level could not be ascertained. Appropriate protection measures will be suggested by inspecting the condition based on the details provided by the project O & M team after lowering down reservoir level.

Detailed drawings showing the above treatment measures have been attached with this report.



PLAN
(SCALE-1:600)

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWING.ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.THE DESIGNER SHALL BE CONSULTED IN CASE OF ANY CLASSIFICATION REQUIRED.
3. GRADE OF CONCRETE BACKFILL BELOW RAFT OF BENCH AT EL.2545 SHALL BE OF M10.
4. SELF DRILLING ANCHORS SHALL BE MANUFACTURED FROM REINFORCING BAR WITH YIELD STRENGTH NOT LESS THAN 500N/mm². (THE REINFORCING BAR SHALL COMPLY WITH IS 1786).
5. DAMAGED CATCH DRAIN SHALL BE REMOVED & CONNECTED WITH MS PIPE OF 300 mm DIA.
6. ALL SDA'S TO BE FULLY GROUTED
7. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH 324-CMC-03A-033 (SHEET 1 OF 2) & 324-CMC-03A-033 (SHEET 2 OF 2).

FOR CONSTRUCTION

SCALE 1:600

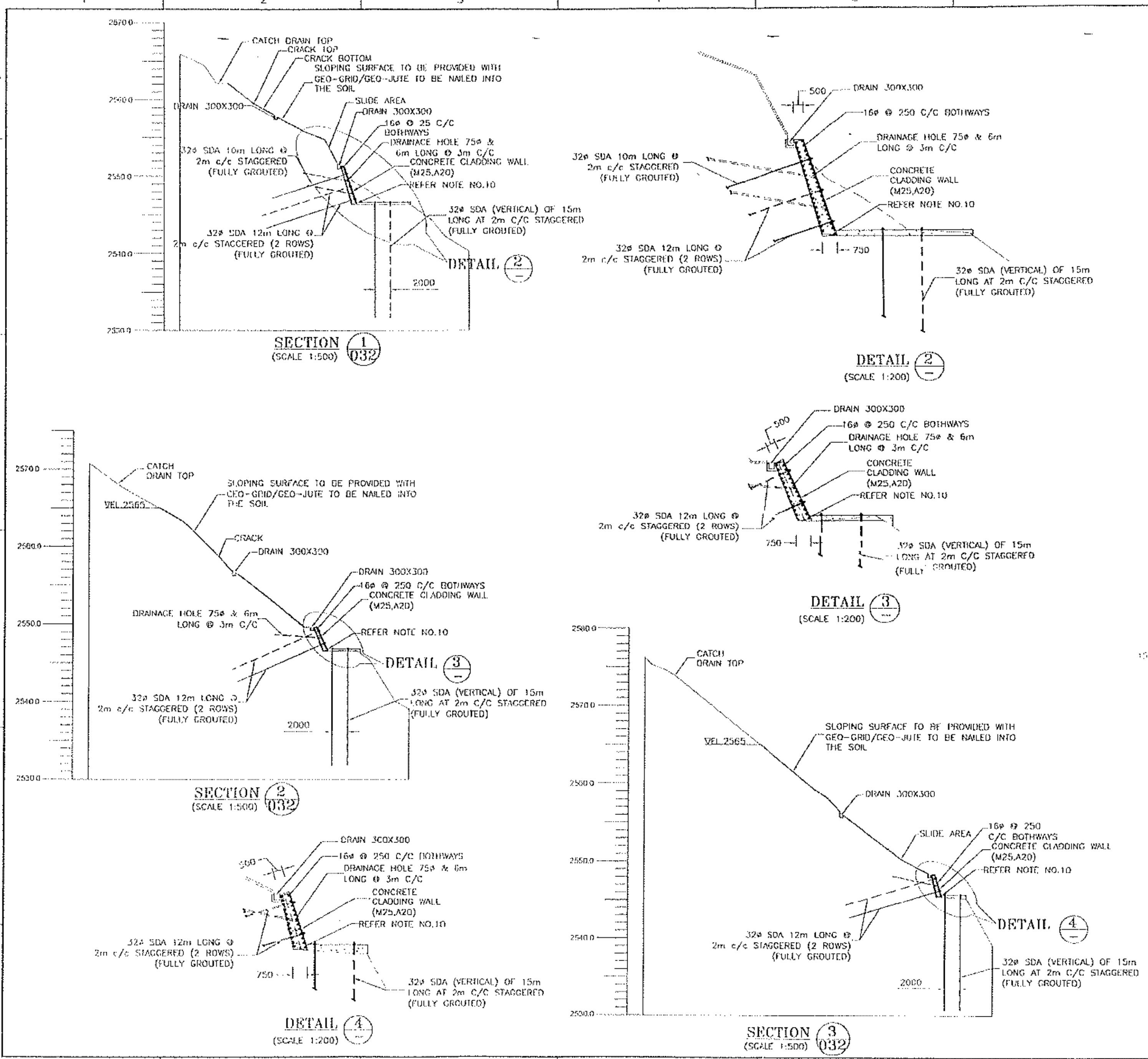
0 6 12 18 24 30 36m

CLIENT:
EVEREST POWER PRIVATE LIMITED

PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

DRAWING TITLE:
DIVERSION DAM
UPSTREAM LEFT BANK
SLOPE PROTECTION WORKS - PLAN

DATE:	PRINT SIZE	DRAWING NO	REV.	SHEET NO.
MAY 2019	A2	324-CMC-03A-032	0	1 OF 1



SECTION 1/032 (SCALE 1:500)

DETAIL 2 (SCALE 1:200)

DETAIL 3 (SCALE 1:200)

SECTION 2/032 (SCALE 1:500)

DETAIL 4 (SCALE 1:200)

SECTION 3/032 (SCALE 1:500)

NOTES :-

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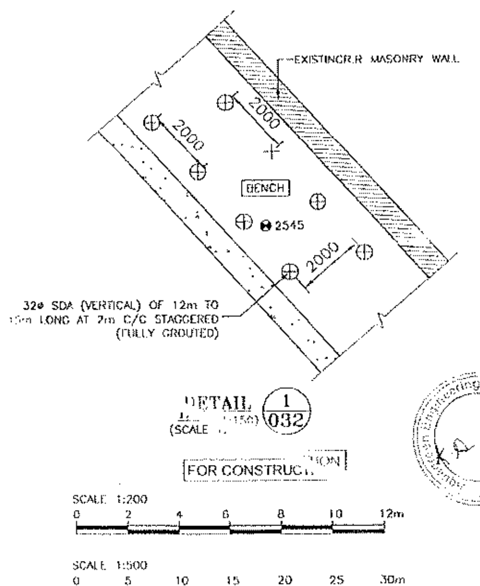
5. DAMAGED CATCH DRAIN SHALL BE REMOVED & CONNECTED WITH MS PIPE OF 300 mm DIA .
6. REINFORCEMENT BARS SHALL BE OF HIGH YEILD STRENGTH COLD TWISTED DEFORMED BARS OF GRADE Fe-500 CONFORMING TO IS:1786.
7. REINFORCEMENT BARS SHALL NOT BE COUNTED.
8. MINIMUM COVER TO REINFORCEMENT BARS SHALL BE 75mm FOR CONCRETE DEPOSITED AGAINST THE GROUND AND 50mm FOR OTHER SURFACES.
9. ALL SDA'S TO BE FULLY GROUTED.
10. THE JOINT BETWEEN OLD CONCRETE AND NEW CONCRETE IS INDEPENDENT, NO STEEL REINFORCEMENT TO BE PROVIDED. ONLY THE JOINT FACE OF OLD CONCRETE NEED TO BE ROUGHENED.
11. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH 324-CMC-03A-032 & 324-CMC-03A-033 (SHEET 2 OF 2).



DETAIL 1/032 (SCALE 1:150)

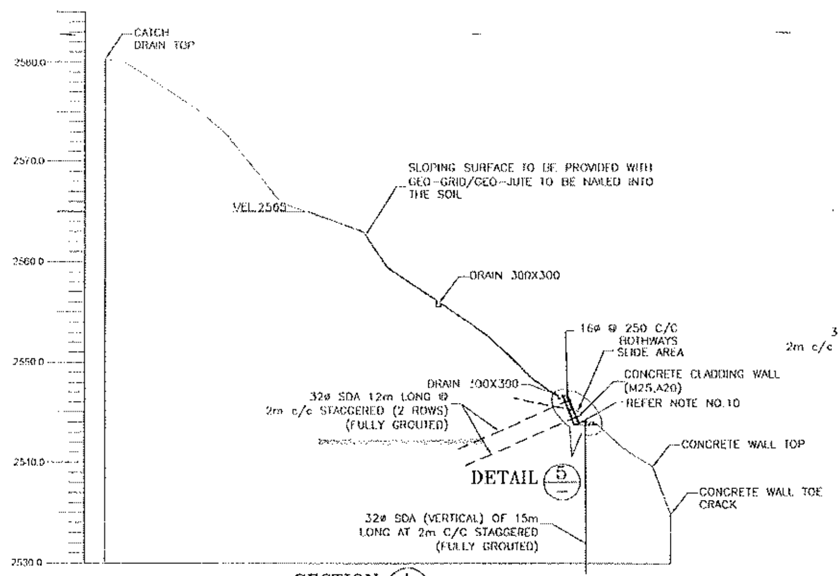
FOR CONSTRUC[illegible]ION

CLIENT: **EVEREST POWER PRIVATE LIMITED**

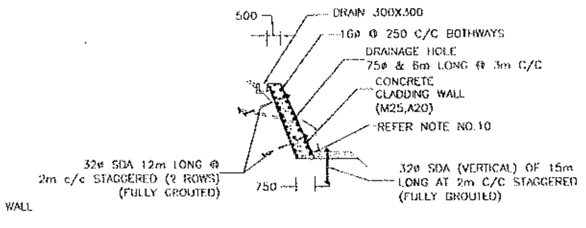
PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

DRAWING TITLE:
DIVERSION DAM
UPSTREAM LEFT BANK
SLOPE PROTECTION WORKS - SECTIONS

DATE:	PRINT SIZE	DRAWING NO	REV.	SHEET NO
MAY,2019	A2	324-CMC-03A-033	0	1 OF 2



SECTION 4/032
(SCALE 1:500)



DETAIL 5
(SCALE 1:200)

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
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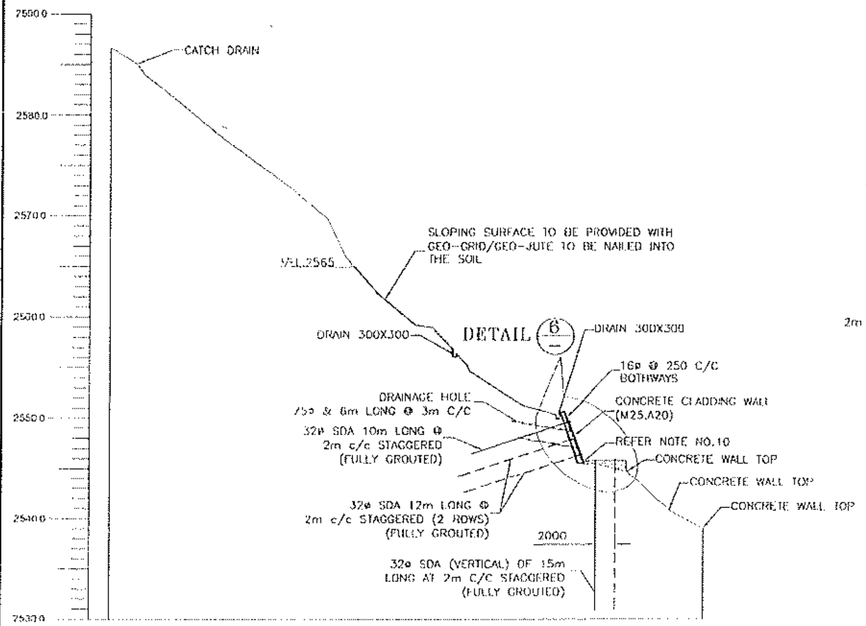
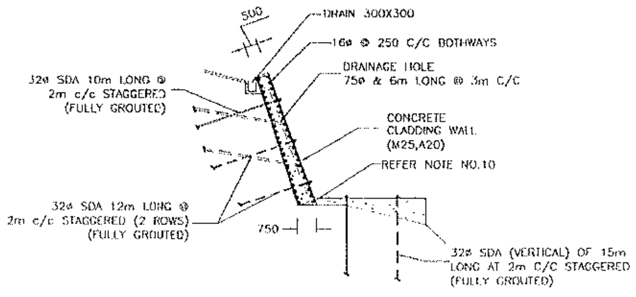
11. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH 324-CMC-03A-032 & 324-CMC-03A-033 (SHEET 1 OF 2).



SECTION 5/032
(SCALE 1:500)



DETAIL 6
(SCALE 1:200)

FOR CONSTRUCTION

SCALE 1:200
0 2 4 6 8 10 12m

SCALE 1:500
0 5 10 15 20 25 30m

CLIENT:
EVEREST POWER PRIVATE LIMITED

PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

DRAWING TITLE:
DIVERSION DAM
UPSTREAM LEFT BANK
SLOPE PROTECTION WORKS - SECTIONS

DATE:	PRINT SIZE	DRAWING NO	REV.	SHEET NO
MAY 2019	A2	324-CMC-03A-033	0	2 OF 2

Annexure-2

EVEREST POWER PRIVATE LIMITED
Corporate Office : Hall A, First Floor, Plot No. 143-144, Udyog Vihar, Phase – IV, Gurgaon – 122015, Haryana. Phone: +91-124-4630870, Fax: +91-11-45823862

WORK ORDER

CST No: CST – 2595 dated 29/07/2005, TIN NO.- 02100200996
GST No: KUL – III 2912 dated 17/05/ 2005

To
Balaji Operation and Maintenance Services Pvt Ltd
Village Chowki, Near Jari
District Kullu, Himachal Pradesh
India

WO No.: EPPL/DAMLEFTBANK/2019-20/30001 date 20.05.2019
Prev W .O No : NA
Internal Ref No : NA
Your Ref No. Quotation& Discussions

Kind Att. : Mr. Shiv Pardeep Sharma

With reference to your above reference number and further discussion with you we are pleased to issue the Work Order for " Construction RCC wall from RD 25 to RD 58 at DAM complex of Left bank" and the rates as per details given below:-

Sl.NO	Particulars of Items	Unit	Qty as per contract	Rate	Amount	Remark
1	2	3	4	5	6	
1	Removal of landslide Debris, excavation of foundation & muck removal	Cum	500.00	550	275000	
2	Laying of PCC for Foundation	Cum	5.00	9704	48520	
3	Reinforced cement concrete (M25) retaining structure including shuttering, scaffolding etc as per drawing and Technical Specifications	Cum	125.00	12184	1523000	
4	TMT bar reinforcement including cutting straightening, bending placing in position and binding as per drawings and Technical Specifications	MT	6.00	76325	457950	
5	Back Filling after construction of RCC retaining structure	Cum	100.00	335	33500	
6	Cutting & and removing of fallen trees from the left bank of Dam complex and cleaning of left bank grid beams	LS	1.00	350000	350000	
7	Drilling and fixing of Soil drilling Anchors and Grouting	Mtrs	915.00	1400	1281000	
	Total (Thirty Nine Lac Sixty Eight Thousand Nine Hundred Seventy)				**3968970**	

Mutually Agreed Terms & Conditions

1. Taxes
    - i. GST Tax : Extra as applicable
2. Completion Period: 6 Months from date of
3. Payment Terms : On progressive basis as per Engineers certification
4. Work Address : Malana - II HE Project, Village Chowki, Jari, District Kullu, Himachal Pradesh
5. Billing Address : Everest Power Pvt Ltd., Malana - II HE Project, Village Chowki, Jari, District Kullu, Himachal Pradesh
6. Contact Person : Mr. Anand Varma - 09805519974
7. Kindly return the duplicate copy of order duly signed & stamped within 3 days towards acceptance of order. Non-receipt of order acceptance/rejection shall be deemed as order is accepted.
8. **Other Terms & Conditions:** Detailed Terms & Conditions Enclosed in Annexure

For Everest Power Pvt. Ltd.

Authorized Signatory

Annexure

Terms and conditions:

1. The mobilization of all the plants equipment, manpower and all the resources necessary for the execution of the work shall be done by you immediately in any case not later than 2 days from the date of this order.
2. You would commence the work immediately or not later than 2 days from the date of this order.
3. You shall complete the works as described in the above clause from the date of this order, to the satisfaction of the Engineer of M/s Everest Power Pvt Ltd, Completion date shall remain firm and you are expected to suitably mobilize all the resources to meet the said completion date.
4. The above-mentioned price/value of the present work order shall be inclusive of all the applicable taxes & duties except GST.
5. Retention amount of 5% of Work done value will be retained as a performance guarantee and same will be returned / paid after completion of performance guarantee period i.e 60 days from the date of work completion certificate issued by the Engineer Incharge on segment wise.
6. The quantities as indicated in Bills of Quantities/Bill of Items mentioned above are approximate and may increase or decrease as per the site conditions. However the rate will be firm and sound for variation in quantities ± 30% of each item. Any variation beyond this will required reworking of item rate mutually.
7. The rates mentioned in the bill of times are inclusive of entire quality control, testing and quality assurance related to works.
8. After completion of work, bills shall be submitted to the Site Engineer for due approvals in accordance with actual progress of work. On verification/reconciliation of said bills by the Engineer on the basis of the certified measurements of the work done, the payment would be made to you within fifteen days of the date of certification of bills by the Engineer.
9. The Engineer of the Company would issue necessary drawings/specification to you for the execution of the works. In case of any clarifications are needed by you on these

drawings/specifications, you will get the same clarified by approaching the Engineer of the Company. The clarification/ instructions of the Engineer of the Company would be final & binding on you. You would not be entitled to claim any additional payment or extension of time for completion of works.

10. That escalation in prices of goods/Services is not permissible during the entire duration of works. The rates/unit rates as shown in the bill of items include all the incidental charges and no other payment other than these would be payable against the actual measurements as certified by the Company Engineer.

11. You would obtain adequate insurance coverage in respect of the following:

    a) All third party risk

    b) You are required to necessary insurance to the work man directly or your sub-contractor and same copies of insurance premium payment receipts to be submitted regularly to the Company Engineer. Default by you to obtain such insurances or any default in payment of regular premium would entitle the Company to obtain the above set requisite insurance policies at your cost including the administrative charges required to obtain the same. Such insurance policy will be kept valid and effective till 6 months after the schedule completion date.

12. That any delay in providing necessary site of works or drawing/specification/instructions would not lead to any claim whatsoever resulting in additional payment or extension of time.

13. Adequate arrangement for your labour camp, accommodation, Food supply, water supply, proper hygienic sanitation, sewerage, latrines and hygienic environment for your labour & staff including their first-Aid & Medical facilities etc. will be your responsibility.

14. You would submit detailed work schedule and the construction methodology for approval of the Engineer of the Company in advance and only on approval of the same, respective construction activities under this work order would be carried out by you.

15. You shall submit a daily/weekly progress report in the format as instructed to you by the Engineer of the Company

16. All statutory deduction on accounts of income tax, GST and other applicable dues etc. on your bills shall be effected from the payment of such bills and the TDS certificates would be forwarded to you in due course.

17. You would not be entitled to suspend the performance of works under this work order. If any such suspension occurs then on determination by the Engineer, The Company shall have the right to get the works completed through other contractor and terminate this work order at your risk & cost.

18. The entire scope of work shall be completed by your strictly in accordance with the provisions of this work order and according to instruction of Engineer of Company and to the full satisfaction of the Engineer. If at any time the quality or progress of the works is found to be unsatisfactory by Engineer of Company, then the Company would be entitled to terminate the work order without any cost to Company. The decision of Company is final in this regard.

19. You would take all the responsibility for the protection of environment & safety in performance of works. This would include and would not be limited to the following acts:-

    a. You would take full responsibility of accommodation and food to all of your employees, transportation, medical and any other needs that may come up from time but not necessarily covered under the contract in detail.

    b. You or your employees are prevented from interfering with the environment, felling of tress, cutting of branches for use as fire wood etc, contractors is expected to provide suitable alternate arrangement. Any such misuse will attract as penalty as shall be decided. You shall dispose all muck in designated areas as shown by Engineer in charge.

    c. Loose rock hanging over area where work is to be carried out is to be removed first and place made safe to work prior to commencement of roadwork.

    d. You are to clear all sharp / loose areas that are a hazard to safe working as per site requirement and/or direction of engineer in charge.

    e. You are expected to practice safe work methods to the satisfaction of site engineer and insurance company and any third party or Govt. agency. This is to be strictly enforced.

f. You shall provide personal protective gear/equipment like helmets, safety shoes, raincoats and safety glasses etc to its labour for safe and efficient discharge or work at their respective work sites.

g. All mule and trekking route shall be kept open for general public during construction and after work. Controlled and fixed time blasting to be followed under close supervision.

20. The Engineers of the Company would be entitled to modify the scope of work. You would be paid for increase in the scope of work according to the rates mentioned in Bill of items and you would also be given a suitable extension of time for completion of works like wise any reduction in the scope of work would entitle the Engineer to reduce the time for completion of the work.

21. Any material supplied by Company to you other than committed material will be charged at actuals and recovered from the bills raised by you. Overhead and administrative expenses @15% would also be chargeable on such material.

22. Any deviation by you from the terms & conditions of this work order will have to be brought to the notice of the Engineer, whose decision in respect of the same would be final and binding.

23. Notwithstanding any of the provisions of this work order, Company will have the right to terminate this work order forthwith without payment of any compensation.

24. You will submit to the Company, following information i.e. submission of attendance register, monthly Provident Fund statement, insurance etc. and report about compliance of other laws on weekly basis. Any default in this might lead to penalty/termination of the work order.

25. You would not be paid any idling/delay charges due to reasons attributable to you. In case of acts of God, charges relating to any delay/idling would not be payable to you for loss of days due to such reasons.

26. You shall shift all equipment to work spot. Cost of shifting is deemed to be included in the unit rates as specified in this work order. Making of Pathways, clearing of bushes etc is deemed to be included in the unit rate.

27. In the event of disputes, the same shall be referred for Arbitration as provided under Arbitration and Conciliation Act 1996. The venue of arbitration shall be Delhi only.

You are requested to sign on duplicate copy of this order as a token of acceptance.

Thanking you,

Yours faithfully,

For Everest Power Private Limited

Authorized Signatory

Accepted by:

Contractor: ------------------------------------

Name:

Date:

264065/2018/IT SECTION

Annexure-3

F. No. 1/6/2011-IT-IV (236746)
Government of India
Ministry of Power

Shram Shakti Bhawan, Rafi Marg,
New Delhi, Dated: 9th October, 2018

To

Additional Chief Secretary, Principal Secretary, Secretary (Energy) of States/UTs

Subject : Guidelines for Mitigation of Cyber Secuirty Threats in Power Sector .

Sir,

I am directed to convey that National Critical Information Infrastructure Protection Centre (NCIIPC) has found following vulnerabilities while conducting cyber security assessment at two Discoms in the country:

(i) Due to lack of patch/update management, the Operating Systems of servers are prone to multiple critical security vulnerabilities such as "Shell Shock", " Remote Code Execution" and are open to various kinds of attacks.

(ii) Applications installed over servers are not being patched to the latest patches/updates and are prone to multiple security critical vulnerabilities and susceptible to different kind of cyber attacks (eg. Oracle Database used in server is having unsupported patches level).

(iii) The team was able to access the Oracle Database remotely over Internet by Exploiting SQL Injection vulnerabilities.

(iv) Telnet services have been configured over services, which provides remote login for administration. As Telnet transmits traffic in clear text, attackers may sniff into the traffic and steal Telnet credentials.

(v) Server is configured with SNMP (Simple Network Management Protocol) community string. An attacker could leverage knowledge of a SNMP community string to collect sensitive information such as device configuration, installed software, running processes, installed patches, network configuration, network connections etc.

(vi) Windows firewall was found disabled on the NMS (Network Management System) server.

(vii) Web and Directory Servers are having high web vulnerabilities such as SQL Injection, Cross Site Scripting. etc.

(viii) Servers have not been hardened, and contain unnecessary services, which increase attack surface sustainability.

(ix) VNC (Virtual Network Computing) Application, third party application, was running on Human Machine Interface (HMI) Workstations which allow remote logon to the systems, hence usage of VNC exposes large attack surface.

(x) Operating systems of Workstations do not have windows security polices such as Password Policy, Account Lockout etc.

Everest Power Private Limited

(xi) No active Anti-Virus application was found on the workstation. This is a critical vulnerability and a serious threat.

(xii) The switch/Router was configured with the default credential. Default credential may allow attacker to compromise the entire network at ease.

(xiii) There is no end to end communication between RTUs and FEP Server. The communication between RTUs and LDMS is in plain text. This may allow attackers to inject commands, sniff and modify traffic.

(xiv) Definition database of Cyberoam Firewall was found to be un-updated, which leave the entire network prone to various kinds of cyber attacks.

(xv) Many of the Passwords were weak and the team could easily crack the hashes to retrieve the password in plain text.

2. National Critical Information Infrastructure Protection Centre (NCIIPC) has issued following guidelines regarding Cyber Security threats in Power Sector and are conveyed for further necessary action and compliance:

(i) Deploy only those critical software application such as Anti-Virus applications, whose technical support and version control are verifiable publically.

(ii) Deploy product releases and firmware update and technical support details which are not available in the open domain.

(iii) Evolve procedural controls such as Security Level SLA which mandates the OEM/System-Integrator & makes him liable to provide/support security patches and firmware updates for longer duration on equipment life cycle.

(iv) Avoid Internet connectivity directly or indirectly (over firewall) to OT/SCADA networks.

(v) Update all Operating Systems, Applications and Firmware as a basic cyber hygiene practice.

(vi) Nominate CISO (Chief Information Security Officer), ISOs' (Information Security Officer) to establish ISD (Information Security Department) for implementing and managing information security at different location of the organisation.

(vii) Accelerate the process of CII identification and notification as Protected Systems, steered by Power Sector CERTs.

Yours faithfully,

(Praveen Kumar)
Under Secretary to Government of India
Telefax; 23715507 extn. 370
it-mop@nic.in

Copy to:

1. MDs of All DISCOMs
2. CISO-MoP for Necessary compliance

F. No. 1/6/2011-IT (241316)
Government of India
Ministry of Power

Shram Shakti Bhawan, Rafi Marg,
New Delhi, Dated: 17th September, 2018

OFFICE MEMORENDUM

Subject : Status regarding Cyber Security activities in Power Sector .

The undersigned is directed to refer to the cyber security activities and the implementation of Cyber Security Crisis Management Plan in power sector and to request you to furnish the latest status on the following points urgently to CISO-MoP for submitting a consolidated report to MoP.

(i) Prepare Cyber Crisis Management Plan (CCMP), including detailed contingency plan for dealing with crisis arising out of cyber attacks in respective areas and cyber security mock drills

(ii) Auditing of the IT infrastructure, web applications and websites on periodic basis through CERT-In empanelled auditors to check resilience of cyber assets against malicious attacks.

17/9/18
(Praveen Kumar)
Under Secretary to Government of India
Telefax; 23715507 extn. 370
It-mop@nic.in

To

1. CERT-Distribution
2. CERT-Thermal
3. CERT-Hydro
4. CERT-Trans

Copy to

1 Chairperson, CEA
2 CMD-NTPC, NHPC, PGCIL
3 CISO-MoP [Kind.Attn. Shri Vijay Menghani, Chief Engineer (IT)-CEA

Everest Power Private Ltd.

एन एच पी सी लिमिटेड
(भारत सरकार का उद्यम)
NHPC Limited
(A Govt. of India Enterprise)
ISO-9001, 14001 & IS 18001 Certified Company

No. NH/IT&C/CEA/2018/ 1470

Date: 03-12-2018

To,
श्री Dr. S S Garhia,
C.O.O,
Everest Power Pvt Ltd
143-144 Ydyog Vihar,Pshase-IV,Gurgaon-122015

Sub: Status regarding Cyber Security activities in Power Sector

Ref. : (i) e-Mail from CEA dated 28.11.2018
(ii) Our e-Mail Dated 25.10.18
(iii) Central Electricity Authority letter no. CEA-CH-13-12/2/2018- IT Division

Sir,

The energy sector has been identified as a critical sector and its protection from any cyber-attack should be the utmost priority. Various communications have been made for receiving about the status of preparation of CCMP and Audit of Critical Information Infrastructure (CII) and applications at enterprise level. But till date no information has been received in this regard.

1. Chief Information Security Officer, Ministry of Power (CISO-MoP) vide their letter under reference (iii) have requested again to provide the action taken report on the following.
    a. Status of preparedness of Cyber Crisis Management Plan (CMPP), including detailed contingency plan for dealing with Crisis arising out of cyber-attacks in respective areas and cyber security mock drills.
    b. Auditing of IT infrastructure, Web Applications and Website on periodic basis through CERT-In empanelled auditors.
2. Further, vide Ministry of Power (MoP) Office Memorandum no. 1/6/2011/IT-Part-V, MoP has desired to identify the CII components in the organizations for further intimating to National Critical Information Protection Centre, Govt. of India. In this regard you are also requested to provide the list of CII installed in your organization.

The information as above may please be provided at the earliest for further transmission to CISO-MoP.

The above information may kindly be furnished to the office of the undersigned or through email at ciso.nhpc@nciipc.gov.in on or before 28.12.2018.

This may please be treated as **MOST URGENT.**

Regards,

Savitri
3.12.2018

(Savitri Srivastav)
Chief General Manager (IT) – CISO NHPC

Copy to : Sh. Vijay Menghani, Chief Engineer (IT&C), CISO-MoP, CEA New Delhi

Anirudh Gupta

From: Savitri Srivastav
Sent: 28 November 2018 13:22
To: Anirudh Gupta; Ayush Kumar Sinha
Subject: FW: very urgent - Cyber Secuirty in Power Sector
Attachments: Cyber-Security-Crisis Management Plan.pdf; Cyber-Secuirty-Guidelines-NCIIPC.pdf

Importance: High

From: itcea@nic.in [mailto:itcea@nic.in]
Sent: 28 November 2018 13:13
To: Vivek Goel; Sunil Agrawal; Savitri Srivastav; Meena Agarwal; Anand Shankar; A K Patel; Anirudh Gupta
Cc: Vijay Menghani; Saumitra Mazumdar
Subject: Fwd: very urgent - Cyber Secuirty in Power Sector
Importance: High

Sir / Madam,

Kindly provide the latest status with reference to the attached MoP's letter's **by today** for submitting a consolidated report to MoP. This may be treated as **very urgent**.

--
भवदीय,
सूचना प्रौद्योगिकी प्रभाग
केंद्रीय विद्युत प्राधिकरण

-------- Original Message --------
From: **"IT Cell, Ministry of Power"** <it-mop@nic.in>
Date: Nov 28, 2018 11:58:39 AM
Subject: very urgent - Cyber Secuirty in Power Sector
To: Vijay Menghani <vmenghani@nic.in>, Saumitra Majumdar <itcea@nic.in>

Sir

Kindly refer to the attached OM and Letter communicated earlier on the following subjects :

1. Status of Cyber Security Activities in Power Sector.

2. Guidelines for Mitigation of Cyber Security Threats in power sector.

The status may kindly be communicated to MoP urgently.

--

Regards,

IT Cell
Ministry of Power
Government of India
Tel.011-23715507 Ext. 370

NHPC Ltd
NHPC Office Complex,
Sec-33,
Faridabad - 121 003
(A Government of India Enterprise)

Annexure-4

IT Security Audit Report OF SCADA Network & IT Infrastructure

EVEREST POWER PRIVATE LIMITED

January 18, 2019

CyberQ Consulting Pvt. Ltd.

Audit Team:
Mr. Arbaz Alam Farooqi
Mr. Sujeet Kumar

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Document Version Control

Data Classification	CLASSIFIED
Reference No.	CQ/IS/18-234
Client Name	EVEREST POWER PRIVATE LIMITED
Document Title	IT Security Audit Report OF SCADA Network & IT Infrastructure
Audit Date	7th Jan -8th Jan, 2018
Author	Sujeet Kumar
Approved By	Mr. Pramod Kumar Pant

Version	**Date of Issue**	**Issued by**	**Change Description**
1.0	18-1-2019	CyberQ Team	Initial Issue

TABLE OF CONTENT

1 Introduction

The purpose of the Vulnerability Assessment/Penetration Testing of SCADA Network & IT Infrastructure is to determine the security vulnerabilities in the Servers, Network devices, Wi-Fi devices etc. The tests were carried out assuming the identity of an attacker or a user with malicious intent. At the same time due care was taken not to harm the device.

1.1 Executive Summary

The significant issues are given in this section, the Executive summary. These list the security flaws that are of major concern. Vulnerabilities have been given a Severity rating of High, Medium or Low based on the risk they may pose. The basis of giving the severity rating is as described below:

S. No	Severity Rating	Basis of giving severity rating
1	High	Severely impact the system
2	Medium	Impact the system in a limited manner
3	Low	No direct impact on the system
4	Information	Suggested improvements which are not non-compliances but would help in further enhancements.

1.2 Methodology

The methodology adopted for **Infrastructure Assessment** consisted of two phases

- Network-based testing
- Detailed manual compliance testing

The methodology applied in **Network Security Testing** is explained in the diagram below:

Define

Select the Device/Servers/Desktop to be tested

- Select Device/Servers/Desktop to be tested
- Testing Strategy

Plan

Foot Printing / Gather information of Device/Servers/Desktop

- Identify type of Device/Servers/Desktop
- Identify the location which Firewall Configuration and ACL Review to be conduct

Conduct Evaluation

Conduct Configuration Review as per OSSTMM Guidelines

- Manually check Device/Servers/Desktop configuration as per define policy

Analysis

Classify vulnerabilities according to the Risk Level

- Analyze findings
- Analyze the threat due to the vulnerability and give the risk rating
- Classify vulnerabilities according to the Risk Level

Recommend

Prepare Report

- Prepare detailed Technical findings Report
- Suggest general recommendations to plug the vulnerability

Summary Conclusion

Conclusion

- Summarize Conclusion

2 Network Security Audit of SCADA Network

2.1 Objective

Supervisory control and data acquisition (SCADA) are an industrial control system which is used by **Everest Power Private Limited, Malana II** for generating power. SCADA systems organize multiple technologies that allows to process, gather and monitor data at the same time to send instructions to those points that transmit data. SCADA system receives the information from programmable logic controllers (PLCs) or remote terminal units (RTUs), which in turn receive their information from the sensors or inputted values which we have given manually. SCADA in a power system is used to collect, analyze and monitor the data effectively, which will reduce the waste potentially and improve the efficiency of the entire system by saving money and time.
The objective of this testing was to ensure the security of the network and server from external and internal threats. The SCADA Network must be isolate from IT network.

Everest Power has engaged CyberQ Consulting Pvt. Ltd to perform the security audit of SCADA Network Security Assessment. The audit team consisted of members drawn from CyberQ. Details were provided to the extent mentioned in "Scope of Work". The audit was carried out from Everest Power Private Limited, Malana II.

2.2 Scope

The scope of this Testing included of **Configuration Audit of Scada Server, PLC devices, Network Device etc of SCADA Network**

- Scanning from Automated tool
- Logical Access to Network & Security devices with administrative / root account.
- Running configuration files of Network & Security Devices and access to log files.

The IP Addresses of Scada Network is given below:

Organization Name	**EVEREST POWER PRIVATE LIMITED, MALANA II**	
IP Addresses of Scada Network	172.17.200.125	172.17.200.151
	172.17.200.1	172.17.200.152
	172.17.200.11	172.17.200.153
	172.17.200.2	172.17.200.154
	172.17.200.12	172.17.200.155
	172.17.200.5	172.17.200.250
	172.17.200.15	

Note: Some devices which is related to DAM was not audited due to not reachable.

2.3 Tools Used

The following tools were used:

- Nmap
- Nessus
- CyberQ Proprietary Checklists and Test Cases

2.4 Vulnerabilities of IT Infrastructure with Recommendation

2.4.1 Finding No. 1

Description: The remote host is running Microsoft Windows XP. Support for this operating system by Microsoft ended April 8th, 2014.

Severity: High

Impact: Lack of support implies that no new security patches for the product will be released by the vendor. As a result, it is likely to contain security vulnerabilities. Furthermore, Microsoft is unlikely to investigate or acknowledge reports of vulnerabilities.

Recommendation(s): It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.80, 172.17.200.81, 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.2 Finding No. 2

Description: The remote Windows host is affected by a remote code execution vulnerability in the 'Server' service due to improper handling of RPC requests. (MS08-067)

Severity: High

Impact: An unauthenticated, remote attacker can exploit this, via a specially crafted RPC request, to execute arbitrary code with 'System' privileges. ECLIPSEDWING is one of multiple Equation Group vulnerabilities and exploits disclosed on 2017/04/14 by a group known as the Shadow Brokers.

Recommendation(s):
Short term: Microsoft has released a set of patches for Windows XP.
Long Term: It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.80, 172.17.200.81, 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.3 Finding No. 3

Description: The remote host is affected by a memory corruption vulnerability in SMB. (Critical MS09-001: Microsoft Windows SMB Vulnerabilities Remote Code Execution (958687))

Severity: High

Impact: The vulnerability in SMB that may allow an attacker to execute arbitrary code or perform a denial of service against the remote host.

Recommendation(s):
Short term: Microsoft has released a set of patches for Windows XP.
Long Term: It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.80, 172.17.200.81, 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.4 Finding No. 4

Description: Multiple remote code execution vulnerabilities exist in Microsoft Server Message Block 1.0 (SMBv1) due to improper handling of certain requests. (MS17-010: Security Update for Microsoft Windows SMB Server (4013389))

Severity: High

Impact: An unauthenticated, remote attacker can exploit these vulnerabilities, via a specially crafted packet, to execute arbitrary code.

Recommendation(s):

Short term: Microsoft has released a set of patches for Windows XP. Additionally, it is recommended that users block SMB directly by blocking TCP port 445 on all network boundary devices. For SMB over the NetBIOS API, block TCP ports 137 / 139 and UDP ports 137 / 138 on all network boundary devices.
Long Term: It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.80, 172.17.200.81

2.4.5 Finding No. 5

Description: It is possible to obtain the default community name of the remote SNMP server. The remote SNMP server replies to the following default community string is **public**.

Severity: High

Impact: Default communities are used by an attacker as first attempt to gain access or information about the remote host, or to change the configuration of the remote system (if the default community allows such modifications).

Recommendation(s): Disable the SNMP service on the remote host if you do not use it. Either filter incoming UDP packets going to this port, or change the default community string.

Affected host(s): 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.6 Finding No. 6

Description: An arbitrary remote code vulnerability exists in the implementation of the Remote Desktop Protocol (RDP) on the remote Windows host. The vulnerability is due to the way that RDP accesses an object in memory that has been improperly initialized or has been deleted. (MS12-020: Vulnerabilities in Remote Desktop Could Allow Remote Code Execution (2671387))

Severity: High

Impact: If RDP has been enabled on the affected system, an unauthenticated, remote attacker could leverage this vulnerability to cause the system to execute arbitrary code by sending a sequence of specially crafted RDP packets to it.

Recommendation(s):
Short term: Microsoft has released a set of patches for Windows XP.
Long Term: It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.11

2.4.7 Finding No. 7

Description: The remote SSH daemon supports connections made using the version 1 of the SSH protocol.

Severity: High

Impact: These protocols are not completely cryptographically safe so they should not be used.

Recommendation(s): Disable compatibility with version 1 of the protocol and use SSH version 2.

Affected host(s): 172.17.200.250

2.4.8 Finding No. 8

Description: The remote host is running Microsoft Windows. It is possible to log into it using a NULL session (i.e., with no login or password).

Severity: Medium

Impact: It may be possible for an unauthenticated, remote attacker to leverage this issue to get information about the remote host.

Recommendation(s):
Short term: Apply the following registry changes per the referenced Technet advisories :
Set :
- HKLM\SYSTEM\CurrentControlSet\Control\LSA\RestrictAnonymous=1
- HKLM\SYSTEM\CurrentControlSet\Services\lanmanserver\parameters\restrictnullsessaccess=1

Remove BROWSER from :
- HKLM\SYSTEM\CurrentControlSet\Services\lanmanserver\parameters\NullSessionPipes

Reboot once the registry changes are complete.

Note: Before implementation of live/production server, Test properly or get advise from OEM.
Long Term: It is highly recommended to upgrade Windows that is currently supported.

Affected host(s): 172.17.200.80, 172.17.200.81, 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.9 Finding No. 9

Description: The remote host is running a Telnet server over an unencrypted channel.

Severity: Medium

Impact: Using Telnet over an unencrypted channel is not recommended as logins, passwords, and commands are transferred in cleartext. This allows a remote, man-in-the-middle attacker to eavesdrop on a Telnet session to obtain credentials or other sensitive information and to modify traffic exchanged between a client and server.

Recommendation(s): Disable the Telnet service and use SSH instead.

Affected host(s): 172.17.200.80 (5250/tcp/telnet), 172.17.200.81(5250/tcp/telnet), 172.17.200.11 (5250/tcp/telnet), 172.17.200.12 (5250/tcp/telnet), 172.17.200.15 (5250/tcp/telnet)

Everest Power Private Limited

2.4.10 Finding No. 10

Description: Signing is not required on the remote SMB server.

Severity: Low

Impact: An unauthenticated, remote attacker can exploit this to conduct man-in-the-middle attacks against the SMB server.

Recommendation(s): Review and Enforce message signing in the host's configuration.

Affected host(s): 172.17.200.80, 172.17.200.81, 172.17.200.11, 172.17.200.12, 172.17.200.15

2.4.11 Finding No. 11

Description: The remote NTP server responds to mode 6 queries.

Severity: Low

Impact: Devices that respond to these queries have the potential to be used in NTP amplification attacks. An unauthenticated, remote attacker could potentially exploit this, via a specially crafted mode 6 query, to cause a reflected denial of service condition.

Recommendation(s): Restrict NTP mode 6 queries.

Affected host(s): 172.17.200.250

2.4.12 Finding No. 12

Description: The remote host has IP forwarding enabled.

Severity: Low

Impact: An attacker can exploit this to route packets through the host and potentially bypass some the devices.

Recommendation(s): Review it. If not require, it is recommended that you disable IP forwarding.

Affected host(s): 172.17.200.1, 172.17.200.2, 172.17.200.5, 172.17.200.151, 172.17.200.152, 172.17.200.153, 172.17.200.154, 172.17.200.155

3 Network Security Audit of IT Infrastructure

3.1 Objective

Everest Power Private Limited, Malana II is located in the Kullu district of the state of Himachal Pradesh with Dam & Power House near the Malana Village. The project utilizes the fall of head in the River course, of about 600 meters between the Dam & Power House. The objective of this testing was to ensure the security of the network Everest Power Private Limited, Malana II including networking devices and server from external and internal threats.

The Security Assessment performed by CyberQ. The audit team consisted of members drawn from CyberQ. Details were provided to the extent mentioned in "Scope of Work". The audit was carried out from Everest Power Private Limited, Malana II.

3.2 Scope

The scope of this Testing included of Configuration Audit of Scada Server, Wi-Fi devices, Network Device CCTV Camera etc of IT infrastructure

- Scanning from Automated tool
- Logical Access to Network & Security devices with administrative / root account.
- Running configuration files of Network & Security Devices and access to log files. The scope of the

The IP Addresses of Scada Network is given below:

Organization Name	EVEREST POWER PRIVATE LIMITED, MALANA II		
IP Addresses of IT Infrastructure	192.168.23.51	192.168.23.52	192.168.23.52
	192.168.23.139	192.168.23.145	192.168.23.156
	192.168.23.2	192.168.23.12	192.168.23.24
	192.168.23.85	192.168.23.91	192.168.23.98
	192.168.23.86	192.168.23.92	192.168.23.99
	192.168.23.88	192.168.23.93	192.168.23.105
	192.168.23.89	192.168.23.97	192.168.23.106
	192.168.23.25	192.168.23.82	192.168.23.101
	192.168.23.157		

3.3 Tools Used

The following tools were used:

- Nmap
- Wifislax
- Nessus
- Wireshark
- Kali linux
- Fern
- Metasploit
- CyberQ Proprietary Checklists and Test Cases

3.4 Vulnerabilities of IT Infrastructure with Recommendation

3.4.1 Finding No. 1

Description: Some devices are directly accessible (Without authentication)

Severity: High

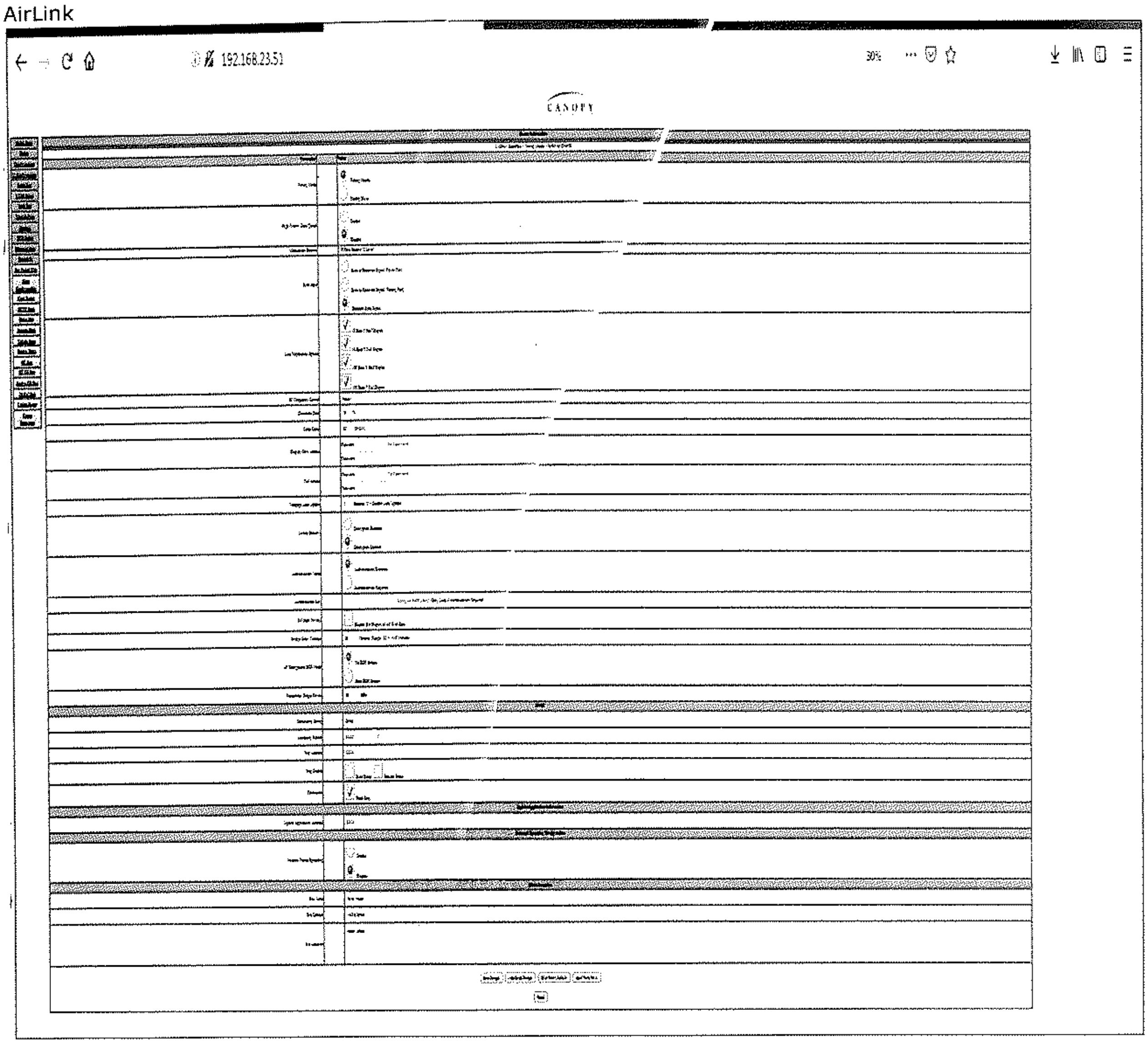
Impact: Malicious user may change any setting as his convenient.

Recommendation(s): All devices should be configured with proper authentication.

Affected host(s): 192.168.23.51, 192.168.23.52, 192.168.23.59

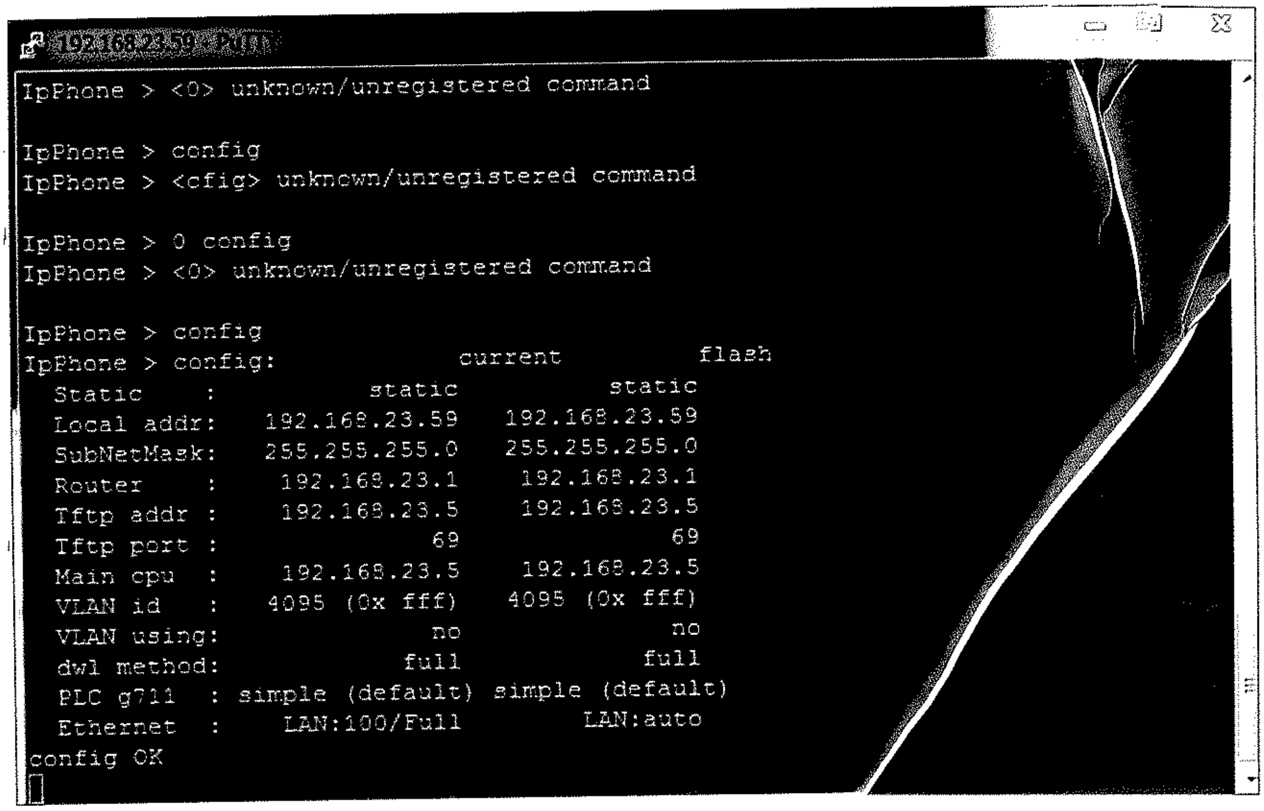
Screenshot/Evidence:

AirLink



```
/---------\
C A N O P Y

Motorola Broadband Wireless Technology Center
(Copyright 2001-2005 Motorola Inc.)

Telnet+>
Telnet+> admin
admin: Command not found
Telnet+> show config
show: Command not found
Telnet+> version
usage -- gethex
Telnet+> syslog

**********System Log Dump**********

00:00:00 UT : 01/01/01 : File root.c : Line 945
        Software Version : CANOPY 7.2.9 Jul 23 2005   01:49:03 BH-DES
00:00:00 UT : 01/01/01 : File root.c : Line 949
        Software Boot Version : CANOPYBOOT 3.0
00:00:00 UT : 01/01/01 : File root.c : Line 955
        FPGA Version : 020205
00:00:00 UT : 01/01/01 : File root.c : Line 959
        FPGA Features : DES
00:00:00 UT : 01/01/01 : File C:/ISIPPC/pssppc.250/bsps/devices/whisp/syslog.c :
 Line 1062
        Time set
00:00:00 UT : 01/01/01 : File C:/ISIPPC/pssppc.250/bsps/devices/whisp/syslog.c :
 Line 918
        System Reset Exception --  External Hard Reset
00:00:00 UT : 01/01/01 : File root.c : Line 940
        ******System Startup******
00:00:00 UT : 01/01/01 : File root.c : Line 945
        Software Version : CANOPY 7.2.9 Jul 23 2005   01:49:03 BH-DES
00:00:00 UT : 01/01/01 : File root.c : Line 949
        Software Boot Version : CANOPYBOOT 3.0
00:00:00 UT : 01/01/01 : File root.c : Line 955
        FPGA Version : 020205
00:00:00 UT : 01/01/01 : File root.c : Line 959
        FPGA Features : DES
00:00:00 UT : 01/01/01 : File C:/ISIPPC/pssppc.250/bsps/devices/whisp/syslog.c :
 Line 1062
        Time set
00:00:00 UT : 01/01/01 : File C:/ISIPPC/pssppc.250/bsps/devices/whisp/syslog.c :
 Line 918
        System Reset Exception --  External Hard Reset
00:00:00 UT : 01/01/01 : File root.c : Line 940
        ******System Startup******
00:00:00 UT : 01/01/01 : File root.c : Line 945
        Software Version : CANOPY 7.2.9 Jul 23 2005   01:49:03 BH-DES
```

IP Phone



```
IpPhone > <0> unknown/unregistered command

IpPhone > config
IpPhone > <cfig> unknown/unregistered command

IpPhone > 0 config
IpPhone > <0> unknown/unregistered command

IpPhone > config
IpPhone > config:              current         flash
  Static     :           static           static
  Local addr:   192.168.23.59   192.168.23.59
  SubNetMask:   255.255.255.0   255.255.255.0
  Router     :    192.168.23.1    192.168.23.1
  Tftp addr :    192.168.23.5    192.168.23.5
  Tftp port :              69              69
  Main cpu  :    192.168.23.5    192.168.23.5
  VLAN id   :   4095 (0x fff)   4095 (0x fff)
  VLAN using:              no              no
  dwl method:            full            full
  PLC g711  : simple (default) simple (default)
  Ethernet  :    LAN:100/Full        LAN:auto
config OK
```

3.4.2 Finding No. 2

Description: Some devices are accessible with default user id and password or easily guessable password.

Severity: High

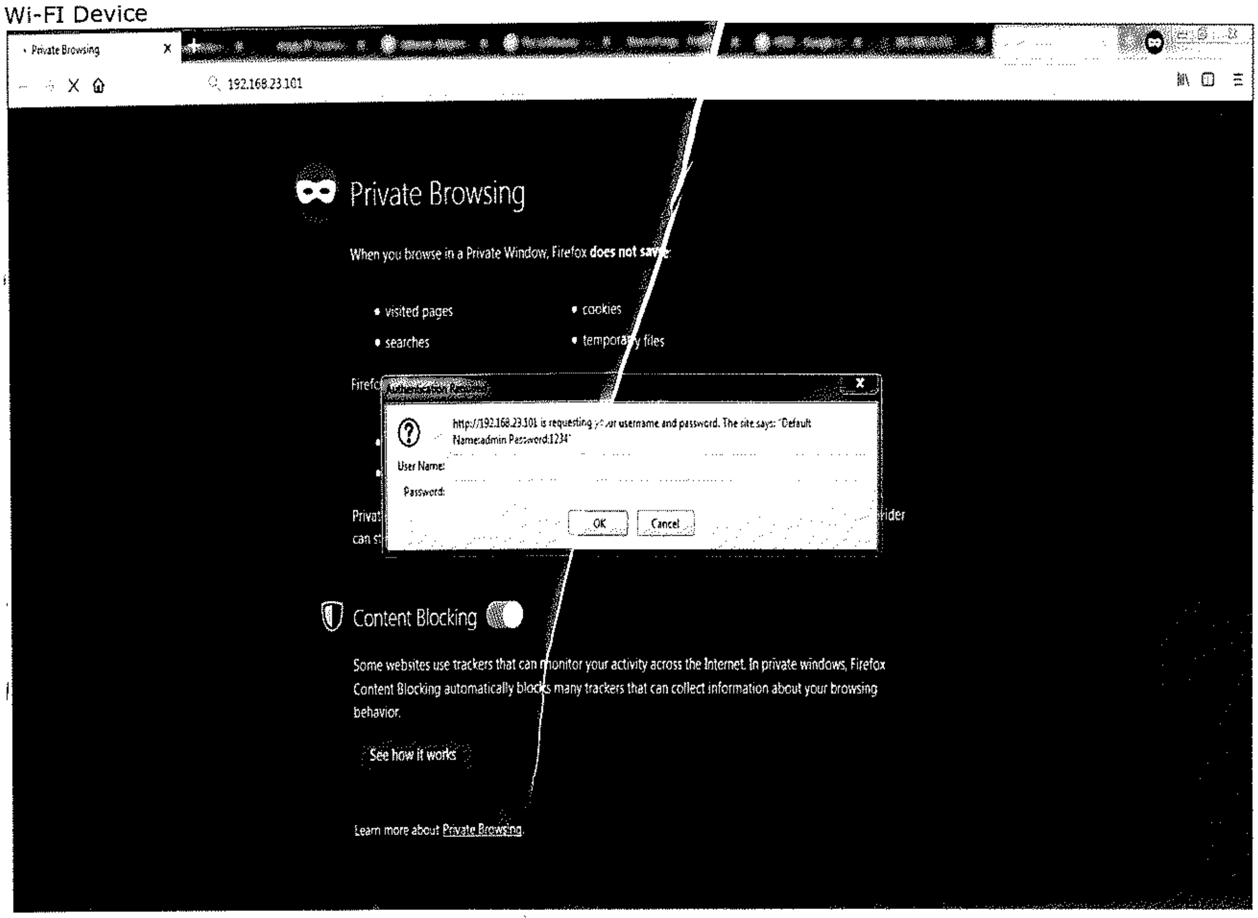
Impact: Malicious user may access using default user id and password and change any setting as his convenient.

Recommendation(s): All devices should not use default user id and password or easily guessable password.

Affected host(s): 192.168.23.139, 192.168.23.145, 192.168.23.156, 192.168.23.157, 192.168.23.101

Screenshot/Evidence:

Wi-FI Device



When you browse in a Private Window, Firefox **does not save**:

- visited pages
- cookies
- searches
- temporary files

http://192.168.23.101 is requesting your username and password. The site says: "Default Name:admin Password:1234"

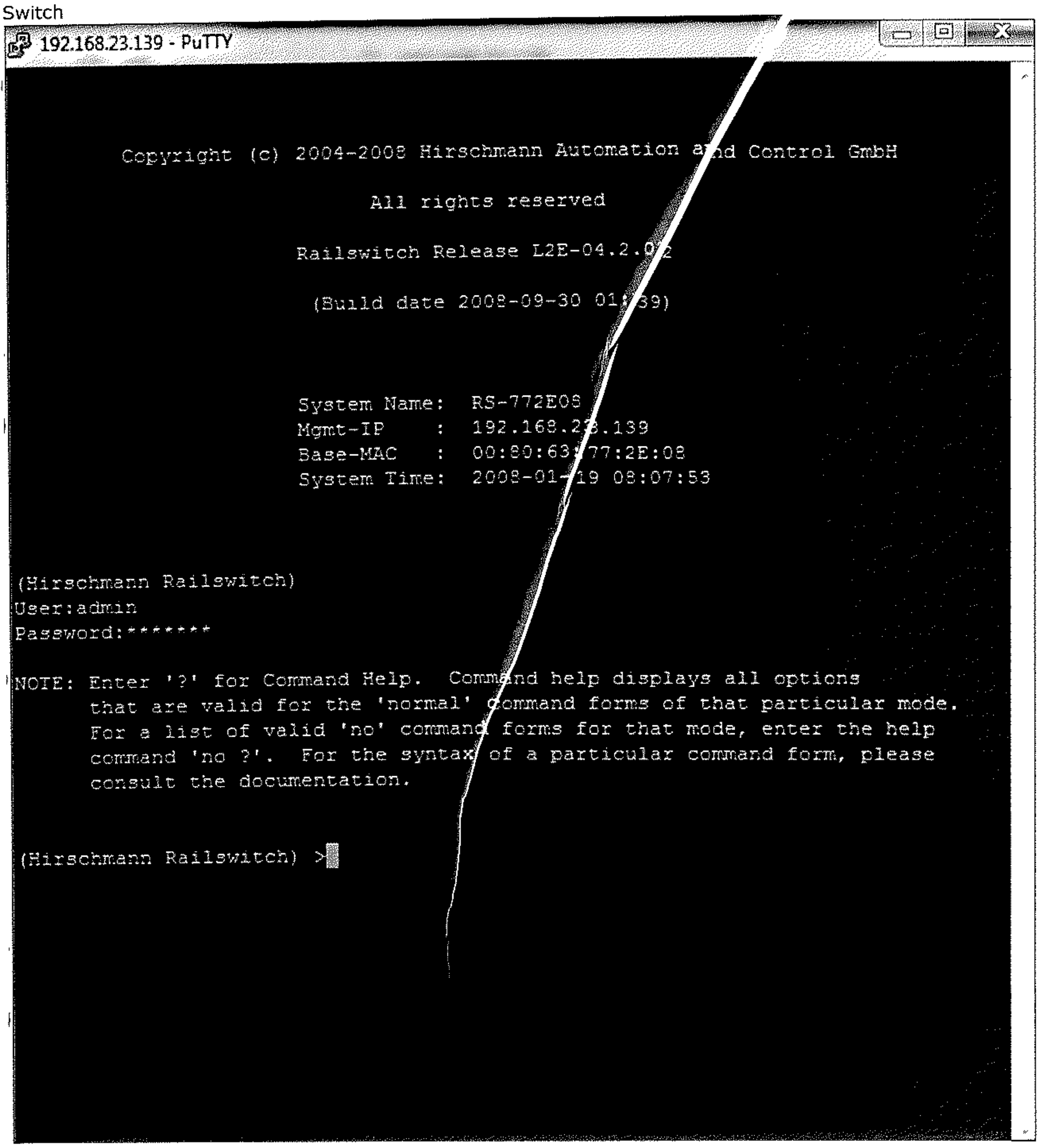
User Name:

Password:

Some websites use trackers that can monitor your activity across the Internet. In private windows, Firefox Content Blocking automatically blocks many trackers that can collect information about your browsing behavior.

Learn more about Private Browsing.

Switch



```
        Copyright (c) 2004-2008 Hirschmann Automation and Control GmbH

                          All rights reserved

                     Railswitch Release L2E-04.2.02

                      (Build date 2008-09-30 01:39)



                     System Name:  RS-772E08
                     Mgmt-IP     :  192.168.23.139
                     Base-MAC    :  00:80:63:77:2E:08
                     System Time:  2008-01-19 08:07:53


(Hirschmann Railswitch)
User:admin
Password:*******

NOTE: Enter '?' for Command Help.  Command help displays all options
      that are valid for the 'normal' command forms of that particular mode.
      For a list of valid 'no' command forms for that mode, enter the help
      command 'no ?'.  For the syntax of a particular command form, please
      consult the documentation.

(Hirschmann Railswitch) >
```

3.4.3 Finding No. 3

Description: Some devices are configured with default setting.

Severity: High

Impact: Malicious user may access using default setting and change any setting as his convenient.

Recommendation(s): All devices should be proper configured as per the security policy of your organization.

Screenshot/Evidence: All Switches and Wi-Fi Devices

3.4.4 Finding No. 4

Description: Operating system/Firmware of the device is not updated. The current running version of Operating System in a device isv5.2 build 718 (GA). Device might be vulnerable for the known vulnerabilities.

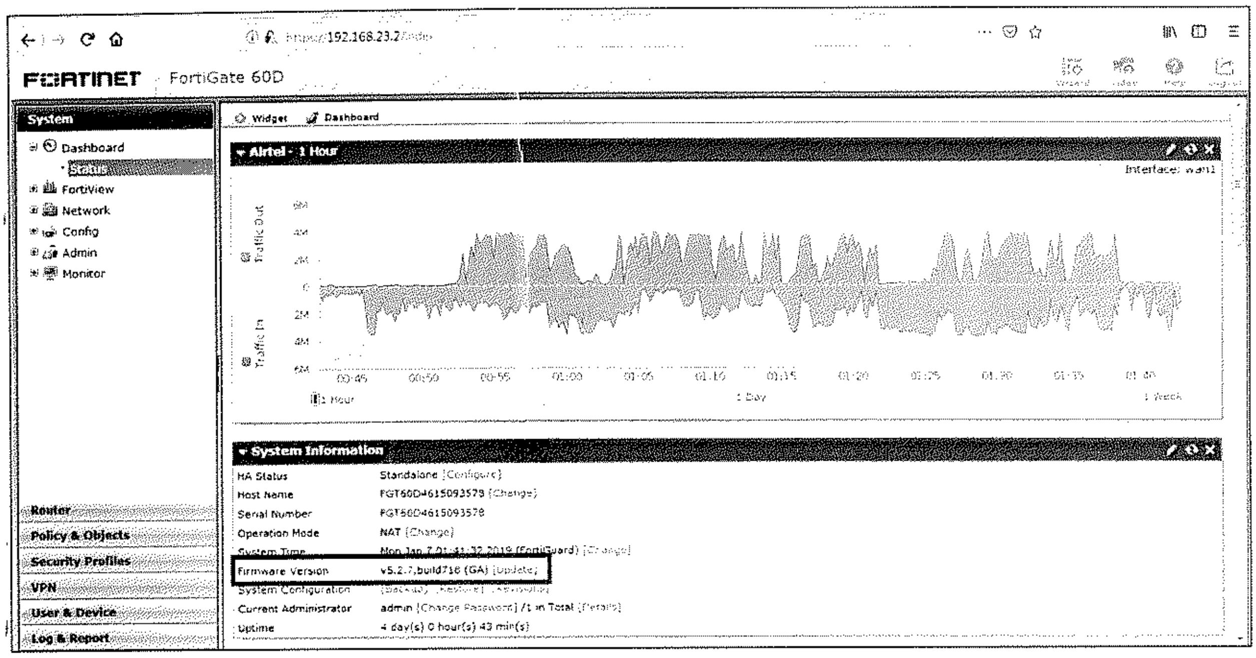
Severity: High

Impact: Malicious user may use known vulnerabilities to compromise the device and the internal network.

Recommendation(s): firmware need to be updated because company is trying to fix vulnerability that was found in current firmware version. Update firmware is similar to system update.

Affected host(s): 192.168.23.2

Screenshot/Evidence:



HA Status: Standalone [Configure]
Host Name: FGT60D4615093578 [Change]
Serial Number: FGT60D4615093578
Operation Mode: NAT [Change]
System Time: Mon Jan 7 01:41:32 2019 (FortiGuard) [Change]
Firmware Version: v5.2.7,build718 (GA) [Update]
Current Administrator: admin [Change Password] /1 in Total [Details]
Uptime: 4 day(s) 0 hour(s) 43 min(s)

3.4.5 Finding No. 5

Description: Some of the policy has set 'All' source to 'All' destinations with 'All' service.

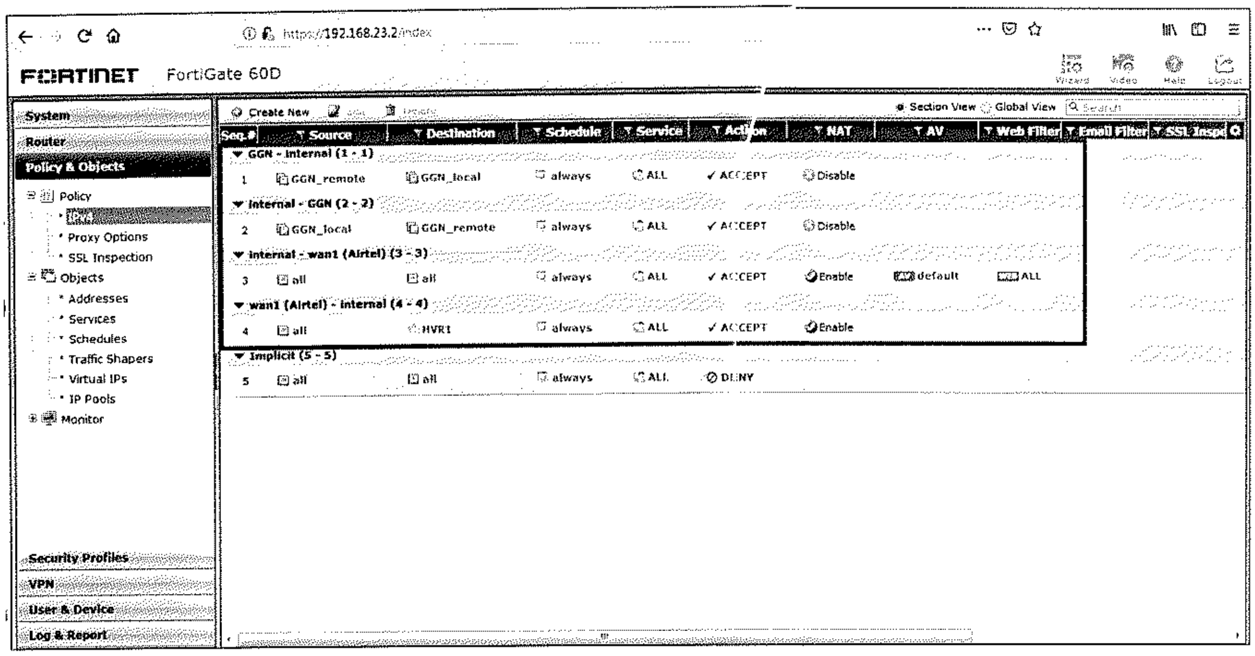
Severity: High

Impact: Malicious user may send from inbound to outbound traffic or outbound to inbound traffic.

Recommendation(s): Policy Should be implemented on the firewall as per the security guidelines set by the organization. It should be set as specific source to specific destinations with specific service (Port) as per your organization requirement.

Affected host(s): 192.168.23.2

Screenshot/Evidence:



Seq.#	Source	Destination	Schedule	Service	Action	NAT	AV	Web Filter	Email Filter	SSL Inspe
GGN - internal (1 - 1)										
1	GGN_remote	GGN_local	always	ALL	✓ ACCEPT	Disable				
internal - GGN (2 - 2)										
2	GGN_local	GGN_remote	always	ALL	✓ ACCEPT	Disable				
internal - wan1 (Airtel) (3 - 3)										
3	all	all	always	ALL	✓ ACCEPT	Enable	default	ALL		
wan1 (Airtel) - internal (4 - 4)										
4	all	HVR1	always	ALL	✓ ACCEPT	Enable				
Implicit (5 - 5)										
5	all	all	always	ALL	⊘ DENY					

3.4.6 Finding No. 6

Description: The running version of Portable SDK for UPnP Devices (libupnp) is 1.6.17 which is affected by multiple remote code execution vulnerabilities.

Severity: High

Impact: A stack-based buffer overflow condition exists in the unique_service_name() function within file ssdp/ssdp_server.c when handling Simple Service Discovery Protocol (SSDP) requests that is triggered while copying the DeviceType URN. An unauthenticated, remote attacker can exploit this, via a specially crafted SSDP request, to execute arbitrary code. (CVE-2012-5958)
A stack-based buffer overflow condition exists in the unique_service_name() function within file ssdp/ssdp_server.c when handling Simple Service Discovery Protocol (SSDP) requests that is triggered while copying the UDN prior to two colons. An unauthenticated, remote attacker can exploit this, via a specially crafted SSDP request, to execute arbitrary code. (CVE-2012-5959)
A stack-based buffer overflow condition exists in the unique_service_name() function within file ssdp/ssdp_server.c when handling Simple Service Discovery Protocol (SSDP) requests that is triggered while copying the UDN prior to the '::upnp:rootdevice' string. An unauthenticated, remote attacker can exploit this, via a specially crafted SSDP request, to execute arbitrary code. (CVE-2012-5960)
Multiple stack-based buffer overflow conditions exist in the unique_service_name() function within file ssdp/ssdp_server.c due to improper validation of the UDN, DeviceType, and ServiceType fields when parsing Simple Service Discovery Protocol (SSDP) requests. An unauthenticated, remote attacker can exploit these issues, via a specially crafted SSDP request, to execute arbitrary code. (CVE-2012-5961, CVE-2012-5962, CVE-2012-5963, CVE-2012-5964, CVE-2012-5965)

Recommendation(s): Upgrade to libupnp version 1.6.18 or later. If libupnp is used as a third party library by a different application, contact the vendor of that application for a fix.

Affected host(s):

1900 / udp / ssdp	192.168.23.85	192.168.23.91	192.168.23.98
	192.168.23.86	192.168.23.92	192.168.23.99
	192.168.23.88	192.168.23.93	192.168.23.105
	192.168.23.89	192.168.23.97	192.168.23.106
49152 / tcp / www	192.168.23.85	192.168.23.91	192.168.23.97
	192.168.23.86	192.168.23.92	192.168.23.98
	192.168.23.88	192.168.23.93	192.168.23.99
	192.168.23.89	192.168.23.105	192.168.23.106

3.4.7 Finding No. 7

Description: Operating Systems of Servers and network devices were not updated with latest security patches and service packs.

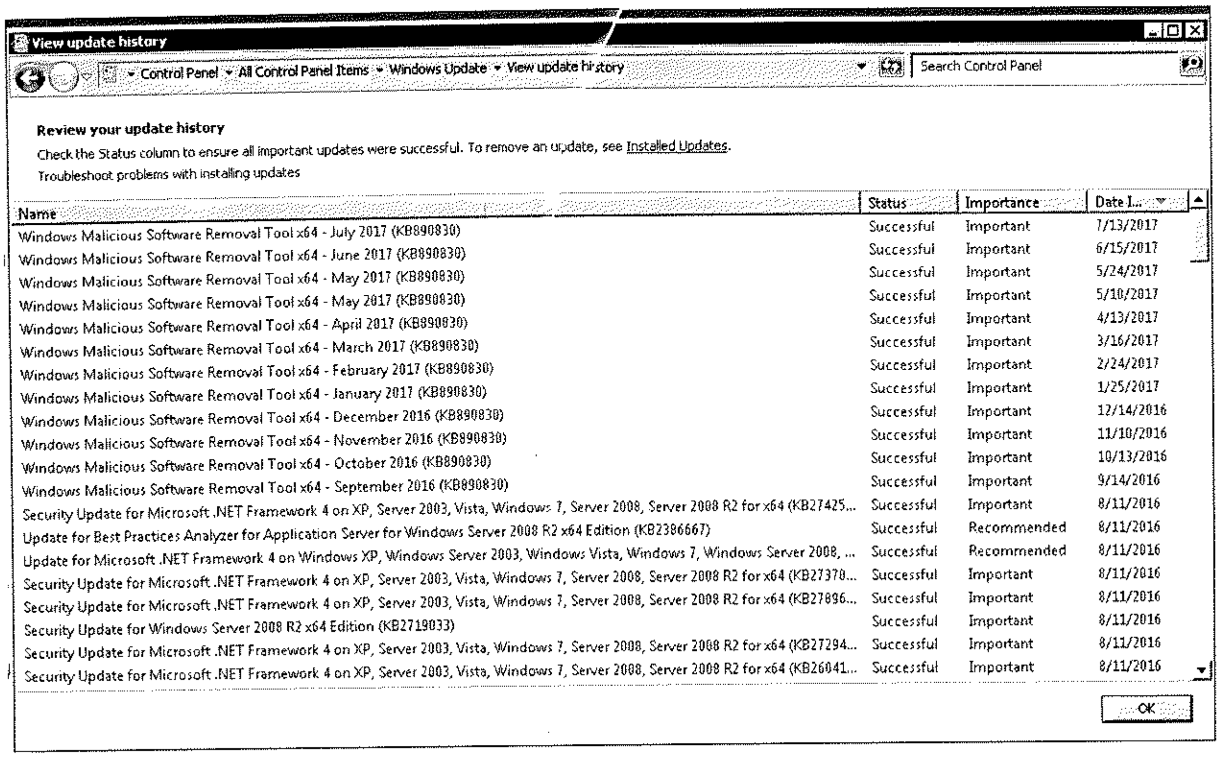
Severity: High

Impact: Default configuration of operating system having the many known vulnerabilities which can be misused by malicious user. In default configuration most of the services were enabled can also be misused.

Recommendation(s): Apply all latest security updates and services packs released by the operating system and application software vendors. Create a procedure to keep system updated by applying latest security patches and updates on regular interval.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Review your update history

Check the Status column to ensure all important updates were successful. To remove an update, see Installed Updates.

Troubleshoot problems with installing updates

Name	Status	Importance	Date I...
Windows Malicious Software Removal Tool x64 - July 2017 (KB890830)	Successful	Important	7/13/2017
Windows Malicious Software Removal Tool x64 - June 2017 (KB890830)	Successful	Important	6/15/2017
Windows Malicious Software Removal Tool x64 - May 2017 (KB890830)	Successful	Important	5/24/2017
Windows Malicious Software Removal Tool x64 - May 2017 (KB890830)	Successful	Important	5/10/2017
Windows Malicious Software Removal Tool x64 - April 2017 (KB890830)	Successful	Important	4/13/2017
Windows Malicious Software Removal Tool x64 - March 2017 (KB890830)	Successful	Important	3/16/2017
Windows Malicious Software Removal Tool x64 - February 2017 (KB890830)	Successful	Important	2/24/2017
Windows Malicious Software Removal Tool x64 - January 2017 (KB890830)	Successful	Important	1/25/2017
Windows Malicious Software Removal Tool x64 - December 2016 (KB890830)	Successful	Important	12/14/2016
Windows Malicious Software Removal Tool x64 - November 2016 (KB890830)	Successful	Important	11/10/2016
Windows Malicious Software Removal Tool x64 - October 2016 (KB890830)	Successful	Important	10/13/2016
Windows Malicious Software Removal Tool x64 - September 2016 (KB890830)	Successful	Important	9/14/2016
Security Update for Microsoft .NET Framework 4 on XP, Server 2003, Vista, Windows 7, Server 2008, Server 2008 R2 for x64 (KB27425...	Successful	Important	8/11/2016
Update for Best Practices Analyzer for Application Server for Windows Server 2008 R2 x64 Edition (KB2386667)	Successful	Recommended	8/11/2016
Update for Microsoft .NET Framework 4 on Windows XP, Windows Server 2003, Windows Vista, Windows 7, Windows Server 2008, ...	Successful	Recommended	8/11/2016
Security Update for Microsoft .NET Framework 4 on XP, Server 2003, Vista, Windows 7, Server 2008, Server 2008 R2 for x64 (KB27370...	Successful	Important	8/11/2016
Security Update for Microsoft .NET Framework 4 on XP, Server 2003, Vista, Windows 7, Server 2008, Server 2008 R2 for x64 (KB27896...	Successful	Important	8/11/2016
Security Update for Windows Server 2008 R2 x64 Edition (KB2719033)	Successful	Important	8/11/2016
Security Update for Microsoft .NET Framework 4 on XP, Server 2003, Vista, Windows 7, Server 2008, Server 2008 R2 for x64 (KB27294...	Successful	Important	8/11/2016
Security Update for Microsoft .NET Framework 4 on XP, Server 2003, Vista, Windows 7, Server 2008, Server 2008 R2 for x64 (KB26041...	Successful	Important	8/11/2016

3.4.8 Finding No. 8

Description: The remote Windows host has Microsoft Server Message Block 1 .0 (SMBv1) enabled.

Severity: High

Impact: It is, therefore, affected by multiple vulnerabilities:
- Multiple information disclosure vulnerabilities exist in Microsoft Server Message Block 1.0 (SMBv1) due to improper handling of SMBv1 packets. An unauthenticated, remote attacker can exploit these vulnerabilities, via a specially crafted SMBv1 packet, to disclose sensitive information. (CVE-2017-0267, CVE-2017-0268, CVE-2017-0270, CVE-2017-0271, CVE-2017-0274, CVE-2017-0275, CVE-2017-0276)
- Multiple denial of service vulnerabilities exist in Microsoft Server Message Block 1.0 (SMBv1) due to improper handling of requests. An unauthenticated, remote attacker can exploit these vulnerabilities, via a specially crafted SMB request, to cause the system to stop responding. (CVE-2017-0269, CVE-2017-0273, CVE-2017-0280)
- Multiple remote code execution vulnerabilities exist in Microsoft Server Message Block 1.0 (SMBv1) due to improper handling of SMBv1 packets. An unauthenticated, remote attacker can exploit these vulnerabilities, via a specially crafted SMBv1 packet, to execute arbitrary code. (CVE-2017-0272, CVE-2017-0277, CVE-2017-0278, CVE-2017-0279)

Recommendation(s): Apply the applicable security update for your Windows version :

- Windows Server 2008 : KB4018466
- Windows Server 2008 R2 : KB4019264

Affected host(s): 192.168.23.12

3.4.9 Finding No. 9

Description: Multiple remote code execution vulnerabilities exist in Microsoft Server Message Block 1.0 (SMBv1) due to improper handling of certain requests. (MS17-010: Security Update for Microsoft Windows SMB Server (4013389))

Severity: High

Impact: An unauthenticated, remote attacker can exploit these vulnerabilities, via a specially crafted packet, to execute arbitrary code.

Recommendation(s): Microsoft has released a set of patches for Windows Server 2008/ 2008 r2. Additionally, It is recommended that users block SMB directly by blocking TCP port 445 on all network boundary devices. For SMB over the NetBIOS API, block TCP ports 137 / 139 and UDP ports 137 / 138 on all network boundary devices.

Affected host(s): 192.168.23.12

3.4.10 Finding No. 10

Description: The remote Windows host is affected by a remote code execution vulnerability due to improper processing of packets by the Secure Channel (Schannel) security package(MS14-066: Vulnerability in Schannel Could Allow Remote Code Execution (2992611))

Severity: High

Impact: An attacker can exploit this issue by sending specially crafted packets to a Windows server.

Recommendation(s): Microsoft has released a set of patches for Windows Server 2008, 2008 R2.

Affected host(s): 192.168.23.12

3.4.11 Finding No. 11

Description: The remote Samba install is prone to a heap-based buffer overflow attack.

Severity: Medium

Impact: An attacker can exploit this issue to execute arbitrary code with the privileges of the application. Failed exploit attempts will result in a denial of service condition.

Recommendation(s): Apply patches from the vendor. A patch addressing this defect has been posted to http://www.samba.org/samba/security/

Affected host(s): 192.168.23.24 (445 / tcp / cifs), **192.168.23.25** (445 / tcp / cifs)

3.4.12 Finding No. 12

Description: Password policy and account lockout policies are not implemented on firewall devices.

Severity: Medium

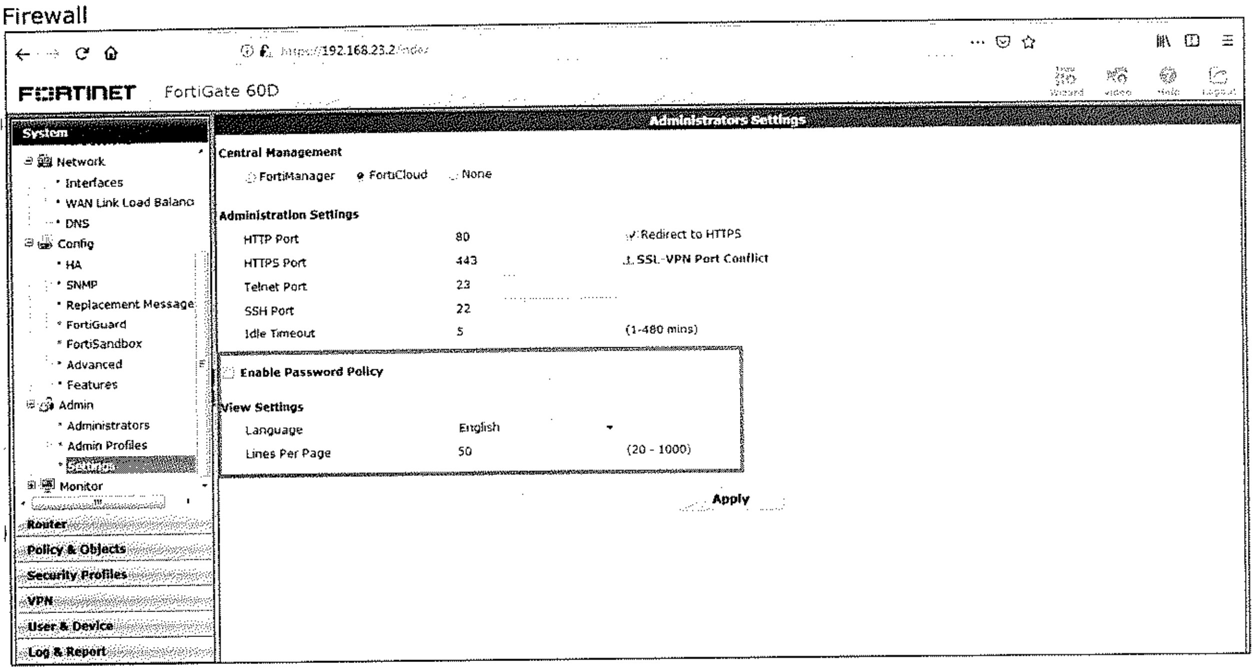
Impact: User can keep easy password for their own ease but this is useful for the malicious user and he may able to crack or guess the password to compromise the critical systems.

Recommendation(s): Password policies and account lockout policies should be implemented as per the security policy of your organization/ best practices of IT industry. System must force to user to keep a strong password as per implemented password policy.

Affected host(s): 192.168.23.2, 192.168.23.12

Screenshot/Evidence:

Firewall



Administrators Settings

Central Management

○ FortiManager ● FortiCloud ○ None

Administration Settings

HTTP Port 80 ☑ Redirect to HTTPS

HTTPS Port 443 SSL-VPN Port Conflict

Telnet Port 23

SSH Port 22

Idle Timeout 5 (1-480 mins)

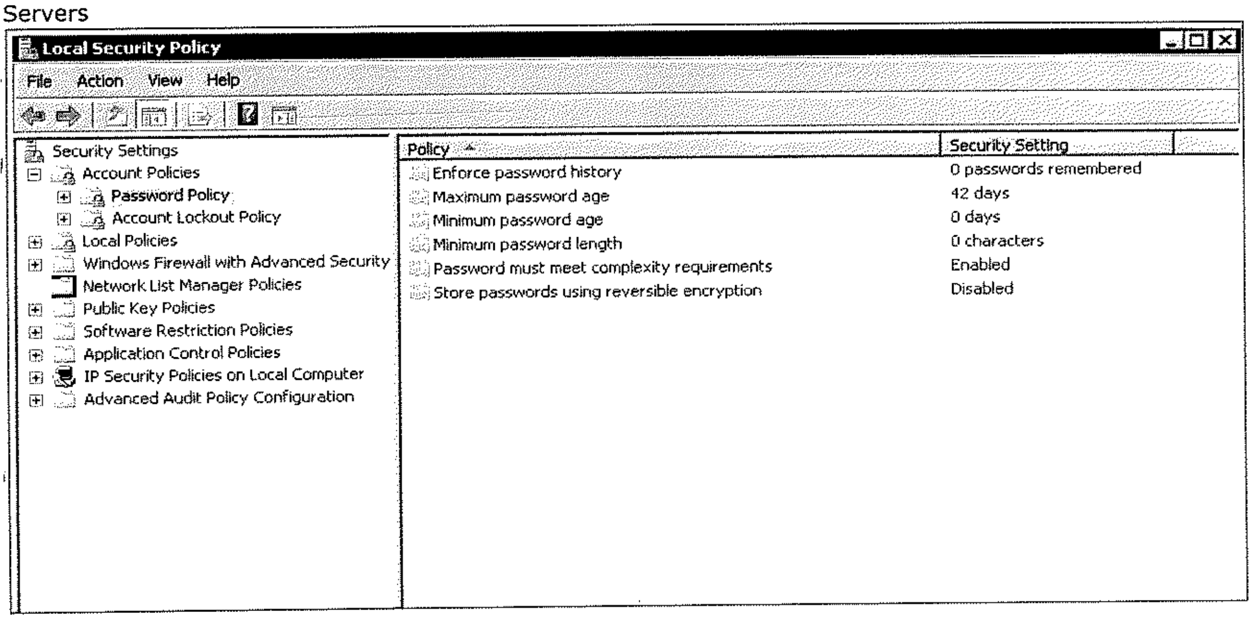
☐ Enable Password Policy

View Settings

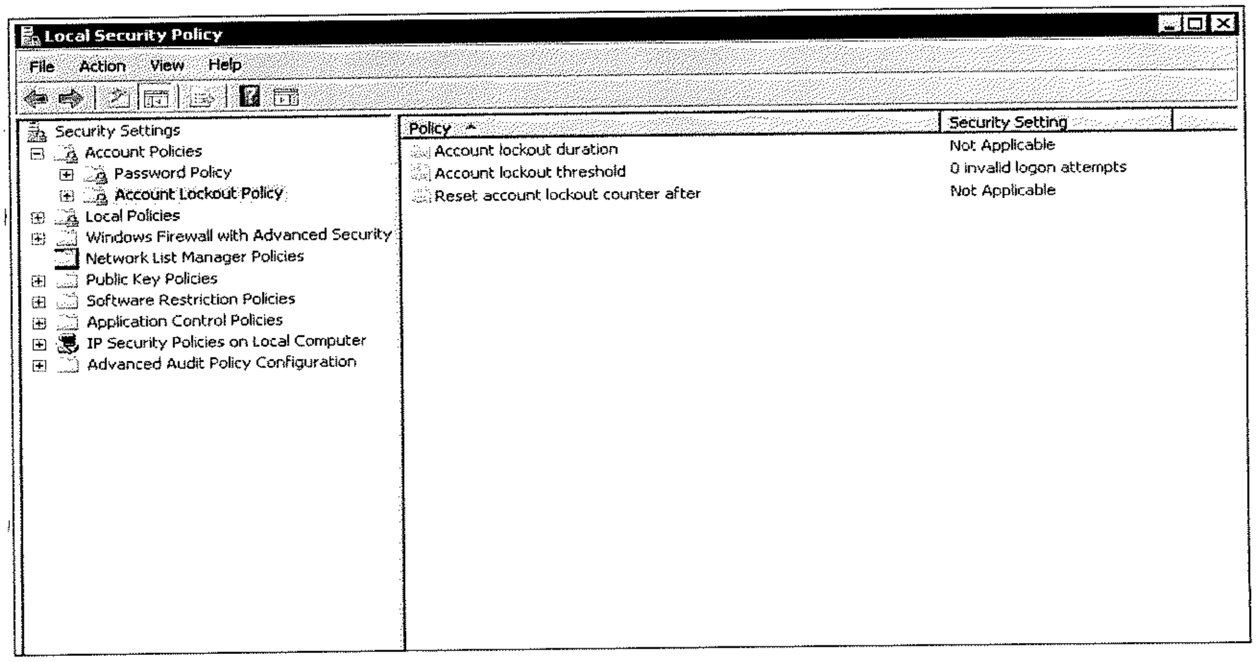
Language English

Lines Per Page 50 (20 - 1000)

Servers



Policy	Security Setting
Enforce password history	0 passwords remembered
Maximum password age	42 days
Minimum password age	0 days
Minimum password length	0 characters
Password must meet complexity requirements	Enabled
Store passwords using reversible encryption	Disabled



Policy	Security Setting
Account lockout duration	Not Applicable
Account lockout threshold	0 invalid logon attempts
Reset account lockout counter after	Not Applicable

3.4.13 Finding No. 13

Description: Telnet was enabled to manage the network devices and it was not restricted to some specific host or IP's. Telnet transfers user name and password in clear text, so it can be compromised by eavesdropping the session.

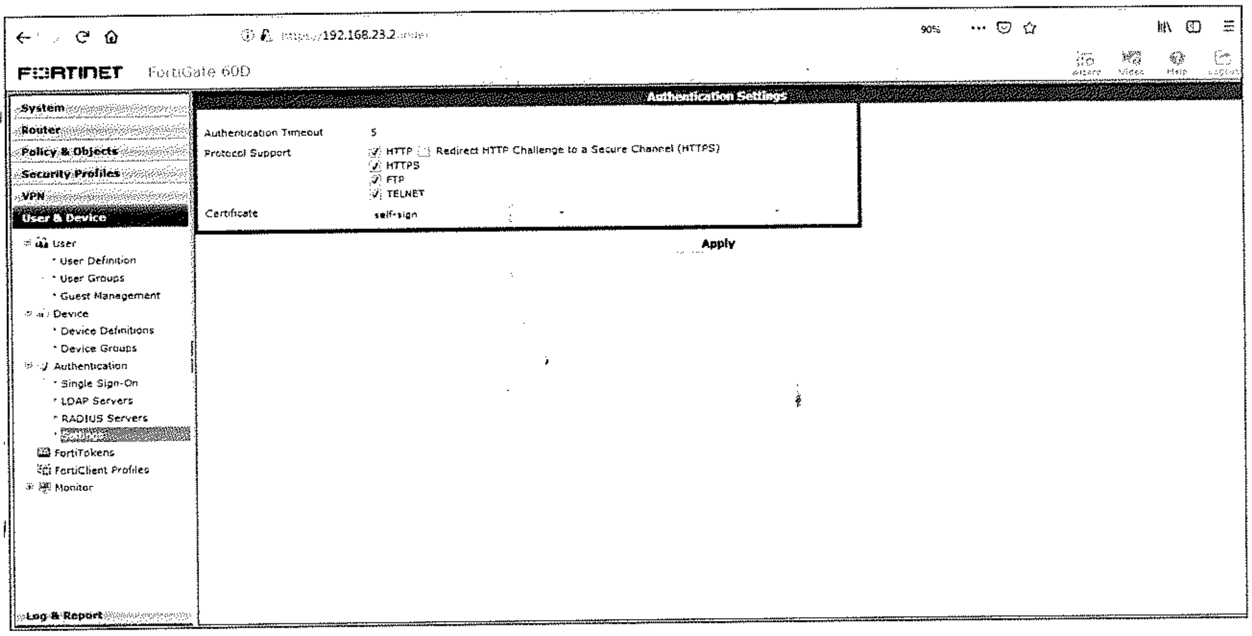
Severity: Medium

Impact: Unauthorized can sniff the network to get the username and password and try to get access to the router and to alter configuration setting as per their requirement to compromise the network.

Recommendation(s): Use only SSH to manage the device remotely and allow access only from some specific IP addresses.

Affected host(s): 192.168.23.2, 192.168.23.24, 192.168.23.25, 192.168.23.51, 192.168.23.52

Screenshot/Evidence(s):



Authentication Settings

Authentication Timeout 5

Protocol Support ☑ HTTP ☐ Redirect HTTP Challenge to a Secure Channel (HTTPS)
☑ HTTPS
☑ FTP
☑ TELNET

Certificate self-sign

3.4.14 Finding No. 14

Description: Event log has setting of 20480 KB and overwrite events as needed.

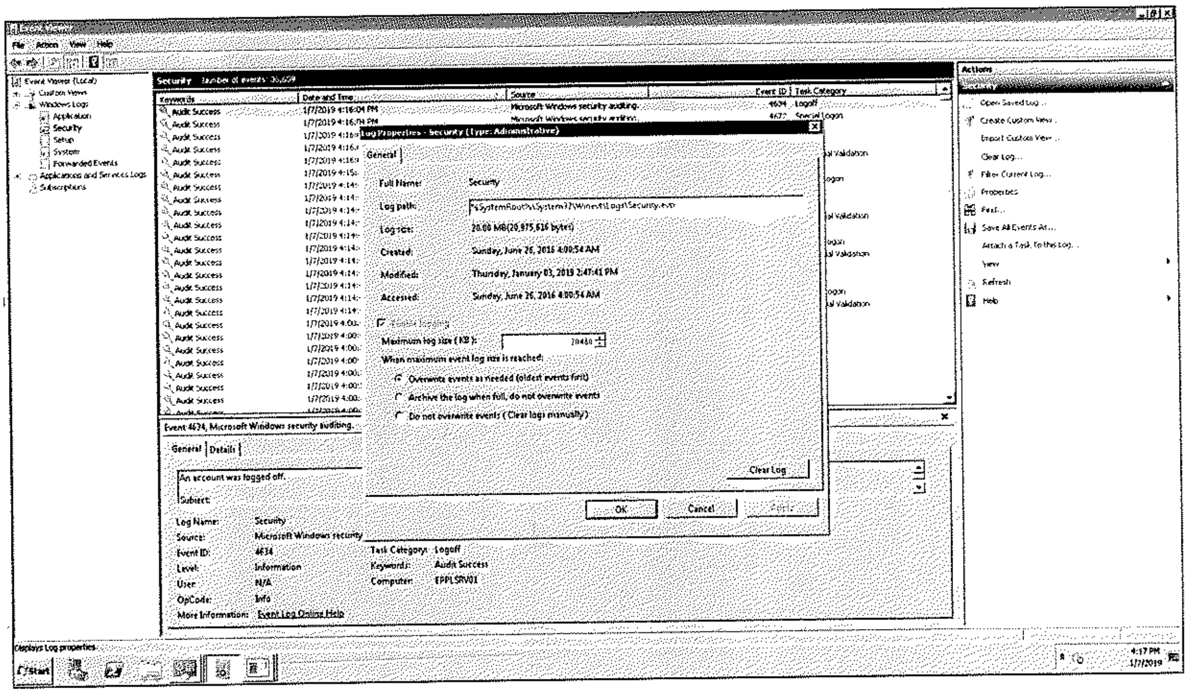
Severity: Medium

Impact: Critical Events may be overwrite with new events if the size allocated gets full.

Recommendation(s): Set the security log size to a value which was sufficient to record the logs generated to backups. It is also set to Archive the log when full, do not overwrite events.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Log Properties - Security (Type: Administrative)

Full Name: Security

Log path: %SystemRoot%\System32\Winevt\Logs\Security.evtx

Log size: 20.00 MB(20,975,616 bytes)

Created: Sunday, June 26, 2016 4:00:54 AM

Modified: Thursday, January 03, 2019 2:47:41 PM

Accessed: Sunday, June 26, 2016 4:00:54 AM

☑ Enable logging

Maximum log size (KB): 20480

When maximum event log size is reached:

● Overwrite events as needed (oldest events first)

○ Archive the log when full, do not overwrite events

○ Do not overwrite events (Clear logs manually)

Event 4634, Microsoft Windows security auditing.

An account was logged off.

Subject:

Log Name: Security

Source: Microsoft Windows security

Event ID: 4634

Task Category: Logoff

Level: Information

Keywords: Audit Success

User: N/A

Computer: EPPLSRV01

OpCode: Info

3.4.15 Finding No. 15

Description: Audit policy under Local Policy is not configured.

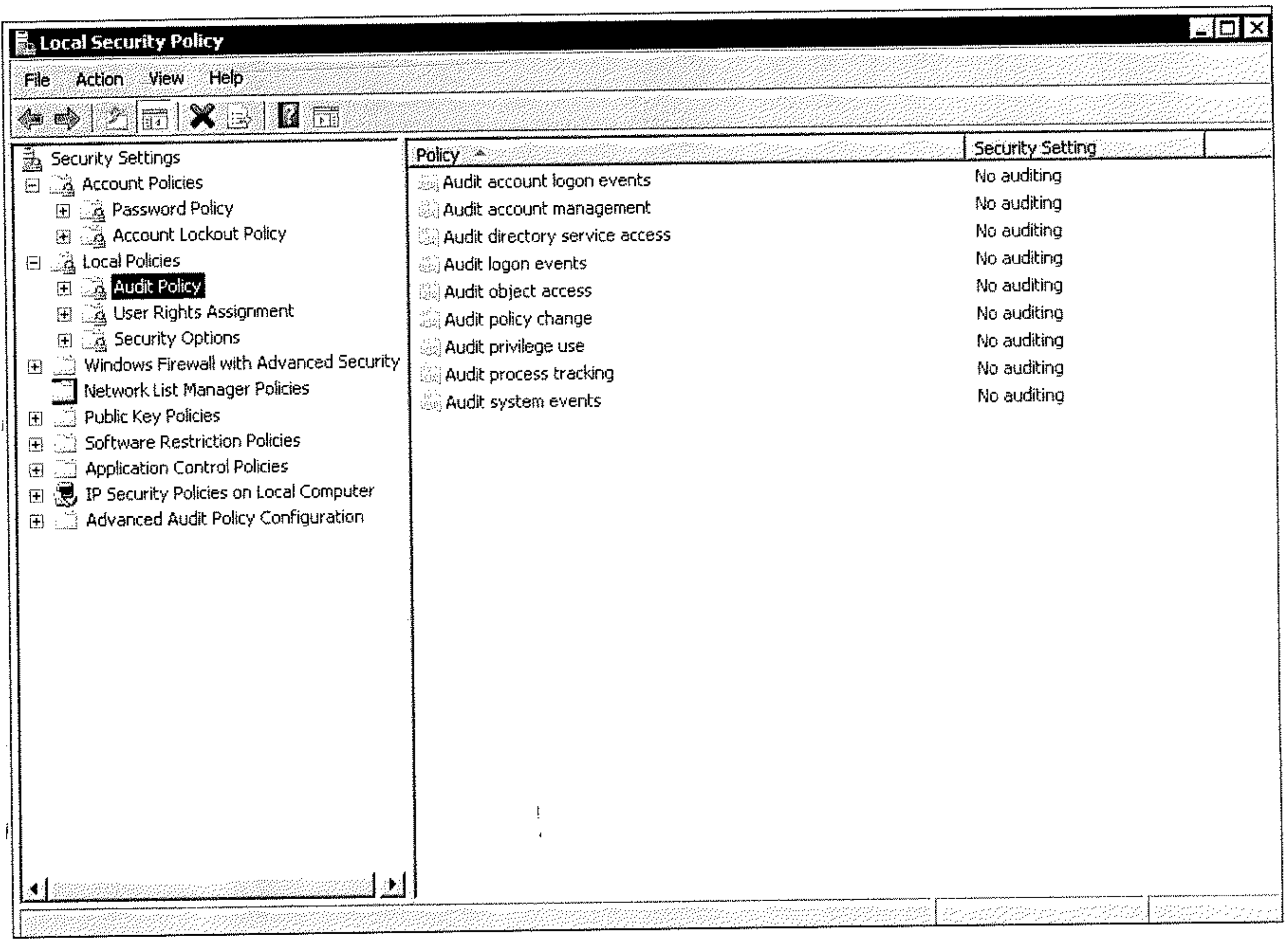
Severity: Medium

Impact: Without Audit policy, It is difficult to generate logs properly and identify the malicious activity.

Recommendation(s): Configure Audit Policy to track the unwanted activities as per the organization security policy.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Policy	Security Setting
Audit account logon events	No auditing
Audit account management	No auditing
Audit directory service access	No auditing
Audit logon events	No auditing
Audit object access	No auditing
Audit policy change	No auditing
Audit privilege use	No auditing
Audit process tracking	No auditing
Audit system events	No auditing

3.4.16 Finding No. 16

Description: Access this computer from the network is set "Everyone".

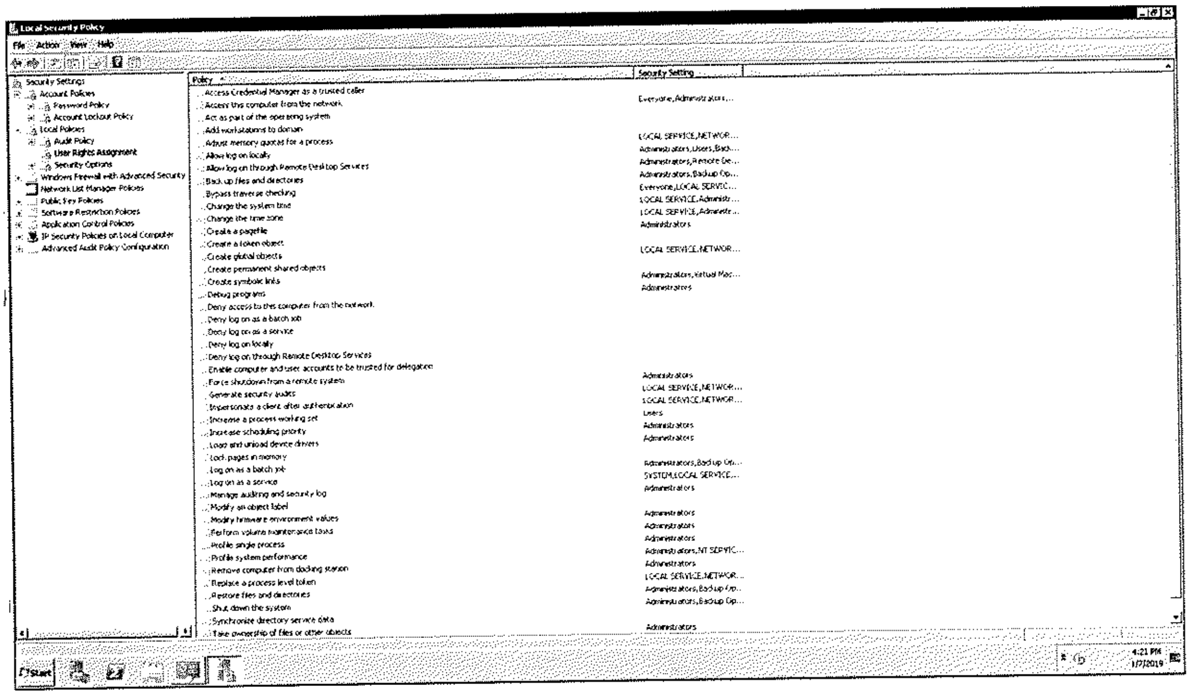
Severity: Medium

Impact: If set "Everyone" anyone can access the computer over network.

Recommendation(s): Only Authenticated User should be allowed to access the system.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Policy	Security Setting
Access Credential Manager as a trusted caller	
Access this computer from the network	Everyone,Administrators,...
Act as part of the operating system	
Add workstations to domain	
Adjust memory quotas for a process	LOCAL SERVICE,NETWOR...
Allow log on locally	Administrators,Users,Back...
Allow log on through Remote Desktop Services	Administrators,Remote De...
Back up files and directories	Administrators,Backup Op...
Bypass traverse checking	Everyone,LOCAL SERVIC...
Change the system time	LOCAL SERVICE,Administr...
Change the time zone	LOCAL SERVICE,Administr...
Create a pagefile	Administrators
Create a token object	
Create global objects	LOCAL SERVICE,NETWOR...
Create permanent shared objects	
Create symbolic links	Administrators,Virtual Mac...
Debug programs	Administrators
Deny access to this computer from the network	
Deny log on as a batch job	
Deny log on as a service	
Deny log on locally	
Deny log on through Remote Desktop Services	
Enable computer and user accounts to be trusted for delegation	
Force shutdown from a remote system	Administrators
Generate security audits	LOCAL SERVICE,NETWOR...
Impersonate a client after authentication	LOCAL SERVICE,NETWOR...
Increase a process working set	Users
Increase scheduling priority	Administrators
Load and unload device drivers	Administrators
Lock pages in memory	
Log on as a batch job	Administrators,Backup Op...
Log on as a service	SYSTEM,LOCAL SERVICE,...
Manage auditing and security log	Administrators
Modify an object label	
Modify firmware environment values	Administrators
Perform volume maintenance tasks	Administrators
Profile single process	Administrators
Profile system performance	Administrators,NT SERVIC...
Remove computer from docking station	Administrators
Replace a process level token	LOCAL SERVICE,NETWOR...
Restore files and directories	Administrators,Backup Op...
Shut down the system	Administrators,Backup Op...
Synchronize directory service data	
Take ownership of files or other objects	Administrators

3.4.17 Finding No. 17

Description: 'Advance Device Control' is not enable on antivirus server.

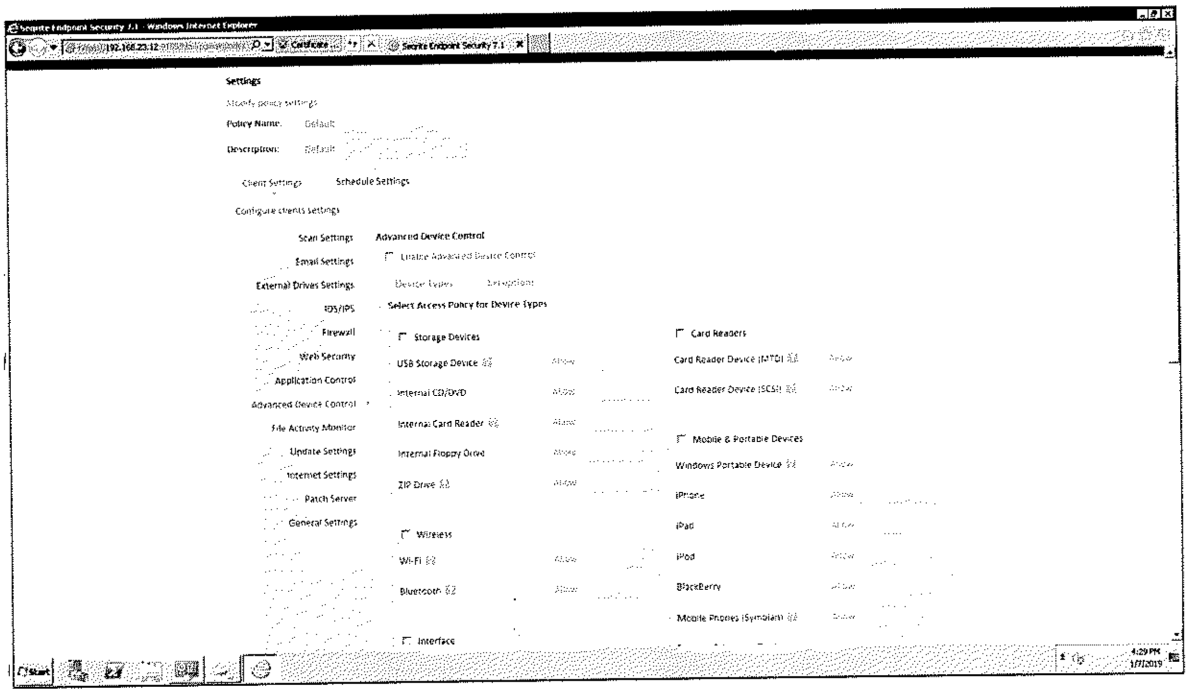
Severity: Low

Impact: 'Advance Device Control' is protect the system from other infected device such as pen drive etc.

Recommendation(s): 'Advance Device Control' should be enable and configure as per the organization security policy.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Settings

Modify policy settings

Policy Name: Default

Description: Default

Configure clients settings

Advanced Device Control

☐ Enable Advanced Device Control

Select Access Policy for Device Types

☐ Storage Devices

USB Storage Device	Allow
Internal CD/DVD	Allow
Internal Card Reader	Allow
Internal Floppy Drive	Allow
ZIP Drive	Allow

☐ Wireless

Wi-Fi	Allow
Bluetooth	Allow

☐ Interface

☐ Card Readers

Card Reader Device (MTD)	Allow
Card Reader Device (SCSI)	Allow

☐ Mobile & Portable Devices

Windows Portable Device	Allow
iPhone	Allow
iPad	Allow
iPod	Allow
BlackBerry	Allow
Mobile Phones (Symbian)	Allow

3.4.18 Finding No. 18

Description: 'File Activity Monitor' is not enable on antivirus server.

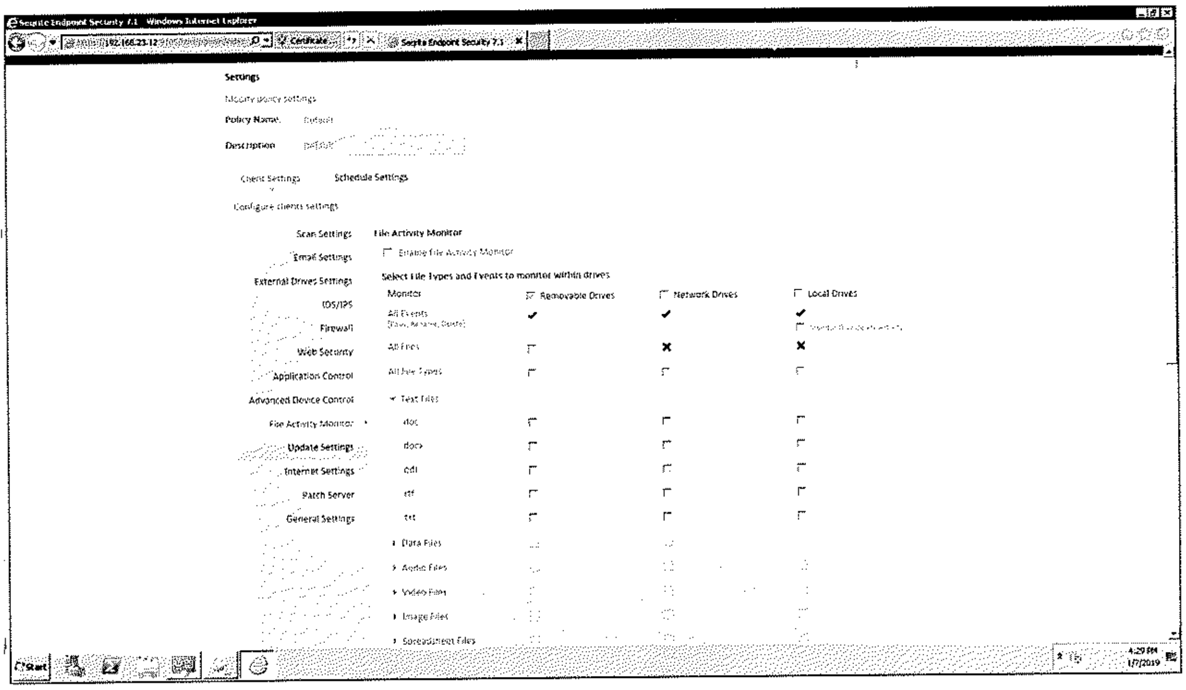
Severity: Low

Impact: 'File Activity Monitor' is monitor and protect our system from malicious file.

Recommendation(s): 'File Activity Monitor' should be enable and configure as per the organization security policy.

Affected host(s): 192.168.23.12

Screenshot/Evidence(s):



Settings

Modify policy settings

Policy Name: Default

Description: Default

Client Settings | Schedule Settings

Configure clients settings

File Activity Monitor

☐ Enable File Activity Monitor

Select File Types and Events to monitor within drives

Monitor	☑ Removable Drives	☐ Network Drives	☐ Local Drives
All Events (Copy, Rename, Delete)	✓	✓	✓
All Files	☐	✗	✗
All File Types	☐	☐	☐
▾ Text Files			
doc	☐	☐	☐
docx	☐	☐	☐
odt	☐	☐	☐
rtf	☐	☐	☐
txt	☐	☐	☐
▸ Data Files			
▸ Audio Files			
▸ Video Files			
▸ Image Files			
▸ Spreadsheet Files			

3.4.19 Finding No. 19

Description: Default user ID "Admin" is used frequently use to access the Devices. Also, Administrator is used for Servers.

Severity: Low

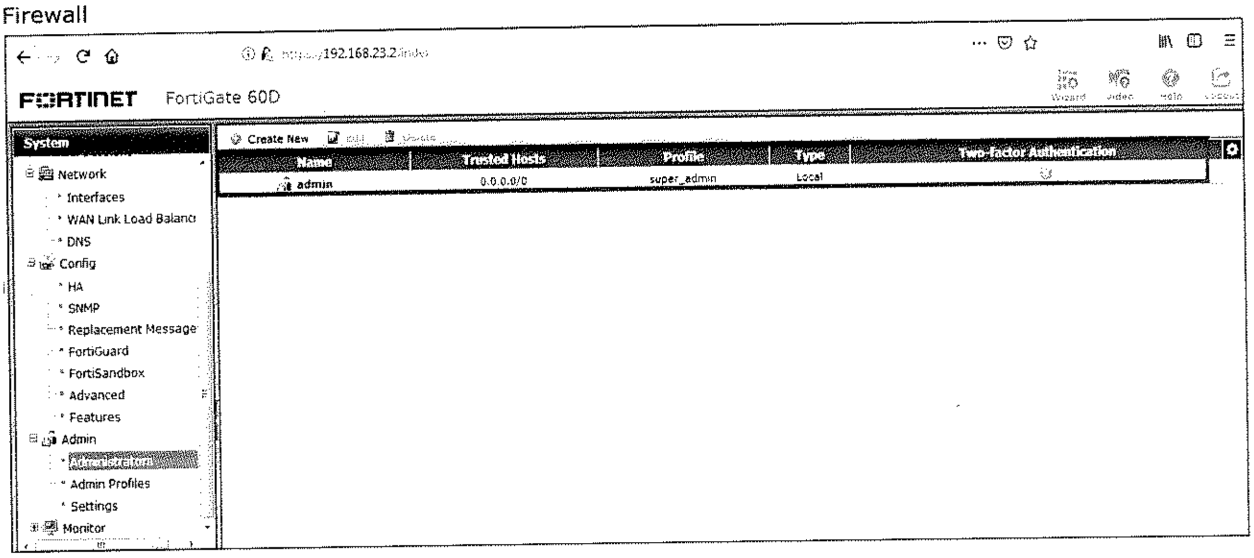
Impact: It will be very difficult to trace and make specific user accountable for the unwanted event as generic user account "Admin" is used.

Recommendation: Create individual user ID's for all authorized user who access the devices/servers and log all the activities. If possible, not avoid generic name.

Affected host(s): 192.168.23.2, 192.168.23.12, 192.168.23.82, 192.168.23.101

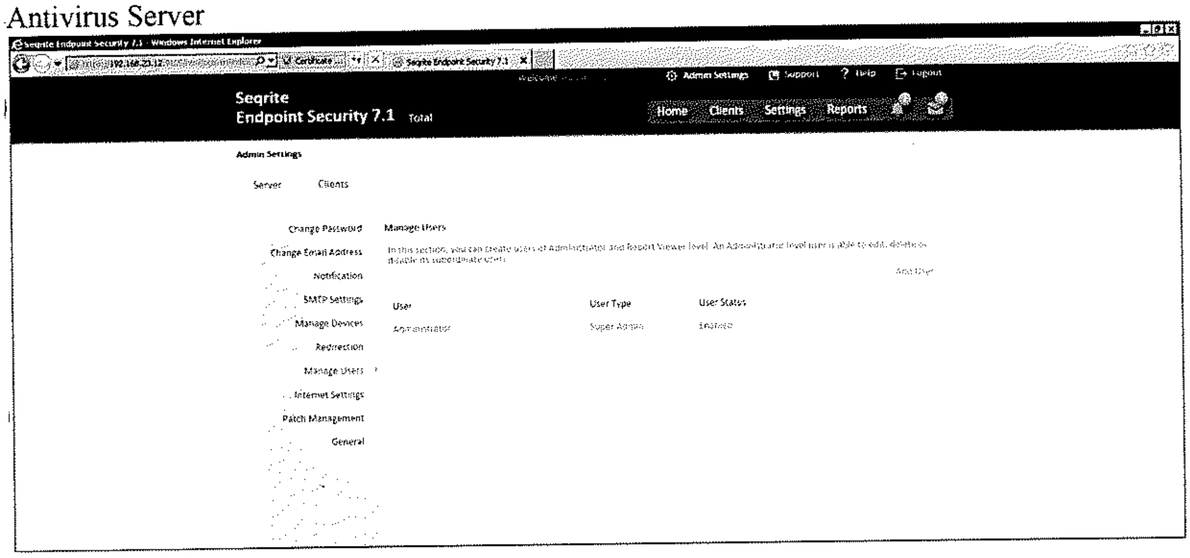
Screenshot/Evidence:

Firewall



Name	Trusted Hosts	Profile	Type	Two-factor Authentication
admin	0.0.0.0/0	super_admin	Local	

Antivirus Server

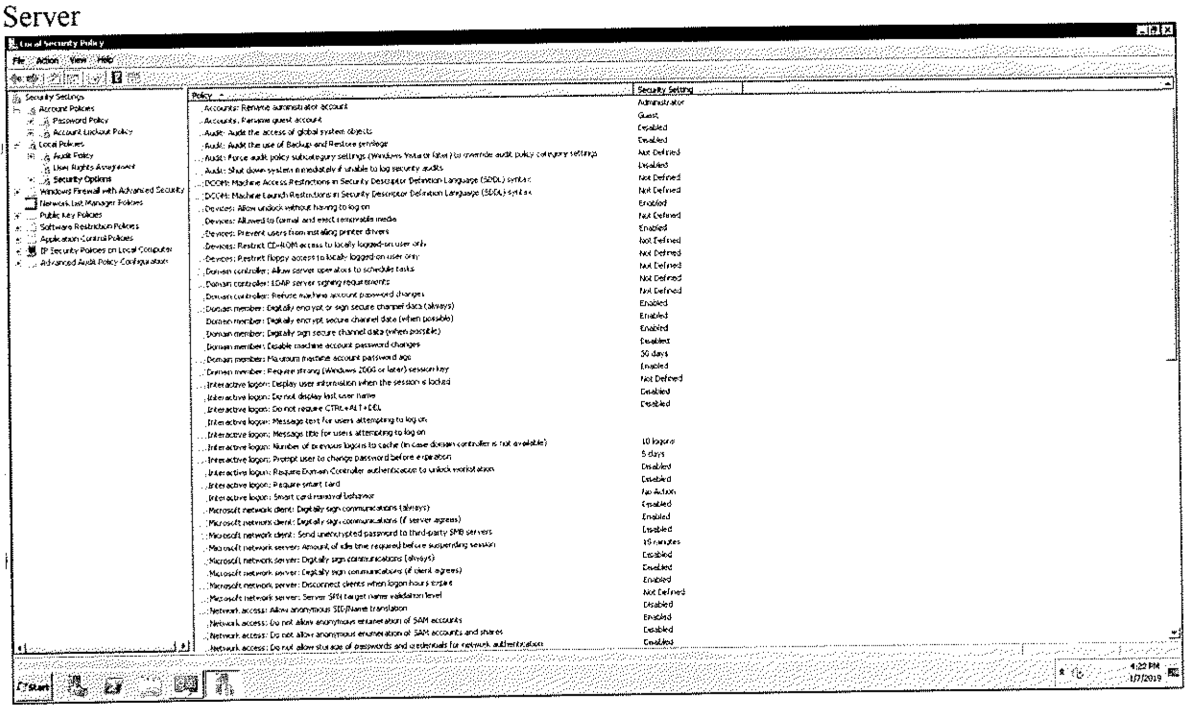


Manage Users

In this section, you can create users of Administrator and Report Viewer level. An Administrator level user is able to edit, delete or disable its subordinate users.

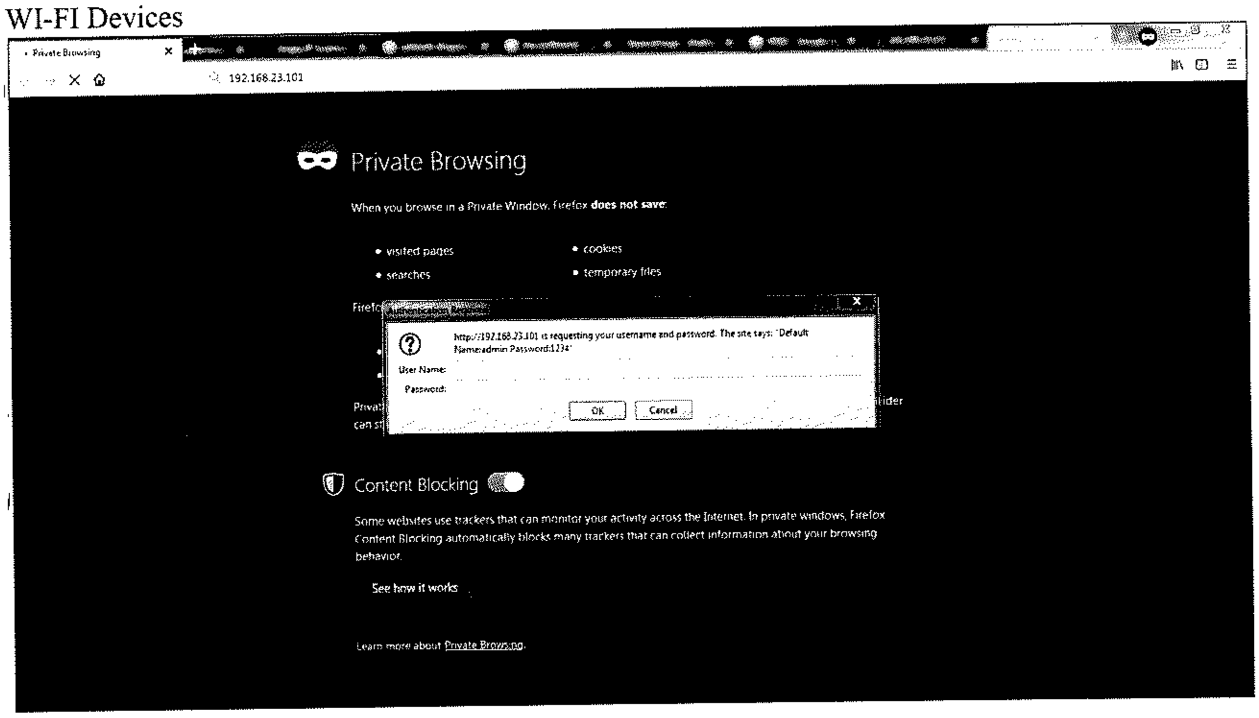
User	User Type	User Status
Administrator	Super Admin	Enabled

Server



Policy	Security Setting
Accounts: Rename administrator account	Administrator
Accounts: Rename guest account	Guest
Audit: Audit the access of global system objects	Disabled
Audit: Audit the use of Backup and Restore privilege	Disabled
Audit: Force audit policy subcategory settings (Windows Vista or later) to override audit policy category settings	Not Defined
Audit: Shut down system immediately if unable to log security audits	Disabled
DCOM: Machine Access Restrictions in Security Descriptor Definition Language (SDDL) syntax	Not Defined
DCOM: Machine Launch Restrictions in Security Descriptor Definition Language (SDDL) syntax	Not Defined
Devices: Allow undock without having to log on	Enabled
Devices: Allowed to format and eject removable media	Not Defined
Devices: Prevent users from installing printer drivers	Enabled
Devices: Restrict CD-ROM access to locally logged-on user only	Not Defined
Devices: Restrict floppy access to locally logged-on user only	Not Defined
Domain controller: Allow server operators to schedule tasks	Not Defined
Domain controller: LDAP server signing requirements	Not Defined
Domain controller: Refuse machine account password changes	Not Defined
Domain member: Digitally encrypt or sign secure channel data (always)	Enabled
Domain member: Digitally encrypt secure channel data (when possible)	Enabled
Domain member: Digitally sign secure channel data (when possible)	Enabled
Domain member: Disable machine account password changes	Disabled
Domain member: Maximum machine account password age	30 days
Domain member: Require strong (Windows 2000 or later) session key	Enabled
Interactive logon: Display user information when the session is locked	Not Defined
Interactive logon: Do not display last user name	Disabled
Interactive logon: Do not require CTRL+ALT+DEL	Disabled
Interactive logon: Message text for users attempting to log on	
Interactive logon: Message title for users attempting to log on	
Interactive logon: Number of previous logons to cache (in case domain controller is not available)	10 logons
Interactive logon: Prompt user to change password before expiration	5 days
Interactive logon: Require Domain Controller authentication to unlock workstation	Disabled
Interactive logon: Require smart card	Disabled
Interactive logon: Smart card removal behavior	No Action
Microsoft network client: Digitally sign communications (always)	Disabled
Microsoft network client: Digitally sign communications (if server agrees)	Enabled
Microsoft network client: Send unencrypted password to third-party SMB servers	Disabled
Microsoft network server: Amount of idle time required before suspending session	15 minutes
Microsoft network server: Digitally sign communications (always)	Disabled
Microsoft network server: Digitally sign communications (if client agrees)	Disabled
Microsoft network server: Disconnect clients when logon hours expire	Enabled
Microsoft network server: Server SPN target name validation level	Not Defined
Network access: Allow anonymous SID/Name translation	Disabled
Network access: Do not allow anonymous enumeration of SAM accounts	Enabled
Network access: Do not allow anonymous enumeration of SAM accounts and shares	Disabled
Network access: Do not allow storage of passwords and credentials for network authentication	Disabled

WI-FI Devices



Private Browsing

When you browse in a Private Window, Firefox **does not save**:

- visited pages
- searches
- cookies
- temporary files

http://192.168.23.101 is requesting your username and password. The site says: "Default Name:admin Password:1234"

User Name:

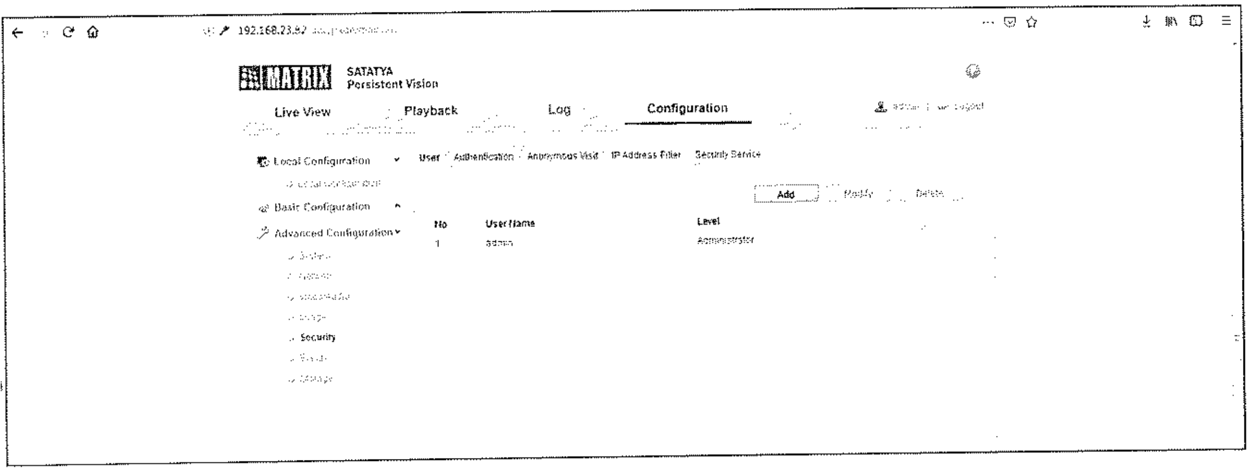
Password:

Content Blocking

Some websites use trackers that can monitor your activity across the Internet. In private windows, Firefox Content Blocking automatically blocks many trackers that can collect information about your browsing behavior.

Learn more about Private Browsing.

Other Devices



No	User Name	Level
1	admin	Administrator

3.4.20 Finding No. 20

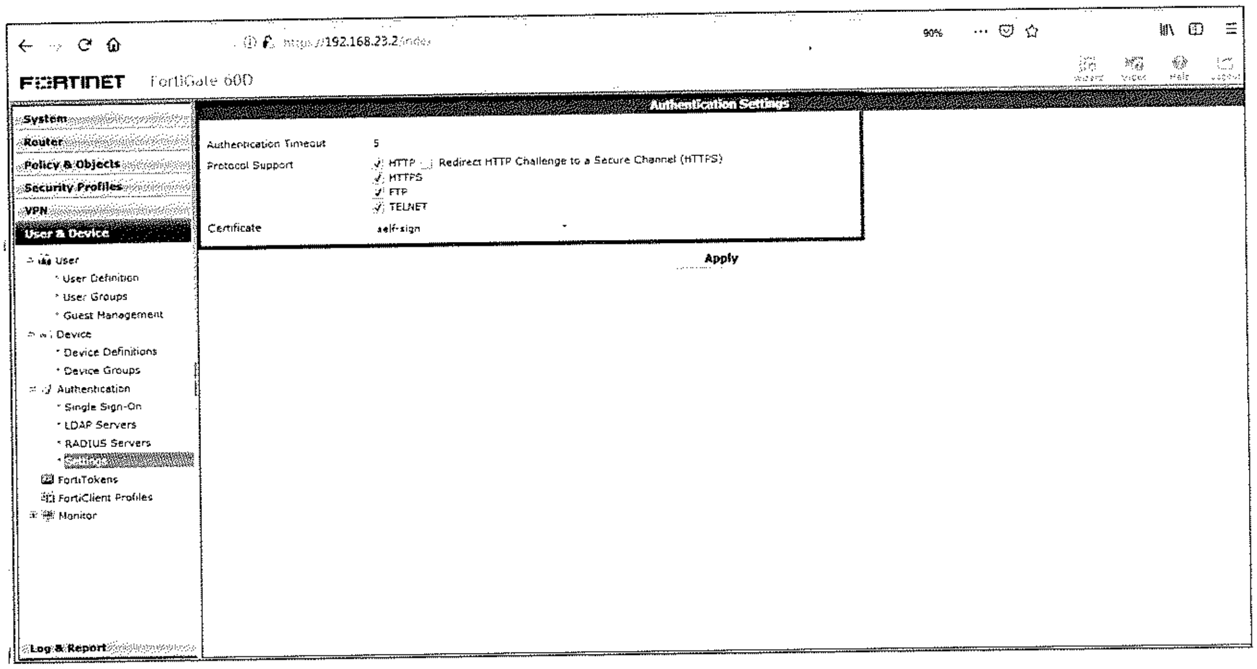
Description: FTP service is enabled.

Severity: Low

Recommendation(s): If not require, FTP service should be disable.

Affected host(s): 192.168.23.2, 192.168.23.51, 192.168.23.52

Screenshot/Evidence(s):

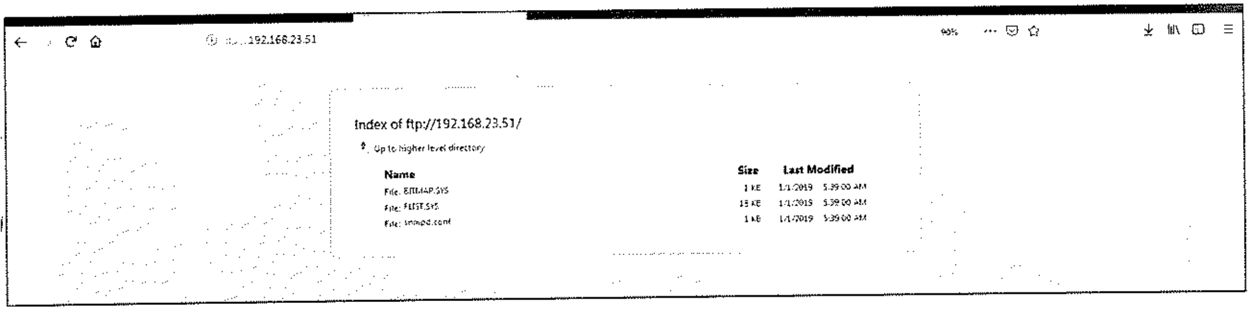


Authentication Settings

Authentication Timeout 5

Protocol Support ☑ HTTP ☐ Redirect HTTP Challenge to a Secure Channel (HTTPS)
☑ HTTPS
☑ FTP
☑ TELNET

Certificate self-sign



[redacted]

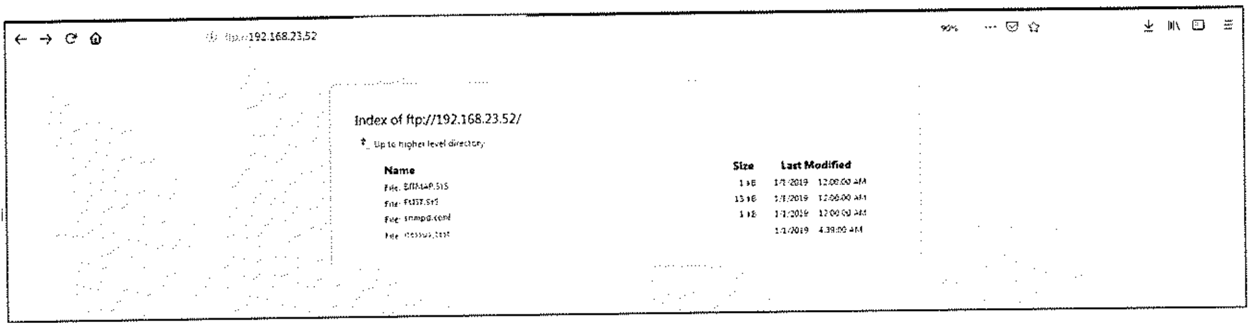
192.168.23.51

90%

Index of ftp://192.168.23.51/

Up to higher level directory

Name	Size	Last Modified
File: BITMAP.SYS	1 KB	1/1/2019 5:39:00 AM
File: FLIST.SYS	15 KB	1/1/2019 5:39:00 AM
File: snmpd.conf	1 KB	1/1/2019 5:39:00 AM



ftp://192.168.23.52

90%

Index of ftp://192.168.23.52/

Up to higher level directory

Name	Size	Last Modified
File: BITMAP.SYS	1 KB	1/1/2019 12:00:00 AM
File: FLIST.SYS	15 KB	1/1/2019 12:00:00 AM
File: snmpd.conf	1 KB	1/1/2019 12:00:00 AM
File: [illegible]		1/1/2019 4:39:00 AM

4 Network Architecture Review of SCADA Network & IT Infrastructure

4.1 Objective

The Network Architecture Review for EVEREST POWER PRIVATE LIMITED infrastructural was performed by CyberQ. The audit team consisted of members drawn from CyberQ. Details were provided to the extent mentioned in "Scope of Work". The audit was carried out in Data center Shastri Park, Delhi. The objective of this testing was to ensure the security of the external and internal threats.

4.2 Network Architecture Review Gap Analysis Findings with Recommendation

4.2.1 Finding No 1

Description: There is no IT security policy for SCADA Network & IT Infrastructure.

Severity: Informational

Recommendation(s): It is recommended to prepare IT security policy for SCADA Network & IT Infrastructure for better IT Security.

4.2.2 Finding No 2

Description: There is no Architectural Diagram for SCADA Network & IT Infrastructure.

Severity: Informational

Recommendation(s): It is recommended to prepare architectural diagram for SCADA Network & IT Infrastructure for better understanding.

4.2.3 Finding No 3

Description: Server and Devices are not configured in HA.

Severity: Informational

Recommendation(s): It is recommended to implement in HA as a good approach.

4.2.4 Finding No 4

Description: There is no security devices like firewall was implemented to segregate the SCADA Network from the IT Infrastructure.

Severity: Informational

Recommendation(s): It is recommended to implement a firewall to segregate the SCADA Network from the IT Network and implement policies to allows only one-way communication from SCADA to IT Network as IT Networks are prone to malicious attacks. No communication should be allowed from IT Network to SCADA Network. This will prevent the critical infrastructure to get compromised if IT network gets compromise.

4.2.5 Finding No 5

Description: VLAN is not implemented in Network infrastructure.

Severity: Informational

Recommendation(s): It is recommended to configure VLAN on networking device such as switch etc in Network infrastructure.

4.2.6 Finding No 6

Description: Internet service is running over SCADA Network.

Severity: Informational

Recommendation(s): It is recommended to block Internet service in SCADA Network.

Annexure - 5

EVEREST POWER PRIVATE LIMITED

Corporate Office : Hall A, First Floor, Plot No. 143-144, Udyog Vihar, Phase – IV, Gurgaon – 122015, Haryana, Phone: +91-124-4630870, Fax: +91-11-45823862

PURCHASE ORDER

GSTIN: 02AABCE0832G2ZC, PAN: AABCE0832G

Order No: EPPL/PH/2018-19/PO-0024 Dated: 29.03.2019

To,

ANDRITZ HYDRO Private Limited,
D-17, MPAKVN Industrial Area,
462 046 Mandideep.
Distt. Raisen / India.

Sub: Purchase Order for Upgradation of existing SCADA system including Design, Engineering & Supply of Compatible hardware & Software & Gradation of Operating System (windows 10) for Power House of Malana Stage - II Hydro Electric Power Project, Himachal Pradesh.

Ref: 1) Your offer mail on dated 16th Apr 2018 & 27th Mar 2019.

Dear Sir,

With reference to your above offer and subsequent discussions, we are pleased to award a Purchase Order as per conditions given below for Malana - II Hydro Electric Power Project, Himachal Pradesh:

S.No	Item Description	Total Price
1	**Upgradation of Existing SCADA System including Design, Engineering & Supply of compatible hardware & up gradation of Operating system (windows 10) for Malana-II HEP**	28,50,000.00
A	Supply of Workstations hardware on windows 10 platform-3 Nos with Windows 10 operating system & Laptop with Operating system (windows 10) for programming with license key (1 Nos) and Configuration of software (SCADA) in all work stations.	
B	HMI's (UCB & CCB) on Windows 10 platform with Operating system (windows 10)-3 Nos	
C	SCADA software License latest version compatible with Windows 10	
2	**Services Charges for Installation/configuration of SCADA system, testing, Commissioning of complete system & training of Operational team**	50,000.00
	Total (Supply & Services)	**29,00,000.00**

(Rupees Twenty Nine Lakhs only).

TERMS AND CONDITIONS:

1. **Taxes & Duties applicable :-**

  i. GST: Shall be payable extra as applicable
  ii. Any change in the Taxation as per Govt. Law shall be applicable time to time

2. **Transportation:** Transportation of items up to site if any shall be arranged by you & price included in the above price.

3. **Payment Terms:**

   Following payment schedule shall be applicable:
   a. 20% advance of total contract value excluding all taxes and duties against acceptance of Purchase Order & issue of Profoma invoice.
   b. 60% with applicable GST, against Performa Invoice after completion of SCADA system including Hardware items & ready for dispatch.
   c. 20% with including all taxes & duties after successful installation, testing & commissioning of System

4. **Incoterm:** (FOR Site)

5. **Upgradation and Design & Engineering:-**

   a. Upgraded SCADA system shall be suitable & integrated with existing panels (UCB, CCB, Bay controllers, Governor Panels, Excitation system, Sensors & control system etc.).
   b. Detailed design and scope of services as mentioned in below,
      i. Replacement of 2 No's of SCADA work stations and 1 No Engineering Work station with latest model of Dell make at the time of delivery & along with preinstalled operating system (Windows 10 or above if any).
      ii. Replacement of all touch panels which are installed in UCB & CCB with latest model at the time of delivery along with operating system (windows 10 & above if any).
      iii. Replacement of Dell laptop with latest version of operating system (windows 10 & above) and SCADA software with license key for program modifications.
      iv. Up gradation of SCADA software for Power House Operation & Control with latest version at time of delivery & suitable for latest operating system (windows10 or above if any) along with Hardware Key's.
      v. Any modifications, changes required in SCADA program same shall be taken up as per the current control system & project requirement at site.
      vi. Data Logging, periodic backup system restoration process.
      vii. Trouble shooting process and techniques.
      viii. Data integration between Powerhouse SCADA and Substation SCADA shall be done as per requirement.

6. **Tools & Tackles:**

   a. Required/suitable tools and tackles for dismantling and assembling of SCADA System shall be supplied by Andritz free of cost along with installation & commissioning team.

Everest Power Private Ltd.

7. **Inspection:**

    a. M/s Andritz shall intimate inspection call during the process of manufacturing/assembly and testing process.
    b. EPPL reserve the rights to deploy third party/independent engineer for inspection.

8. **Installation, Testing & Commissioning:**

    a. M/s Andritz shall deploy erection and Commissioning team/staff for installation, testing & commissioning of new SCADA system.
    b. Local transportation & site accommodation, food etc shall be arranged by EPPL during installation period.

9. **Training:**

M/s Andritz shall train the operation team at project site by conducting onsite/class room training program at project site.

Training may cover the day to day operations, trouble shouting, data/event logging, backup & restoration etc.

10. **Operation and Maintenance Manuals:**
    a. M/s Andritz shall supply two sets of drawings, operation & Maintenance manuals in English along with spares list and OEM details.

11. **Delivery & Schedule:**

    a. SCADA system shall be delivered to site and commissioned within 3 months from the date of Purchase Order.

12. **Consignee & Billing Address:** Everest Power Private Limited, Malana – II Hydro Electric Project, Village Chowki, Near Jarri, District Kullu, Himachal Pradesh – 175105.

13. **Contact Person:** Mr. Dr SS Garhia #9717700652 at HO & Mr. Ananda Varma #9805519974 at Project Site.

14. You should mention the PO number during submission of your road challan/ invoice & send the original Invoice along with the material at our project site.

15. **Liquidated Damages**: In case delay in completion of work is attributable to you, you are liable to pay Liquidated Damages as follows:

    i) 0.5 % per week after scheduled delivery period and up to maximum of 10% of the milestone payment against delivery of items as per clause 3 (iii).

Total LD shall be limited to 10% of the total order value.

16. Vendor has to mention ECC No., CST No. & LST No. on their Invoice along with P.O. No. Any Penalty /Expenses due to non-- mentioning above in Invoice/Delivery Challan will be on supplier account.

17. **Warranty Period:** warranty Period shall be 18 months from the date of receipt at site. Or 12 months from date of commissioning, whichever early

    During this period, you will replace/repair defects due to defective manufacturing/fabrication or workmanship at your own cost.

18. **Price Escalation:** This is a firm price contract and no escalation whatsoever is applicable on this contract.

19. **Quality Assurance Plan:** You will prepare and submit for approval, a detailed quality plan for manufacturing of all items manufactured by you and/or your sub-vendors. The quality plan shall set out the practices and procedures, relevant reference to the documents/standards, acceptable norms, inspection, documentation etc. to be followed by you during various stage of manufacture. Any deviation on account of approved QAP shall be subject to the approval of Everest Power. Submission of QAP shall also be done within 1 month from the date of order.

20. **Progress Reports:** You shall submit monthly progress reports including status/progress achieved during the month for all activities covered.

21. **Shop Assembly, Inspection & Testing**: Shop Assembly, Inspection and testing shall be carried out as per the standard procedures and as specified in technical specifications at your premises prior to dispatches. Representative of EPPL will witness tests if required, and shall be intimated at least one week in advance.

    Dispatch clearance of items shall be obtained from EPPL or its representative.

22. **Force Majeure**: In the event of 'Force Majeure' such as War, Fire, Earthquake, Flood, Strike, etc. the employer is to be intimated with details of such happening within 3 days. The time for performance of the contract shall then be extended by period not more than the duration of such events.

    Settlement of Disputes: If any dispute arises between the parties arising out of or relating to or in respect of this Work Order is not settled mutually the same will be referred for arbitration through the sole Arbitrator appointed by the Managing Director of the Employer. The Arbitration would be conducted under the provisions of Arbitration and Conciliation Act, 1996 and the place of Arbitration will be New Delhi.

23. Kindly return the duplicate copy of Purchase Order duly signed and stamped within 3 days towards acceptance/rejection of order. Non receipt of order acceptance/rejection shall be deemed as order is accepted.

24. **Jurisdiction:** In case of any disputes, courts in Delhi Jurisdiction are only applicable.

25. **Limitation of Liability:** The aggregate liability of the contractor in this contract to owner, whether under the contract, in tort or otherwise including the cost of repairing or replacing defective equipment, shall not exceed 100% of the contract price including escalation. Under no circumstances contractor shall be liable for any consequential or indirect damages incurred by Owner, including but not limited to loss of profit or loss of production etc.

You are requested to return the duplicate copy of this order duly signed & stamped on each page by authorized signatory of your company as a proof of your acknowledgement and confirmation.

Thanking You

Yours Faithfully,

For Everest Power Pvt.Ltd.

Authorized Signatory

EVEREST POWER PRIVATE LIMITED
Corporate Office : Hall A, First Floor, Plot No. 143-144, Udyog Vihar, Phase – IV, Gurgaon – 122015, Haryana, Phone: +91-124-4630870, Fax: +91-11-45823862

PURCHASE ORDER

GSTIN: 02AABCE0832G2ZC, PAN: AABCE0832G

Order No: EPPL/PH/2018-19/PO-0025 Dated: 29.03.2019

To,

ANDRITZ HYDRO Private Limited,
D-17, MPAKVN Industrial Area,
462 046 Mandideep.
Distt. Raisen / India.

Sub: Purchase Order for Upgradation of existing SCADA system including Design, Engineering & Supply of Compatible hardware, Software & Gradation of Operating System (windows 10) for 132/220 kV LILI step up Substation of Malana Stage - II Hydro Electric Power Project, Chhaur, Kullu, Himachal Pradesh.

Ref: 1) Your offer mail on dated 27th Mar 2019.

Dear Sir,

With reference to your above offer and subsequent discussions, we are pleased to award a Purchase Order as per conditions given below for Malana - II Hydro Electric Power Project, Himachal Pradesh:

S.No	**Item Description**	**Total Price**
1	**Upgradation of Existing SCADA System including Design, Engineering, Supply of compatible hardware, SCADA automation Software, for 132/220 KV LILO setup substation of Malana – II HEP, Chhaur, Kullu, Himachal Pradesh**	24,50,000.00
A	Supply of Workstations hardware on windows 10 platform, monitors -3 Nos with Windows 10 operating system and Automation software (SCADA) with Licence key, RTU & Ethernet Switch etc. Detailed Specification & BoQ is as per final proposal dated on 27.03.19	
B	Data Integration/communication with Power house SCADA system/back up system via PLCC and Data Communication with CTU SCADA, NRLDC, New Delhi SCADA via PLCC system	
C	Erection, supervision, testing & commissioning of automation system and data communication system	
2	**Services Charges for Installation/configuration of SCADA system, testing, Commissioning of complete system & training of Operational team**	50,000.00
	Total (Supply & Services)	**25,00,000.00**

(Rupees Twenty Five Lakhs only).

TERMS AND CONDITIONS:

1. **Taxes & Duties applicable :-**

   i. GST: Shall be payable extra as applicable
   ii. Any change in the Taxation as per Govt. Law shall be applicable time to time

2. **Transportation:** Transportation of items up to site if any shall be arranged by you & price included in the above price.

3. **Payment Terms:**

   Following payment schedule shall be applicable:
   a. 20% advance of total contract value excluding all taxes and duties against acceptance of Purchase Order & issue of Profoma invoice.
   b. 60% with applicable GST, against Performa Invoice after completion of SCADA system including Hardware items & ready for dispatch.
   c. 20% with including all taxes & duties after successful installation, testing & commissioning of System

4. **Incoterm:** (FOR Site)

5. **Upgradation and Design & Engineering:-**

   a. Replacement of existing ABB Automation (SCADA) system with your latest version of ANDRITZ Autorotation (SCADA) system for Operation & control of 132/220 kV LILO step-up substation
   b. Detailed design and scope of services as mentioned in below,
      i. Replacement of 2 No's of SCADA work stations and 1 No Engineering Work station with latest model of Dell make at the time of delivery & along with preinstalled operating system (Windows 10 or above if any) with RTU panel and other components if any.
      ii. Integration with existing protection relays & bay controllers (REL 670, RET 670, REB 670, RET 543, REF 543) of ABB.
      iii. Data integration with powerhouse SCADA via 132 kV PLCC communication.
      iv. Data integration with NRDC via 220 kV PLCC communication.
      v. Any modifications, changes required in SCADA program same shall be taken up as per the current control system & project requirement at site.
      vi. Installation of ABB protection system DR software in Engineering PC for analysis and reports.
      vii. Data Logging, periodic backup system restoration process.
      viii. Trouble shooting process and techniques.

6. **Tools & Tackles:**

   a. Required/suitable tools and tackles for dismantling and assembling of SCADA System shall be supplied by Andritz free of cost along with installation & commissioning team.

Everest Power Private Limited

7. **Inspection:**

   a. M/s Andritz shall intimate inspection call during the process of manufacturing/assembly and testing process.
   b. EPPL reserve the rights to deploy third party/independent engineer for inspection.

8. **Installation, Testing & Commissioning:**

   a. M/s Andritz shall deploy erection and Commissioning team/staff for installation, testing & commissioning of new SCADA system.
   b. Local transportation & site accommodation, food etc shall be arranged by EPPL during installation period.

9. **Training:**

   M/s Andritz shall train the operation team at project site by conducting onsite/class room training program at project site.

   Training may cover the day to day operations, trouble shouting, data/event logging, backup & restoration etc.

10. **Operation and Maintenance Manuals:**
    a. M/s Andritz shall supply two sets of drawings, operation & Maintenance manuals in English along with spares list and OEM details.

11. **Delivery & Schedule:**

    a. SCADA system shall be delivered to site and commissioned within 3 months from the date of Purchase Order.

12. **Consignee & Billing Address:** Everest Power Private Limited, Malana – II Hydro Electric Project, Village Chowki, Near Jarri, District Kullu, Himachal Pradesh – 175105.

13. **Contact Person:** Mr. Dr SS Garhia #9717700652 at HO & Mr. Ananda Varma #9805519974 at Project Site.

14. You should mention the PO number during submission of your road challan/ invoice & send the original Invoice along with the material at our project site.

15. **Liquidated Damages**: In case delay in completion of work is attributable to you, you are liable to pay Liquidated Damages as follows:

    i) 0.5 % per week after scheduled delivery period and up to maximum of 10% of the milestone payment against delivery of items as per clause 3 (iii).

Total LD shall be limited to 10% of the total order value.

16. Vendor has to mention ECC No., CST No. & LST No. on their Invoice along with P.O. No. Any Penalty /Expenses due to non-- mentioning above in Invoice/Delivery Challan will be on supplier account.

17. **Warranty Period:** warranty Period shall be 18 months from the date of receipt at site. Or 12 months from date of commissioning, whichever early

    During this period, you will replace/repair defects due to defective manufacturing/fabrication or workmanship at your own cost.

18. **Price Escalation:** This is a firm price contract and no escalation whatsoever is applicable on this contract.

19. **Quality Assurance Plan:** You will prepare and submit for approval, a detailed quality plan for manufacturing of all items manufactured by you and/or your sub-vendors. The quality plan shall set out the practices and procedures, relevant reference to the documents/standards, acceptable norms, inspection, documentation etc. to be followed by you during various stage of manufacture. Any deviation on account of approved QAP shall be subject to the approval of Everest Power. Submission of QAP shall also be done within 1 month from the date of order.

20. **Progress Reports:** You shall submit monthly progress reports including status/progress achieved during the month for all activities covered.

21. **Shop Assembly, Inspection & Testing**: Shop Assembly, Inspection and testing shall be carried out as per the standard procedures and as specified in technical specifications at your premises prior to dispatches. Representative of EPPL will witness tests if required, and shall be intimated at least one week in advance.

    Dispatch clearance of items shall be obtained from EPPL or its representative.

22. **Force Majeure**: In the event of 'Force Majeure' such as War, Fire, Earthquake, Flood, Strike, etc. the employer is to be intimated with details of such happening within 3 days. The time for performance of the contract shall then be extended by period not more than the duration of such events.

    Settlement of Disputes: If any dispute arises between the parties arising out of or relating to or in respect of this Work Order is not settled mutually the same will be referred for arbitration through the sole Arbitrator appointed by the Managing Director of the Employer. The Arbitration would be conducted under the provisions of Arbitration and Conciliation Act, 1996 and the place of Arbitration will be New Delhi.

23. Kindly return the duplicate copy of Purchase Order duly signed and stamped within 3 days towards acceptance/rejection of order. Non receipt of order acceptance/rejection shall be deemed as order is accepted.

24. **Jurisdiction:** In case of any disputes, courts in Delhi Jurisdiction are only applicable.

25. **Limitation of Liability:** The aggregate liability of the contractor in this contract to owner, whether under the contract, in tort or otherwise including the cost of repairing or replacing defective equipment, shall not exceed 100% of the contract price including escalation. Under no circumstances contractor shall be liable for any consequential or indirect damages incurred by Owner, including but not limited to loss of profit or loss of production etc.

You are requested to return the duplicate copy of this order duly signed & stamped on each page by authorized signatory of your company as a proof of your acknowledgement and confirmation.

Thanking You

Yours Faithfully,

For Everest Power Pvt.Ltd.

Authorized Signatory

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Annexure - 6

DIRECTORATE OF ENERGY
GOVERNMENT OF HIMACHAL PRADESH
SHANTI BHAWAN PHASE-III SECTOR-6 NEW SHIMLA-9
Phone/ Fax No: 0177-2673553 , Email: ceauthoritydoe@gmail.com

No. HPDOE/CE /Authority/Malana-II/2018- 8760 **Dated:** 02/02/2018

To

M/s Everest Power Private Limited,
First House, Bhumian Estate, Nav Bahar Bhumian Road,
Chotta Shimla, Shimla-171002, HP.

Subject: - Submission of revised DPR of 100 MW Malana-II HEP Additional spillway construction converting non-over flow blocks into spillway on right bank of dam.

Ref:- Your letter No. EPPL/DOE/Addl. Spillway/20171110 dated 10.11.2017.

Sir,

This is with reference to your office letter under reference wherein you have forwarded revised proposed Additional Spillway Construction converting non-over-flow blocks into Spillway on right bank of dam by carrying out the necessary model studies as advised by the DoE vide No. HPDoE/CE/Authority/ Safety/ Malana-II HEP/2014-1912-13 dated 01.06.2016. The report dated Sept. 2017 regarding Physical Model Study of ungated Surface Spillway Arrangement submitted by Deptt. of Civil Engineering of IIT Roorkee has been annexed with the proposal. The modification in the arrangement of surface spillway & Energy Dissipation system thereof from earlier Flip Bucket Type with Plunge Pool to Stilling Basin with broad crested weir has been found incorporated as per recommendations of the Model Studies in the revised proposal.

In view of above, the proposal for setting up of additional surface spillway is found to be in order and as such, you are requested to implement the proposed spillway works expeditiously due to its urgent requirement for the safety of dam. In addition, following points to be looked into during construction:

- Due precaution with respect to specifications and detailed design engineering as per applicable BIS codes be carried out for safety of Dam Structure.
- All the codal formalities if required, w.r.t. implementation from concerned agencies, may be completed.

Yours faithfully,

2/2/18
Chief Engineer(Energy),
Directorate of Energy,
Govt. of Himachal Pradesh.

Everest Power

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Annexure-7

AQUAGREEN
Engineering Management (P) Ltd.

AQUAGREEN/EPPL/2017/004

Dated: 12-10-2017

To,
CEO,
Everest Power Private Limited,
143-144, Udyog Vihar, Phase-IV,
Gurgaon-122015 (Haryana)

Subject: Detailed Project Report "**Construction of additional un-gated surface spillway converting Non-overflow blocks into Overflow blocks**" of Malana-II Project.

Dear Sir,

The Detailed Project Report for "**Construction of additional un-gated surface spillway converting Non-overflow blocks into Overflow blocks**" of Malana-II Project Hydroelectric project (H.P) is enclosed herewith for further necessary action. All corrections as suggested have been incorporated in the report.

Thanking you,

Yours Sincerely

(K Dayalan)
Aquagreen Engineering Management (P) Ltd.

Enclosures – As above

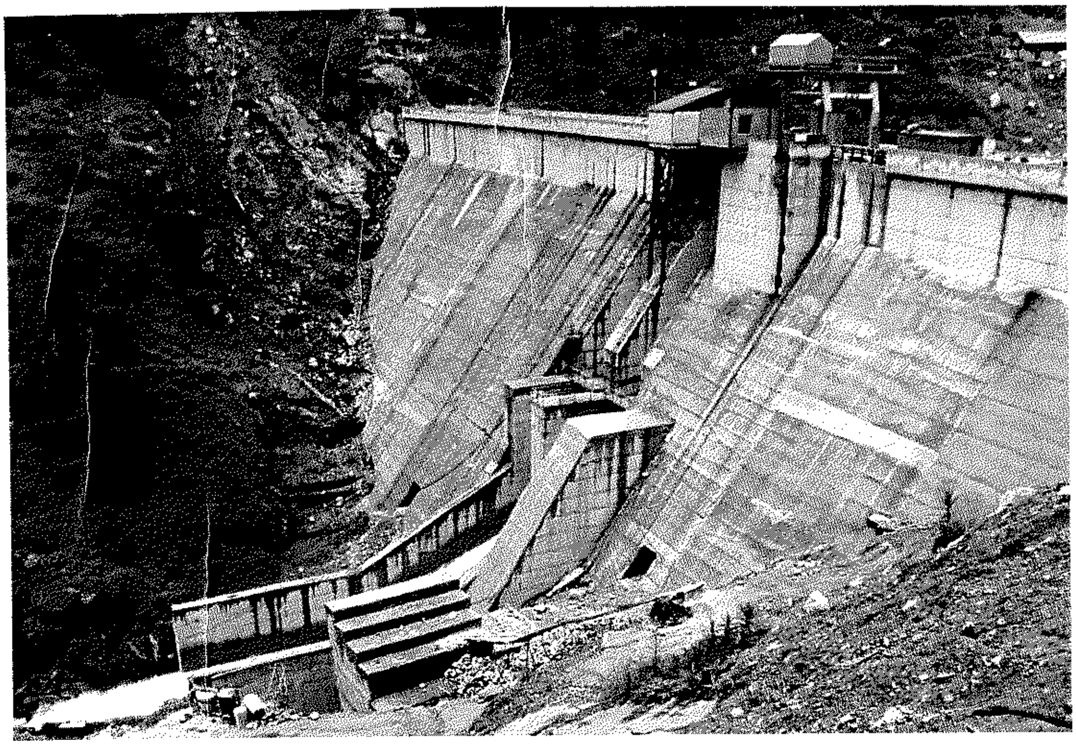
AQUAGREEN ENGINEERING MANAGEMENT PRIVATE LIMITED

DESIGN OFFICE: 143 – 144, Udyog Vihar, Phase – IV, Gurgaon – 122015 (Haryana), Tel:- 0124 – 4630871
REGISTERED OFFICE: 2nd Floor, A-Block, Plot No. 14, Factory Road, Adj. to Safdarjung Hospital, Delhi – 110029
CIN No. U45200DL2008PTC175410 **Website:** www.aquagreen.in

EVEREST POWER PRIVATE LIMITED
(2X50MW MALANA STAGE-II HYDRO ELECTRIC PROJECT)

CONSTRUCTION OF ADDITIONAL UNGATED SURFACE SPILLWAY CONVERTING NON-OVERFLOW BLOCKS INTO OVERFLOW BLOCKS

DETAILED PROJECT REPORT



PROJECT ENGINEERING

(VOLUME – I)

OCTOBER - 2017

AQUAGREEN ENGINEERING MANAGEMENT PVT. LTD.
143-144, UDYOG VIHAR, PHASE-IV, GURGAON-122015

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Everest Power Private Limited

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PROJECT ENGINEERING

(VOLUME – I)

OCTOBET – 2017

Everest Power Private Limited

EXECUTIVE SUMMARY

The Malana-II Hydro Electric Project in Kullu district of Himachal Pradesh with an installed capacity of 100 MW (2x50 MW) has been developed by Everest Power Private Limited (EPPL). The project is a high head, run-of-river scheme with 4 hours pondage and is located on Malana Khad, a tributary of the Parbati River. The Project exploits the Hydro Power potential in the upper reaches of Malana Nallah upstream of Malana–I Hydro Electric Project.

The project was constructed as per Techno Economic Clearance (TEC) granted by Himachal Pradesh State Electricity Board (HPSCB) in the month of October 2004. The project comprises of a 53m high Concrete Gravity Dam, a 4.987km long 2.9m dia. Head Race Tunnel (HRT) aligned on the left bank of Malana Khad, a 87m deep 6m dia. Surge Shaft, 2.5m dia. and 564m high vertical & 260m horizontal Single Pressure Shaft (PS) and an Underground Power House Complex. The water conductor system carries a design discharge of 20cumecs to feed water to 2nos. vertical Pelton Turbines housed in the underground Power House to generate 100MW (2X50 MW) power under a net head of 603m.

The maximum height of the dam from the deepest foundation level is 53m, and its length at the top is 221.50m comprising 158.50m length of the dam blocks and 63.0m length of the key wall provided inside the left bank abutment. The dam block comprises of one overflow block with two sluice bays and nine NOF blocks (four on the left & five on the right side of the overflow block). Two nos. of sluice type Spillway with radial gate each of size 4.0m (W) x 5.50m(H) with crest at EL. 2514.50m have been provided in the overflow dam block No. 5 to pass a design flood of 650cumecs.

Construction of the Malana-II HE Project commenced in January' 2006 and the Project was successfully completed in May' 2012.The Malana-II HEP has been operating smoothly since its Commercial Operation Date (COD) on 12th July' 2012.

On 24th August' 2013 both the units of the project were under operation with 16cumecs discharge in the river. However, both the generating units tripped suddenly and consequently the water level in the reservoir which was initially at MDDL started rising. The project authorities tried to open the sluice Spillway radial gates provided in the main dam, but the gates could not be lifted / raised. This was due to excessive deposition of the silt in front of the radial gates and consequently the gates could not be lifted/ operated. As a result, the reservoir water level rose beyond the top of the dam / crest EL.2545.0m, resulting in overtopping of the concrete dam. This overtopping of the dam by an inflow river discharge of around 16cumecs continued for about 4 hours. Part of the overtopping water flowed over the junction of Gravity Dam Block No.-1 & key wall leading to partial erosion/ washout of the overburden material present downstream of the key wall structure. A small portion of the road on the left bank constructed in overburden material also got washed away. However at the right bank, where the sound rock is exposed at the abutments as well as in the foundation was stable, no sign of distress was observed on the hill slope/ foundation rock due to the water overtopping.

In view of the over topping of Dam on 24th August 2013, even at the low discharge of 16 cumec due to inoperational of gates, it became necessary to avoid such an emergency situation in future for safety of dam. In this regard, a letter received from Directorate of Energy, Govt. of Himachal Pradesh vide letter no. HPDOE/CE/(Authority)/Safety/Dam Safety/Vol.VI/2016-709-731 dated 27.04.2017 (enclosing the recommendations of First & Second National Dam Safety Conference conducted by Central Water Commission (CWC), Govt. of India), copy enclosed at **Annexure-I** recommends that all efforts must be taken to ensure complete safety of the Dam. The recommendations further provides for improving the emergency action plan and ensure the soundness and stability of Dam abutment which must be duly featured in Dam design for mitigation of risk associated with abutment failure.

In view of such recommendations made by the National Conference of Dam Safety held on 24th & 25th March, 2015 was adopted by the Govt. of Himachal Pradesh in 2017. It was felt that due to presence of only two no. of under sluice gates of Malana HEP, any re-occurrence of over topping due to inoperational of gates may be detrimental to the stability of Malana Dam abutments. As such, and in compliance to the recommendations made by Dam Flood Committee, it is felt that an un-gated surface spillway on the right flank of Malana Dam will ensure complete safety without any manual intervention in case of any impending flood in the eventuality of inoperational of gates due to any reason, whatsoever.

In light of the above mentioned recommendations, it is proposed that the existing dam Non-overflow blocks on the right bank may be used by converting these non-overflow blocks no. 6, 7, 8 and 9 into overflow (un-gated surface) blocks so that water can safely pass through these overflow (un-gated surface) blocks in case the existing under sluice gates cannot be lifted /operated during high floods.

Accordingly, the maximum available length of the NOF blocks at the dam crest has been proposed to be converted into un-gated overflow dam so that maximum discharge can be spilled/ managed. Seven bays of **6.25m wide** have been proposed/ modified in existing **NOF block Nos. 6, 7, 8 and 9** with spillway crest at **El. 2543.00m.** The overall water way proposed shall be **43.75m** (maximum available length at dam crest) with the **spillway crest El.2543.00m** and the maximum water level in the reservoir is considered as crest level of the existing dam (**El.2545.00m**). 1.0m high concrete parapets have been proposed in the upstream side of the dam which will cater the function of free board in concrete dam. The maximum observed flood so far during monsoon period in the river is below **$100m^3$/sec** whereas the discharging capacity of the newly proposed un-gated surface spillway shall be around **$239.51m^3$/sec.** Therefore, the

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flood water during the high flood will safely pass through the proposed un-gated surface spillway in the eventuality when both the existing under sluice gates do not work. This additional spilling will occur very rarely in extreme emergency condition as in normal situation/ condition the river flood/ discharge shall be regulated/ managed through the existing sluice spillway.

The invert and top of the bridge deck slab at un-gated surface overflow section has been proposed as El. 2545.10m and El. 2545.75m respectively. However the crest elevation of remaining NOF blocks will be **El 2545.00m**. It is proposed to connect the crest level of NOF blocks and the top of the bridge of newly proposed un-gated surface spillway by providing a slope of 1 in 12 as transition at the dam crest in the beginning and end of the bridge deck slab.

Also to avoid silt depositions in front of sluice gates on the river banks, it is desirable to remove it manually or mechanically during the period when draw down flushing of the reservoir is carried out by lowering the water level in the reservoir up to the spillway crest. Further, the reservoir drawdown flushing needs to be done frequently to avoid recurrence. In addition to this the gates shall be operated on daily basis even when the discharge in the river is less than the design discharge required for power generation. This will facilitate smooth operation of spillway sluice gates and to avoid jamming of gates due to silt deposition in front of gates. Also from time to time the silt deposited on the banks near the dam shall be removed manually/ mechanically and flush it downstream of the river.

This report describes the various developments taken place during operation of the Malana - II project. The report also provides the need for the modifications and alteration required to be carried in the existing Malana–II project structures and their complete design details of all the components/ structures those are necessary for flood management and smooth functioning of the Malana – II Hydro Electric Project. The Salient Features of the completed project as against those provided in the approved DPR are shown below in the report. This Detailed Project Report is presented in following two volumes:

VOLUME	TITLE
Volume – I	Project Engineering
Volume – II	Drawings

MALANA-II H.E PROJECT (2x50 MW), HIMACHAL PRADESH

CONSTRUCTION OF ADDITIONAL UNGATED SURFACE SPILLWAY CONVERTING NON-OVERFLOW BLOCKS INTO OVERFLOW BLOCKS

SALIENT FEATURES

OCTOBER – 2017

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SALIENT FEATURES

The Salient features of completed project and proposed changes of the Malana-II Hydro Electric Project are given below:

1.1 LOCATION:

State	Himachal Pradesh
District	Kullu
River	Malana, Nallah, a tributary of Parbati River in the Beas Basin
Vicinity for Dam	Dam site located 3km up stream of Malana village at EL 2500m
Vicinity for Power House	Power House on left bank of Malana Khad immediately upstream of Malana-I HEP diversion Weir
Latitude	Between 32°02'15"N and 32°05'06"N
Longitude	Between 77°15'26"E and 77°16'51"E
Access to project by road	Via Chandigarh (325 Km),-Kiraatpur, Bhunter.
Nearest rail head	Kiraatpur (225 Km)
Nearest airport	Bhunter (25 Km)

1.2 HYDROLOGY

	Project Features	**As Proposed**
Catchment Area	158.7 Sq Km	158.7 Sq Km
Design discharge	19.7 cumecs	19.7 cumecs
Design flood (PMF)	650 cumecs	650 cumecs
Snow fall Catchment	76.20 km^2	76.20 km^2
Type of stream	Perennial	Perennial
Average annual rainfall	218 mm	218 mm

1.3 PROJECT STRUCTURES

1.3.1 DIVERSION STRUCTURE

(i) RESERVOIR

F.R.L	2543.00m	2543.00m
M.D.D.L.	2528.00 m	2528.00 m

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	Gross storage	0.386 M m^3	0.386 M m^3
	Live storage	0.2875 M m^3	0.2875 M m^3
	Submergence area at FRL	3.5 Ha	3.5 Ha
	Village affected	Nil	Nil
	Population affected	Nil	Nil
(ii)	**DAM**		
	Type	Concrete Gravity	Concrete Gravity
	Height above river bed	45.00 m	45.00 m
	Top of Dam	EL 2545.0m	EL 2545.00m
	Crest Length	158.50m(Dam block)+63m(Key wall)	158.50m(Dam block)+63m(Key wall)
	FRL	EL2543m	EL2543m
	MDDL	EL2528m	EL2528m
	Live storage	0.2875 M. cum	0.2875 M. cum
(iii)	**SPILLWAY BAYS**		
	Type & Size	Breast wall type	Breast wall + Surface type
	a) Breast wall type	2 Nos. bays of 4m x 5.5m	2 Nos. bays of 4m x 5.5m
	b) Surface	-	7 Nos. bays of 6.25m x 2.0m
	Spillway		
	a) Breast wall Type	Chute Spillway	Chute Spillway
	b) Surface Type	-	Surface Chute Spillway
	Gates		
	a) Breast wall Type	Radial Gates operated by Hydraulic Hoist	Radial Gates operated by Hydraulic Hoist
	b) Surface Type	-	Un-gated
	Crest Level		
	a) Breast wall Type	EL2514.50m	EL2514.50m
	b) Surface Type	-	EL2543.00m

(iv)	**POWER INTAKE**		
	Intake structure	In non-overflow block no.4 on left bank	In non-overflow block no.4 on left bank
	No.& size of opening	One number of 3m x 3m Bell mouth opening	One number of 3m x 3m Bell mouth opening
	Trash rack Structure	In non-overflow block no.4on left bank	In non-overflow block no.4 on left bank
(v)	**INTAKE PIPE**		
	Size	One no. of 2.2m dia pipe	One no. of 2.2m dia pipe
	Length	144m long	144m long
	Center line of pipe	EL 2523.1m	EL 2523.1m
1.3.2	**HEAD RACE TUNNEL**		
	Type	D-shaped, concrete and shotcrete lined	D-shaped, concrete and shotcrete lined
	Size and length	2.9 m x 2.9 m D-shaped, 4.987 km long	2.9 m x 2.9 m D-shaped, 4.987 km long
	Bed Slope	1 in 151.00	1 in 151.00
	Invert level at portal	EL2512.812m	EL2512.812m
	Design discharge	20 cumecs	20 cumecs
	Velocity	2.67 m/sec.	2.67 m/sec.
	Adit 1	3.5 m D-shaped, 273 m long	3.5 m D-shaped, 273 m long
	Adit 2	3.5 m D-shaped, 171 m long	3.5 m D-shaped, 171 m long
	Adit-3	4mx4m,105m Long	4mx4m,105m Long
	Adit-3A	4.5mx4.5m,46.6m Long	4.5mx4.5m,46.6m Long
	Adit 4	4.5mx4.5m,248.5m Long	4.5mx4.5m,248.5m Long
	Adit 5	6mx6m,158m Long	6mx6m,158m Long
	Adit 6	4.5mx4.5m,	4.5mx4.5m,180m Long

	180m Long	
Adit 7	5mX5m,43m Long	5mX5m,43m Long

1.3.3 SURGE SHAFT

Type	Underground- simple Surge Shaft	Underground- simple Surge Shaft
Size	6 m dia, 87m height	6 m dia, 87m height

1.3.4 BONNET GATE CHAMBER

Size	2.2m x 2.2 m	2.2m x 2.2 m
Invert level	EL2483.978m	EL2483.978m

1.3.5 PRESSURE SHAFT

Type	Underground	Underground
Size/length Main Pressure Shaft	1 no. of 2.5 m dia, 824 m long including unit pressure shafts	1 no. of 2.5 m dia, 824 m long including unit pressure shafts
Unit Pressure Shaft	2nos. of 1.8 m dia, 40.24m and 30.73long	2nos. of 1.8 m dia, 40.24m and 30.73long
Design Discharge	20.0 cumecs	20.0 cumecs
Type of steel for steel liner	IS 2002-Grade 3 SAILMA 550 HI, ASTM A 517Grade F	IS 2002-Grade3, SAILMA 550 HI, ASTM A 517 Grade F
Thickness	10 mm – 28 mm	10 mm – 28 mm

1.3.6 POWER HOUSE

Type	Underground	Underground
Size	67.5m(L)x17.5m(W) x35.85m(H)	67.5m(L) x 17.5m(W) x 35.85m(H)
Transformer Bay	26.5m x 12m x 13m, Size	26.5m x 12m x 13m, Size
Power House Levels	EL 1912.0m, Bottom elevation of Power House EL 1947.85m, Top elevation of Power House EL 1929.57m, Service bay level	EL 1912.0m, Bottom elevation of Power House EL 1947.85m, Top elevation of Power House EL 1929.57m, Service bay level
Control Block	Size,12m(L) x 17.5m(W)	Size,12m(L) x 17.5m(W)
Bus Duct	Bus duct,3 m (W) x 4 m (H),	Bus duct,3 m (W) x 4 m (H),

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	D-shaped	D-shaped
No. of Units	2	2
Type of turbines	Vertical axis Pelton wheel	Vertical axis Pelton wheel
C/L of turbines	EL1919.40m	EL1919.40m
Type of Generator	Vertical Shaft	Vertical Shaft
Terminal Voltage	11kV	11kV
Transformer Capacity	63.9 MVA	63.9 MVA
Installed capacity	100 MW (2x50MW)	100 MW (2x50MW)
Gross Head	624m	624m
Rated net Head	603m	603m

1.3.7 MAIN ACCESS TUNNEL

Main Access Tunnel	Size,6m x 6m, D-shaped Length,382m long Starting level, EL 1951.50m Slope of MAT, 1 in 17	Size,6m x 6m, D-shaped Length,382m Starting level, EL 1951.50m Slope of MAT, 1 in 17

1.3.8 TRT

Main Tail Race Tunnel		
	Unit-I TRT	**Unit-I TRT**
	Length of Unit-I TRT,31.7m	Length of Unit-I TRT,31.7m
	Size of Unit-I TRT, 2.5m (W) x 4.5m (H), D- shaped	Size of Unit-I TRT, 2.5m (W) x 4.5m (H), D- shaped
	Unit-II TRT	**Unit-II TRT**
	Length of Unit-II TRT, 22.11 m	Length of Unit-II TRT, 22.11 m
	Size of Unit-II TRT, 5m (W) x 6m (H), D-shaped	Size of Unit-II TRT, 5m (W) x 6m (H), D-shaped
	TRT cum Cable Tunnel	**TRT cum Cable Tunnel**
	Length of TRT cum Cable Tunnel, 255m	Length of TRT cum Cable Tunnel, 255m

		Size of TRT cum Cable Tunnel,5m (W) x 6.75m (H), D-shaped Slope of TRT – 1 in 1000 Starting level, EL 1912.4m	Size of TRT cum Cable Tunnel,5m (W) x 6.75m (H), D-shaped Slope of TRT – 1 in 1000 Starting level, EL 1912.4m
	Control Cable Tunnel	Control cable tunnel,3 m (W) x 3.25 m (H), D-shaped	Control cable tunnel, 3m (W) x 3.25 m (H), D-shaped
1.4	**ENERGY GENERATION**		
	Energy generation in 90% dependable year	403.27 M Kwh	403.27 M Kwh

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CHAPTER - 1

INTRODUCTION

1. INTRODUCTION

1.1 GENERAL

The Malana II Hydro Electric Project in the Kullu district of Himachal Pradesh was conceived as a run-of-the-river scheme on the Malana Nallah (tributary of the Parbati river, which itself is a tributary of Beas river), to utilize a gross head of about 624m and to generate 100 MW of power. The Power House is located on the left bank of the Malana Khad. The Dam is situated 10km upstream of the Malana II Power House. The Project (Malana-II HEP) exploits the Hydro Power potential in the upper reaches of Malana Nallah upstream of Malana –I Hydro Electric Project.

The Malana-II Hydro-electric Project comprises following structures:

- A Concrete Gravity Dam of about 45m high above river bed across Malana Nallah, about 3km upstream of Malana village, with 2 Nos. of breast wall type Spillway bays of size 4.0m x 5.5m to spill down design flood of 650 cumecs.
- The FRL and minimum draw down level are kept at EL2543.00m and EL2528.00m respectively, to obtain a live storage of about 0.2875 Million cubic meter to meet diurnal peaking requirement during lean season.
- A 2.9m X 2.9m D-shaped, 4.987Km long Head Race Tunnel on left bank of Malana Nallah designed to carry 20.0cumecs discharge at 2.75m/sec velocity.
- A Bonnet Gate of size 2.2mx2.2m located upstream of Surge Shaft for emergency closure of flow for maintenance of penstock and Pressure Shaft.
- An open to sky 6.0m diameter and about 87m deep, simple type of Surge Shaft at the end of HRT.
- A single Pressure Shaft 2.5m diameter, 824m long designed to carry 20cumecs discharge into Power House at a velocity of 4.07m/sec. The Pressure Shaft is horizontal for 63m from Surge Shaft up to top bend at EL 2485.228m, vertical for 564m up to bottom bend at EL 1919.4 m, then horizontal for 126m up to the bifurcation point. The lengths of the two units Pressure Shafts each of 1.8 m dia. are 40.24m and 30.73m respectively.
- Construction Adits were provided at top and intermediate and bottom levels to facilitate excavation and erection of steel liner in the Pressure Shaft.
- An underground Power House of size 67.5m (long) x 17.5m (wide) and 35.85m (high) on the left bank hill of Malana Nallah, to houses 2 Nos. of vertical axis Pelton Wheel driven generating units of 50 MW each to provide

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total installed capacity of 100 MW. The two numbers of generator step up transformers are also housed in the same cavern.

- A transformer hall of size 26.5m (long) x 12m (wide) and 13m (high) is provided to house the two numbers transformers.
- The underground Power House is approachable by MAT (Main Access Tunnel) which is 6m X 6m in size and about 382m long
- A 5.4m x 6.75m D-shaped, Tail Race Tunnel (TRT) 380m long discharges the water back into Malana Nallah immediately upstream of diversion weir of Malana-I HEP.

The diversion structure consists of a Concrete Gravity Dam 45.0m high above river bed which creates a reservoir for diurnal pondage of about 0.2875 M cum between FRL (EL 2543.0m) and MDDL (EL 2528.0m), and provides a design discharge of 19.7 cumecs for generation of 100 MW power. The water so stored is conveyed to the Power House through a water conductor system (WCS) located on the left bank. The WCS is 4.987km long comprising 2.2m dia & 144m long steel pipe at the intake, 4.843 Km long Head Race Tunnel of finished size 2.9m x 2.9m terminating at 6.0m dia Surge Shaft. From Surge shaft, a 824 m long Pressure Shaft of 2.5m dia, including bifurcating into 1.8m dia each of 30.73m and 40.24m long respectively conveys the power draft to generate 100 MW of power in an underground Powerhouse having 2 units of 50 MW each. The water from Power House is discharged back into Malana Nallah, just upstream of the Barrage of Malana – I HEP, through a 365m long Tail Race Tunnel (TRT).

The diversion dam comprises of nine Non-Over Flow (NOF) and one overflow block (Block No.-5) for passing floods. The NOF dam Block Nos.-1, 2, 3 and 4 are located on the left bank of the river whereas NOF Block Nos. - 6, 7, 8, 9 and 10 are located on the right bank of the river. The Spillway is planned in such a way as to help flushing of silt deposited in front of the Power Intake Structure and ensuring unobstructed flow of water into the water conductor system. To achieve this objective the Spillway crest has been kept close to the Intake Structure. The Spillway is therefore accommodated in Block-5, whereas the Power Intake Structure is provided in Block-4. Two Spillway bays of size 4.00m (W) x 5.50m (H) controlled by radial gates have been provided. The crest level of the Spillway has been kept at EL.2514.50m. Provision for stop logs is made in front of the radial gate in each of the bays, to facilitate repairs and maintenance of the main gates. The Power Intake invert has been provided at EL 2522.0m level which means 21.0m below the F.R.L. An orifice type Spillway with a breast wall has been provided as this is hydraulically more efficient.

1.2 APPROACH TO THE PROJECT AREA

The Project Site is approachable by road up to Barrage Site of Malana –I HEP located about 10 Km from Jari village on Bhunter -Manikaran road which is at a distance of 22km from Bhunter. There is an air field at Bhunter. The nearest rail head is Kiratpursahib about 200km from Malana–I HEP. The project area is located between Latitude 32°05'06"N to 32°02'15"N and Longitude 77°16'51"E to 77°15'26"E.

1.3 PROJECT BACKGROUND

Private sector participation in power development of the country is seen as an important means to bridge the huge gap between supply and demand. Policy to encourage greater participation by private enterprises in the power sector was formulated in 1991 with the objective of mobilizing additional resources for capacity addition. Harnessing the small, medium & mega hydro potential by private developers is encouraged through various schemes and incentives.

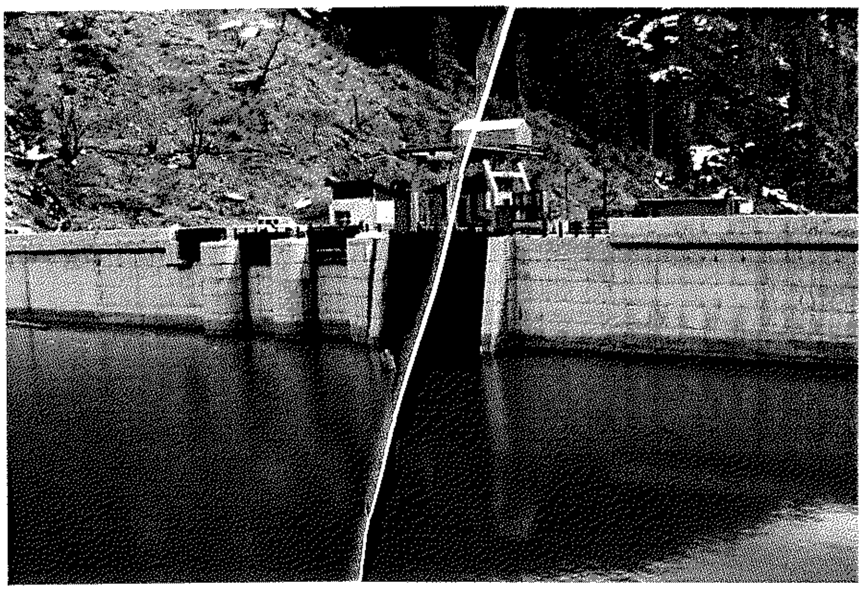
Construction of the Project commenced in January' 2006 and the Project was successfully completed in May' 2012 and commercial operation date (COD) declared on 12th July 2012. The Project involved construction of roads of more than 14 Km total length to provide access to the Dam Complex, Head Race Tunnel, Powerhouse and other component structures of the Project. Inspite of inadequate approach, very difficult terrain and geological surprises, the Project has been completed in a reasonable period.

Malana-II Hydro Electric Project is a 100MW hydropower facility in the Beas Basin. M/s Everest Power Private Limited (EPPL) is the owner of the project. M/s Energy Infratech Private Limited (EIPL) provided complete engineering support to the project including detailed designs, quality control and site supervision.

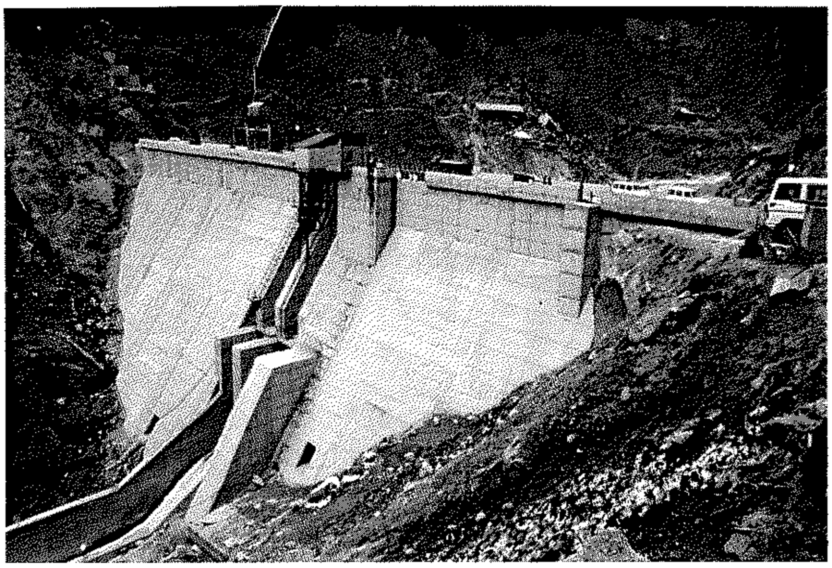
The project is located in a topographically rugged and inaccessible terrain which necessitated construction of additional roads of more than 14 Km length to provide access to the Dam Complex, Head Race Tunnel, Powerhouse and other component structures of the Project. Major part of the catchment is snow covered. During the construction of the project, several obstacles were faced. In order to overcome the obstacles during the construction, few additional provisions were made and certain innovative construction techniques were also followed. Great efforts have been put in, in the form of innovative techniques, to handle the various geological adverse occurrences, to provide access to the various components of the project etc. to complete the project in time.

Since Commercial Operation the project has been successfully supplying entire generated power excluding free power to Punjab State Power Corporation Limited (PSPCL) through PTC India limited. Free power to home State is supplied as per Implementation agreement executed with the Government of Himachal Pradesh.

The photographs showing the upstream and downstream view of diversion structure and underground Power House view of Malana-II taken after completion of the project are shown below:

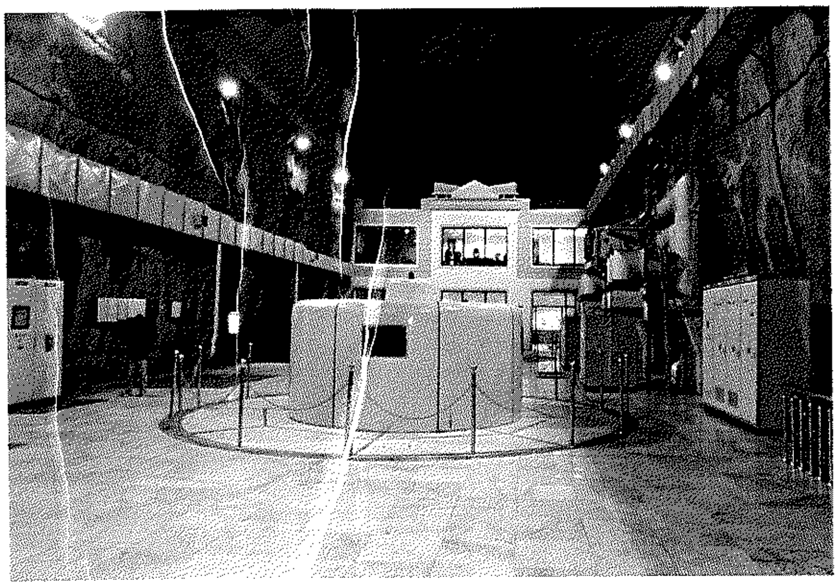


UPSTREAM VIEW OF MALANA-II DIVERSION STRUCTURE



DOWNSTREAM VIEW OF MALANA-II DIVERSION STRUCTURE

Everest Power Private Limited



UNDERGROUND POWER HOUSE VIEW OF MALANA-II

1.4 LIST OF CLEARANCES

The under mentioned clearances were obtained for execution of the Malana – II Hydroelectric Project, Himachal Pradesh:

Everest Power Private Limited

List of Clearances Various Designated Authorities for Malana-II HEP 100MW

S. N.	**Type of Permit/Clearance**	**Approval Authority**	**Date**	**Remarks**
1	Awarded of Project	Govt. of Himachal Pradesh Dept of MPP & Power	2nd May 2002	
2	Implementation of the Project	Govt. of Himachal Pradesh	27th May 2002	
3	Site Clearance For Investigation & Survey	Govt. of India MOEF	23rd Oct 2002	
4	NOC from Electricity Board	HPSEB	11th Dec 2002	
5	Implementation Agreement	Govt. of Himachal Pradesh	14th Jan 2003	
6	NOC For the use of Water From Malana	Himachal Pradesh irrigation & Public Health Dept	12th Oct 2004	
7	NOC from Fisheries	H.P. Aquaculture and Marketing Society	9th April 2004	
8	Techno Economic Clearance	HPSEB	15th Oct 2004	
9	Certificate of importer exporter Code(IEC)	Govt. of India Ministry of Commerce	2nd June 2005	
10	Pollution Clearance Renewal	State Pollution Control Board Govt. of H.P	3rd June 2005 3rd June 2006	Letter Received from HPSPCB dated. 23.01.2009 for Renewal of the Consent for the year 2009-10
11	Environmental Clearance	Govt. of India, Ministry of Environment & Forests	21st June 2005	
12	Signing of PPA		25th July 2005	
13	Clearance of Forests Land	Govt. of India Ministry of Environment& Forests (FC Division)	9th Dec 2005	
14	Certificate of Registration from Labour Department	Govt. of H.P Labour Department.	28th Dec 2005	
15	License from Petroleum and Explosives Safety Organization (Renewal) Renewal of license E/NC/HP/22/220	Govt. of India , Ministry of commerce and industry(PESO)	13th July 2006 17th April,2008	Valid upto 31.03.2008 Valid upto 31.03.2010

16	License from Petroleum and Explosives Safety Organization for Petroleum Class B consumer pump Renewal of the Licence.no P/NC/HP/14/489(P179157)	Govt. of India , Ministry of commerce and industry(PESO)	21st Nov. 2008 13.02.2009	Valid till 31.12.2008 (Applied) Renewed upto 31.12.2010
17	Approval of PSERC for purchase of power	PTC India	19th Jan. 2007	
18	Petition for approval of power sale agreement	Punjab State Electricity Commission (PSEC)	24th Jan. 2007	
19	License from Petroleum and Explosives Safety Renewal License No.E/NC/HP/22/289	Govt. of India , Ministry of commerce and industry	26th Mar. 2007	Regarding Renewal of license no. E/NC/HP/22/289 for the period ending 31.03.2009
20	Letter of Credit for Import of Electro mechanical equipment	Punjab National Bank, New Delhi	3rd Apr. 2007	
21	Letter of Credit for Import of Electro mechanical equipment (Rs.39.70 Crores)	State Bank of Patiala, New Delhi	17th Apr. 2007	
22	Debt. Financing for HEP (Rs. 328.90 Crores)	REC, GOI	19th Apr. 2007	
23	Bank Guarantee (5 Crores) Extended up to 26th Sep. 2008	State Bank of Hyderabad	26th Sep. 2007	

CHAPTER - 2

JUSTIFICATION OF ADDITIONAL SPILLWAY

2. JUSTIFICATION OF ADDITIONAL SPILLWAY

2.1 NEED FOR ADDITIONAL SPILLWAY

The Malana-II Hydro Electric Project has been operating smoothly since, it's commissioning in, July' 2012. Both units of the project which were under operation with 16cumecs discharge in the river suddenly tripped on 24th August 2013. Consequently, the water level in the reservoir which was initially at MDDL, suddenly started rising. The project authorities tried to open the sluice spillway radial gates provided in the main dam, but the same could not be opened / raised. As a result, the reservoir level rose beyond the dam top elevation of EL. 2545.0m, resulting in overtopping of the concrete dam. This overtopping of the dam by an inflow river discharge of around 16cumecs continued for about 4 hours. Part of the overtopping water flowed over the junction of Dam Block-1 & key wall leading to partial erosion/washout of the overburden material present downstream of the key wall structure. A small portion of the road on the left bank constructed in overburden material also got washed away.

However, the detailed inspection of the entire complex area particularly the dam structure indicates that no damage has occurred to the dam structure after overtopping of the dam by the river discharge. No scour holes/scouring was observed in the rock foundation at the toe of the dam and there are no sign of any distress whatsoever in the dam concrete near the toe at its junction with the foundation rock. All the divide walls and training walls were in good condition. No damage was visible on the downstream concrete face of the dam structure.

The right bank where sound rock is exposed both at the abutments as well as in the foundation was totally stable and no sign of distress was observed on the rock slope / foundation rock on the right bank.

In view of the over topping of Dam on 24th August 2013, even at the low discharge of 16 cumec due to inoperational of gates, it became necessary to avoid such an emergency situation in future for safety of dam. In this regard, a letter received from Directorate of Energy, Govt. of Himachal Pradesh vide letter no. HPDOE/CE/(Authority)/Safety/Dam Safety/Vol.VI/2016-709-731 dated 27.04.2017 (enclosing the recommendations of First & Second National Dam Safety Conference conducted by Central Water Commission (CWC), Govt. of India), copy enclosed at **Annexure-I** recommends that all efforts must be taken to ensure complete safety of the Dam. The recommendations further provides for improving the emergency action plan and ensure the soundness and stability of Dam abutment which must be duly featured in Dam design for mitigation of risk associated with abutment failure.

In view of such recommendations made by the National Conference of Dam Safety held on 24th & 25th March, 2015 was adopted by the Govt. of Himachal Pradesh in 2017. It was felt that due to presence of only two no. of under sluice gates of Malana HEP, any re-occurrence of over topping due to inoperational of gates may be detrimental to the stability of Malana Dam abutments. As such, and in compliance to the recommendations made by Dam Flood Committee, it is felt that an un-gated surface spillway on the right flank of Malana Dam will ensure complete safety without any manual intervention in case of any impending flood in the eventuality of inoperational of gates due to any reason, whatsoever.

The matter regarding non operation of the radial gates when water level in the reservoir started rising due to sudden tripping of both the generating units was examined. This was due to sloughing/ collapse of the silt deposited and excessive deposition of the silt in front of the radial gates and as a result the gates could not be operated. During site inspection, it was seen that lot of silt had deposited both on the left and the right banks adjacent to the dam axis. This type of silt deposition in the transverse direction is common when the number of overflow blocks is less. To avoid such type of silt depositions on the river banks, it is desirable to manually or mechanically remove it during the period when draw down flushing of the reservoir is carried out by lowering the water level in the reservoir up to the spillway crest. Further, the reservoir drawdown flushing needs to be done frequently to avoid recurrence.

In addition, the gates are operated on daily basis even when the discharge in the river is less than the design discharge required for power generation. Also from time to time the silt deposited on the banks near the dam is removed manually/ mechanically and flush it downstream of the river.

In light of the overtopping incident and to avoid its consequences in future as per the recommendations of First and Second National Dam Safety Conference, two alternatives were worked out:

1) Provision of additional un-gated surface spillway by converting NOF blocks into overflow blocks
2) Provision of a separate spillway tunnel

Both options were compared viz a viz its cost and construction period. The first option i.e., provision of un-gated surface spillway is found more feasible. Therefore, it is proposed that the existing dam Non-overflow blocks on the right bank may be used by converting these non-overflow blocks nos. 6, 7, 8 and 9 into overflow (un-gated surface) blocks by keeping the spillway crest at EL. 2543.00m i.e. same as the reservoir FRL which is 2.00m below the existing dam crest EL. 2545.00m. The entire proposed scheme has been detailed in this report.

2.2 PROPOSED SCHEME

The maximum available length of NOF blocks on the Right flank at dam crest has been utilized and converted into un-gated overflow dam so that maximum discharge can be safely discharged through these NOF dam blocks in the eventuality when both the existing under sluice gates do not work as has happened on 24th August 2013. Seven bays of **6.25m wide** have been proposed/ modified in existing **NOF block Nos. 6, 7, 8 and 9** with un-gated spillway crest at **El. 2543.00m.** The overall water way proposed shall be **43.75m** (maximum available length at dam crest) with the **spillway crest El.2543.00m** and the maximum water level in the reservoir is considered as crest level of the existing dam **El.2545.00m** and 1.0m high concrete parapets have been proposed in the upstream side of the dam which will cater the function of free board in concrete dam. The maximum observed flood so far during monsoon period in the river is below **100m^3/sec** whereas the discharging capacity of the newly proposed un-gated surface spillway has been theoretically calculated as **239.51m^3/sec.** Therefore, the flood water during the high flood will safely pass through the proposed un-gated spillway in the eventuality both the existing under sluice gates does not work. This additional spilling will occur very rarely in extreme emergency condition as in normal situation/ condition the river flood/ discharge shall be regulated/ managed through the existing sluice spillway.

The crest elevation of existing NOF blocks is at **El 2545.00m**. It is proposed to connect the crest level of existing NOF blocks and the top of the dam of newly proposed un-gated surface spillway by providing a slope of 1(V):12(H) in NOF block No.- 6 and 10 as shown in the drawing **"General Layout Plan"**. One meter high concrete parapet has been provided on the upstream side of the dam crest which will function as required minimum free board in concrete dam. The invert and the top of the bridge deck slab at the un-gated overflow section have been proposed **El. 2545.10m** and **El. 2545.75m** respectively.

The water spilling over from the proposed un-gated surface spillway shall be consisting lot of energy as it will fall from substantial height. Therefore, the energy dissipation arrangement at the toe of the spillway is necessary to minimize erosion of foundation on the downstream of spillway structure. The Stilling Basin with broad crested weir has been proposed as energy dissipation arrangement. Finally the water spilled over from the proposed un-gated surface spillway will be discharged through the channel in the main Malana River as shown in the drawings.

ANNEXURE - "1"

DIRECTORATE OF ENERGY
GOVERNMENT OF HIMACHAL PRADESH
SHANTI BHAWAN PHASE-III SECTOR-6 NEW SHIMLA-9
Phone/ Fax No: 0177-2673553, Email: ceauthoritydoe@gmail.com

No. HPDOE/CE(Authority)/Safety/Dam Safety/Vol.VI/2016- 708-731 Dated: 27/04/201
To

All the Independent Power Producer/
Govt. Organization /Semi Govt. CPUs,
(Under Large Dam category) Malana-II HEP (100 MW)

Subject: - Recommendations of First and Second National Dam Safety Conference.

Sir,

In reference to subject cited above, enclosed find herewith a copy of letter No. MPP-F(10)-40/2016 dated-17.03.2017 alongwith its enclosures received from the Addl. Chief Secretary(Power), GoHP. It is requested to implement relevant recommendations appropriate in your hydroelectric project in the interest of promoting the dam safety/ safety in general and action taken report in this regard be sent to this office. These recommendations have been uploaded in the website of DoE i.e http://admis.hp.nic.in/doe and can also be downloaded from this website.

DA: - As Above

yours faithfully,

26/4/17
Chief Engineer (Authority)
Directorate of Energy
Govt. of Himachal Pradesh

Copy to the Additional Chief Secretary (Power), to the Govt. of Himachal Pradesh, Shimla-171002 for kind information please.

26/4/17
Chief Engineer (Authority)
Directorate of Energy
Govt. of Himachal Pradesh

Dy. No. ...
Dt. 25/3/2017

No. MPP-F(10)-40/2016
Government of Himachal Pradesh
Department of Multi Purpose Projects & Power
****

From

The Addl. Chief Secretary (Power) to the
Government of Himachal Pradesh

To

The Director (Energy),
Shanti Bhawan, Phase-III, Sector-VI,
New Shimla-09.

Dated: Shimla-02, the 17 March, 2017

Subject: **Recommendations of First and Second National Dam Safety Conference.**

Sir,

I am directed to enclose herewith a photocopy of letter No. IPH-B(F)8-4/2012 dated 14.03.2017 alongwith its enclosures received from the Deputy Secretary (I&PH) to the Government of Himachal Pradesh, on the subject cited above and to request you to look into the matter and take necessary action in the matter accordingly.

Yours faithfully,

(Dr. Ajay Sharma)
Special Secretary (Power) to the
Government of Himachal Pradesh
Phone No. 0177-2620757

Endst: No. As above Dated: Shimla-02 March, 2017

Copy to the Deputy Secretary (I&PH) to the Government of Himachal Pradesh w.r.to above referred letter for information.

Sr Xen-II

Special Secretary (Power) to the
Government of Himachal Pradesh

Director
CEN(Energy)
CE (~~[illegible]~~) (Authority)
CE (Power)
CE (Safety)
Sr. XEN
Legal Cell
ACF
S.O.
PS

25/3

PL

Study & discuss.

25/3/17

20/3

18-3-2017

No. IPH-B (F) 8-4/2012
Government of Himachal Pradesh
Irrigation & Public Health Department

From:

The Secretary (IPH) to the
Government of Himachal Pradesh

To:

1. The Additional Chief Secretary (Revenue) to the
   Government of Himachal Pradesh

2. The Additional Chief Secretary (Power) to the
   Government of Himachal Pradesh

Dated Shimla-171002, the 14-03-2017

14/3
SS (Power)

14/3
SO(P)

15-3-17
Sh. H.K.

Subject: - **Recommendations of First and Second National Dam Safety Conference.**

Sir,

I am directed to enclose herewith a photocopy of D.O. letter No.DRIP/18/1/2016-DSRD/NDSC/2017 dated 13-12-2016 along with the recommendations of the First and Second National Conference on Dam Safety held in March 2015 and January 2016 received from the Chairman & Ex-Officio Secretary, CWC, MoWR, RD&GR and to request you to circulate these to all executing agencies for implementation of the recommendations made by 1st & 2nd National Conference on Dam Safety to promote the dam safety in the State.

Yours faithfully,

(Chhavi Nanta)
Deputy Secretary (I&PH) to the
Government of Himachal Pradesh
Ph.0177-2621110

Everest Power Private Ltd.

एस. झा
S. JHA
अध्यक्ष
एवं पदेन सचिव, भारत सरकार
Chairman
& Ex-Officio Secretary to the Govt. of India

5386 0801
27/1/2017

केन्द्रीय ..
जल संसाधन, नदी विका
और गंगा संरक्षण मंत्राल
कमरा नं० 315 (द), सेवा भव
आर. के. पुरम, नई दिल्ली-11006
Government of Indi
Central Water Commissio
Ministry of Water Resources.
River Development and Ganga Rejuvenatio
Room No. 315 (S), Sewa Bhawa
R. K. Puram, New Delhi-11006

Ref: DRIP/18/1/2016-DSRD/NDSC/2017/

Date: 13 December, 2016

Dear Shri Narinder,

The Central Water Commission (CWC) is coordinating implementation of the Dam Rehabilitation and Improvement Project (DRIP), with financial assistance from the World Bank to rehabilitate about 250 large dams in seven states. As part of its institutional capacity building initiative CWC is taking the lead in organizing National Dam Safety Conferences in different states as yearly events. These conferences promote the concepts, techniques, instruments, and materials for design and construction of new dams, as well as for monitoring, operation, maintenance and rehabilitation of existing dams. They provide an opportunity for dam professionals and organizations to share their knowledge and experience as well as their technologies, innovations, and dam safety initiatives.

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CWC joined hands with Tamil Nadu Water Resources Department and Indian Institute of Technology, Madras for the First National Dam Safety Conference, which was held in Chennai in March 2015. The Second National Dam Safety Conference took place in Bengaluru in January 2016, where CWC collaborated with the Karnataka Water Resources Department and the Indian Institute of Science, Bengaluru.

The profile of the delegates participating in the conferences included policy and decision makers in the management of large dams in India and engineers, hydrologists, geologists, dam owners / operators, industry representatives, academic and research institutes and other stakeholders both within and outside the country. Based on the technical papers presented by the dam professionals, and the deliberations that took place afterwards, recommendations for improving the dam safety in India were adopted in the conferences. I am glad to attach the recommendations adopted at these conferences for your kind information; these recommendations along with a compendium of technical papers are available on our official website: www.damsafety.in.

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You may consider issuing a suitable direction to concerned agencies for implementing these recommendations as appropriate in the interest of promoting dam safety in your State.

Looking forward for a positive response on this matter.

With due regards,

Sincerely yours

(G.S. JHA)

Shri Chauhan Narinder
Principal Secretary
Irrigation & Public Health Department
Govt. of Himachal PradeshSecretariat
Shimla - 171 002
HIMACHAL PRADESH

Pr. Secy (IPH), may like to circulate recommendations on dam safety. ...thanks

Recommendations based on the deliberations during the First National Conference on Dam Safety, 24-25 March 2015

TS-I: Design Flood Estimation and Dam safety Measures for Flood Mitigations

i. For dams with small catchment areas, storms having less than 24 hours duration may be critical and should be adopted while assessing their design flood. It would be worthwhile to adopt multiple storm durations to produce multiple inflow design flood hydrographs to arrive at the most severe inflow design flood hydrograph.

ii. Frequency of extreme events has been seen to be increasing in the South Indian peninsula. More extensive data needs to be analyzed for establishing the reasons for significant increasing trends in rainfall in this region. The impact of the likely increase in extreme hydro-meteorological events on river valley projects should be addressed.

iii. The Probable Maximum Precipitation (PMP) atlases form a comprehensive knowledge bank which provide not only readily useable SPS/PMP estimates at sub basin level/ grid points but also detailed data of around 700 storms for carrying out project/ catchment specific SPS/PMP studies. Use of revised PMS atlas for design flood reviews are recommended.

iv. In case of blockage of rivers due to a major landslide, the information pertaining to possible additional rise in river water level and warning time in the event of possible dam breach is very important input for disaster management planning. The river cross sections and other data along with breach modelling framework may be kept ready so as to provide requisite information to concerned authorities at the shortest possible time.

v. While carrying breach analysis of blockage of river due to land slide or any other reason, the assessment of sediment volume likely to be generated during the event should also be taken care of.

vi. As hydrology is a dynamic process, the hydrological parameters such as design flood, should be reviewed periodically, particularly when a significant hydro-meteorological event occurs in the catchment of the project.

vii. Impact on design flood due to cloud burst and GLOF needs to be analyzed and incorporated in the practice.

TS-II: Risk assessment and emergency preparedness

- The conference recommends that the efforts to ensure 'fail safe' dam structures shall be made with a timely release of the funds required for the purpose.
- Institutional capacities of dam owning organizations as well as premier academic institutes shall be improved to develop emergency action plans for every large dam in the country and keep them updated.
- The soundness and stability of dam abutments needs to be thoroughly investigated and suitably featured in the dam design for mitigation of risks associated with abutment failures.

TS-III: Institutional arrangements and good management practices for sustainable dam safety

- Dam safety organizations in every state and other dam owning authorities shall be strengthened with adequate and qualified manpower.
- Development of information system for monitoring the status of dam health and long term data backup shall be taken up as priority.
- Quality control set up for monitoring the quality of works during construction of new dams or during dam rehabilitation shall be strengthened in each state.
- DRIP can provide the necessary initiative for a three-way collaboration involving experts in technical organizations, dam owners and academic and research institutions for effective implementation of new technologies in dam safety.
- A suitable workflow process for dam rehabilitation works, similar to DRIP mechanism, needs to be replicated by non DRIP states.

TS-IV: Latest Innovations and Methods for Monitoring Dam Health

- State-of-art tools have become available at affordable costs for real time, automated monitoring of dam behaviour. The dam owners are advised to make maximum use of these technologies for ensuring the health and safety of their dams.
- Pollution of dam reservoirs can have significant impact on the health of dams and hence preventive measures are needed to check the entering of pollutants in dam reservoirs.
- Dam instrumentation is also vital for establishing the prevalent design philosophies so as to improve upon them. All new dam constructions shall be encouraged to incorporate such instrumentation preferably in collaboration with premier academic and research institutes.

TS-V: New Materials and Methods for Dam Rehabilitation

- Existing techniques of dam rehabilitation based on grouts, guniting, etc. may not be effective in all cases. New techniques based on geomembranes, micro-fine cements, fibre reinforced concrete and other chemical based grouts shall be adopted based on sound engineering judgement.
- Wherever appropriate, new materials and technologies shall be encouraged in a select few dams so as to derive confidence on their performance, and also to scale up their usage for financial viability of such new techniques.

TS-VI: Compliance with the Provisions of Design Standards – Issues & Strategies for Existing Dams

- Periodic maintenance and adherence to codal requirements in dam construction is important.
- The relaxation of codal stipulations for rehabilitation of dams needs to be examined case-to-case based on the site conditions, hazard potential and techno-economics.
- The effect of alkali-silica slow reaction (ASSR) for dam rehabilitation works needs to be validated through more field data. The phenomenon of Delayed Entringite Formation (DEF) and its impact on dam concrete swelling needs to be investigated on ageing concrete dams.

Second National Dam Safety Conference

12 - 13 January 2016, JN Tata Auditorium, IISc, Bengaluru
Organized by CWC, KaWRD and IISc
Website: www.damsafety.in

RECOMMENDATIONS

The Second National Dam Safety Conference was organized during 12-13, January 2016 at IISc, Bengaluru. The deliberations were held on 6 different themes spanning over 9 technical sessions. The Conference also had one Open Session dealing with the topic 'Need for DRIP like programmes for sustaining Dam Safety Initiatives across India'. The sessions were highly interactive and informative. The following recommendations have emerged during the deliberations at the Conference:

TS-1: Design flood estimation and methodology for ensuring hydrological and hydraulic safety of Dams

- The hydro-meteorological approach is an acceptable method for assessment of PMF for projects. Detailed analysis would help the professionals in understanding the required studies in a systematic manner.
- There is urgent need for assessing the impact of climate change on PMF to be used for taking appropriate dam safety measures in the country
- Sensitivity analysis for dam breach parameters should be carried out while carrying out dam break analysis
- The downscaling of GCM to local scale for Indian conditions need to be studied in details keeping in view the requirement of dam safety studies as also for proper management of water resources, however its application for extreme events should be used cautiously.
- Volume and duration of flood events should also be considered along with the peak discharge rates using multivariate modelling to assess the risk of flood events in its entirety.

TS-2: Extent and Methodology for site investigations for the health and safety of dams

- Investigations for assessment of health status of existing dams are important for their safety.
- Structural safety of the dams is required to be assessed at regular intervals to know the health status and taking up remedial measures for keeping them structurally safe and fit for their intended use.
- State-of-the-art tools are available for assessment of health status of dams. These tools are cost effective and quick to deliver results. Dam owners are advised to use latest available technologies such as geophysical methods, modern dam instrumentation etc. for ensuring health and safety of dams.
- Periodic and systematic maintenance of dams is important to ensure their sound health and safety.

Everest Power Private Limited

TS-3: Planning and design considerations for safe dam

- Reservoir operating condition corresponding to Flood Reservoir Level (FRL) in non-monsoon, between FRL and Minimum Draw Down Level (MDDL) in monsoon and one or two flushing every year could be the better option for the sediment management as well as optimal power generation aspect for the river valley projects in Himalayas.
- Catchment area treatment and construction of check dams in upper river reaches in general may be helpful in better silt management.
- Deformation measurement by conventional Electronic Distance Measurement (EDM) has some limitations in fixing measuring points, prompt measurement in emergency. This has been overcome by Global Positioning System (GPS) method, with high precision which reveals behaviour of dams which were previously undetectable with existing methods.
- The heterogeneity of foundation has to be considered during the Finite Element Method (FEM) analysis of dam using concept of fracture mechanics.
- Proper co-ordination among the designers, fabricators, erection personnel/agencies, stringent quality control/checks at each stage of erection/fabrication of hydro mechanical equipment should be adhered to.

TS-4: Challenges in Dam Health Monitoring and Mitigation of Dam Health Issues

- The flexible geo-membrane can effectively be used in waterproofing of dams both in dry condition and under water.
- There is a need to strengthen the institutional set up of Dam Safety Organisations.
- Proper planning and investigation coupled with quality control during construction stage are key to avoid havoc later and to perform the intended purpose of any water resources development project.
- The development of vulnerability index methodology for dams considering associated risk factors and dependence of society on the dam would be very useful in prioritizing the desired remedial measures for the safety of the dam.
- There is a need to enhance the value of existing dams by harnessing additional possible benefits. Vast area available in dams can be utilized for harnessing solar power.

TS-5: Innovations and integration of technologies for dam safety

- The open source numerical models such as WFlow, RTC-Tools & Delft-FEWS have the capability for short-term operational inflow forecasting which can be used for decision support system for reservoir operations.
- The Hedge Management Model (HMM) for reservoir operation and management with the objective for minimising the impact of different accruing water demands will have

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greater efficacy than Standard Operating Procedure (SOP) when water stress exists and future reservoir inflow is more uncertain.

- The instrumentation and remote control system for gate operation has many applications. However the cost aspects and efficiency needs to be verified.
- The advancement in instrumentation of dams and new technologies which are proposed for Idukki dam has applications for other dams which are to be rehabilitated.
- The concrete injection technologies for treatment of leakages, abrasions etc. in old dams have practical significance. However, the comparison with similar products with regard to cost, durability, equipment for application etc. needs to be considered while selecting such products.
- Dredging systems should be environment friendly.

TS-6: Quality Control & Quality Assurance

- Quality control and quality assurance as a measure in totality and is required to be carried out from design stage to procurement and construction stage till commissioning of the project.
- The particular aspects to be focused will vary for new construction projects as opposed to that of rehabilitation project.
- Inadequate Quality Control & Quality Assurance during the active period of construction / rehabilitation may put the entire work in jeopardy. Hence a strict vigilance throughout the project period is the recommended solution.
- Quality Management System shall be introduced in the State Dam safety Organisations across the country.

Open Session: Need for DRIP like programmes for sustaining Dam Safety Initiatives across India

- Even though there is considerable attention towards improvement of the distribution network for better management of surface runout water though 'Extension, Renovation and Modernisation (ERM)' projects under 'Accelerated Irrigation Benefits Programme (AIBP)', the issues of dam performance and health are not receiving adequate attention and largely, the dams are being neglected; there is need to sensitise the decision makers on the issue.
- For building climate change resilience, consistent operational and storage policies shall be adopted to provide assurance of a safe and consistent dam behaviour from structural and flood point of view.
- There is a need to implement the dam safety programme in a systematic and sustained manner with emphasis on providing adequate technical and managerial advice to the dam owners and also providing funding through different means.

- Many issues of dam safety and operation will come up due to changes in downstream flood plain developments as well as interventions that may happen on the upstream catchment areas. There is also lack of awareness in the engineering and scientific community for capacity building in the field of flood and other hazard assessment as well as the understanding of the material behaviour and deterioration phenomena. Such issues need to be resolved through the nationwide dam safety assurance programme.
- The DRIP programme has been successful in bringing about greater awareness on dam safety and it has provided a great opportunity for introducing new solutions and technologies in dam management and rehabilitation. However, there are large areas of various basins which are not benefitting from the DRIP programme. Therefore, it is essential that the programme is uniformly adopted across all basins.
- Adoption of Dam Safety Legislation and consequent establishment of a uniform hazard assessment and mitigation regime will be greatly helped if the same is also supported by a national programme like DRIP for all such states who adopt the Legislation.

CHAPTER - 3
GEOLOGY

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3. GEOLOGY

3.1 GENERAL

The Malana-II Hydro Electric Project in the Kullu district of Himachal Pradesh was conceived as a run-of-the-river scheme on the Malana Nallah (sub-tributary of Parbati river which is a tributary of River Beas) to utilize a gross head of about 626m and to generate 100 MW of power.

The project comprises a 45m high Concrete Dam, a 4.9 Km long, 3m Ø HRT aligned on the left bank, a 75 m deep , 6m Ø surge shaft , a 2.5m dia 600m deep pressure shaft leading to an underground power house hosting two turbines of 50MW each , located 300m inside the hill and a short tailrace tunnel. The Power House is located on the left bank of the Malana Khad. The Dam is situated 10km upstream of the Malana-II Power House. Two nos. of sluice type spillway with radial gates each of size 4.0m (W) x 5.50m (H) with crest at EL. 2514.50m have been provided in the Overflow dam block no.5 to pass the design flood.

As mentioned in **chapter 2 (Para No. 2.2)**, It has been proposed that the existing dam Non-overflow blocks on the right bank may be used by converting these non-overflow blocks no. 6, 7, 8 and 9 into overflow (un-gated surface) blocks so that water can safely pass through these overflow (un-gated surface) blocks in case the existing under sluice gates cannot be lifted / operated during high floods.

3.2 REGIONAL GEOLOGY

The project is located in an extremely rugged terrain where the malana nallah, having a steep bed gradient of 1:10, has carved out a steep gorge through towering, steep and rocky escarpments on both banks with relief varying from 1900 m to 2600m. The project has been planned within two major formations viz. - Kullu & Banjar. These two formations are separated by a regional tectonic contact known as the **Juthog Thrust**.

The project area is characterized by four well defined structural units viz:

Member	Formation	Lithology	Project Component
Kullu	Jutogh	Garnetiferous quartz chlorite/ biotite schists, micaceous quartzite with bands of porphyroblastic granite gneiss and thinly foliated quartz mica schists and quartz chlorite schists.	Dam Area, HRT

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Kharmada	Jutogh	Carbonaceous and grey slates, schists and quartzite (at few places Garnetiferous)	HRT
Manikaran	Banjar	Thick bands of white grey and banded massive quartzite, at places showing Flows and sills.	HRT, PH Complex
---	Larji	Granite	

3.3 GEOLOGY OF DAM COMPLEX

The 45m high 158m long concrete dam having 10 nos. of blocks, with deepest foundation level at approx. EL 2487m is located in a wide, U shaped glaciated valley. The malana nallah with average bed level at EL.2500m (at dam axis) had incised a 15m to 20m deep channel in this valley. Initial investigations and subsequent excavation of the river bed and abutments during construction revealed that a 14.5m long , 9 to 10m deep palaeo-channel of this nallah existed on the right bank, confluencing with the present channel at the toe of the dam. The lowest level of the palaeo-channel bed was at EL 2494.5m. The steep gradient of the nallah had eroded numerous deep cut potholes/sink holes in the main river bed and the palaeo-channel.

The left abutment of dam axis has covered by approx. 25m to 60m deep overburden constituted by upper consolidated slope debris overlying a riverine deposit of 17m-25m thickness. While the right abutment of dam axis is rocky and rise from the river bed at about 50°-60° angle. It generally displays bedrock exposures intermittently all along its profile under a thin cover of vegetation and overburden. Along the right bank outcrops comprising Biotite schist with subordinate bands of quartzite of Kullu formation form steep escarpment face, and at places, as at the dam axis, these exposures touch the river channel and are exposed by the river water action and continue further downstream on both the banks, however, along the hill slope 3-4m thick overburden comprising of slope wash material and rock fragments overlays the bed rock. Some isolated outcrops of bed rock are exposed in between EL.2535m to EL.2570m (**Figure-1**).

Detailed geological mapping revealed that the bedrock exposed in area is light grey to dark grey coloured biotite schist with subordinate bands of quartzite. In general bed rock is moderately jointed and dissected by four sets of discontinuities. The average trend of discontinuities and their geotechnical parameters are described as follows:

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Set no.	Average Orientation	Spacing (cm)	Persistence (m)	Aperture (cm)	Condition
S1	010⁰/35⁰	6 - 20	5 - 8	0.5 – 2.0	Rough Irregular
S2	210⁰/81⁰	20 - 60	8 - 10	10 - 20	Rough Planar
S3	170⁰/55⁰	> 60	5 - 12	. 5 – 20	Rough Irregular
S4	040/66	> 60	2-3	tight	Rough Irregular

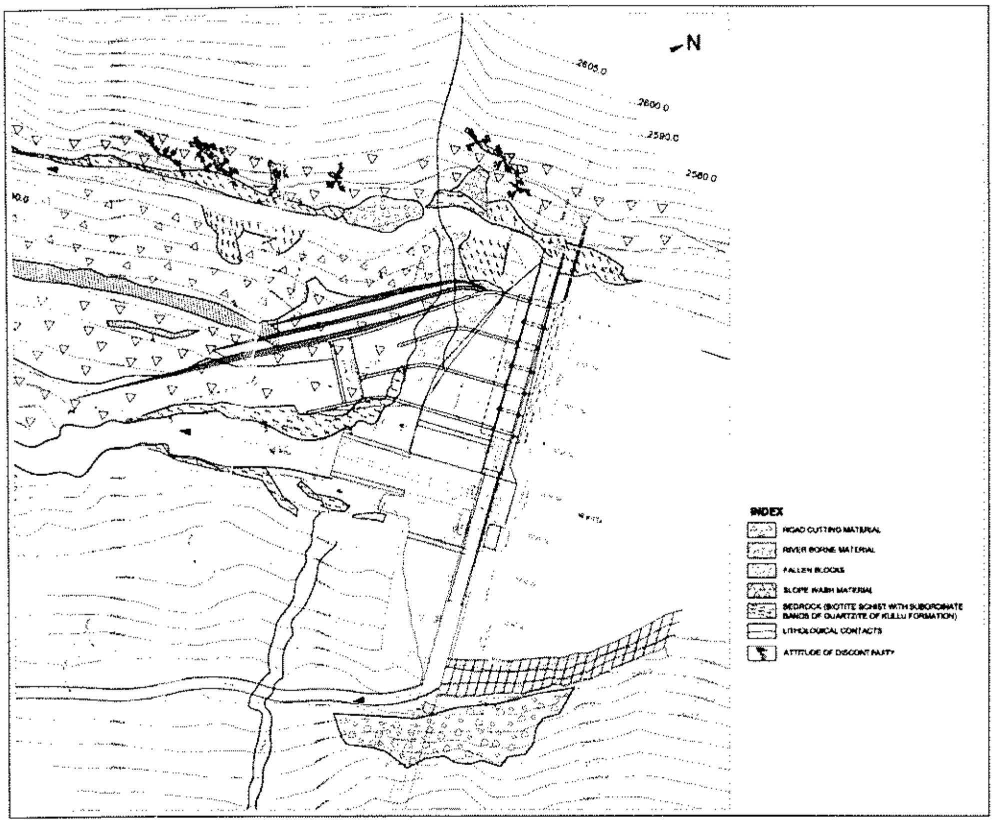

Figure-1 Geological Map of the dam area

The overall water way width proposed shall be 43.75m with the spillway crest El.2543.00m and the maximum water level in the reservoir is considered as El. 2545.00m. It is proposed to connect the crest level of existing NOF blocks and the top of the dam of newly proposed un-gated surface spillway by providing a slope of 1(V):12(H) in NOF block No.- 6 and 10. The excavation of downstream channel will be carried out in bed rock comprising light grey to dark grey colored biotite schist with subordinate bands of quartzite. Bed rock will be available within the river bed and along the proposed structure under a varying overburden cover of 3 to 4m while it exposed at river bed in between EL 2500.0m to EL. 2506.0m.

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To achieve the foundation grade the excavation in right bank is proposed from EL.2532.20m down to EL 2513.33m by providing 1 in 6 slope in bed rock. Possibility of toppling failure from steep almost vertical to steep valley dipping joints is apprehended during excavation of right abutment slopes. Therefore the cut slopes will be supported with rock bolts of adequate diameter and length followed by a layer of shotcrete.

CHAPTER - 4

DESIGN OF CIVIL STRUCTURES

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4. CIVIL ENGINEERING STRUCTURE RELATED TO UNGATED SURFACE SPILLWAY

4.1 GENERAL

The Malana-II Hydro Electric Project in Kullu district of Himachal Pradesh with an installed capacity of 100 MW (2x50 MW) has been developed by Everest Power Private Limited (EPPL). The project is a high head, run-of-river scheme with 4 hour pondage and is located on Malana Khad, a tributary of the Parbati River. The Project exploits the Hydro Power potential in the upper reaches of Malana Nallah upstream of Malana–I Hydro Electric Project.

The maximum height of the dam from the deepest foundation level is 53m and its length at the top is 213.0m comprising 150.0m length of the dam blocks and 63.0m length of the key wall provided inside the left bank abutment. The dam block comprises of one overflow block with two sluice bays and nine NOF blocks. Two nos. of sluice type spillway with radial gate each of size **4.0m(W) x 5.50m(H) with crest at EL. 2514.50m** have been provided in the Over Flow dam block No. 5 to pass a design flood of 650cumecs.

This chapter deals with the design aspects of various civil engineering components required for providing additional un-gated surface Spillway by using the Non-overflow **block nos. 6, 7, 8 and 9** into overflow (un-gated surface) blocks by keeping the spillway crest level **EL. 2543.00m** (existing FRL) and the maximum water level in the reservoir **EL. 2545.00m.**

4.2 PROPOSED SCHEME

As mentioned in **chapter-2 (Para No. 2.2)** above in this report, it is proposed that the existing dam on the Non Overflow blocks (Right Bank) may be used by converting these non-overflow blocks nos. 6, 7, 8 and 9 into overflow (un-gated surface) blocks by keeping the spillway crest level EL. 2543.00m which is 2.00m below the existing dam crest EL. 2545.00m. In case both the existing under sluice gates do not work in that situation the flood water during the high flood will safely pass through these proposed un-gated spillway.

The maximum observed flood during monsoon period in the river is below **$100m^3$/sec.** Accordingly, the available length of NOF blocks at dam crest has been utilized and converted into overflow dam so that maximum discharge can be safely discharged through these overflow dam blocks. Initially six bays of **6.25m wide** and one bay of **4.5 m wide** were proposed in existing **NOF block Nos. 6, 7, 8 and 9** with spillway crest at **El. 2543.00m.** The overall water way proposed was **42.00m** (available length at dam crest) with the **spillway crest El.2543.00m** and the maximum water level in the reservoir is considered as **El.2545.00m.**

The water spilling over from the proposed un-gated surface spillway shall be consisting lot of energy as it will fall from substantial height. The energy dissipation arrangement at the toe of the spillway is necessary to minimize erosion of foundation on the downstream of spillway structure. Therefore, Flip Bucket was proposed as energy dissipation arrangement at the toe of the spillway for the safety of the dam and natural hill slope. The hydraulic efficiency of the proposed profile of spillway glacis and energy dissipation arrangements has been reviewed / optimized through the physical model studies.

The physical model study of spillway considering the above arrangement was carried out by **Indian Institute of Technology (IIT), Roorkee** with reference to discharging capacity of the proposed un-gated surface spillway, energy dissipation and cavitation etc. The discharging capacity of the proposed un-gated surface spillway as per the model studies is 229.79 m^3/sec. The energy dissipation arrangement of the physical model study has been discussed separately in this report under the paragraph 4.4.

The maximum available length of NOF blocks at dam crest has been utilized and converted into overflow dam so that maximum discharge can be safely discharged through these overflow dam blocks. Therefore, seven bays of **6.25m wide** have been proposed/ modified in existing **NOF block Nos. 6, 7, 8 and 9** with spillway crest at **El. 2543.00m.** The overall water way width proposed shall be **43.75m** (maximum available length at dam crest) with the **spillway crest El.2543.00m**, and the maximum water level in the reservoir is considered as **El.2545.00m.** As mentioned above, the maximum observed flood during monsoon period in the river is below **100m^3/sec.** It is revealed from the theoretical calculation that the discharging capacity of the newly proposed spillway shall be around **239.51m^3/sec** and the computations are appended as **Annexure-"2"**.The additional un-gated surface spillway has been planned for much more spilling capacity (around 239.51m^3/sec). Therefore, the flood water during the high flood will safely pass through the proposed un-gated surface spillway in case both the existing under sluice gates do not work. This additional spilling will occur very rarely in extreme emergency condition as in normal situation/ condition the river flood/ discharge shall be regulated/ managed through the existing sluice spillway. The hydraulic efficiency of the proposed un-gated surface spillway and its energy dissipation arrangements has been reviewed / optimized through the physical model studies.

The crest elevation of existing NOF blocks is at **El 2545.00m**. It is proposed to connect the crest level of existing NOF blocks and the top of the dam of newly proposed un-gated surface spillway by providing a slope of 1(V):12(H) in NOF block No.- 6 and 10 as shown in the drawing **"General Layout Plan"**. One meter high concrete parapet has been provided on the upstream side of the dam crest which will function as required minimum free board in concrete dam. The invert and the top of the bridge deck slab (at overflow section) have been proposed **El. 2545.10m** and **El. 2545.75m** respectively.

The weathered concrete from the surface of the old concrete shall be removed and the surface of the old concrete shall be made rough and made wet with water. The anchor bars 25mm dia. @ 1.00m center to center shall be placed to have proper bond between old and new concrete is shown in the drawings. The excavation of the downstream channel shall be completed before placement of concreting of spillway glacis/ chute to avoid any damages.

It is apprehended that flow may deflect from one bay to another bay and therefore, the divided walls are provided combining the flows from two bays. The entire spillway arrangement has been depicted in the drawing **"General Layout Plan".**

4.3 STABILITY ANALYSIS OF THE PROPOSED UN-GATED SURFACE SPILLWAY

The stability analysis of the proposed un-gated, surface overflow dam section has been carried out as per **IS: 6512-1984 "Criteria for design of solid Gravity Dams"** for the worst loading combinations using Horizontal design seismic coefficient **α_h= 0.18g** and Vertical design seismic coefficient **α_v= 0.12g,** as the project area falls in the **Seismic Zone - IV** as per **IS: 1893 (Part-1) – 2002.** The detailed stability analysis calculations of the proposed un-gated surface dam section are enclosed at **"Part – A" of Annexure –"3".**

The stability analysis results reveals that the proposed dam section is safe against sliding as the factor of safety is more than 1.0 as stipulated in **IS: 6512-1984.** The stresses are also within permissible values for all the loading combination as mentioned in IS: **6512-1984.**

The stability analysis of the NOF dam section, after dismantling the dam block up to El. **2543.00m** and considering the water level in reservoir up to **El 2543.00m**, has also carried out. The detailed stability analysis calculations of the proposed NOF dam section are also enclosed at **"Part – B" of Annexure –"3".** The stability analysis results reveals that the proposed dam section is safe against sliding as the factor of safety is more than 1.0 as stipulated in **IS: 6512-1984.** The stresses are also within permissible values for all the loading combination as mentioned in IS: **6512-1984.**

4.4 ENERGY DISSIPATION ARRANGEMENT FOR THE PROPOSED UNGATED SURFACE SPILLWAY

The water spilling over from the proposed un-gated surface spillway shall be consisting lot of energy as it will fall from substantial height. Therefore, the energy dissipation arrangement at the toe of the spillway is necessary to minimize erosion of foundation on

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the downstream of spillway structure. The flip bucket with plunge pool was proposed as energy dissipation arrangement. Finally the water spilled over from the proposed un-gated surface spillway will be discharged through the channel in the main Malana River as shown in the drawings. The physical model study of spillway considering the above arrangement was carried out by **Indian Institute of Technology (IIT), Roorkee** with reference to discharging capacity of the proposed un-gated surface spillway, energy dissipation and cavitation etc.

It was also revealed from the above model that the discharging capacity of the additional un-gated surface spillway is in order. The spillway profile of the proposed surface spillway was found in order from cavitation considerations. However, the flow onwards to the toe of the un-gated surface spillway was chaotic and full of strong cross-currents. The flip bucket was also not performing well due to rise in depth of flow and mixed directional flow as a results of cross-currents upstream of the bucket. It was difficult to control the cross currents/ waves due to formation of multiples cross currents in the presence of various concave and convex boundaries in the form of side walls and training walls. Therefore, it was decided to replace the flip bucket arrangement with hydraulic jump type stilling basin by pooling the water with provision of a submerged broad crested weir of height 3.5 m along with steps downstream of the weir. Such arrangement controlled the cross-currents. However, still a strong cross current from the toe of dam block no.6 at the left end wall was impinging the pooled water. It was decided to shift the left side wall at the toe of the dam glacis by 3.0 m towards left side to minimize the formation of the cross-currents.

The suggested changes in the proposed surface spillway were incorporated in the model. Suggested changes comprise replacement of flip bucket by 3.5 m high broad crested weir with pool with steps cascade downstream of the weir. Each step is having 5 m width and of 1 m drop and at the end of the first two steps, an end sill of height 0.5 m is provided. Left side wall was shifted by 3 m further left side near the dam toe. The width of the channel was kept 22 m in the place of earlier 21 m at the broad crested weir.

Flow pattern in the stilling basin and over the submerged weir was observed during the run. Due to pooled water in the stilling basin with the provision of submerged weir, relatively drown hydraulic jump was forming. The cross-currents were merging into the pooled water and losing their high kinetic energy. Flow in the stilling basin was highly turbulence with large size rollers which leaded to energy dissipation in the stilling basin.

Flow over the submerged weir was almost uniformly distributed across the width of the channel and was falling onto the each step downstream of the weir. Overall, flow in the stilling basin and over the submerged weir was favorable from the hydraulic

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considerations. The Stilling Basin with the above modification was preforming efficiently. In Model, the proposed un-gated surface spillway profiles were found in order from the cavitation considerations. The hydraulic design calculations for proposed un-gated surface spillway are presented in **Annexure –"4A"**, and the physical model study report of proposed ungated surface spillway is enclosed in **Annexure –"4B"**.

4.5 BRIDGE OVER THE PROPOSED UNGATED SURFACE SPILLWAY

It is proposed to erect **6.00m wide** and **43.75m long** RCC Bridge over the spillway piers at El 2545.10m leaving a gap of 0.10m between maximum water level and invert of the proposed deck of the RCC Bridge. The top of the deck slab of the bridge (Dam crest) has been proposed at El 2545.75m. The bridge shall be designed for **Class AA / IRC Class 70R** loading. There are seven span of proposed bridge. The clear and effective span of each of the seven bays is **6.25m and 7.05m** respectively. As per "**Standard Plans for Highway Bridges R.C.C Slab Superstructure**" of the Indian Road Congress (**IRC**), Ministry of Surface Transport (Road Wing), the solid deck slab thickness for 7.00m span and IRC Class 70R loading shall be 0.50m at the ends and 0.65m in the center of the bridge. The thickness of the end piers and intermediate piers has been proposed as 0.75m and 1.00m.

4.6 CONSTRUCTION OF WALLS IN WATER WAY OPENING OF UNGATED SURFACE SPILLWAY

The construction of un-gated surface spillway and bridge has to be completed quickly as the dam crest is being used as the access / connectivity of left and right bank road by the local people. It is apprehended that the excavation of proposed channel in the downstream side may take substantial time. Also the RCC of the chute of the proposed spillway will be undertaken after completion of excavation of this channel to avoid damage of RCC of the chute. The spillway crest level is proposed as El 2543.00m which is the existing FRL. Due to reservoir water waves the water is likely to spillover in the downstream proposed spillway channel area. It is, therefore, proposed to fill up this spillway opening with Pre-cast Cement Concrete blocks and cement mortar wall temporarily as shown in the drawing to avoid any catastrophe during construction. These temporarily walls shall be removed after construction of downstream channel and spillway chute.

4.7 BOND IN OLD AND NEW CONCRETE

The weathered concrete from the downstream surface of NOF Blocks (old concrete) shall be removed and the surface of the old concrete shall be made rough and made wet with water. The anchor bars 25mm dia. @ 1.00m center to center shall be placed to have proper bond between old and new concrete is shown in the drawings. The excavation of

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the downstream channel shall be completed before placement of concreting of spillway glacis/ chute to avoid any damages.

4.8 DIVIDE WALL IN PROPOSED UNGATED SURFACE SPILLWAY

It is apprehended that flow may deflect from one bay to another bay and therefore, the divided walls are provided combining the flows from two bays. The entire un-gated surface spillway arrangement has been depicted in the drawing **"General Layout Plan".**

4.9 WATER STOPS (CONTRACTION JOINTS)

As per IS 12200: 2001, PVC water stops have been provided in the piers joints and dam blocks near to the upstream face to prevent any leakage through the joints as shown in the drawings.

4.10 CRACK CONTROL

It is proposed to adopt thickness of lifts of 1.5 – 2.00 m and minimum time gap between two consecutive lifts of 3 days. The initial 2 or 3 lifts of concrete starting from foundation levels shall be 0.5 m thick followed by subsequent lifts of 1.5 -2.00 m thickness. Cooling studies based on the BIS specifications would be carried out during the construction stage.

Following methods can be used to prevent cracks in a concrete dam:

- Properly spaced contraction joints.
- Construction of dam blocks in lifts preferably not exceeding 2.00m.
- Use of concrete having low cement content.
- Allowing sufficient time gap between the constructions of vertical lifts to permit large amount of heat loss from the surface.
- Pre-cooling of aggregates and use of chilling plants cooling of concrete by circulating chilled water through thin metal pipes embedded in concrete.

4.11 TRAINING WALL

The concrete gravity wall of 0.75 m thickness has been provided to guide the spill water. The spillway training wall along the glacis portion is kept as 2.00m and the divide wall between Block No. 7 & Block No. 8 and Block No.8 & Block No.9 has been kept 1.5m. The divide wall has been proposed to guide the water flow into the pool proposed in the downstream of dam toe. The training wall top has been kept as EL. 2520.00m and the invert of the pool kept at EL. 2513.83m. The training wall height has been proposed based on the water profiles observed during the model studies. The stone masonry wall has also been proposed behind the training wall in the transverse direction in a stepped manner.

The training wall details and stone masonry wall details have been depicted in the drawings.

4.12 DOWNSTREAM SPILL CHANNEL

The excavation of the downstream channel shall be completed before placement of concreting of spillway glacis/ chute to avoid any damages.

4.13 DISMANTLING OF NOF BLOCK CONCRETE

No blasting operation shall be carried out to dismantle the concrete of NOF block No. 7, 8, 9 and Part of Block No.6. It shall be done with at most care to prevent any damage in adjacent dam blocks and other appurtenant structure.

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ANNEXURE - "2"

MALANA-II H. E. PROJECT, HIMACHAL PRADESH

Computation of Spillway discharge :

S.N.	MWL (In Metres)	Crest Elevation	Water level in Reservoir	Design Head (H_d) (85%)	Water Head over the crest (H_e)	$(H_e)^{3/2}$	Approach level	Height of crest from bed (P)	P/H_d	H_e/H_d	C_0	C/C_0	Coeff. Of Discharge (C)	$L^{'}$	N	K_p	K_a	Effective Length $L= L' - 2(N X Kp +Ka) H_e$	Discharge (In M^3 / Sec.) $Q = C X L X H_e^{3/2}$	Remarks
1	2545.00	2543.00	2545.00	1.70	2.00	2.83	2505.00	38.00	22.35	1.18	2.18	1.023	1.96	43.75	6	0.01	0.10	43.11	239.51	

Note:- The Value of Coefficient of discharge "C" is based on the model test report of IIT, Roorkee.

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ANNEXURE - "3"

(Part-A) Stability Analysis of proposed Un-gated Surface dam section

MALANA-II HYDRO-ELECTRIC PROJECT

Spillway Stability Analysis at foundation level

The stability analysis of Overflow Concrete Dam (Surface Spillway) has been carried ou as per the procedure given in IS 6512 -1984 and IS 1893-1984.

Basic data:

Top of the dam Level	2545.750 m
Maximum water level	2545.000 m
Full reservoir level	2543.000 m
Maximum Tail water level	2506.150 m
Minimum tail water level	2505.500 m
Foundation Level	2504.900 m
Crest Level of spillway	2543.000 m
Total Height of the dam	40.85 m
Head at MWL	40.1 m
Head at FRL	38.100 m
Top width	6.000 m
U/S slope	0.050
Base width of dam (B)	34.700 m
Tail water depth for MWL	1.250 m
Tail water depth for FRL	0.6 m
Compressive strength of concrete fc	1500.000 t/sq.m
Design horizontal seismic coefficient (α_h)	0.180 g
Design vertical seismic coefficient (α_v=2/3*α_h)	0.120 g
Unit weight of concrete	2.400 t/cu.m
Unit weight of water	1.000 t/cu.m
Vertical density of silt	1.963 t/cu.m
Horizontal density of silt	1.360 t/cu.m
Distance of drainage gallery from Heel	3.00 m
Cross sectional area "A_1" from drawing (Autocad)	707.4240 m^2
Distance of C.G of "A_1" from Heel	12.9446 m
Elevation of C.G. of "A_1" from base	2519.0746 m
Cross sectional area "A_2" from drawing (Autocad)	4.479 m^2
Distance of C.G of "A_2" from Heel	5.489 m
Elevation of C.G. of "A_2" from base	2545.457 m
Cross sectional area "A_3" from drawing (Autocad)	21.3500 m^2
Distance of C.G of "A_3" from Heel	6.6194 m
Elevation of C.G. of "A_3" from base	2543.2873 m
Average width of Pier (For Two Piers)	1.500 m
Crest level of Lower tier spillway(Max.Silt level)	2504.900 m
Length of block	15.000 m
Cross sectional area of water A_4(FRL)	28.5682 m^2
Distance of C.G of W_4 from Heel(FRL)	1.6860 m
Cross sectional area of water A_5 (MWL)	28.568 m^2
Distance of C.G of W_5 from Heel(MWL)	1.6860 m
Cross sectional area of Silt A_6 (MWL)	0.0000
Distance of C.G of W_6 from Heel	0.0000
Elevation where the stability is checked	2504.900 m

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(1).Self Weight of the dam:

1. Weight of Spillway

	C/s Area (m^2)	Wt/Force	Lever Arm	Moment
A.Cross sectional area of A_1	707.42			
Weight of W_1		25467.26	12.94,	329663.55
B. Cross sectional area of A_2	4.48			
Weight of W_2		129.00	5.49	708.14
C. Cross sectional area of A_3	21.35			
W3 = 2*21.35*1.5*2.4 =		153.72	6.62	1017.53
Total weight (W) & moment		25749.98		331389.22

vertical force = V = 25749.98 t ↓

moments =M = 331389.22 t-m

(2). Weight of water:

(a). At FRL (W_4)

	C/s Area (m^2)	Wt/Force		Lever Arm	Moment
Weight of W_4 =	28.57	428.52 t	↓	1.69	722.49

vertical force = V = 428.52 t ↓

moments =M = 722.49 t-m

(b) At MWL (W_5)

	C/s Area (m^2)	Wt/Force		Lever Arm	Moment
Weight of W_5 =	28.57	428.52 t	↓	1.69	722.49

vertical force = V = 428.52 t ↓

moments =M = 722.49 t-m

(3). Water pressure:

(a). At FRL

	Wt/Force		Lever Arm	Moment
Hw1 = 0.5*38.0999999999999*15*38.099999	10887.1 t	→	12.70	138265.85
Hw2 = 0.5*0.6*15*0.6*1	2.7 t	←	0.20	0.54
Net pressure =	**10884.4 t**	→		**138265.31**

Horizondal Pressure = P_w = 10884.375 t →

moments =M = 138265.31 t-m

(b). At MWL

	Wt/Force		Lever Arm	Moment
Hw1 = 0.5*40.1*15*40.1*1	12060.07 t	→	13.37	161203.00
Hw2 = 0.5*1.25*15*1.25*1	11.72 t	←	0.42	4.88
Net pressure =	**12048.36 t**	→		**161198.12**

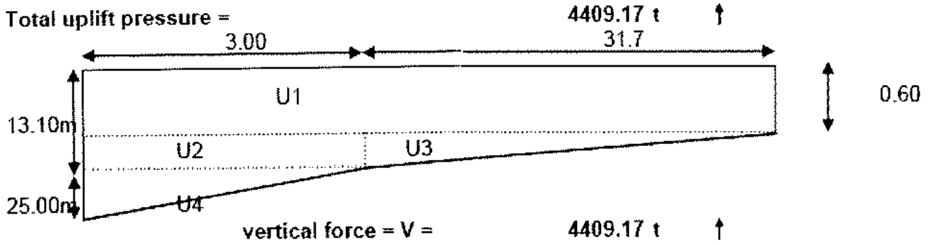
Horizondal Pressure = P_w = 12048.36 t →

moments =M = 161198.12 t-m

(4). Uplift pressure

a. At FRL

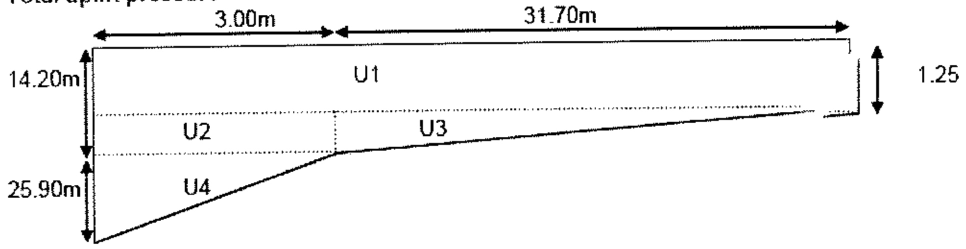
	Wt/Force		Lever Arm	Moment
U1 = 34.7*15*0.6*1	312.30 t	↑	17.35	5418.40
U2 = 3*15*12.5*1	562.50 t	↑	1.50	843.75
U3 = 0.5*31.7*15*12.5*1	2971.88 t	↑	13.57	40318.44
U4 = 0.5*3*15*25*1	562.50 t	↑	1.00	562.50
Total uplift pressure =	**4409.17 t**	↑		**47143.09**



vertical force = V = 4409.17 t ↑

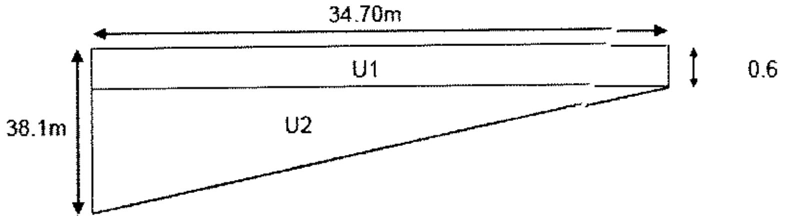
moments =M = 47143.09 t-m

b. At MWL	Wt/Force		Lever Arm	Moment
U1 = 34.7*15*1.25*1	650.63 t	↑	17.35	11288.34
U2 = 3*15*12.95*1	582.75 t	↑	1.50	874.12
U3 = 0.5*31.7*15*12.95*1	3078.86 t	↑	13.567	41769.90
U4 = 0.5*3*15*25.9*1	582.75 t	↑	1.000	582.75
Total uplift pressure =	**4894.99 t**	↑		**54515.12**



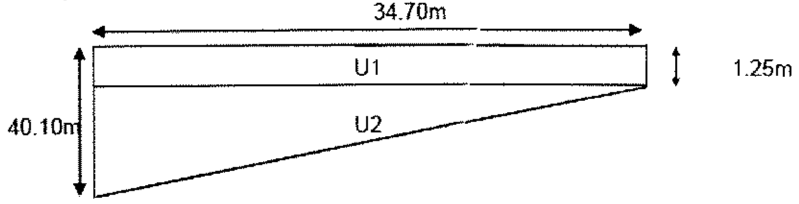
vertical force = V = **4894.99 t** ↑
moments =M = **54515.12 t-m**

c. Drain choked at FRL	Wt/Force		Lever Arm	Moment
U1 = 34.7*15*0.6*1	312.30 t	↑	17.35	5418.40
U2 = 0.5*34.7*15*37.5*1	9759.38 t	↑	11.567	112883.44
Total pressure =	**10071.68 t**	↑		**118301.84**



vertical force = V = **10071.68 t** ↑
moments =M = **118301.84 t-m**

d. Drain choked at MWL	Wt/Force		Lever Arm	Moment
U1 = 34.7*15*1.25*1	650.63 t	↑	17.35	11288.34
U2 = 0.5*34.7*15*38.85*1	10110.71 t	↑	11.567	116947.24
Total pressure =	10761.34 t	↑		128235.59



vertical force = V = **10761.34 t** ↑
moments =M = **128235.59 t-m**

(5). Silt weight	C/s Area	Wt/Force		Lever Arm	Moment
W_6 =	0.000	0.000 t	↓	0.00	0.000

vertical force = V = **0.00 t** ↓
moments =M = **0.00 t-m**

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(6). Silt pressure

	Wt/Force		Lever Arm	Moment
Hs = 0.5*0*15*0*1.36 =	0.00 t	→	0.00	0.000
Horizondal Pressure = P_s =	0.00 t	→		
moments =M =	**0.00 t-m**			

(7). Horizontal earthquake Force:

Horizontal earthquake force= 0.6 X W X α_h (As per IS:1893-1984,Page No.- 43)

H1 = 0.6 * 0.18 * 25749.985 = 2781.0 t →

Total force = 2781.00 t →

Moment = 0.9 X W X h' X α_h (As per IS:1893-1984,page No.- 43)

M_1 = 0.9 * 25467.264 * 14.175 * 0.18 = 58480.10141 t-m

M_2 = 0.9 * 129.001 * 40.557 * 0.18 = 847.5560443 t-m

M_3 = 0.9 * 153.72 * 38.387 * 0.18 = 955.9451125 t-m

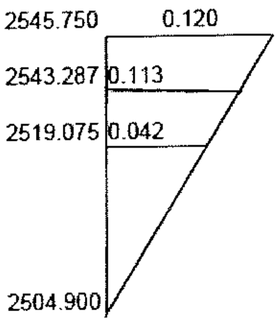
Total = 60283.60256 t-m

Horizondal Earth quake force = 2781.00 t

moments =M = 60283.60 t-m

(8). Vertical earthquake:

Vertical earthquake force= W X α_V



	Wt/Force		Lever Arm	Moment
V1= 25467.26*0.042 =	1060.4 t	↑	12.94m	13726.85
V2= 129*0.12 =	15.5 t	↑	5.49m	84.98
V3= 153.72*0.113 =	17.3 t	↑	6.62m	114.74
Total vertical EQ force =	1093.2 t	↑		13926.57

vertical force = V = 1093.25 t →

moments =M = 13926.57 t-m

(9). Hydrodynamic pressure

$p_e = C_s * \alpha_h . w * h$

$$C_s = \frac{C_m}{2}\left\{\left\{\frac{y}{h}\left(2-\frac{y}{h}\right)+\sqrt{\frac{y}{h}\left(2-\frac{y}{h}\right)}\right\}\right\}$$

C_m = 0.715 As per IS 1893-1984 the value of C_m has been taken.

y = 38.100 = Depth below FRL

h = 38.100 = Depth of Reservoir

Cs = 0.715

p_e = 5*0.18*1*1000*38.0999999999999*15 = 73552.050 kg/m

V_h = 0.726*p_e*h = 552.0499999998*38.0999999999999 = 2034493.834 Kg/m

V_h = 2034.494 t/m

Moment = 0.299*p_e*h^2 = 0.299*73552.0499999998*38.0999999 = 31923898.499 Kg-m/m

moment = 31923.898 t-m/m

Vertical force (v) = 2034.49 t/m

moments =M = 31923.90 t-m

Description of all forces

Sl. No	Particulars	Forces		Moments
		Vertical	Horizontal	
1	**Self weight**	25749.98		331389.22
2	**Water Wt.**			
	FRL	428.52		722.49
	MWL	428.52		722.49
3	**Water pressure**			
	FRL		10884.37	138265.31
	MWL		12048.36	161198.12
4	**Uplift pressure**			
	Normal FRL	4409.17		47143.09
	Normal MWL	4894.99		54515.12
	DC FRL	10071.68		118301.84
	DC MWL	10761.34		128235.59
5	**Silt Wt**	0.00		0.00
6	**Silt pressure**		0.00	0.00
7	**Hor. EQ**		2781.00	60283.60
8	**Ver. EQ**	1093.25		13926.57
9	**Hyd Dy.pres.**		2034.49	31923.90

Stresses in Different Load Conditions:

Load combination A:

Reservoir Empty

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.985	331389.218

$$P_{\max/\min.} = \frac{\Sigma V}{Bl}\left[1 \pm \frac{6e}{Bl}\right]$$

Where,

e= Eccentricity of the resultant force from the center of the base.

∑V = Total vertical force.

B = Base width.

l= Total length of Block.

X⁻ = 331389.218/25749.985 = 12.87 m

e = 34.7/2-(12.869) = 4.48 m

6e/B = (6*4.481)/(34.7) = 0.775

Stress on U/S = (25749.985/(34.7*15))*(1+0.775) = 87.799 t/m^2

Stress on D/S = (25749.985/(34.7*15))*(1-0.775) = 11.145 t/m^2

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Load combination B:

Reservoir at FRL, normal uplift, without earthquake, Min TWL, Silt

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.985	331389.218
2	W_W(FRL)	428.523	722.490
3	W_P(FRL)	0.000	138265.312
4	S_w	0.000	0.000
5	S_p	0.000	0.000
6	Uplift (FRL)	4409.175	47143.092
	Net	21769.333	423233.927

$\bar{X}$ = 423233.927/21769.333 = 19.44 m

e = 34.7/2-(19.442) = -2.09 m

6e/B = (6*-2.092)/(34.7) = -0.36

Stress on U/S = (21769.333/(34.7*15))*(1-0.362) = 26.697 t/m^2

Stress on D/S = (21769.333/(34.7*15))*(1+0.362) = 56.951 t/m^2

Load combination C:

Reservoir at MWL, normal uplift, without eathquake, Max. TWL, Silt

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.98	331389.218
2	W_W(MWL)	428.523	722.490
3	W_P(MWL)	0.000	161198.120
4	S_w	0.000	0.000
5	S_p	0.000	0.000
6	Uplift (MWL)	4894.987	54515.120
	Net	21283.52	438794.707

$\bar{X}$ = 438794.707/21283.52 = 20.62 m

e = 34.7/2-(20.617) = -3.27 m

6e/B = (6*-3.267)/(34.7) = -0.56

Stress on U/S = (21283.52/(34.7*15))*(1-0.565) = 17.794 t/m^2

Stress on D/S = (21283.52/(34.7*15))*(1+0.565) = 63.987 t/m^2

Load combination D:

Combination A, with earthquake

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.98	331389.218
2	EQ Hor.	0.000	60283.603
3	EQ ver.	1093.245	13926.571
	Net	24656.740	257179.045

$\bar{X}$ = 257179.045/24656.74 = 10.43 m

e = 34.7/2-(10.43) = 6.92 m

6e/B = (6*6.92)/(34.7) = 1.20

Stress on U/S = (24656.74/(34.7*15))*(1+1.196) = 104.050 t/m^2

Stress on D/S = (24656.74/(34.7*15))*(1-1.196) = -9.307 t/m^2

Load Combination E:

Combination B, with earthquake

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.985	331389.218
2	W_W(FRL)	428.523	722.490
3	W_P(FRL)	0.000	138265.312
4	S_w	0.000	0.000
5	S_p	0.000	0.000
6	UPLIFT (FRL)	4409.175	47143.092
7	Hydro dy.	0.000	31923.898
8	Eq hor.	0.000	60283.603
9	Eq ver.	1093.245	13926.571
	Net	20676.088	501514.858

X¯ = 501514.858/20676.088 = 24.26 m
e = 34.7/2-(24.256) = -6.91 m
6e/B = (6*-6.906)/(34.7) = -1.19
Stress on U/S = (20676.088/(34.7*15))*(1-1.194) = -7.710 t/m^2
Stress on D/S = (20676.088/(34.7*15))*(1+1.194) = 87.157 t/m^2

Load combination F:

Combination C, but Drains choked

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.985	331389.218
2	W_W(MWL.)	428.523	722.490
3	W_P(MWL)	0.000	161198.120
4	S_w	0.000	0.000
5	S_p	0.000	0.000
6	DC.(MWL)	10761.338	128235.585
	Net	15417.170	365074.242

X¯ = 365074.242/15417.17 = 23.68 m
e = 34.7/2-(23.68) = -6.33 m
6e/B = (6*-6.33)/(34.7) = -1.09
Stress on U/S = (15417.17/(34.7*15))*(1-1.094) = -2.798 t/m^2
Stress on D/S = (15417.17/(34.7*15))*(1+1.094) = 62.038 t/m^2

Load combination G:

Combination E, but Drains choked

Sl. No	Discription	Vertical forces	Moments
1	Self Weight	25749.985	331389.218
2	W_W(FRL)	428.523	722.490
3	W_P(FRL)	0.000	138265.312
4	S_w	0.000	0.000
5	S_p	0.000	0.000
6	Uplift (DC FRL)	10071.675	118301.842
7	Hydro dy.	0.000	31923.898
8	Eq hor.	0.000	60283.603
9	Eq ver.	1093.245	13926.571
	Net	15013.588	430356.108

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X¯ = 430356.108/15013.588 =	28.66 m
e = 34.7/2-(28.664) =	-11.31 m
6e/B = (6*-11.314)/(34.7) =	-1.956

Stress on U/S = (15013.588/(34.7*15))*(1-1.956) =	-27.587 t/m^2
Stress on D/S = (15013.588/(34.7*15))*(1+1.956) =	85.276 t/m^2

Factor of safety againgt sliding:

$$F=\left(\frac{(w-u)\tan\phi}{F\phi}+\frac{CA}{Fc}\right)\div P$$

Load combination B:

For load combination B, take Fø = 1.5 and Fc = 3.6,

F= factor of safety against sliding

w= Total mass of the dam + water + silt	26178.51 t		256811.16
u= Total uplift force	4409.17 t		43254.007
Θ = Angle of internal friction	40.00 Deg		
tan ø = coefficient of internal friction of the material	0.84		
C= cohesion	100.00 t/sq.m		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1.5		
Fc= partial factor of safety in respect of cohesion	3.6		
p= Total horizontal force	10884.37 t		

F=(((26178.51-4409.17)*0.84)/1.5)+((*100*34.7*15)/3.6)))/10884.375 = 2.45

Load combination C:

For load combination C, take Fø = 1.5 and Fc = 3.6

w= Total mass of the dam + water + silt	26178.51 t		
u= Total uplift force	4894.99 t		
tan ø = coefficient of internal friction of the material	0.84		
C= cohesion	100.00 t/sq.m		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1.5		
Fc= partial factor of safety in respect of cohesion	3.6		
p= Total horizontal force	12048.36 t		

F=(((26178.51-4894.99)*0.84)/1.5)+((*100*34.7*15)/3.6)))/12048.356 = 2.19

Load combination D:

For load combination D, take Fø = 1.2 and Fc = 2.4

w= Total mass of the dam	24656.74 t		
u= Total uplift force	0 t		
tan ø = coefficient of internal friction of the material (Ø-45	0.84		
C= cohesion	100.00 t/sq.m		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1.2		
Fc= partial factor of safety in respect of cohesion	2.4		
p= Total horizontal force	2781.00 t		

F=(((24656.74-0)*0.84)/1.2)+((*100*34.7*15)/2.4)))/2780.998 = 14.00

Load combination E:

For load combination E, take Fø = 1.2 and Fc = 2.4

w= Total mass of the dam + water + silt	25085.26 t		
u= Total uplift force	4409.17 t		
tan ø = coefficient of internal friction of the material	0.84		
C= cohesion	100.00 t/sq.m		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1.2		
Fc= partial factor of safety in respect of cohesion	2.40		
p= Total horizontal force	15699.87 t		

F=(((25085.26-4409.17)*0.84)/1.2)+((*100*34.7*15)/2.4)))/15699.867 = 2.30

Load combination F:

For load combination F, take Fø = 1.0 and Fc = 1.2

w= Total mass of the dam + water + silt	26178.51		
u= Total uplift force	10761.34		
tan ø = coefficient of internal friction of the material	0.84		
C= cohesion	100.00		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1		
Fc= partial factor of safety in respect of cohesion	1.2		
p= Total horizontal force	12048.36		

F=(((26178.51-10761.34)*0.84)/1)+((*100*34.7*15)/1.2)))/12048.356 = 4.67

Load combination G:

For load combination G, take Fø = 1.0 and Fc = 1.2

w= Total mass of the dam + water + silt	25085.26		
u= Total uplift force	10071.68		
tan ø = coefficient of internal friction of the material	0.84		
C= cohesion	100.00		
A= area under consideration for cohesion	34.70 m	X	15 m
Fø= partial factor of safety in respect of friction=	1		
Fc= partial factor of safety in respect of cohesion	1.2		
p= Total horizontal force	15699.87		

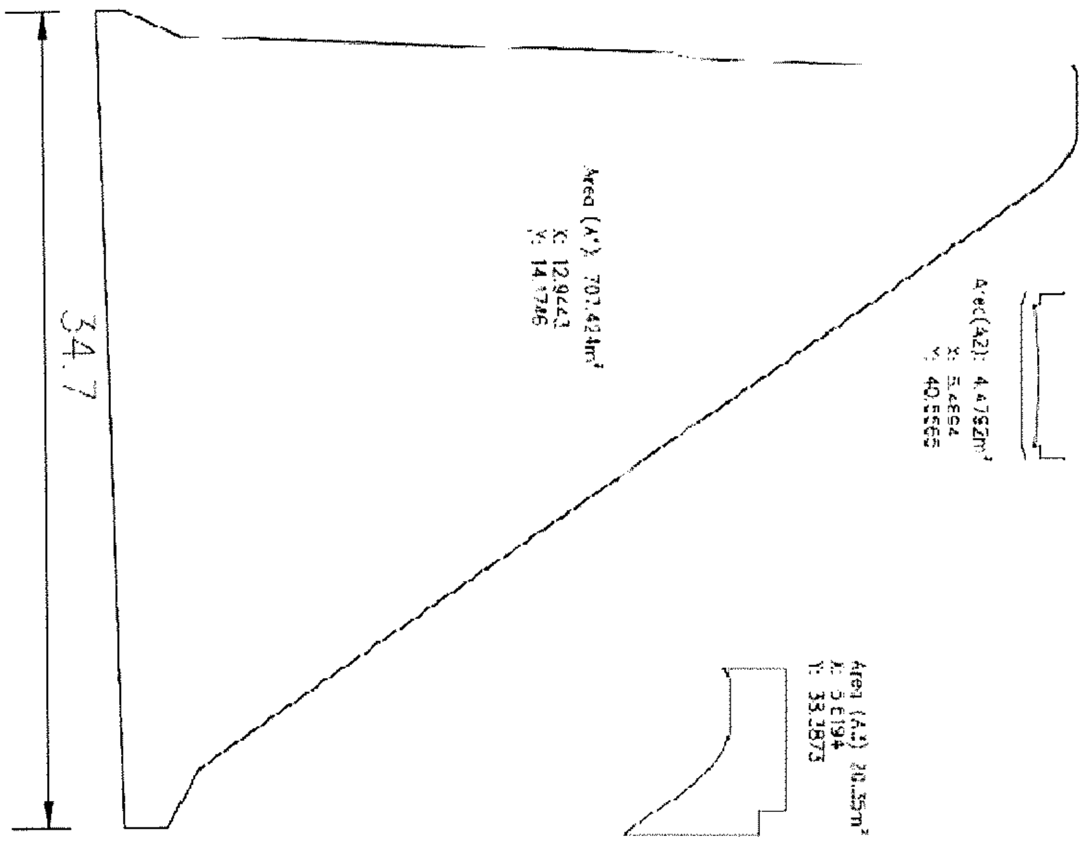
F=(((25085.26-10071.68)*0.84)/1)+((*100*34.7*15)/1.2)))/15699.867 = 3.57

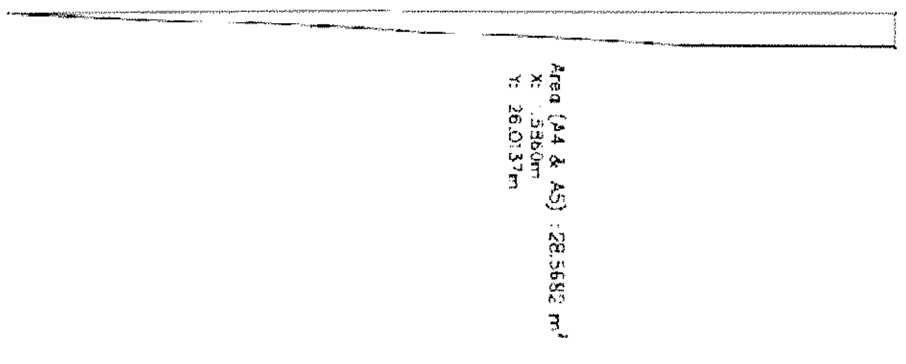
Summary of results

Load Combination	Stress U/s	Stress D/s	Factor of Safety	Permissible Tensile Stress
A	87.80	11.14		
B	26.70	56.95	2.45	
C	17.79	63.99	2.19	15.00
D	104.05	-9.31	14.00	
E	-7.71	87.16	2.30	30.00
F	-2.80	62.04	4.67	30.00
G	-27.59	85.28	3.57	60.00

Conclusion:

(1). Factor of safety against sliding is more than 1.0 in each case.


34.7
Area (A1): 707.424m²
X: 12.9443
Y: 14.1746
Area(A2): 4.4752m²
X: 5.4664
Y: 40.5565
Area (A3): 20.35m²
X: 5.6194
Y: 33.3873


Area (A4 & A5) :28.5682 m²
X: .5360m
Y: 26.0137m

(Part-B) Stability Analysis of Non-Overflow blocks after dismantling up to EL. 2543.00m

MALANA HYDRO-ELECTRIC PROJECT

Stability Analysis of Gravity dam (NOF Section):

The stability analysis of Non-overflow concrete dam has been carried out as procedure given in **IS 6512 -1984** and **IS 1893-1984**.

Basic data:

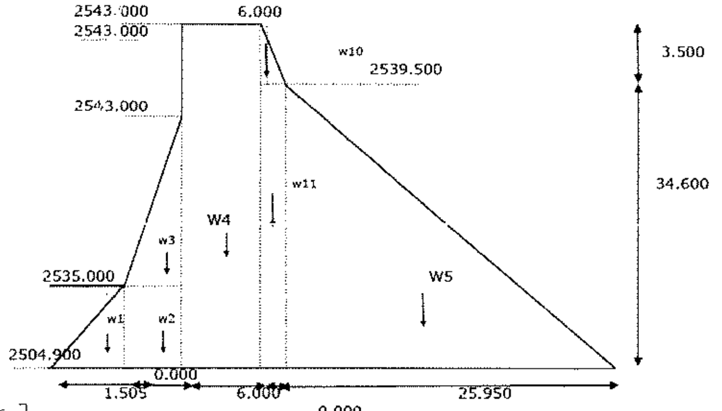
Top of the dam Level			2543.000 m
Maximum water level			2543.000 m
Full reservoir level			2543.000 m
Maximum Tail water level			2504.900 m
Minimum tail water level			2504.900 m
Elevation where the stability is checked			2504.900 m
Total Height of the dam (h)			38.100 m
Head at MWL			38.100 m
Head at FRL			38.100 m
Top width			6.000 m
D/S slope	From	To	
(i) First Slope	2543.000	2539.500	0.000
(ii) Second Slope	2539.500	2504.900	0.750
U/S slope	From	To	
(i) First Slope	2543.000	2535.000	0.000
(ii) Second Slope	2535.000	2504.900	0.050
Base width of dam (B)			33.455 m
Tail water depth for MWL			0.000 m
Tail water depth for FRL			0.000 m
Compressive strength of concrete fc			1500.000 t/sq.m
Design horizontal seismic coefficient			0.180 g
Design vertical seismic coefficient			0.120 g
Unit weight of concrete			2.400 t/cu.m
Unit weight of water (w)			1.000 t/cu.m
Max. Silt level			2504.900 m
Vertical density of silt			1.963 t/cu.m
Horizontal density of silt			1.360 t/cu.m
Foundation Level			2504.900 m

Load combination A:

Reservoir empty

(1).Self Weight of the dam:

	Wt/force		Lever Arms	Moments
W1=0.5*30.1*1.51*2.4	54.36 t/m	↓	1.003	54.54
W2 = 0*30* 2.4	0.00 t/m	↓	1.505	0.00
W3 = 0.5*0*8*2.4	0.00 t/m	↓	1.505	0.00
W4 =6*38.1*2.4	548.64 t/m	↓	4.505	2471.62
W10 = 0.5*0*3.5*2.4	0.00	↓	7.505	0.00
W11 =0*34.6*2.4	0.00	↓	7.505	0.00
W5 = 0.5*25.95*34.6*2.4	1077.44 t/m	↓	16.155	17406.11
Total (W) =	**1680.45 t/m**	↓		**19932.27**



$$p_{\max/\min.} = \frac{\Sigma V}{B}\left[1 \pm \frac{6e}{B}\right]$$

Where,
e= Eccentricity of the resultant force from the center of the base.
ΣV = Total vertical force.
B = Base width.

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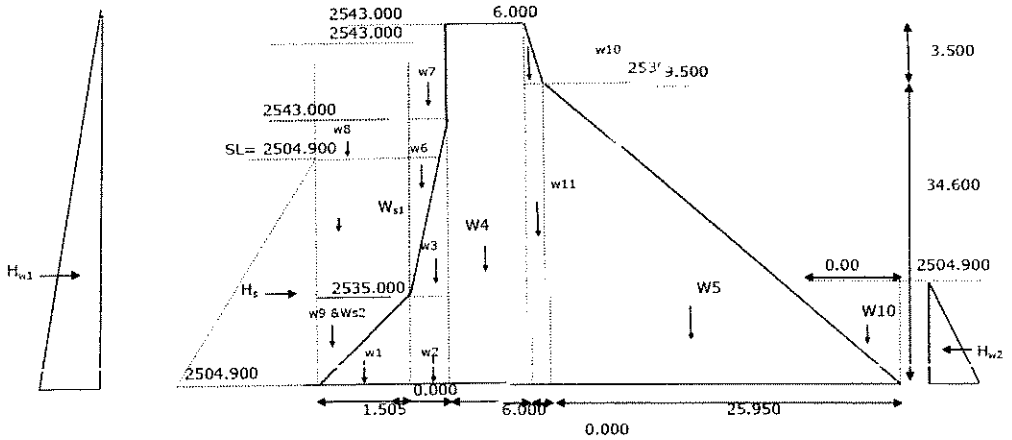
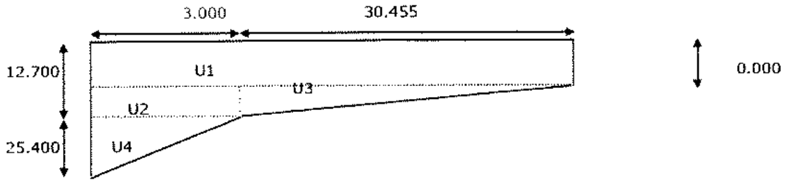
x¯ = 19932.27/1680.45		11.861 m
e= (33/2)-11.861		4.866 m
6e/B =	0.873	
Stress at u/s= (W/B)*(1+(6e/B)) =	(1680.45/33.45)*(1+ 0.873)	**94.08** t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) =	(1680.45/33.45)*(1- 0.873)	**6.38** t/sq.m

Load combination B:

Reservoir at FRL, normal uplift, without earthquake, Min TWL, Silt



	Wt/force		Lever arm		Moments
(1). Self Weight(Same as above for "A"	1680.45 t/m	↓			19932.27
(2). Weight of water:					
(a). Water at FRL					
W6 = 0.5*0*8*1	0.00 t/m	↓	1.505		0.00
W7 =0*0*1	0.00 t/m	↓	1.505		0.00
W8 = 1.505*8*1	12.04 t/m	↓	0.752		9.06
W9 = 0.5*1.505*30*1	22.65 t/m	↓	0.502		11.36
(B). Water at Min. TWL					
W10 = 0.5*0*0*1	0.00 t/m	↓	33.455		0.00
Total weight =	34.69 t/m	↓		Total =	20.42
(3). Water pressure:					
Hw1 = 0.5*38*38*1	725.805 t/m	→	12.700		9217.72
Hw2 = 0.5*0*0*1	0.000 t/m	←	0.000		0.00
Net pressure =	725.805 t/m	→			9217.72
(4). Silt pressure					
Hs = 0.5*0*0*1.36	0.000 t/m	→	0.000		0.00
(5). Silt weight					
Ws1 = (0.5*(1.505+1.505))*-	0.000 t/m	↓	0.752		0.00
Ws2 =	0.000 t/m	↓	0.502		0.00
Total =	**0.000**				**0.00**
(6). Uplift pressure (Normal):					
U1 = 0*33.455*1	0.000 t/m	↑	16.728		0.00
U2 = 3*12.7*1	38.100 t/m	↑	1.500		57.15
U3 = 0.5*30.455*12.7*1	193.389 t/m	↑	13.152		2543.39
U4 = 0.5*3*25.4*1	38.100 t/m	↑	1.000		38.10
Total uplift pressure =	**269.589 t/m**	↑			**2638.64**



Net vertical force = 1680.45+34.69+0+0-269.59 =		**1445.55** t/m ↓
Net moments = 19932.27+20.42+9217.72+0+0+0-2638.64=		**26531.78**
x¯ = 26531.778/ 1445.546		18.354 m
e= 16.7275-18.354		-1.627 m
6e/B =	-0.292	
Stress at u/s= (W/B)*(1+(6e/B)) =	1445.546/33.45*(1-0.292)	30.592 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) =	1445.546/33.45*(1+0.292)	55.826 t/sq.m

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Factor of safety againgt sliding:

$$F=\left(\frac{(w-u)\tan\phi}{F\phi}+\frac{CA}{Fc}\right)\div P$$

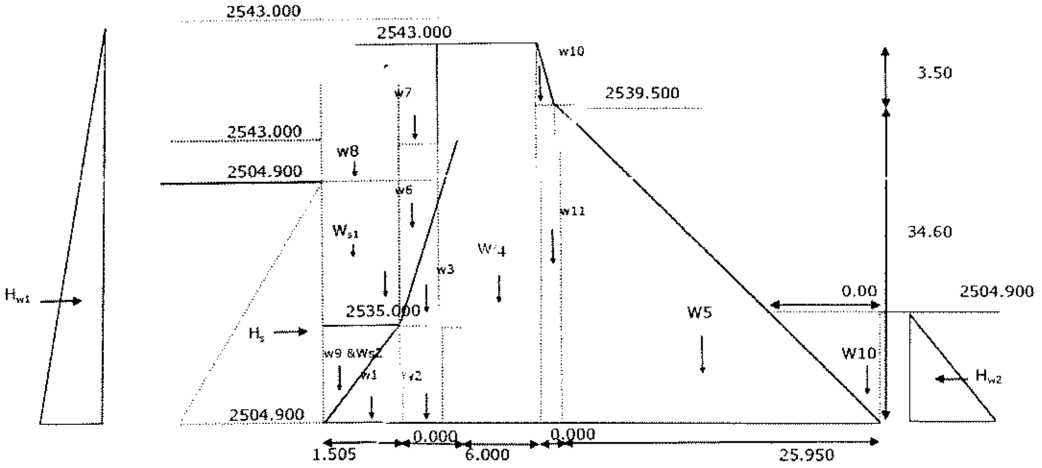
F= factor of safety against sliding		
w= Total mass of the dam + water + Silt =		1715.14 t/m
u= Total uplift force =		269.59 t/m
tan ø = Coefficient of internal friction of the material	ø=40	0.84
C= Cohesion at contact between rock and concrete		100.00 t/sq.m
A= area under consideration for cohesion		33.45
Fø= partial factor of safety in respect of friction		1.50
Fc= partial factor of safety in respect of cohesion		3.60
P= Total horizontal force		725.80

For load combination B,take Fø =1.5 and Fc = 3.6

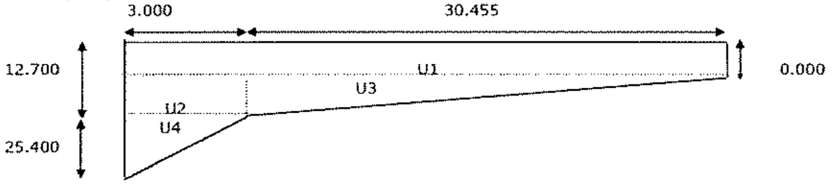
So, factor of safety = 2.39

Load combination C:

Reservoir at MWL, normal uplift, without eathquake, Max. TWL, Silt



(1). Self Weight	1680.445 t/m ↓		19932.27
(2). Weight of water:			
(a). Water at MWL			
W6 = 0.5*0*8*1	0.000 t/m ↓	1.505	0.00
W7 =0*0*1	0.000 t/m ↓	1.505	0.00
W8 = 1.505*8*1	12.040 t/m ↓	0.752	9.06
W9 = 0.5*1.505*30.1*1	22.650 t/m ↓	0.502	11.36
(B). Water at Max. TWL			
W10 = 0.5*0*0*1	0.000 t/m ↓	33.455	0.00
Total weight =	**34.690 t/m** ↓		**20.42**
(3). Water pressure:			
Hw1 = 0.5*38.0999999999999*38.099999	725.805 t/m →	12.700	9217.72
Pressure above FRL	0.000	38.100	0.00
Hw2 = 0.5*0*0*1	0.000 t/m ←	0.000	0.00
Net pressure =	**725.805 t/m** →		**9217.72**
(4). Silt pressure	0.000 →		0.00
(5). Silt weight	0.000 ↓		0.00
(6). Uplift pressure (Normal):			
U1 = 33*0*1	0.000 t/m ↑	16.728	0.00
U2 = 3*12.7*1	38.100 t/m ↑	1.500	57.15
U3 = 0.5*30*12.7*1	193.389 t/m ↑	13.152	2543.39
U4 = 0.5*3*25.4*1	38.100 t/m ↑	1.000	38.10
Total uplift pressure =	**269.589 t/m** ↑		**2638.64**



Net vertical force =1680.45+34.69+0-269.59= **1445.55** t/m ↓
Net moments =19932.27+20.42+9217.72+0+0-2638.64 = **26531.78**

x̄ = 26531.778/1445.546 18.354 m
e= 16.7275-18.354 -1.627 m
6e/B = -0.292

Stress at u/s= (W/B)*(1+(6e/B)) = 1445.546/33.45*(1-0.292) 30.592 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) = 1445.546/33.45*(1+0.292) 55.826 t/sq.m
For load combination C, take Fø = 1.5 and Fc = 3.6
FOS = 2.39

Load combination D:
(Combination A, with earthquake)

Wt/force
(1). Self weight 1680.445 t/m ↓ **Moments =** 19932.27

(2). Horizontal earthquake Force: $=0.6 \times w \times \alpha_h$
Where, w = weight of the element (t/m)

H1 = 0.6*54.36*0.18 5.871 t/m ←
H2 = 0.6*0*0.18 0.000 t/m ←
H3 = 0.6*0*0.18 0.000 t/m ←
H4 = 0.6*548.639999999999*0.18 59.253 t/m ←
H5 = 0.6*1077.444*0.18 116.364 t/m ←
Total force = 181.488 t/m ←

Moments $= 0.9 \times w \times h \times \alpha_h$
Mb1 = 0.9*54.36*10.033*0.18 88.358 t-m/m
Mb2 = 0.9*0*15.05*0.18 0.000 t-m/m
Mb3 = 0.9*0*32.767*0.18 0.000 t-m/m
Mb4 = 0.9*548.639999999999*19.05*0.18 1693.158 t-m/m
Mb5 = 0.9*1077.444*11.533*0.18 2013.096 t-m/m
Total = 3794.612 t-m/m

(3). Vertical earhquake:
The Design vertical seismic coefficient has been considered 2/3 of Design horizondal seismic coefficient as suggested by Department of Earthquake Engineering, IIT Roorkee.

V1 = W*C'
= 54.36*0.032 1.740 t
Lever arm= 2/3*1.505 1.003 m Moment= 1.75

V2 = W*C'
= 0*0.032 0.000 t
Lever arm= 1.505+1/2*0 1.505 m Moment= 0.00

V3 = W*C'
= 0*0.036 0.000 t
Lever arm= 1.505+2/3*0 1.505 m Moment= 0.00

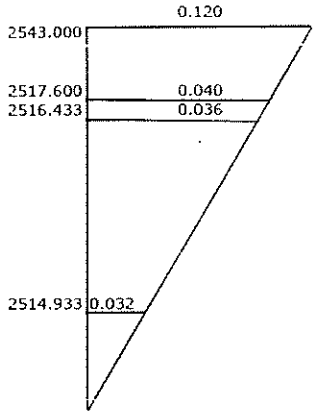
V4 = W*C'
= 548.639999999999*0.12 65.837 t
Lever arm= 1.505+0+3 4.505 m Moment= 296.59

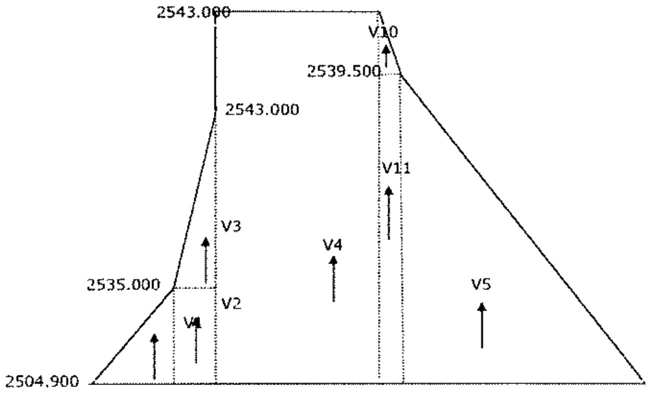
V10 = W*C'
= 0*0.12 0.000 t
Lever arm= 1.505+0+6+0 7.505 m Moment= 0.00

V11 = W*C'
= 0*0.12 0.000 t
Lever arm= 1.505+0+6+0 7.505 m Moment= 0.00

V5 = W*C'
= 1077.444*0.04 43.098 t
Lever arm= 1.505+0+6+8.65 16.155 m Moment= 696.24

Total = 110.674 994.58





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Net vertical force	= 1680.445-110.674 =	1569.771 t/m ↓
Net moments	= 19932.273-3794.612-994.584 =	15143.076
x¯ =	15143.076/1569.771	9.647 m
e=	16.7275-9.647	7.081 m
6e/B =	1.270	
Stress at u/s= (W/B)*(1+(6e/B)) =	1569.771/33.45*(1+1.27)	106.513 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) =	1569.771/33.45*(1-1.27)	-12.669 t/sq.m

For load combination D, take Fø = 1.2 and Fc = 2.4

FOS = 13.73

Load Combination E:

Combination B, with earthquake

	Wt/force		Moments
(1). Self weight	1680.445 t/m	↓	19932.27 t-m/m
(2). Weight of water	34.690 t/m	↓	20.42 t-m/m
(3). Water pressure	725.805 t/m	→	9217.72 t-m/m
(4). Silt weight	0.000 t/m	↓	0.00 t-m/m
(5). Silt pressure	0.000 t/m	→	0.00 t-m/m
(6). Uplift force	269.589 t/m	↑	2638.64 t-m/m
		Total =	**26531.778** t-m/m

(7). Hydrodynamic pressure

p_e = Cs*a_h*w*h

$$C_s = \frac{C_m}{2}\left\{\left\{\frac{y}{h}\left(2-\frac{y}{h}\right)+\sqrt{\frac{y}{h}\left(2-\frac{y}{h}\right)}\right\}\right\}$$

C_m = **0.715** As per IS 1893-1984 the max. value of C_m has been taken.

y = 38.100 = Depth below FRL

h = 38.100 = Depth of Reservoir

Cs = 0.715

p_e = 0.715*0.18*1000*38= 4903.470 Kg/m^2

V_h = 0.726*pe*h = 0.726 *4903.47*38= 135632.922 Kg/m

= **135.633** t/m →

Moment= 0.299*pe*H*H= 0.299 *4903.47*38.1^2= 2128259.900 Kg-m/m

= **2128.260** t-m/m

(8). Horizontal earthquake	181.488 t/m	→	3794.612
(9). Vertical earthquake	110.674 t/m	↑	994.584

Net vertical force = 1680.445+34.69+0-269.589-110.674= **1334.872** t/m ↓

Net moments =26531.778+2128.26+3794.612-994.584= **31460.066** t-m/m

x¯ =	31460.066/1334.872	23.568 m
e=	16.7275-23.568	-6.841 m
6e/B =	-1.227	
Stress at u/s= (W/B)*(1+(6e/B)) =	1334.872/33.45*(1-1.227)	-9.057 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) =	1334.872/33.45*(1-1.227)	88.858 t/sq.m

For load combination E, take Fø = 1.2 and Fc = 2.4

FOS = 2.23

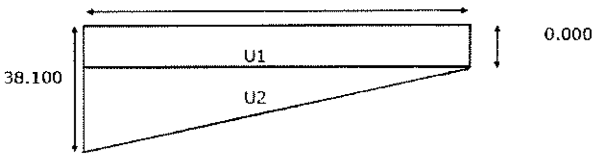
Load combination F:

Combination C, but Drains choked

	Wt/force		Moments
(1). Self weight	1680.445 t/m	↓	19932.27 t-m/m
(2). Weight of water:	34.690 t/m	↓	20.42 t-m/m
(3). Water pressure:	725.805 t/m	→	9217.72 t-m/m
(4). Silt weight	0.000 t/m	↓	0.00 t-m/m
(5). Silt pressure	0.000 t/m	→	0.00 t-m/m
		Total =	**29170.42** t-m/m

(6).Uplift pressure:

			Lever Arms	
U1 = 0*33.45*1	0.000 t/m	↑	16.728	0.00 t-m/m
U2 = 0.5*33.45*38.1*1	637.318 t/m	↑	11.152	7107.16 t-m/m
Total pressure =	**637.318 t/m**	↑		**7107.16** t-m/m



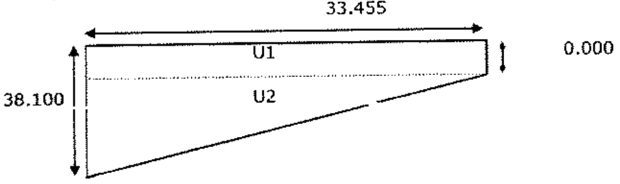
Net vertical force =1680.445+34.69+0-637.318= 1077.818 t/m
Net moments =29170.419-7107.155= 22063.264

x¯ = 22063.264/1077.818 20.470 m
e= 16.7275-20.47 -3.743 m
6e/B = -0.671
Stress at u/s= (W/B)*(1+(6e/B)) = 1077.818/33.45*(1-0.671) 10.599 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) = 1077.818/33.45*(1+0.671) 53.834 t/sq.m
For load combination f, take Fø = 1.0 and Fc = 1.2
FOS = 5.09

Load combination G:
Combination E, but Drains choked

	Wt/force		Moments	
(1). Self weight	1680.445 t/m	↓	19932.273	t-m/m
(2). Weight of water	34.690 t/m	↓	20.423	t-m/m
(3). Water pressure	725.805 t/m	→	9217.723	t-m/m
(4). Silt weight	0.000 t/m	↓	0.000	t-m/m
(5). Silt pressure	0.000 t/m	→	0.000	t-m/m
(6). Uplift force			**Total = 29170.419**	t-m/m

			Lever arm	Moment
U1 = 33.45*0*1	0.000 t/m	↑	16.728	0.00 t-m/r
U1 = 0.5*33.45*38.1*1	637.318 t/m	↑	11.152	7107.16 t-m/r
Total pressure =	637.318 t/m	↑		7107.16 t-m/r



(7). Hydrodynamic pressure	135.633 t/m	→	2128.26 t-m/r
(8). Horizontal earthquake	181.488 t/m	→	3794.61 t-m/r
(9). Vertical earthquake	110.674 t/m	↑	994.58 t-m/r

Net vertical force =1680.445+34.69+0-637.318-110.674= 967.143 t/m
Net moments =29170.419-7107.155+2128.26+3794.612-994.584= 26991.552 t-m/r
x¯ = 26991.552/967.143 27.909 m
e= 16.7275-27.909 -11.182 m
6e/B = -2.005

Stress at u/s= (W/B)*(1+(6e/B)) = 967.143/33.45*(1-2.005) -29.053 t/sq.m
Stress at d/s= (W/B)*(1-(6e/B)) = 967.143/33.45*(1+2.005) 86.871 t/sq.m

For load combination G, take Fø = 1.0 and Fc = 1.2
FOS = 3.45

Summary of results

Load combination	Stress U/s (t/m^2)	Stress D/s (t/m^2)	Factor of safety	Permissible Tensile Stress (t/m^2)
A	94.08	6.38		
B	30.59	55.83	2.39	
C	30.59	55.83	2.39	15.00
D	106.51	-12.67	13.73	
E	-9.06	88.86	2.23	30.00
F	10.60	53.83	5.09	30.00
G	-29.05	86.87	3.45	60.00

Conclusion:
(1). Factor of safety against sliding is more than one in each case.

ANNEXURE - "4A"

Hydraulic Design of Surface Spillway

As mentioned above in **Para No. 4.2** of this report, it is proposed that the existing dam NOF blocks on the right bank may be used by converting these non-overflow blocks nos. 6, 7, 8 and 9 into overflow (un-gated surface) blocks by keeping the spillway crest level EL. 2543.00m which is 2.00m below the existing dam crest EL. 2545.00m. In case both the existing under sluice gates do not work in that situation the flood water during the high flood will safely pass through these proposed un-gated surface spillway.

The maximum available length of NOF blocks on the right flake at dam crest has been utilized and converted into un-gated overflow dam so that maximum discharge can be safely discharged through these NOF dam blocks in the eventuality the sluice gates do not work during floods. Therefore, seven bays of **6.25m wide** have been proposed/ modified in existing **NOF block Nos. 6, 7, 8 and 9m.** The overall water way proposed shall be **43.75m** (maximum available length at dam crest) with the **spillway crest El.2543.00m** and the maximum water level in the reservoir is considered as **El.2545.00m.** It is revealed from the calculation that the discharging capacity of the newly proposed un-gated surface spillway shall be around **239.51m³/sec** and the computations are appended as **Annexure-"2"**. However, the maximum observed flood during monsoon period in the river is below **100m³/sec.**

The hydraulic design computations of the proposed un-gated surface spillway are as under considering the following parameters of the dam:-

Top Level of dam	EL 2545.00m
MWL	EL 2545.00m
Top width of the dam	6.00 m
River bed	EL 2498.00m
Nos. of bays	7Nos.
Width of each bay	7 nos. of 6.25m
Spillway Crest level	2543.00m
Discharging capacity	239.51m³/sec.

The Downstream Quadrant Profile shall conform to the following equation as per CWC **"Manual on Hydraulic Design of Overflow Spillway Crest"**:-

1. Downstream Quadrant Profile:

$$X_2^{1.85} = K_2 \times H_d^{0.85} \times Y_2$$

Where,

X_2 = Co-ordinate of the profile

K_2 = Variable Parameter = 2.00

H_d = Design Head (85% of total head = 0.85 x 2.00 = 1.70 m)

Y_2 = Co-ordinate of the profile

$X_2^{1.85} = 2.00 \times 1.70^{0.85} \times Y_2$, Or, $Y_2 = X_2^{1.85} / 3.14$

The Downstream Quadrant Profile is followed by a slope of 1 in 0.75. By differentiating the above equation and equating it with the slope of 1 in 0.75, the transition point (T.P) is obtained.

On differentiating the above equation:

d_y / d_x $= 1.00 / 0.75$ Or, $1.00 / 0.75 = (1.85 \times X_2^{0.85}) / 3.14$

$X_2^{0.85} = (3.14 \times 1.33) / 1.85$

Or, $X_2 = 2.60$m

Or, $Y_2 = X_2^{1.85} / 3.14 = 2.60^{1.85} / 3.14 = 1.87$

Substituting the values of K_2 and H_d in the downstream quadrant equation, the ordinates of the profile is given below:

Sl. No.	X_2	Y_2
1	0	0.00
2	0.15	0.01
3	0.3	0.03
4	0.45	0.07
5	0.6	0.12
6	0.75	0.19
7	0.9	0.26
8	1.05	0.35
9	1.2	0.45
10	1.35	0.55
11	1.4	0.59
12	1.55	0.72
13	1.6	0.76
14	1.75	0.90
15	1.9	1.04
16	2.15	1.31
17	2.2	1.37
18	2.30	1.49
19	2.40	1.61
20	2.50	1.73
21	2.60	1.87

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2. Upstream Quadrant Profile:

The upstream Quadrant Profile shall conform to the following equation:-

$$\frac{X_1^2}{A_1^2}+\frac{Y_1^2}{B_1^2}=1$$

Where,

X_1 = Co-ordinate of the profile

Y_1 = Co-ordinate of the profile

A_1 = Horizontal dimension defining upstream quadrant of the crest

B_1 = Vertical dimension defining upstream quadrant of the crest

$A_1 / H_d = 0.28$

$A_1 = 0.28 \times 1.70 = 0.476$, say **0.48**

$B_1 / H_d = 0.163$ or, $B_1 = 0.163 \times 1.70 = 0.277$, say **0.28**

On putting the value of A_1 and B_1

$(X_1^2 / 0.48^2) + (Y_1^2 / 0.28^2) = 1.00$

$(X_1^2 / 0.23) + (Y_1^2 / 0.08) = 1.00$

When $X_1 = 0.00$,

$Y_1^2 / 0.08 = 1.00$ Or, $Y_1^2 = 0.08$ Or, $Y_1 = 0.28$

And when $Y_1 = 0.00$, $X_1^2 / 0.28 = 1.00$ or, $X_1^2 = 0.28$ or, $X_1 = 0.53$

By substituting the values of A_1 and B_1, the ordinate of the upstream profile of the spillway is given below:

Sl. No.	X_1	Y_1
1	0	0.28
2	0.1	0.28
3	0.15	0.27
4	0.2	0.26
5	0.25	0.25
6	0.3	0.23
7	0.35	0.21
8	0.4	0.19
9	0.45	0.15
10	0.5	0.09
11	0.51	0.08
12	0.53	0.00

3. Upper Nappe Profile:

- Water head of proposed un-gated spillway (H_e) = 2.00m
- Design head of proposed un-gated spillway (H_d) = 1.70m

Therefore the ratio of H_e/ H_d = 2.00/ 1.70 = 1.177. The coordinates of the upper nappe profile along the piers and Centre line of the bay has been calculated below as per Chart No.-8 and 9 of **"CWC's Manual on hydraulic design of Overflow spillway crest"** by interpolation of H_e/ H_d as 1.177 and the X and Y ordinates have been calculated as below:

Coordinates of Upper Nappe along Centre Line of Bay:

Sl. No.	H_e/H_d = 1.00		H_e/H_d = 1.33		H_e/H_d = 1.177	X	Y
	X/H_d	Y/H_d	X/H_d	Y/H_d	Y/H_d		
1	-1.0	-0.941	-1.0	-1.230	-1.096	-1.7	-1.860
2	-0.8	-0.932	-0.8	-1.215	-1.083	-1.4	-1.840
3	-0.6	-0.913	-0.6	-1.194	-1.063	-1.0	-1.810
4	-0.4	-0.890	-0.4	-1.165	-1.037	-0.7	-1.760
5	-0.2	-0.855	-0.2	-1.122	-0.998	-0.3	-1.700
6	0.0	-0.805	0.0	-1.071	-0.947	0.0	-1.610
7	0.2	-0.735	0.2	-1.015	-0.885	0.3	-1.500
8	0.4	-0.647	0.4	-0.944	-0.806	0.7	-1.370
9	0.6	-0.539	0.6	-0.847	-0.704	1.0	-1.200
10	0.8	-0.389	0.8	-0.725	-0.569	1.4	-0.970
11	1.0	-0.202	1.0	-0.564	-0.396	1.7	-0.670
12	1.2	0.015	1.2	-0.356	-0.183	2.0	-0.310
13	1.4	0.266	1.4	-0.102	0.069	2.4	0.120
14	1.5	0.521	1.6	0.172	0.334	2.610	0.570

Coordinates of Upper Nappe along Piers:

Sl. No.	H_e/H_d = 1.00		H_e/H_d = 1.33		H_e/H_d = 1.177	X	Y
	X/H_d	Y/H_d	X/H_d	Y/H_d	Y/H_d		
1	-1.0	-0.950	-1.0	-1.235	-1.102	-1.7	-1.874
2	-0.8	-0.940	-0.8	-1.221	-1.090	-1.4	-1.853
3	-0.6	-0.929	-0.6	-1.209	-1.079	-1.0	-1.834
4	-0.4	-0.930	-0.4	-1.218	-1.084	-0.7	-1.843
5	-0.2	-0.925	-0.2	-1.244	-1.096	-0.3	-1.863
6	0.0	-0.779	0.0	-1.101	-0.951	0.0	-1.617
7	0.2	-0.651	0.2	-0.950	-0.811	0.3	-1.379
8	0.4	-0.545	0.4	-0.821	-0.693	0.7	-1.177

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9	0.6	-0.425	0.6	-0.689	-0.566	1.0	-0.963
10	0.8	-0.285	0.8	-0.549	-0.426	1.4	-0.725
11	1.0	-0.121	1.0	-0.389	-0.264	1.7	-0.449
12	1.2	0.067	1.2	-0.215	-0.084	2.0	-0.142
13	1.4	0.286	1.4	-0.011	0.127	2.4	0.216
14	1.535	0.321	1.6	0.208	0.261	2.610	0.443

ENERGY DISSIPATION ARRANGEMENT – FLIP BUCKET ALTERNATIVE

The water spilling over from the proposed un-gated surface spillway shall be consisting lot of energy as it will fall from substantial height. Therefore, the energy dissipation arrangement at the toe of the spillway is necessary to minimize erosion of foundation on the downstream of spillway structure. The flip bucket with plunge pool has been proposed as energy dissipation arrangement. Finally the water spilled over from the proposed un-gated surface spillway will be discharged through the channel in the main Malana River as shown in the drawings.

Fixation of Bucket Invert:

The lip level of the bucket has been kept above the maximum Tail Water Level (i.e., El. 2489.20 m) corresponding to 325.00cumecs. The invert elevation of bucket is proposed at El. 2512.61m. As per **IS: 7365-1985**, the exit angle / lip angle shall be varied from 30° to 40°. The lip angle of 36° has been proposed so that the water from the trajectory falls in the main river.

Bucket Radius:

As per **IS: 7365-1985** the radius of bucket can be calculated from the following equation:

(0.6 to 0.8) $\sqrt{\mathbf{HxH5}}$**.** (The value of this constant is considered as 0.8 in design)

where,

H = Depth of flow over Surface spillway crest (El. 2545.00 – El. 2543.00 = 2.00 m)

$\mathbf{H_5}$ = Reservoir Pool Level - Jet Surface Level on Bucket

$\mathbf{H_5}$ = 2545.00-2512.61 = 32.39m

Considering the bucket invert elevation of El. 2512.61m, the water surface elevation at the bucket invert is determined by applying the principle conservation of energy (Bernoulli's Equation) and equating the energy at the crest of surface (un-gated) spillway and bucket invert;

$$Z_a + d_a + \frac{V_a^2}{2g} = Z_b + d_b + \frac{V_b^2}{2g}$$

where,

$\mathbf{Z_a}$ = Datum level at crest of spillway

$\mathbf{d_a}$ = depth of water at crest

V_a = Approach velocity at crest (considered as negligible)

Z_b = Datum level at bucket invert

d_b = depth of water at bucket invert

V_b = Velocity at bucket invert

$2543.00 + (2545.00-2543.00) + 0 = 2512.61 + d_b + V_b^2/2g$

The discharge through spillway is 239.51cumecs. The width of waterway of surface (un-gated) spillway at the bucket invert is 22.00m and the velocity at bucket invert (V_b) = 239.51/(22.00 X d_b). By substituting this in the above equation:

$2543.00 + (2545.00-2543.00) + 0 = 2512.61 + d_b + (239.51/(22.00 \times d_b)^2/(2 \times 9.81)$

$d_b^3 - 32.39\, d_b^2 + 6.04 = 0$

Solving the above equation we get, **d_b = 0.435 m.**

And v= 239.51/(22.00 X 0.435) = 25.04m/sec

Jet surface level at the bucket invert is determined by adding the depth of water with bucket invert elevation. i.e., El. 2512.61 + 0.435 = El. 2513.045m. Therefore, H_5 = El. 2545.00 – El. 2513.045 = 31.96m.

The radius of the bucket is calculated by the following expression:

$R = 0.8 \sqrt{HxH5}$.

R = 0.8 x **SQRT** (2.00 x 31.96) = 6.40m

Lip elevation of bucket is worked out using the following equation:

$$\text{Lip Elevation} = \text{Bucket Invert} + \{R - [\text{R} \times \sin(90 - \theta)]\}$$

$= 2512.61 + (6.40 - (6.40 \times \sin(90 - 36^\circ)$

= 2512.61 + 1.22

= 2513.83m

The lip level of El. 2513.83 m is worked out, which is higher than the maximum TWL of El. 2489.20m corresponding to the check flood of 325.00cumecs.

Computations for Trajectory Length:

Considering the bucket parameters fixed as above, the trajectory length of jet has been calculated for design discharge of 239.51cumecs discharging from FRL. As per **IS: 7365-1985**, the trajectory length is calculated using the following expression:

$$\frac{X}{H_v} = \sin 2\phi + 2\cos\phi\sqrt{\sin^2\phi + \frac{Y}{H_v}}$$

where,

X = Horizontal throw distance from bucket lip to centre point of impact with tail water (m)

H_v = Velocity Head at the Lip of Bucket (m)

= Bucket Lip angle with Horizontal in degrees (36°)

y = Difference between Lip level and Tail Water level, sign taken as +ve for TWL below Lip.

To calculate the velocity head at the bucket lip, applying the principle of conservation of energy (Bernoulli's Equation) and equating the energy at crest (El. 2543.00m) and bucket lip (El. 2513.83m):

Considering approach velocity as zero the equation is as under:

$2543.00 + (2545.00-2543.00) + 0 = 2513.83 + d_b + V_b^2/2g$

Where

d_b = depth of water at bucket invert

V_b = Velocity at bucket invert

The discharge through un-gated surface spillway is 239.51cumecs. The width of waterway of un-gated surface spillway at the bucket invert is 22.00 m and the velocity at bucket invert (V_b) is 239.51/ (22.00 x d_b). By substituting this in the above equation;

$2543.00 + (2545.00-2543.00) + 0 = 2513.83 + d_b + (239.51/(22.00 \times d_b)^2/(2 \times 9.81)$

$d_b^3 - 31.17\ d_b^2 + 6.04 = 0$

Solving the above equation we get, **d_b = 0.443m**.

Hence, velocity of at the bucket lip (V_b) is 239.51/(22.00 x 0.443) = 24.55m/s. Therefore velocity head (H_v) at bucket lip = $V_b^2/(2 \times 9.81)$ = $24.55^2/(2 \times 9.81)$ = 30.73m.

The difference between lip level and tail water level **y** = El. 2513.83 – El. 2489.20 = 24.63m

The trajectory length is calculated by following expression:

$$\frac{X}{H_v} = sin2\phi + 2cos\phi\sqrt{sin^2\phi + \frac{Y}{H_v}}$$

X/30.73 = sin (2 x 36) + 2 cos (36) SQRT [($\sin^2 36$ + (24.63/30.73)]

X = 82.4769 m. **Say 83.00 m**

<u>Scour Depth and Plunge Pool Invert:</u>

The entire discharging capacity of un-gated surface spillway is considered as design discharge for scour depth calculations. As per **IS: 7365-1985**, scour depth is calculated using the following equation:

$$d_s = m(qH_4)^{0.5}$$

where,

d_s = Scour depth

m = Constant (value 0.36 corresponding to minimum expected scour is considered)

q = Discharge intensity (239.51/ 22.00 = 10.88cumecs)

H_4 = Reservoir pool elevation - Lip Level (El. 2545.00 – El. 2513.83 = 31.17m)

Substituting these values in the above equation the scour depth is calculated as;

$d_s = 0.36 \times (10.89\times 31.17)^{0.5} = 6.63m$

The Tail Water Level corresponding to PMF (650.00Cumecs) shall be El. 2490.80m.

Hence, the plunge pool invert elevation = TWL - d_s = 2490.80 – 6.63 = **El. 2482.57m which is almost ≤ to the river bed. Hence no excavation for plunge pool shall be necessary.**

ENERGY DISSIPATION ARRANGEMENT – STILLING BASIN ALTERNATIVE

The physical model study of Spillway considering the above arrangement was carried out by **Indian Institute of Technology (IIT), Roorkee** with reference to discharging capacity of the proposed surface spillway, energy dissipation and cavitation etc. It was also revealed from the above model that the discharging capacity of the additional un-gated surface spillway is in order. The spillway profile of the proposed un-gated surface spillway was found in order from cavitation considerations. However, the flow onwards to the toe of the un-gated surface spillway was chaotic and full of strong cross- currents. The flip bucket was also not performing well due to rise in depth of flow and mixed directional flow as a results of cross-currents upstream of the bucket.

It was difficult to control the cross currents/ waves due to formation of multiples cross currents in the presence of various concave and convex boundaries in the form of side walls and training walls. Therefore, it was decided to replace the flip bucket arrangement with hydraulic jump type stilling basin by pooling the water with provision of a submerged broad crested weir of height 3.5 m along with steps downstream of the weir. Such arrangement controlled the cross-currents. However, still a strong cross current from the toe of dam block no.6 at the left end wall was impinging the pooled water. It was decided to shift the left side wall at the toe of the dam glacis by 3.0 m towards left side to minimize the formation of the cross-currents. The suggested changes in the un-gated surface spillway were incorporated in the model. Suggested changes comprise replacement of flip bucket by 3.5 m high broad crested weir with pool with steps cascade downstream of the weir. Each step is having 5 m width and of 1 m drop and at the end of the first two steps, an end sill of height 0.5 m is provided. Left side wall was shifted by 3 m further left side near the dam toe. The width of the channel was kept 22 m in the place of earlier 21 m at the broad crested weir.

Flow pattern in the stilling basin and over the submerged weir was observed during the run. Due to pooled water in the stilling basin with the provision of submerged weir, relatively drown hydraulic jump was forming. The cross-currents were merging into the pooled water and losing their high kinetic energy. Flow in the stilling basin was highly turbulence with large size rollers which leaded to energy dissipation in the stilling basin.

Flow over the submerged weir was almost uniformly distributed across the width of the channel and was falling onto the each step downstream of the weir. Overall, flow in the

Everest Power Private Limited

stilling basin and over the submerged weir was favorable from the hydraulic considerations. The Stilling Basin with the above modification was preforming efficiently. In Model, the proposed un-gated surface spillway profiles were found in order from the cavitation considerations.

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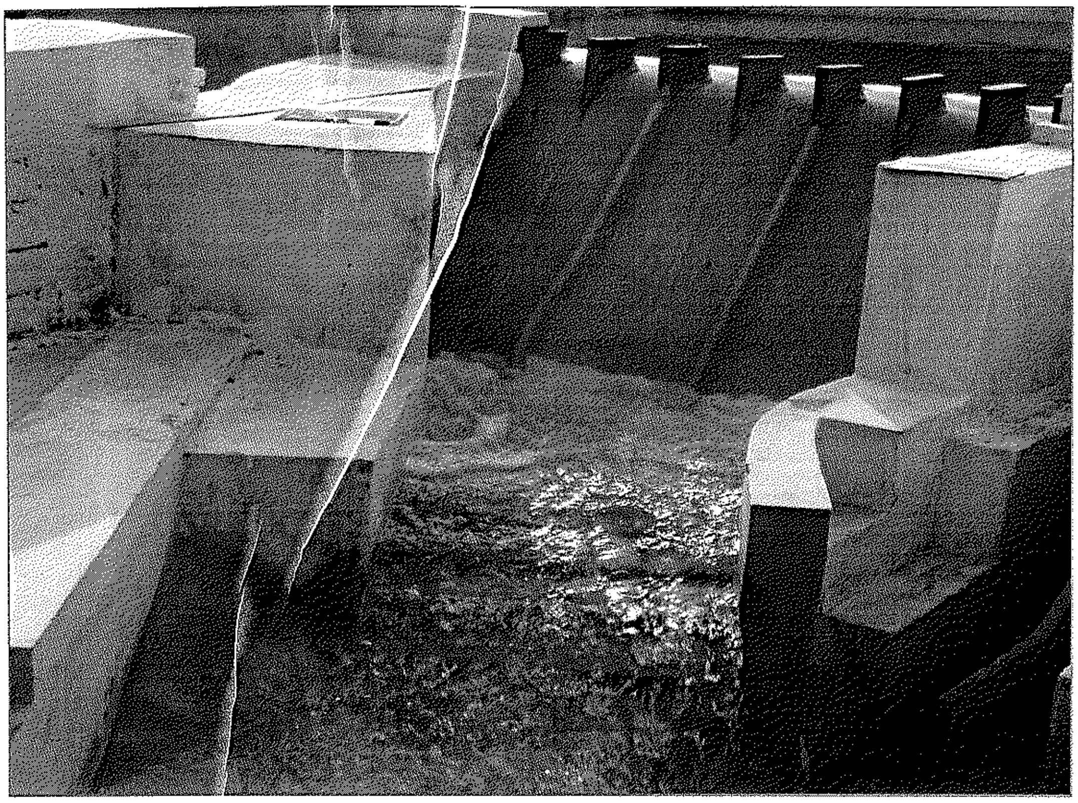
Annexure - 4B

PHYSICAL MODEL STUDY OF UNGATED SURFACE SPILLWAY ARRANGEMENT OF MALANA-II HYDRO ELECTRIC PROJECT (2x50MW)
KULLU, HIMACHAL PRADESH



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SEPTEMBER 2017

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EXECUTIVE SUMMARY

Malana-II Hydro Electric Project (HEP) with an installed capacity of 100MW is a run-of-river scheme and is located on Malana Khad, a tributary of the river Parbati in the Kullu district of Himachal Pradesh.

The project comprises of a 53m high Concrete Gravity Dam across Malana Khad to divert 20 cumec of design discharge into a 4.987 km long Head Race Tunnel to generate 100MW (2 x 50MW) of power under a design head of 603m. The two generating units are located in an Underground Power House. The design flood (PMF) for the project has been estimated as 650 cumec and two nos. of sluice type spillway with radial gate each of size 4.0m (W) x 5.50m (H) with crest at EL. 2514.50m have been provided in the Over Flow dam block to pass this design flood downstream into the river.

The Malana - II HEP has been operating smoothly since its commissioning in July 2012, except for a few problems generally associated with a hydro power project in the initial 1-2 years. On 24th August 2013, the water level in the reservoir started rising from the minimum drawdown level due to tripping of both the generating units. The project authorities tried to pass the inflow by opening the radial gates of sluice spillways. However, the gates could not be opened as some big boulders obstructing the opening of gate resulted the rise of water level in reservoir and finally overtopped the dam.

For ensuring safety of the dam, a committee of experts constituted by Everest Power to review the situation and recommend suitable arrangement to avoid such problem in future. The committee recommended that *"The provision of proper overflow spillway in the existing Dam should be planned so that water can safely pass high floods in case under sluice gates do not work"*. The maximum observed flood during monsoon period in the river is below 100 cumec as reported by the project authorities.

Accordingly, Everest Power Private Limited (EPPL) proposed additional un-gated surface spillway of six bays of 6.25m wide and one bay of 4.5m wide by converting the existing non-overflow dam block nos. 6, 7, 8 and 9 into overflow dam blocks with crest at El. 2543.0 m.

Accordingly, EPPL vide service order No. S.O-200010 dated 01/08/2016 awarded the task of physical model study of Spilling arrangement of Malana-II hydropower project to IIT Roorkee with reference to discharging capacity of the un-gated surface spillway, energy dissipation and cavitation, if any.

A comprehensive and geometrically similar model of the dam and its spillway was built to a scale of 1:40 invoking the Froude number similarity for studying the discharging capacity of the un-gated surface spillway, cavitation over the surface of the un-gated spillway, if any and energy dissipation arrangement at downstream of the un-gated surface spillway. Available cross-sections along with contour maps were used to replicate the river in the model.

The crest level of the proposed un-gated surface spillway is at level of 2543.0m. Seven pressure points were provided on the surface of the un-gated spillway in the middle of the sections D-D' and E-E'.

For the fulfillment of objectives of the model study, it was performed under various operating conditions, when the water level in reservoir is at EL. 2545.00m and both under sluices are closed. The model study on the proposed un-gated surface spillway reveals that the discharging capacity of un-gated surface spillway is 229.79 cumec. The ogee profiles of the proposed un-gated surface spillway are in order from the cavitation considerations.

Flow pattern on the surface of un-gated spillway was smooth and free from eddies. However, flow onwards to the toe of the un-gated surface spillway was chaotic and full of strong cross-currents. The flip bucket was also not performing well due to rise in depth of flow and mixed directional flow as a results of cross-currents upstream of the bucket.

For controlling the cross currents, lower portions of the proposed training wall between Block No.8 & 9 and Block No. 7 & 8 were removed. In addition, the super elevation in the sloping glacis of the right bay spillway block was also removed. Improvement in the flow pattern was observed, however, the cross currents persisted.

After detailed discussions with the project authorities during inspection of model performance, it was decided to replace the flip bucket arrangement with hydraulic jump type stilling basin by pooling the water with provision of a submerged broad crested weir of height 3.5 m along with steps downstream of the weir. It was also decided to shift the left side wall at the toe of the dam glacis by 3.0 m towards left side to minimize the formation of the cross-currents. The width of the channel was kept 22 m in the place of earlier 21 m at the broad crested weir.

The model was run again for different discharges to observe the flow pattern in the stilling basin and over the submerged weir over flow spillway. Due to pooled water in the stilling basin with the provision of submerged weir, relatively drown hydraulic jump was forming. The crosscurrents were merging into the pooled water and losing their high kinetic energy. Flow in the stilling basin was highly turbulence with large size rollers which lead to energy dissipation in the stilling basin.

Flow over the submerged weir was almost uniformly distributed across the width of the channel and was falling onto the each step downstream of the weir. Overall, flow in the stilling basin and over the submerged weir was favorable from the hydraulic considerations.

Modified bed levels and measured water level for different discharges along left and right side walls were measured. From distance of 12 m to 52 m from the face of the dam, the revised bed level along the right side wall was lower than the earlier bed level. The maximum observed water level in the stilling basin along right and left side walls were 2521.8 m and 2521 m, respectively.

It is recommended that the changes suggested in the un-gated surface spillway shall be adopted for its hydraulic efficiencies.

(Z. Ahmad)

(P K Sharma)

Date & Place: 14 Sept.,2017, Roorkee

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CONTENTS

LIST OF SYMBOLS

G = Gauge

Q = Discharge

g = Acceleration due to gravity

P_a = Atmospheric pressure (10.3 m of water head)

P_{ob} = Observed pressure in m of water head

P_v = Water vapor pressure (0.24 m of water head at 20^0 C)

V = Flow velocity

σ = Cavitation index

DoE = Directorate of Energy

PWD = Public Works Department

MWL = Maximum water level

OFS = Over-flow (Un-gated Surface) spillway

HEP = Hydro Electric Project

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2	Plan layout of the modified dam & spillway
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	(c) Section C-C' and (d) Section D-D' of the un-gated surface spillway
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5	Plan of the river downstream of the dam
6	Longitudinal section of the river along centre line downstream of the dam
7	**a1& b1** Upstream cross-sections of river A1-A1 & B1-B1
	a-e Sections of the rivers A-A, B-B, C-C, D-D, & E-E
	f-i Sections of the rivers F-F, G-G, H-H, & I-I
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	n-q Sections of the rivers N-N, O-O, P-P, & Q-Q
	r-t Sections of the rivers R-R, S-S, & T-T
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1.0 INTRODUCTION

Everest Power Private Limited (EPPL) has developed the 100 MW (2x50 MW) Malana - II Hydro Electric Project (HEP) in Himachal Pradesh. The project is a high head, run-of-river scheme with 4 hour pondage and is located on Malana Khad, a tributary of the Parbati River.

The project comprises of a 53m high Concrete Gravity Dam, a 4.987km long 2.9m dia. Head Race Tunnel (HRT) aligned on the left bank of Malana Khad, a 87m deep 6m dia. Surge Shaft, 2.5m dia. and 564m high vertical & 260m horizontal Single Pressure Shaft (PS) and an Underground Power House Complex. The water conductor system is designed to carry 20cumec design discharge to feed water to two vertical Pelton Turbines each of 50 MW capacities under 603m net head.

The maximum height of the dam from the deepest foundation level is 53m. and its length at the top is 213.0m comprising 150.0m length of the dam blocks and 63.0m length of the key wall provided inside the left bank abutment. The dam block comprises of 1 no. overflow block with 2 sluice bays and 9 nos. NOF blocks.

Two nos. of sluice type spillway with radial gate each of size 4.0m(W) x 5.50m(H) with crest at EL. 2514.50m have been provided in the Over Flow dam block No. 5 to pass a design flood of 650 cumec.

The salient feature of the project is enclosed at **Annexure-X.**

On 24th August 2013, the water level in the reservoir started rising from the minimum drawdown level of 2528 m due to tripping of both the generating units. The project authorities tried to pass the incoming flow by opening the radial gates of sluice spillways. However, they could not be opened. As a result, the reservoir level rose and overtopping of the dam took place for about 4 hour. At the time of the overtopping, the discharge in the river was about 16 cumec. For ensuring safety of the dam, a committee of experts constituted by Everest Power to review the situation and recommend suitable arrangement to avoid such problem in future.

The committee recommended that "The provision of proper un-gated spillway in the existing Dam should be planned so that water can safely pass high floods in case under sluice gates do not work". The maximum observed flood during monsoon period in the river is below 100 cumec as reported by the project authorities.

Accordingly Everest Power Private Limited (EPPL) proposed additional un-gated surface spillway of six bays of 6.25 m wide and one bay of 4.5m wide by converting the existing non-overflow block nos. 6 (Partly), 7, 8 and 9 into overflow blocks with crest at El. 2543.0 m.

The Directorate of Energy, Govt. of Himachal Pradesh stressed that various important features of the proposed un-gated surface spillway needs to be vetted/optimized through model studies for hydraulic efficiencies w.r.t discharge capability, efficient energy dissipation without any erosion at toe & right bank having PWD road for safety of the dam in particular before its implementation.

Accordingly Everest Power Private Limited, Gurgaon, vide service order No. S.O-200010 dated 01/08/2016 awarded the task of physical model study of spilling arrangement of Malana-II hydropower project to IIT Roorkee with reference to discharging capacity of the spillway, energy dissipation and cavitation, if any.

2.0 TERMS OF REFERNCE

The following were the terms of reference and objectives of the model study:

a) Construction of the spillway model to a scale 1:40 invoking the Froude number similarity.

b) Determination of discharging capacity of the un-gated surface spillway.

c) Downstream pressure distribution -cavitation formations, if any.

d) Energy Dissipation of flow through the un-gated surface spillway

The present report deals with model studies of the spilling arrangement of the Malana-II hydro-electric project in the respect of discharging capacity of the un-gated surface spillway, energy dissipation and cavitation, if any.

3.0 DRAWINGS / DATA

The following drawings / data as provided by the sponsor were used for the model construction and study.

(a) Plan and section of the existing dam (Drg. 1)
(b) Plan layout of the modified dam & spillways (Drg.2)
(c) Plan and section of the un-gated surface spillway (Drg.3)
(d) Sections A-A'; B-B'; C-C'; D-D'; E-E'; and F-F'of the un-gated surface spillway (Drg.4)
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(h) Plan layout of the modified un-gated surface spillway (Drg. 8).
(i) L-section of the modified stilling basin of the un-gated surface spillway (Drg. 9)

Some of the important salient features related to the physical model study are as under:

- Top of the concrete dam = 2545 m
- Additional proposed un-gated surface spillway = 6 bays of 6.25m wide & One bay of 4.5m wide
- Crest level of the proposed un-gated surface spillway = 2543 m
- Waterway width of proposed un-gated surface Spillway = 42.00m

4.0 SET UP OF THE MODEL

A comprehensive and geometrically similar model of the Malana-II hydro-electric project dam and its spillway was built to a scale of 1:40 invoking the Froude number similarity for studying the discharging capacity of the un-gated surface spillway, cavitation over surface of the spillway, and energy dissipation downstream of the un-gated surface spillway. Cross-sections of the river were provided at 25 m and 50 m upstream of the dam and up to 237.5 m downstream of the dam at an interval of 12.5 m. Such cross-sections along with contour maps were used to replicate the river in the model. Even though cross-section was available up to 50 m upstream of the dam only, the extent of the reservoir was reproduced more to control the entry of foreign eddies into the un-gated surface spillway and to minimize the effect of limited size of the reservoir on the hydraulics of the un-gated surface spillway.

Un-gated surface spillway consisting of 6 bays each of clear bay width of 6.25 m and one bay of clear bay width 4.5m was constructed and the crest was kept at level of 2543.0 m. Total bay width of the un-gated surface spillway including pier and abutment thickness was 51.00m. Profile of the un-gated surface spillway including its crest and downstream glacis were constructed along with two training walls and flip bucket. Some photographs of the constructed model are shown in the Plates 1-5.

Spilling part of the model i.e., un-gated surface spillway, flip bucket were constructed in cement mortar making inner surface smooth with neat cement layer. Shingles of size 20 mm to 50 mm were laid on the bed of the channel downstream of the section T-T over a length of 100 m to keep it mobile for comparing depth of scour as an indicator of the energy dissipation under flow combinations.

Seven pressure points were also provided on the surface of the un-gated spillway in the middle of the sections D-D' and E-E' and at distances x = 0, 1.8 m, 4.8 m, 10 m, 15.6 m, 25.4 m, and 30.6 m from the dam axis (x=0). Pressure at these locations were measured using vertical manometer as shown in the Plate 6.

Inflow to the model was measured using magnetic flowmeter fitted in the water supply pipe to the model. Plate 7 shows the fitted Magnetic flowmeter in the supply pipe. Flow in the supply pipe was also cross-checked using Ultrasonic flowmeter shown in Plate 8. Water level in the reservoir was also measured through a gauge pit so that disturbance effect of water surface can be minimized. Pointer gauge of accuracy 0.1 mm was used for the measurement of the water surface profile while velocity was measurement using classical Pitot tube.

5.0 MODEL STUDY

For the fulfillment of objectives of the model study, it was performed under different discharges, when the water level in reservoir is at EL. 2545.00m and both under sluices are closed. The model study on the proposed un-gated surface spillway reveals that the discharging capacity of un-gated surface spillway is 229.79 cumec. The ogee profiles of the proposed un-gated surface spillway are in order from the cavitation considerations.

The model was run for flow through un-gated surface spillway under different water levels in the reservoir. The gate of the both under sluice spillway were closed. Discharge passing through the un-gated surface spillway was measured by a rectangular sharp crested weir of width 40 cm for different water levels in the reservoir. The discharges passed at different reservoir levels are given in Table 1.

Table 1 Discharging capacity of the proposed un-gated surface spillway

S.No.	Model		Prototype	
	Head over crest (cm)	Discharge(L/s)	Gauge (m)	Discharge (m^3/s)
1	3.22	4.76	2543.72	48.20
2	4.88	9.00	2544.08	91.06
3	5.29	10.19	2544.20	103.09
4	5.88	11.99	2544.36	121.34
5	6.04	12.50	2544.40	126.48
6	6.94	15.50	2544.64	156.81
7	8.87	22.71	2545.00	229.79
8	12.64	39.68	2545.88	401.57

The discharging capacity of the un-gated surface spillway is shown in the Fig. 1.

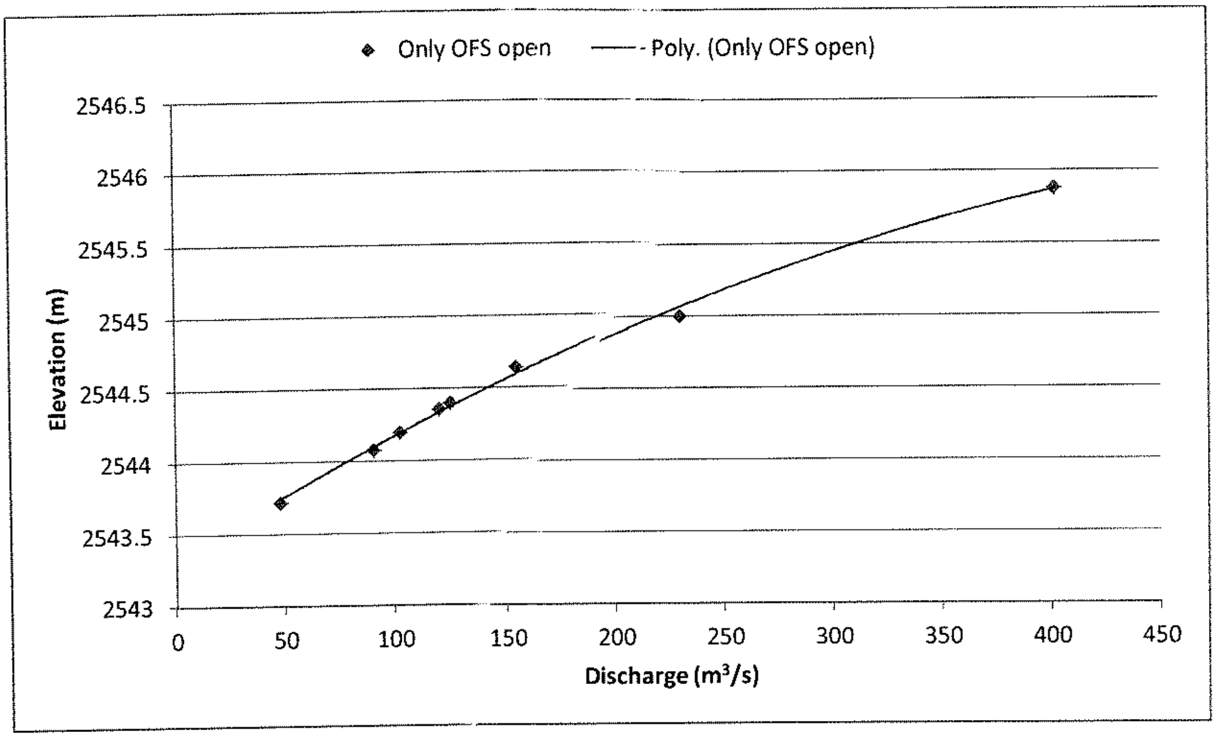

Figure 1 Discharging capacity of the un-gated surface spillway

It may be noted that at the maximum water level of 2545 m, the un-gated surface spillway passed 229.79 m^3/s while the passing discharge at reservoir level of 2544 m is 90 m^3/s.

Water surface profile was measured over the surface of the un-gated spillway when the reservoir level was at 2545 m. Cavitation index of the flow over un-gated surface spillway at all the seven pressure points were also calculated using measured pressure and flow velocity at the pressure points invoking Eq. (1). Velocity was measured using Pitot tube.

The computed cavitation indices are given in Table 2.

Table 2 Computation of the cavitation index of flow over un-gated surface spillway

Pressure point No.	Model: Pressure measurement			Model: Velocity measurement		Prototype			
	Manometric reading under flow (cm)	Manometric reading no flow (cm)	Pressure (cm)	Manometric reading of the Pitot tube (cm)	V (m/s)	Pressure P_{ob} (m)	V (m/s)	$V^2/2g$	σ
1	109	105	4	1.19	0.48	1.6	3.06	0.476	18.57
2	109	105	4	2	0.63	1.6	3.96	0.8	11.05
3	103	103.2	-0.2	8.6	1.30	-0.08	8.22	3.44	3.06
4	86	87.2	-1.2	23	2.12	-0.48	13.44	9.2	1.19
5	68	67.5	0.5	35	2.62	0.2	16.57	14	0.73
6	42.8	37.7	5.1	63	3.52	2.04	22.24	25.2	0.33
7	38.5	33.5	5	58	3.37	2	21.34	23.2	0.36

As the computed cavitation index at all the seven pressure points are higher than 0.30 thus as per IS code 12804:2004, the flow over the spillway surface will not be subjected to cavitation.

Flow over the crest and downstream glacis of the un-gated surface spillway was in order, however, due to being supercritical in nature, flow onwards to the toe of the spillway in the stilling basin was consisted of strong cross-currents. Partial flip action of the flip bucket was observed due to such cross-currents. The flow was highly comlex and chaotic in nature. Multiples convcave and convex boundaries were the main source of the cross-currents. Major dissipation of the energy was at the about 13 m drop available from the section L-L to N-N. Plate 9 show respectively strong cross-currents in the stilling basin and flow over the flip bucket.

6.0 COMMENTS ON THE PROPOSED UNGATED SURFACE SPILLWAY

Determination of discharging capacity of the un-gated surface spillway, formation of cavitation in the flow through the un-gated surface spillway and energy dissipation of the flow downstream of the un-gated surface spillway were the objectives of the model study. The model study on the proposed un-gated surface spillway reveals that the discharging capacity of un-gated surface spillway is 229.79 cumec. The ogee profiles of the proposed un-gated surface are in order from the cavitation considerations.

Flow pattern over the un-gated surface spillway was smooth and free from eddies. However, flow onwards to the toe of the un-gated surface spillway was chaotic and full of strong cross-currents. The flip bucket was also not performing well due to rise in depth of flow and mixed directional flow as a results of cross-currents upstream of the bucket. Thus there was need to make changes in the stilling basin, training walls, side walls and flip bucket of the un-gated surface spillway.

7.0 MODEL STUDY DURING SPONSOR'S VISITS

A team of officers from M/s EPPL & M/s AEMPL (Consultant of EPPL) visited the model on 17th & 18th Oct 2016. The model was inspected by the officers under different discharges when the water level in reservoir at EL. 2545.00m and both under sluices are closed.

The team observed that the discharging capacity of the additional un-gated surface spillway is in order. The spillway profile of the proposed un-gated surface spillway was found in order from cavitation considerations. However, unfavorable flow in the form of strong cross currents was found onwards to the toe of the un-gated surface spillway up to the flip bucket.

For controlling the cross currents, lower portions of the proposed divide wall between Block No.8 & 9 and Block No. 7 & 8 were removed. In addition, the super elevation in the sloping glacis of the right bay spillway block was also removed. Improvement in the flow pattern was observed, however, the cross currents were persisted. It was difficult to control the cross currents/waves due to formation of multiples cross currents in the presence of various concave and convex boundaries in the form of side walls and training walls. At outset, it was decided to replace the flip bucket arrangement with hydraulic jump type stilling basin by pooling the water with provision of a submerged broad crested weir of height 3.5 m along with steps downstream of the weir. Such arrangement controlled the cross-currents, however, still a strong cross current from the toe of dam block no.6 at the left end wall was impinging the pooled water. It was decided to shift the left side wall at the toe of the dam glacis by 3.0 m towards left side to minimize the formation of the cross-currents. Subsequently, through email dated Oct. 24, 2016, M/s AEMPL sent revised drawings of the broad crested weir and its steps and also alignment of the left side wall. Such drawings are shown in the Drawing No. 8 & 9.

8.0 MODEL STUDY OF UNGATED SURFACE SPILLWAY ARRANGEMENT WITH PROPOSED MODIFICATIONS

The suggested changes in the un-gated surface spillway were incorporated in the model. Plates 11 show view of the modified un-gated surface spillway in dry condition. Suggested changes comprises replacement of flip bucket by 3.5 m high broad crested weir with pool with steps cascade downstream of the weir. Each step is having 5 m width and of 1 m drop and at the end of the first two steps, an end sill of height 0.5 m is provided. Left side wall was shifted by 3 m further left side near the dam toe. The width of the channel was kept 22 m in the place of earlier 21 m at the broad crested weir.

The model was run with exclusively un-gated surface spillway for discharges of 101.19 m^3/s, 182.15 m^3/s and 263.10 m^3/s. The under sluice spillways were kept closed.

Flow pattern in the stilling basin and over the submerged weir was observed during the run. Due to pooled water in the stilling basin with the provision of submerged weir, relatively drown hydraulic jump was forming. The cross-currents were merging into the pooled water and losing their high kinetic energy. Flow in the stilling basin was highly turbulence with large size rollers which leaded to energy dissipation in the stilling basin.

Flow over the submerged weir was almost uniformly distributed across the width of the channel and was falling onto the each step downstream of the weir. Overall, flow in the stilling basin and over the submerged weir was favorable from the hydraulic considerations.

Water levels along the right and left side walls were measured under changed scenarios. Earlier & modified bed levels and measured water level for different discharges along right side wall are given in the Table 3 and also shown in Fig. 2 (water level is shown for only maximum discharge). It may be noted that from distance of 12 m to 52 m from the face of the dam, the revised bed level is lower than the earlier bed level. The maximum observed water level observed in the stilling basin was of the order of 2521.8 m.

Table 3 Modified bed level and measured water levels for different discharges along right side wall

Distance along right wall (m)	Earlier Bed level (m)	Distance along right wall (m)	Modified Bed level (m)	Water level (m)		
				Q = 101.19 m^3/s	Q = 182.15 m^3/s	Q = 263.10 m^3/s
0	2543	0.00	2543	2543.6	2543.9	2544.6
0.52	2543	4.00	2542.8	2543.4	2543.7	2544.2
3.1	2543	8.00	2538	2538.8	2539.0	2539.8
5.73	2541.09	12.00	2534	2534.6	2534.6	2534.7
7.06	2539.07	16.00	2530.8	2531.6	2532.0	2531.8
9.75	2535.34	20.00	2527.2	2528.4	2529.0	2528.8
10.54	2534.5	24.00	2524.6	2525.8	2526.0	2526.4
11.5	2533.87	28.00	2521.2	2523.6	2523.8	2523.8
50.95	2514.03	32.00	2519.2	2520.2	2521.8	2522.2
51.9	2513.67	36.00	2517.4	2518.8	2519.2	2520.0
52.9	2513.51	40.00	2515.6	2519.4	2519.4	2519.0
68.43	2512.61	44.00	2515	2519.6	2519.8	2519.8
70.59	2512.86	48.00	2514.4	2519.3	2520.4	2521.4
72.55	2513.82	52.00	2514	2519.2	2520.4	2521.8
73.55	2513.82	56.00	2513.6	2519.1	2520.1	2521.8
93	2512.2	60.00	2513.2	2519.0	2519.8	2521.0
		64.00	2513.12	2518.8	2519.4	2520.2
		68.00	2513.28	2520.9	2519.7	2520.9
		72.00	2513.48	2521.3	2519.9	2521.3
		76.00	2516.88	2521.1	2519.9	2521.1

		82.7	2516.33	2519.9	2517.6	2519.9
		88	2515.33	2519.1	2518.9	2519.1
		93	2514.33	2517.7	2517.7	2517.7

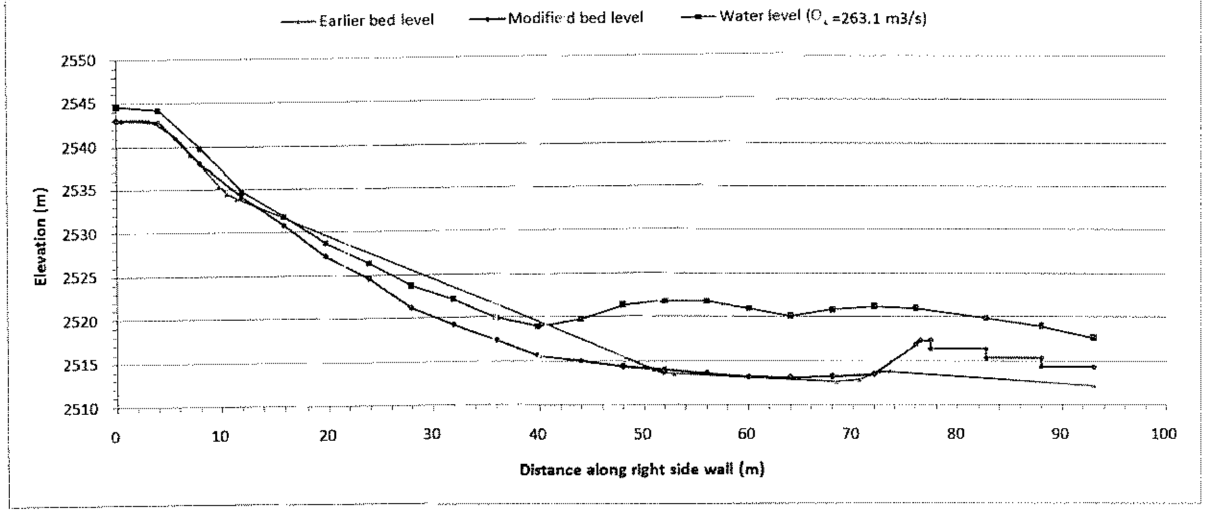

Figure 2 Modified bed level and measured water levels for different discharges along the right side wall

Modified bed levels and measured water level for different discharges along the left side wall are given in the Table 4 and also shown in the Fig. 3 (water level is shown for only maximum discharge). The maximum water level observed in the stilling basin was of the order of 2521 m.

Under the modified scenarios, the performance of the un-gated surface spillway model was witnessed by M/s AEMPL officials on Nov. 8 & 9, 2016 for discharges of 100 cumecs, 150 cumecs, 200 cumecs and 270 cumecs. The performance of the un-gated surface spillway model with the cited modification was found satisfactory.

Table 4 Bed level and measured water levels for different discharges along the left side wall

Distance along left wall (m)	Modified Bed level (m)	Water level (m)		
		Q = 101.19 m^3/s	Q = 182.15 m^3/s	Q = 263.10 m^3/s
0	2543	2543.6	2543.9	2544.6
4	2542.8	2543.4	2542.3	2544.2
8	2537.6	2538.2	2538.2	2539.4
12	2533	2532.8	2532.8	2533.6
16	2527.4	2528.2	2527.4	2527.8
20	2521.2	2522.8	2521.2	2522.0
24	2515.6	2518.8	2518.6	2518.2
28	2515.12	2518.6	2518.4	2517.8
32	2515.12	2518.9	2518.7	2520.0
35.2	2515.08	2519.1	2519.2	2519.7
36	2514.8	2519.0	2519.6	2520.2
38.8	2513.6	2519.2	2519.4	2520.2
40	2513.4	2519.0	2519.4	2520.2
44	2513	2519.0	2519.4	2520.2
48	2512.92	2519.0	2519.4	2520.2
52	2512.92	2519.0	2519.2	2520.2
54	2513.2	2519.0	2519.2	2520.2
56	2516.2	2519.0	2518.6	2520.2
58	2517.44	2518.8	2519.0	2519.8
59.01	2516.33	2518.5	2518.6	2519.4
64.3	2516.33	2518.4	2518.6	2519.2
69.6	2515.33	2516.5	2517.4	2518.3
69.61	2514.33	2517.6	2517.6	2517.8

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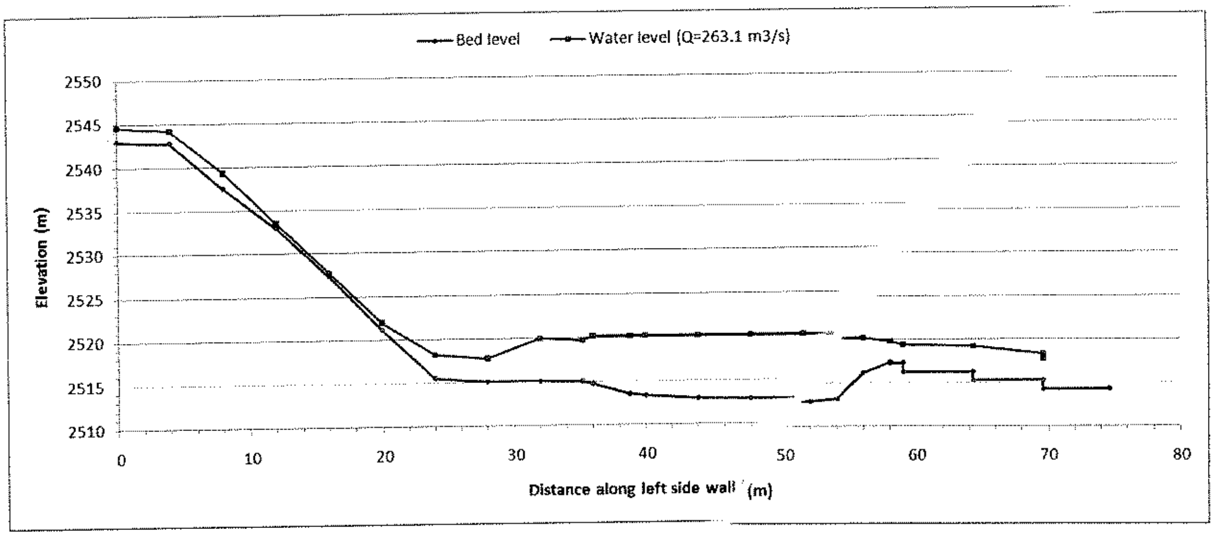

Figure 3 Modified bed level and measured water levels for different discharges along left side wall

8.0 CONCLUSIONS

The physical model study of spilling arrangement of Malana-II Hydro Electric Project was carried out under the various discharging conditions of the un-gated surface spillway, when the water level in reservoir is at EL. 2545.00m and both under sluices are closed.

The model study on the proposed un-gated surface spillway reveals that the discharging capacity of un-gated surface spillway is 229.79cumec. The ogee profiles of the proposed overflow are in order from the cavitation considerations.

Following conclusions were drawn:

- The model was run with exclusively un-gated surface spillway for different discharges. Flow pattern in the stilling basin and over the submerged weir was observed during the run. Due to pooled water in the stilling basin with the provision of submerged weir, relatively drown hydraulic jump was forming. The cross-currents were merging into the pooled water and losing their high kinetic energy. Flow in the stilling basin was highly turbulence with large size rollers which leaded to energy dissipation in the stilling basin.

- Flow over the submerged weir was almost uniformly distributed across the width of the channel and was falling onto the each step downstream of the weir. Overall, flow in the stilling basin and over the submerged weir was favorable from the hydraulic considerations.
- Modified bed levels and measured water level for different discharges along left and right side walls were measured. From distance of 12 m to 52 m from the face of the dam, the revised bed level along the right side wall was lower than the earlier bed level. The maximum observed water level in the stilling basin along right and left side walls were 2521.8 m and 2521 m, respectively.
- At outset, it is recommended that the changes suggested in the un-gated surface spillway shall be adopted for it hydraulic efficiencies. Such changes are:
    a) Removal of lower portions of the training wall between Block No. 8 & 9 and Block No. 7 & 8 as shown in the Drg. No. 8.
    b) Removal of super elevation in the sloping glacis of the right bay spillway block. Refer to Figure 2 and Table 3.
    c) Replacement of flip bucket arrangement by hydraulic jump type stilling basin by pooling the water with provision of a submerged broad crested weir of height 3.5 m along with steps downstream of the weir. Refer to Drg. No. 8 & 9.
    d) Shifting of left side wall at the toe of the dam glacis by 3.0 m towards left side. The width of the channel was kept 22 m in the place of earlier 21 m at the broad crested weir. Refer to Drg. No. 8.

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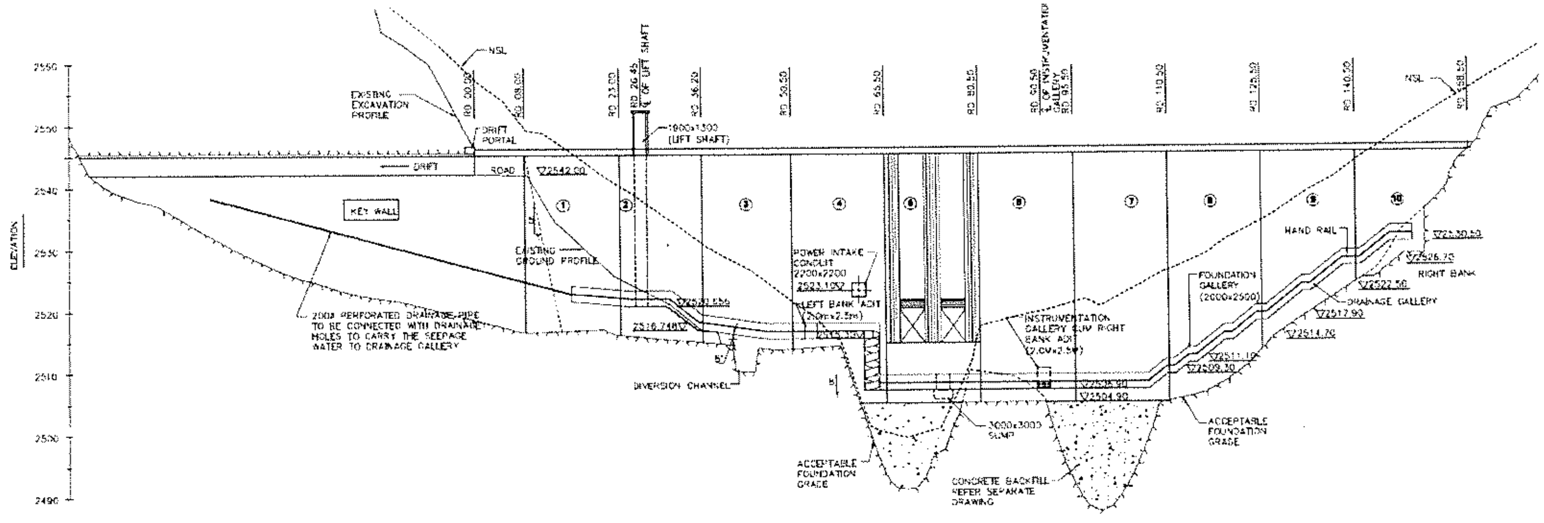
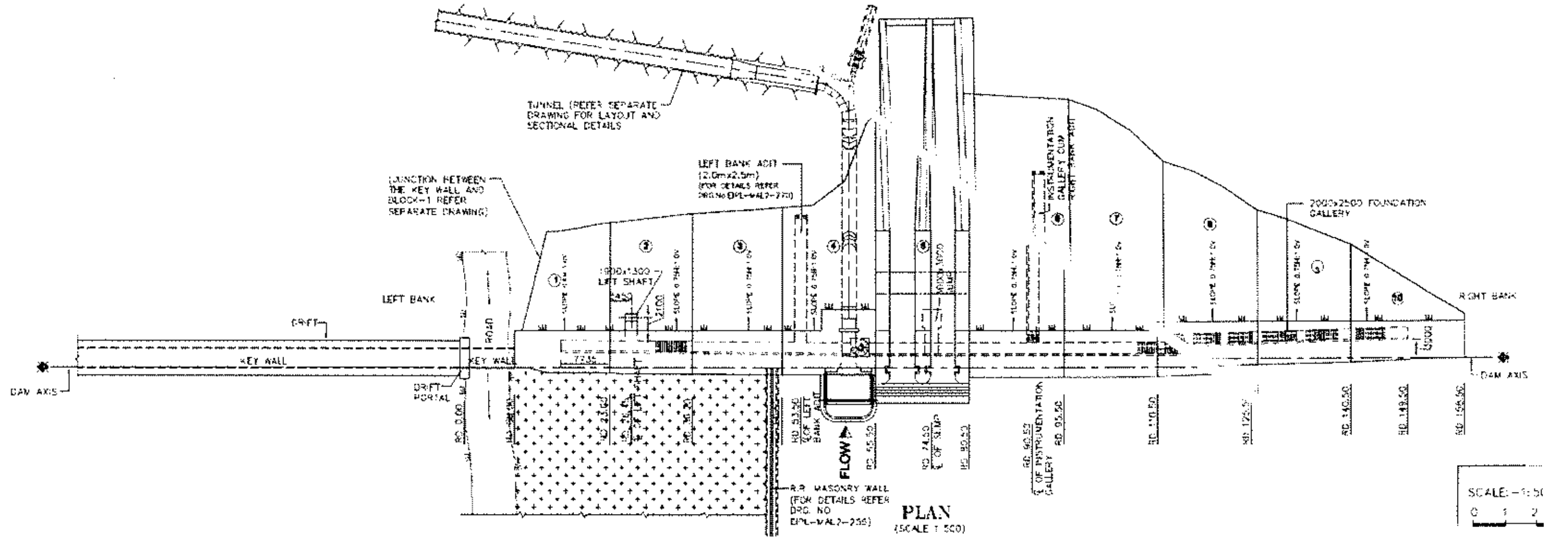
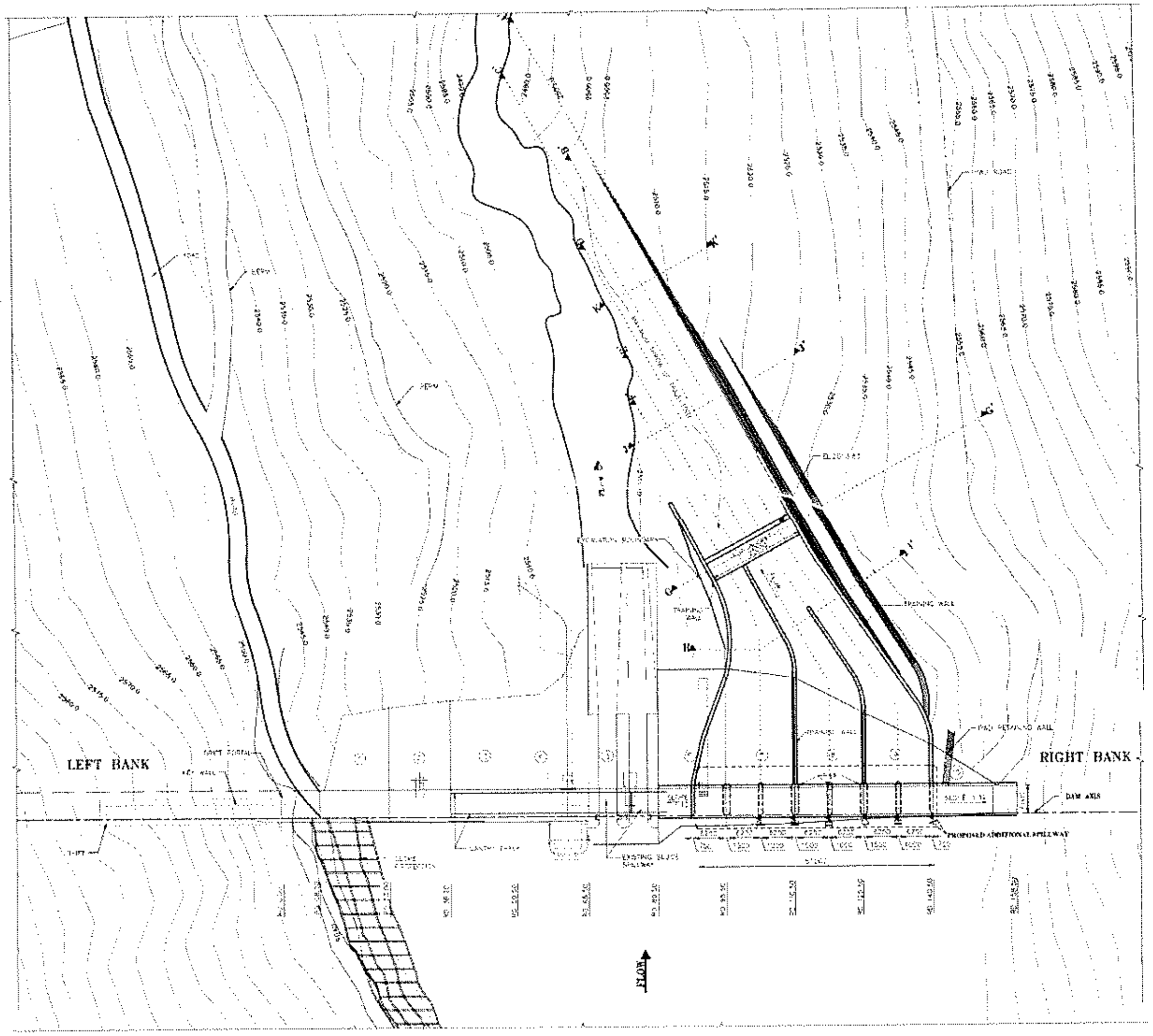


LONGITUDINAL SECTION OF DAM ALONG DAM AXIS
(SCALE 1:500)



PLAN
(SCALE 1:500)

Drg. 1 Plan and section of the existing dam



Drg. 2 Plan layout of the modified dam & spillways

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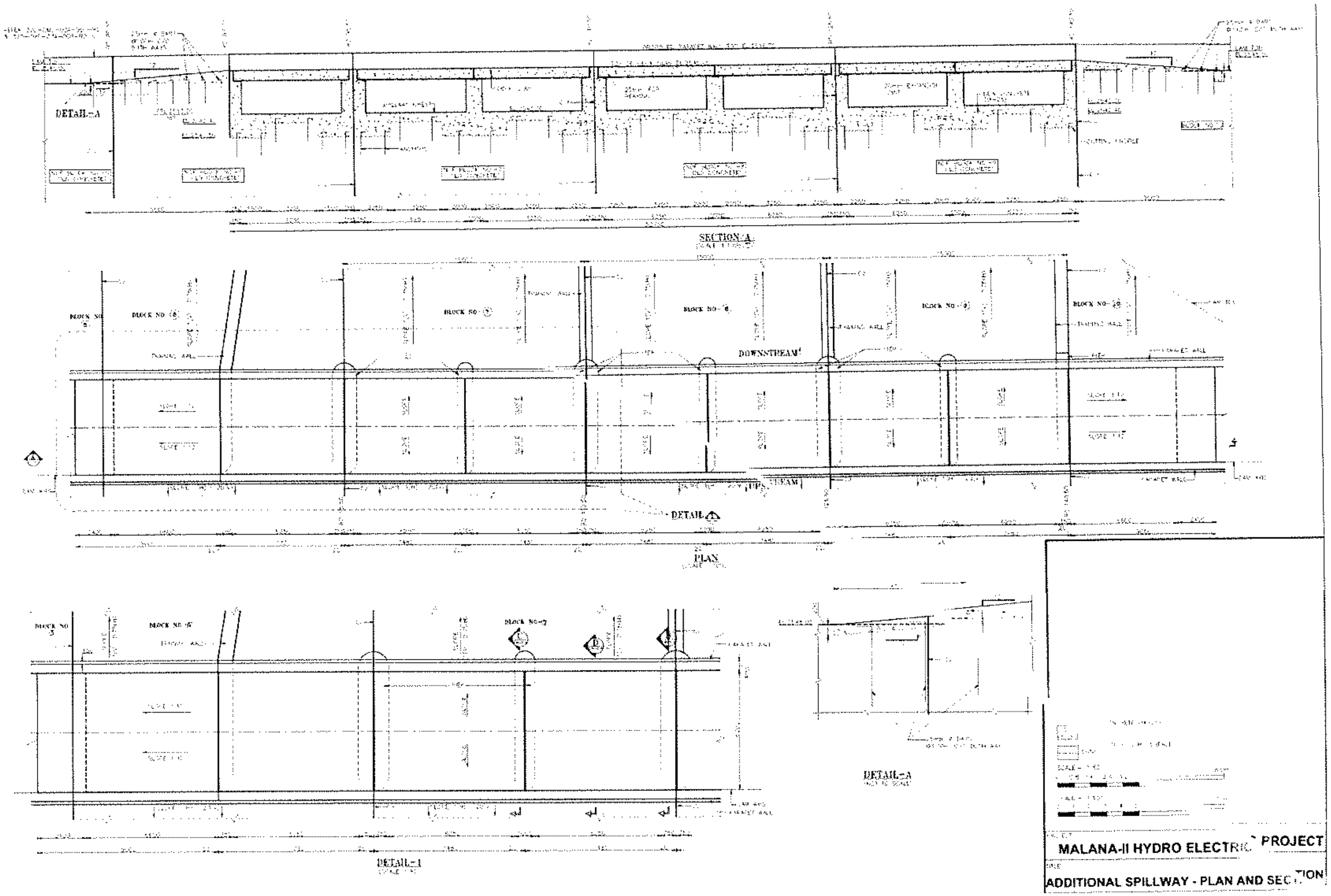
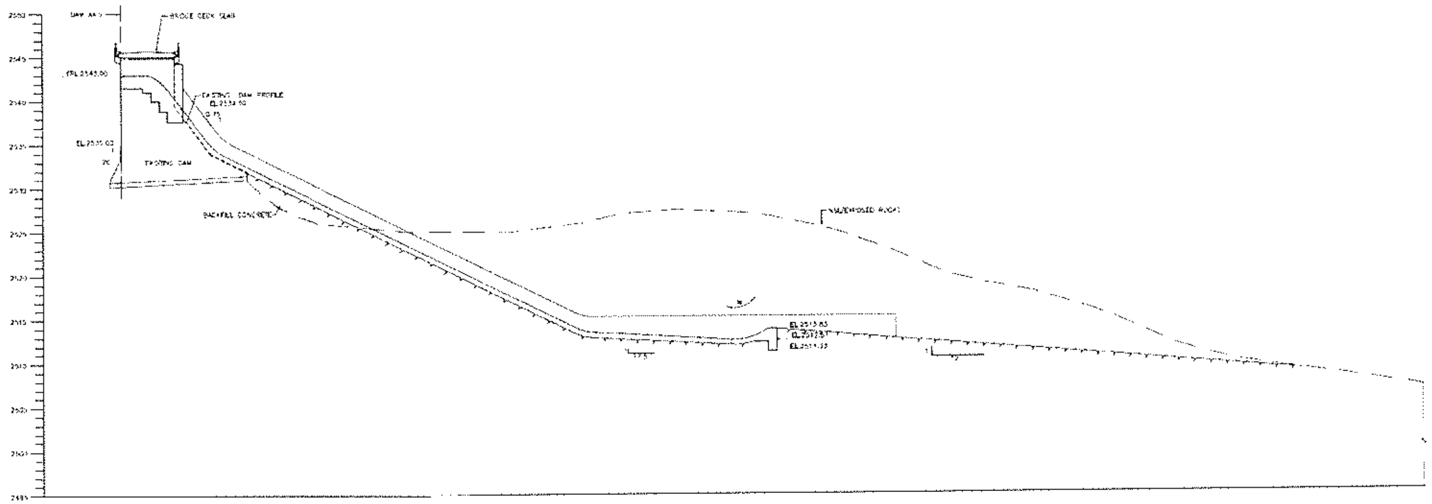
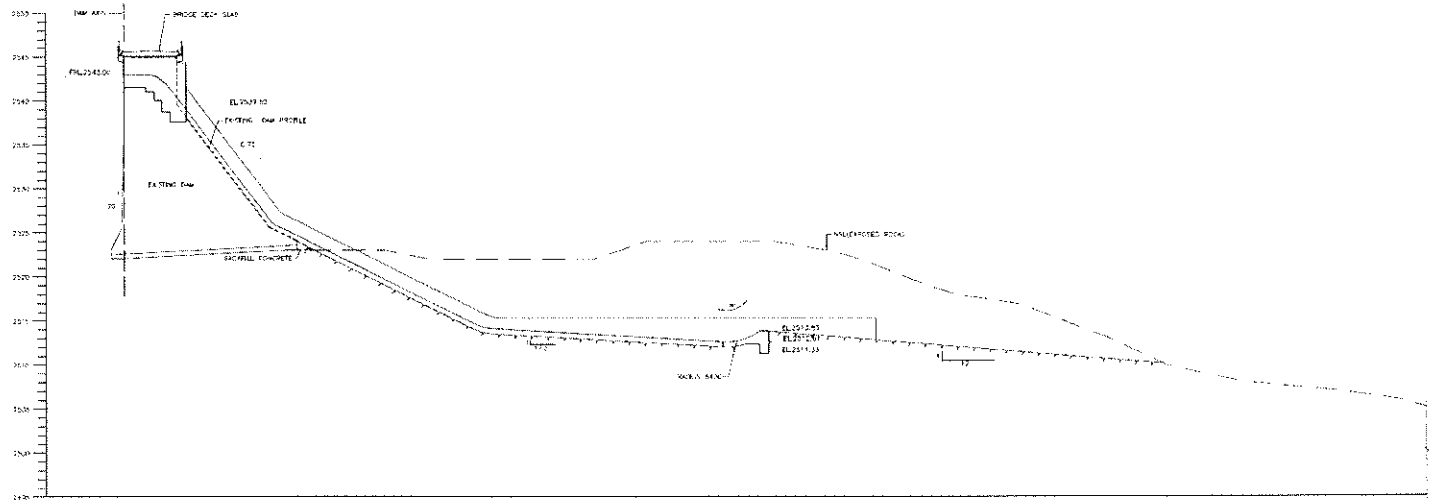


Drg. 3 Plan and section of the un-gated surface spillway

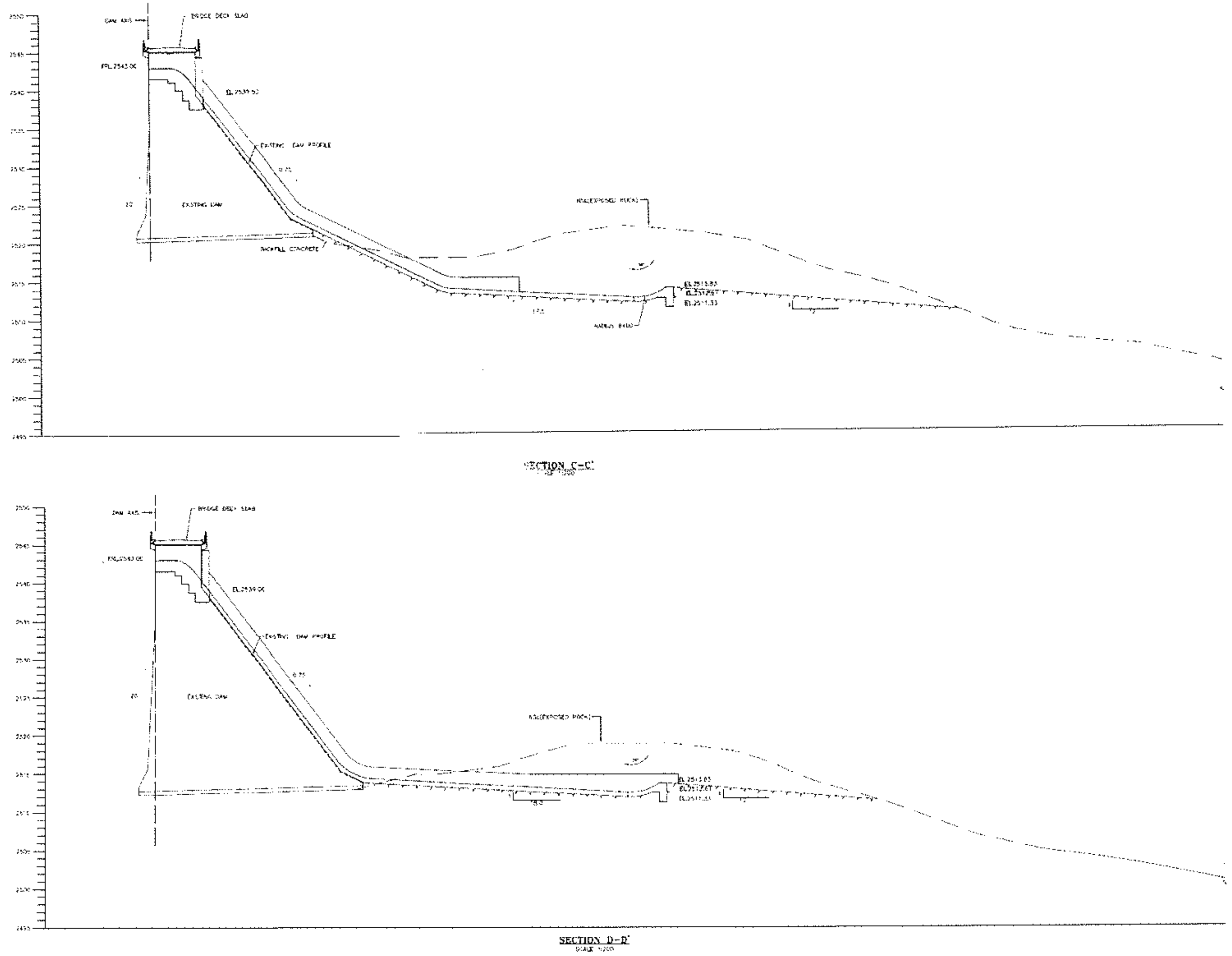


SECTION A-A'



SECTION B-B'

Drg. 4 (a) Section A-A' and (b) Section B-B' of the un-gated surface spillway



Drg. 4 (c) Section C-C' and (d) Section D-D' of the un-gated surface spillway

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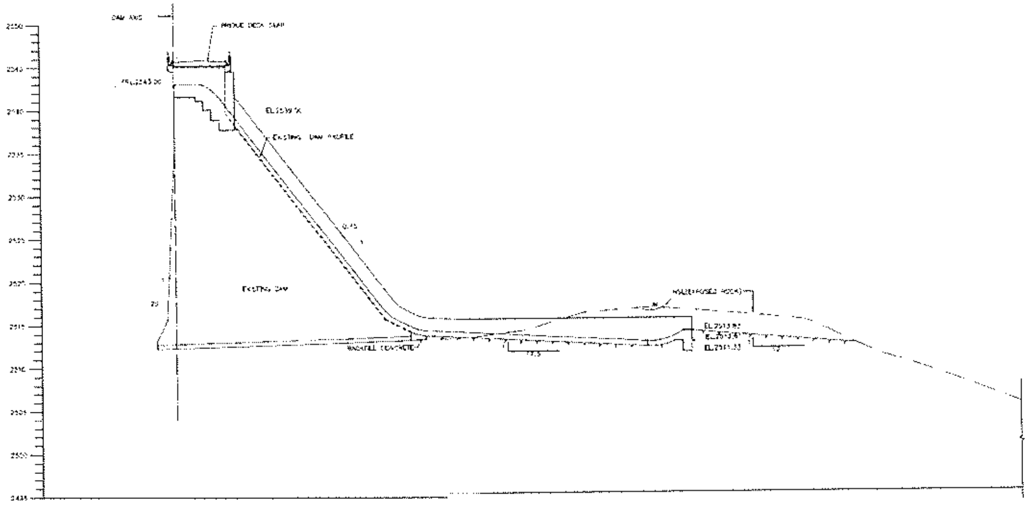
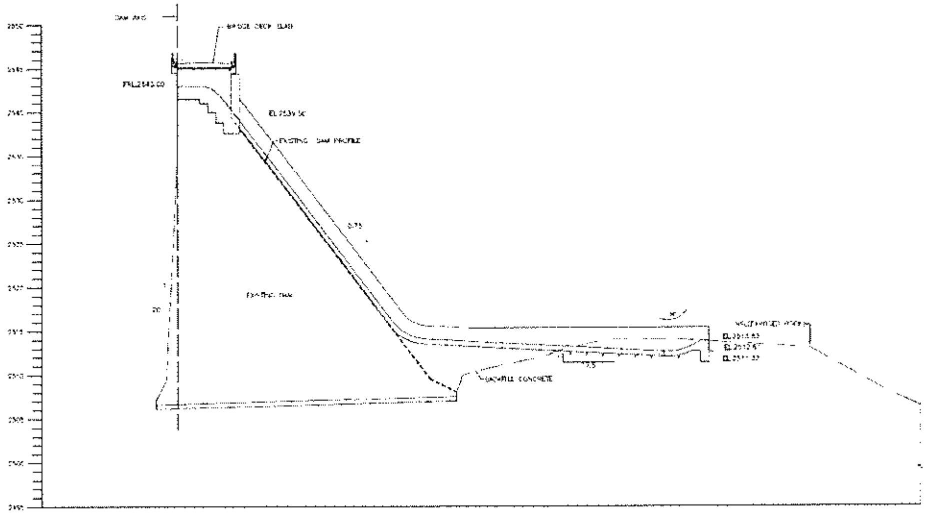
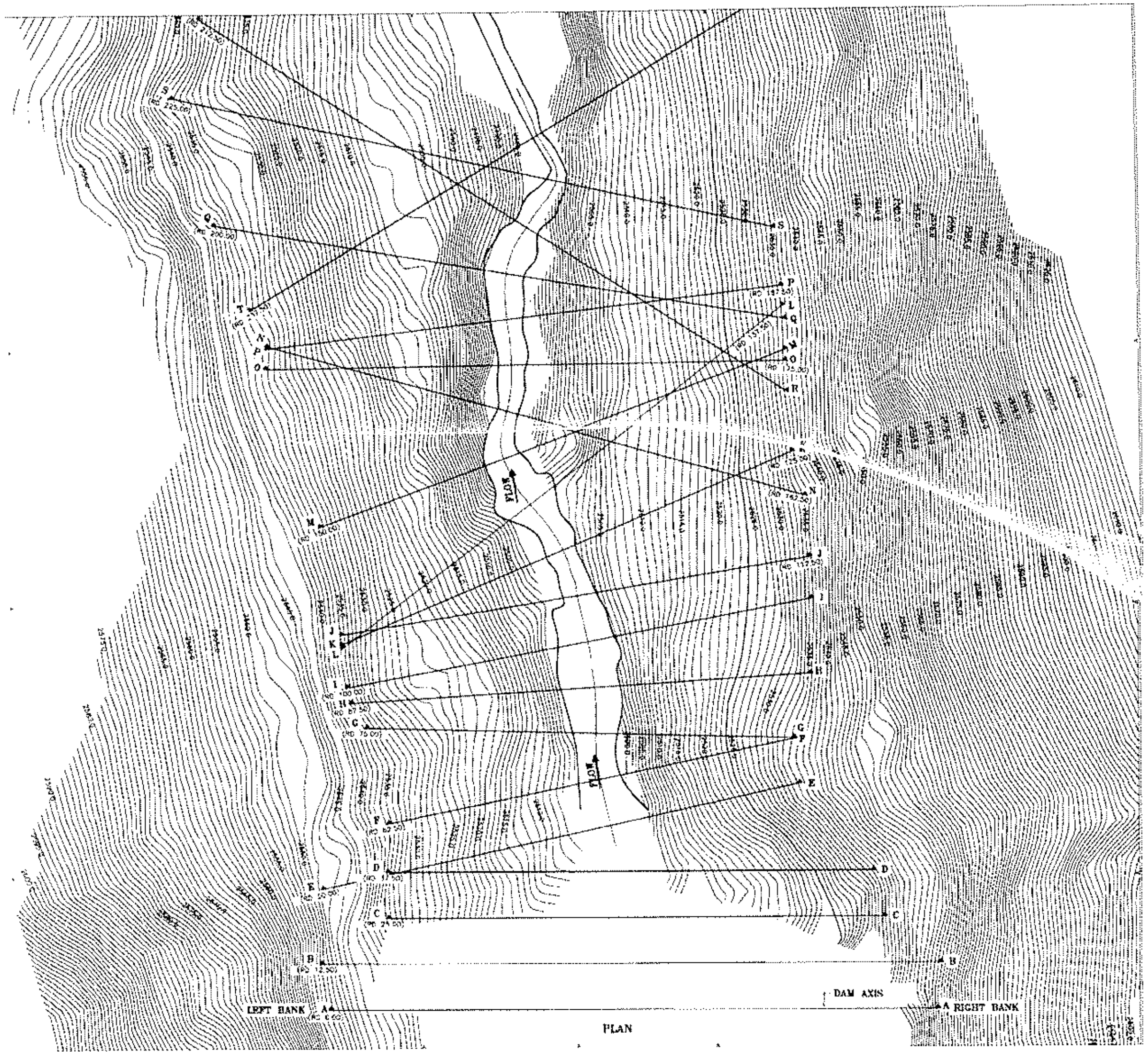


SECTION E-E'

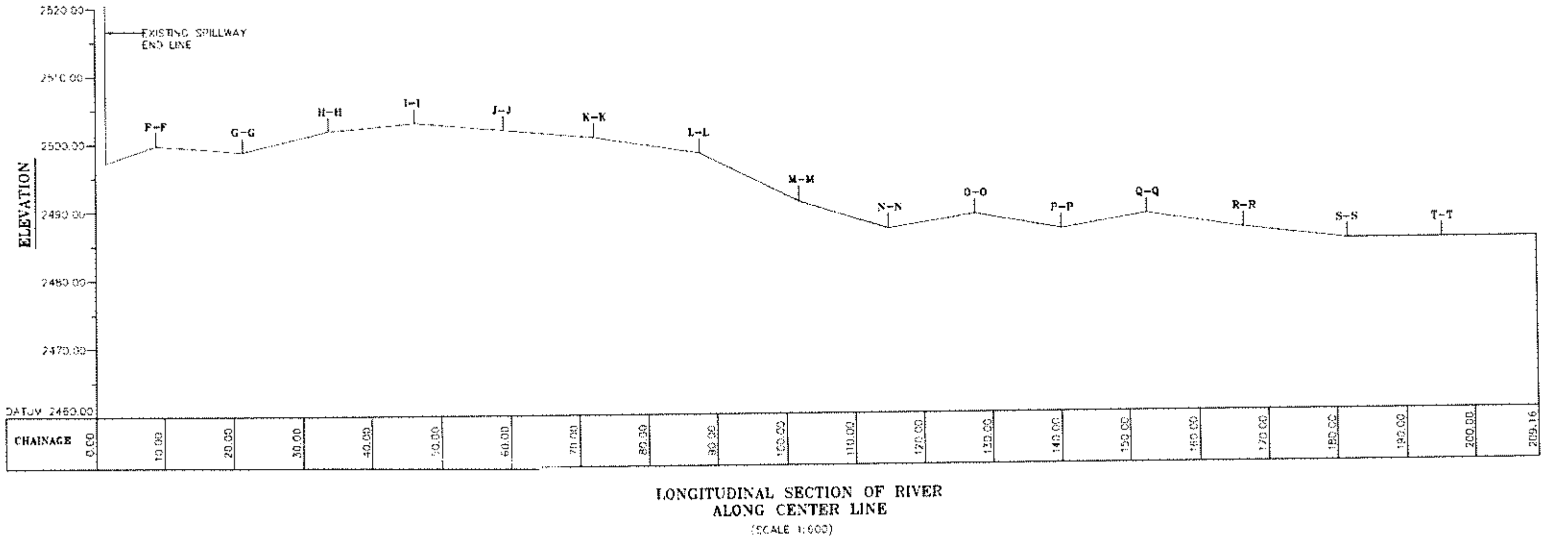


SECTION F-F'

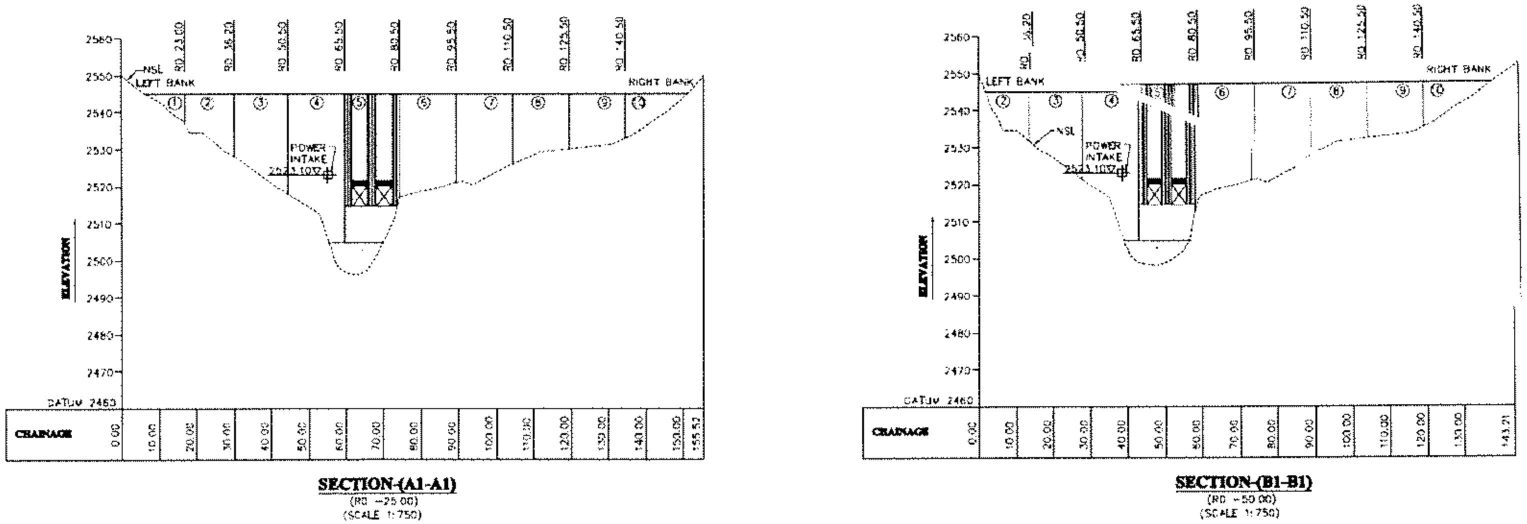
Drg. 4 (e) Section E-E' and (f) Section F-F' of the un-gated surface spillway



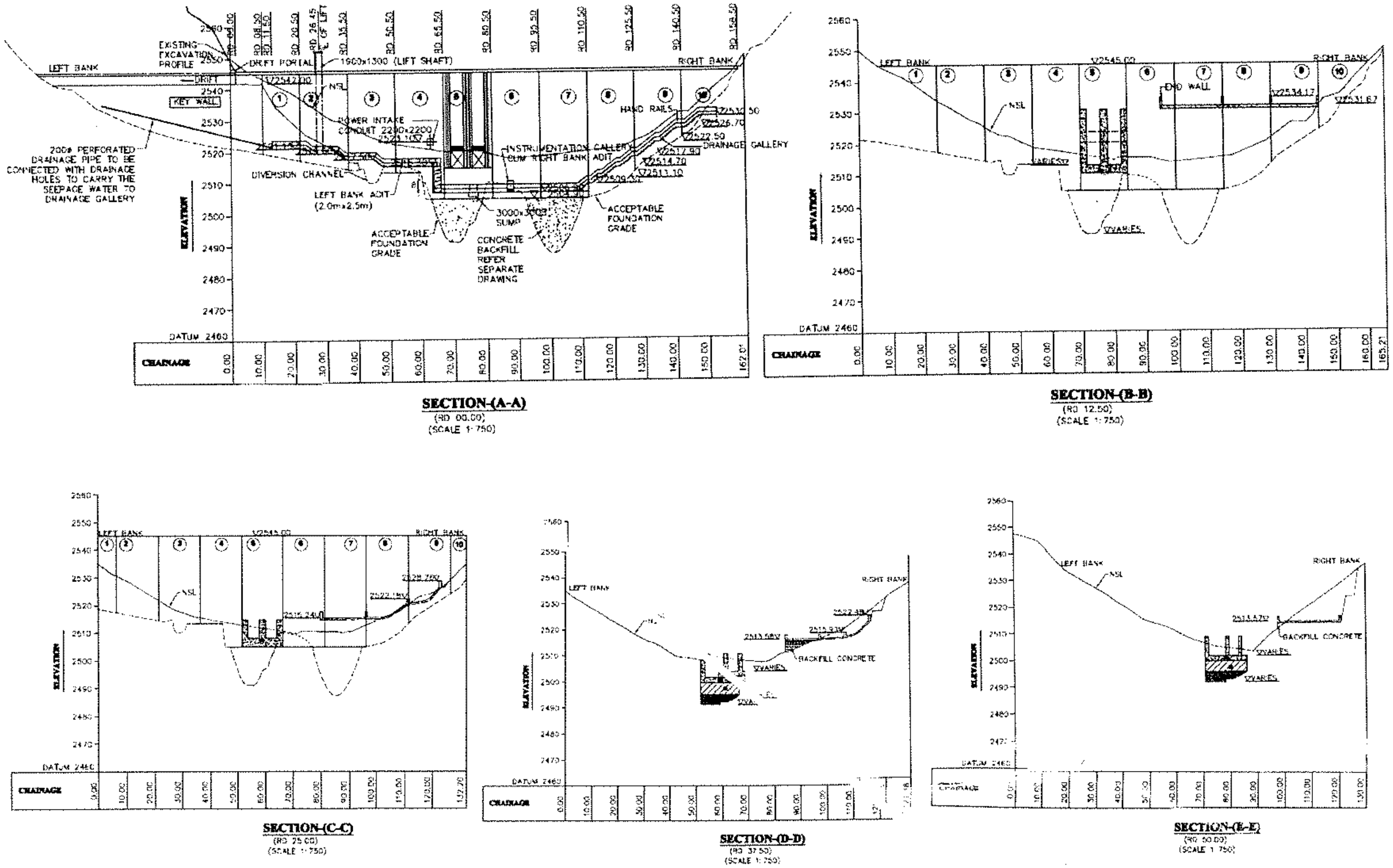
Drg. 5 Plan of the river downstream of the dam



Drg. 6 Longitudinal section of the river along centre line downstream of the dam



Drg. 7 a1& b1 Upstream cross-sections of river A1-A1 & B1-B1



Drg. 7 a-e Sections of the rivers A-A, B-B, C-C, D-D, & E-E

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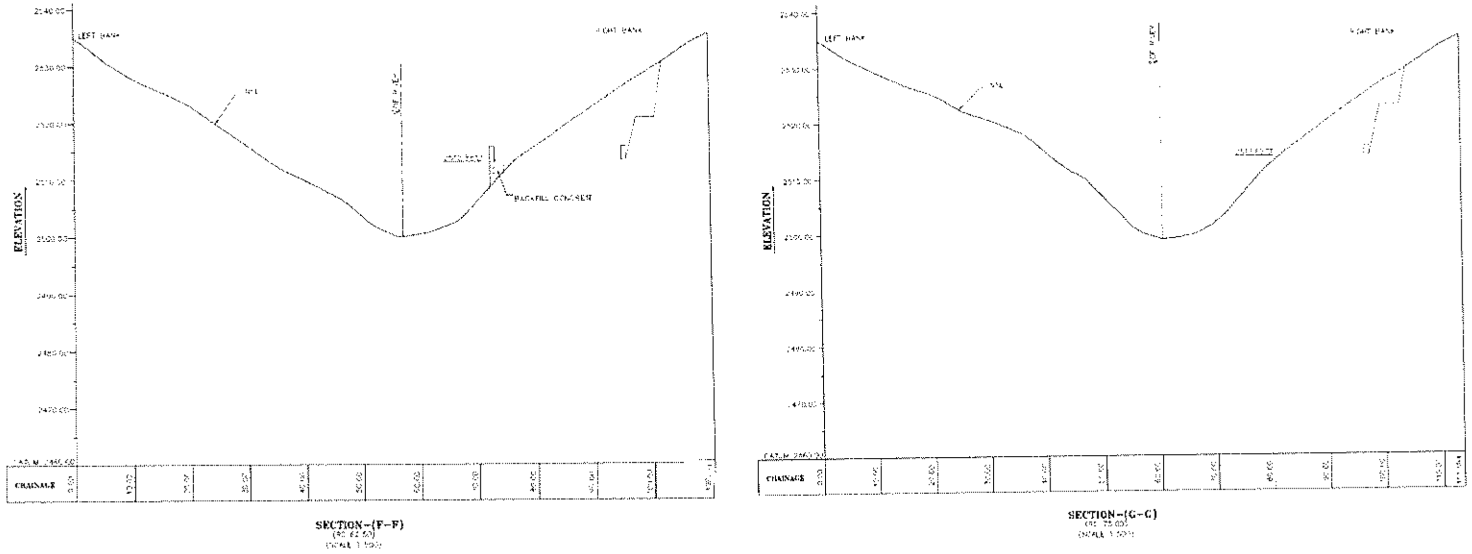
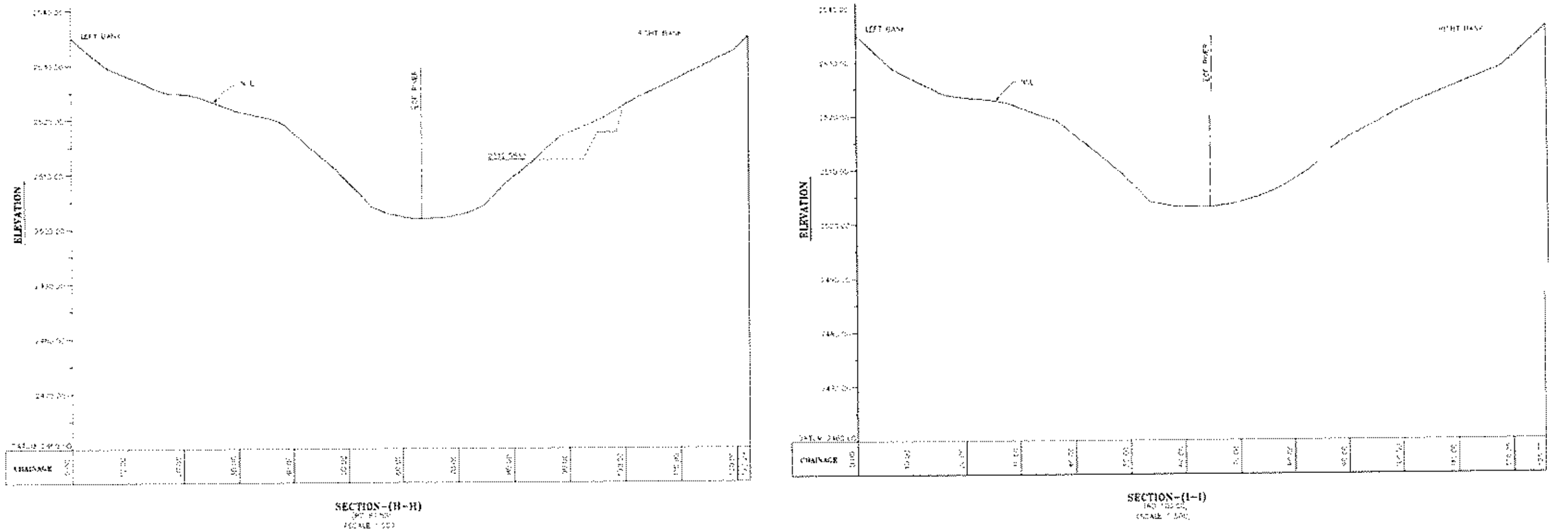


SECTION-(F-F)

SECTION-(G-G)



SECTION-(H-H)

SECTION-(I-I)

Drg. 7 f-i Sections of the rivers F-F, G-G, H-H, & I-I

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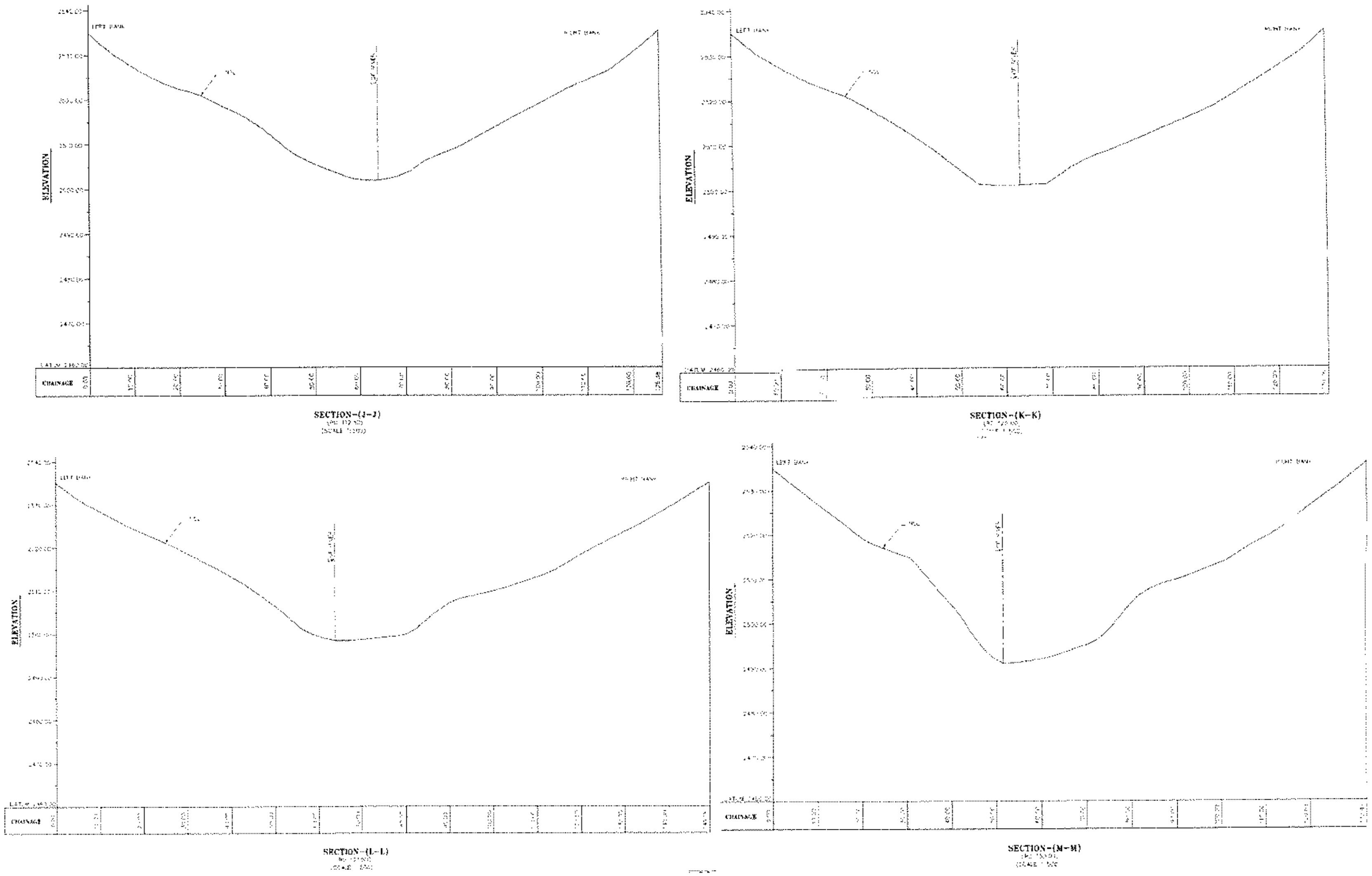
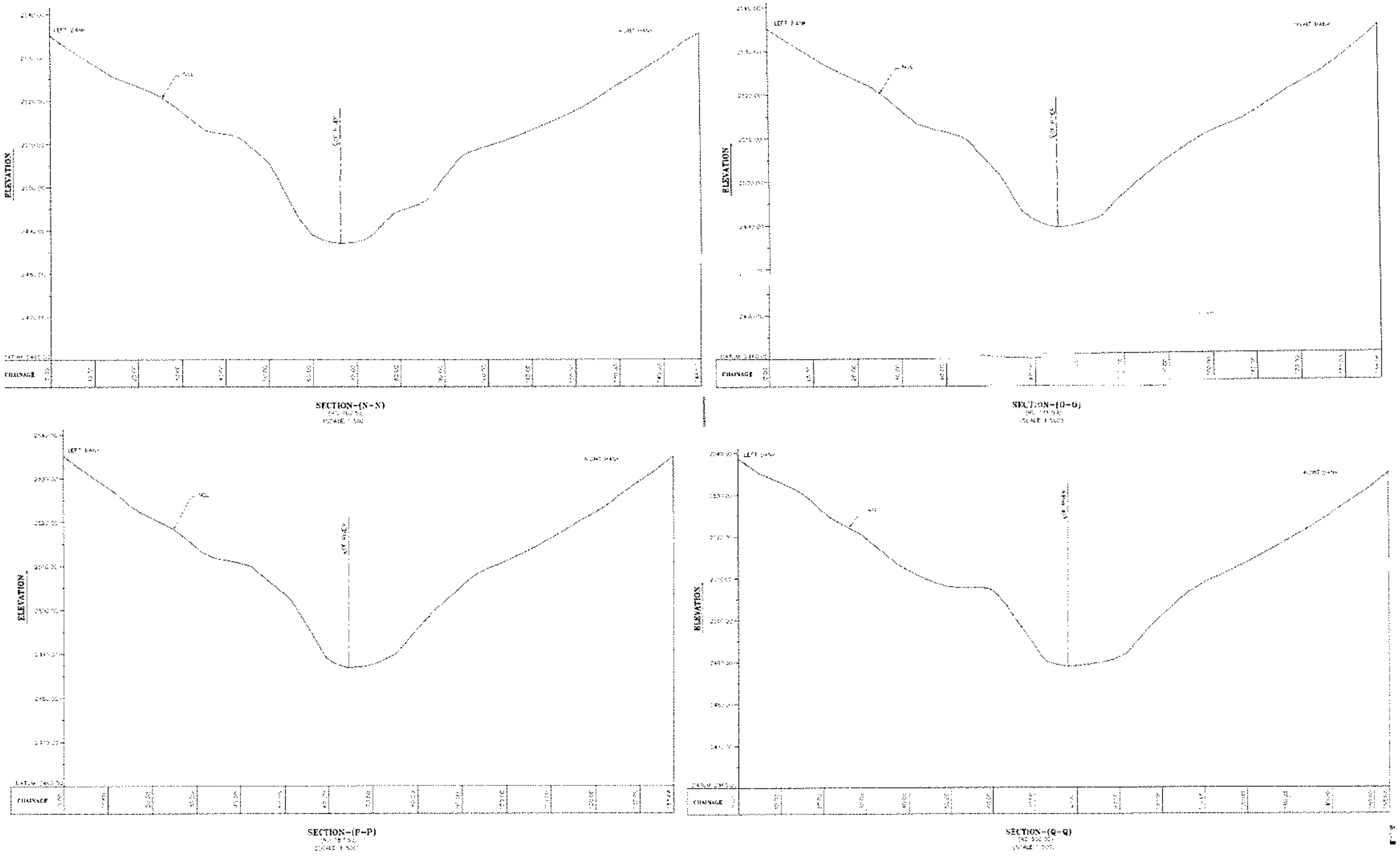
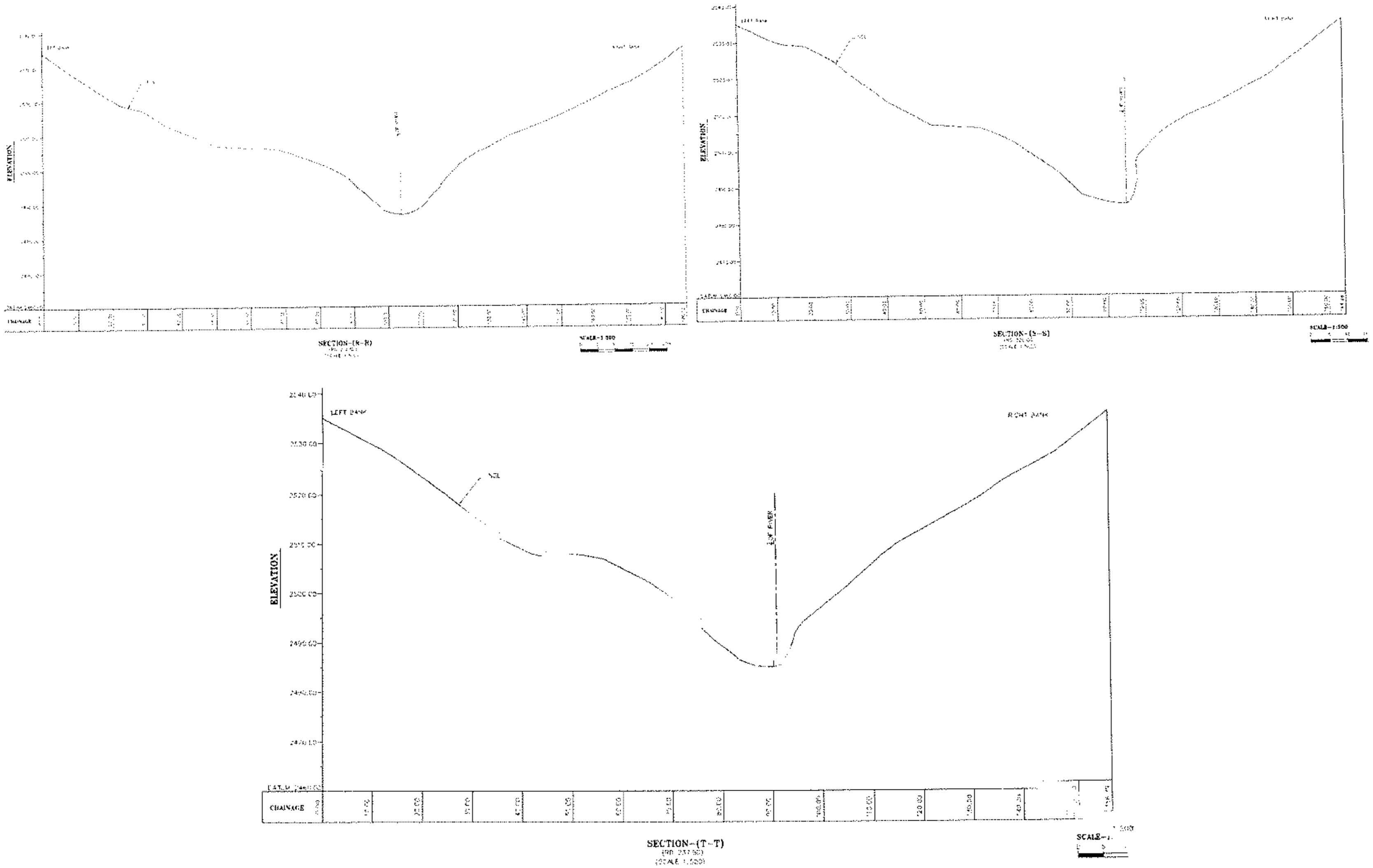


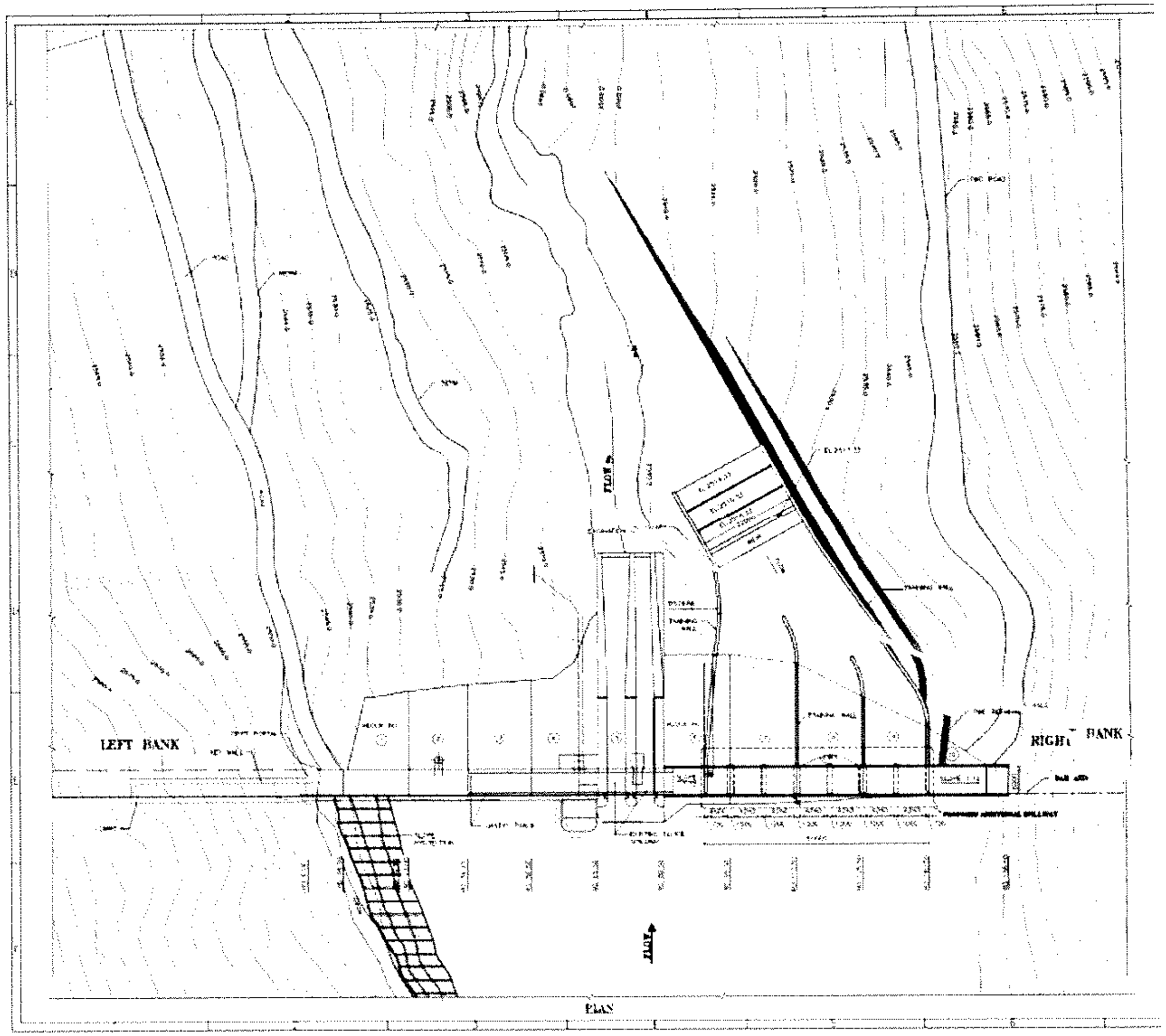
Drg. 7 j-m Sections of the rivers J-J, K-K, L-L, & M-M



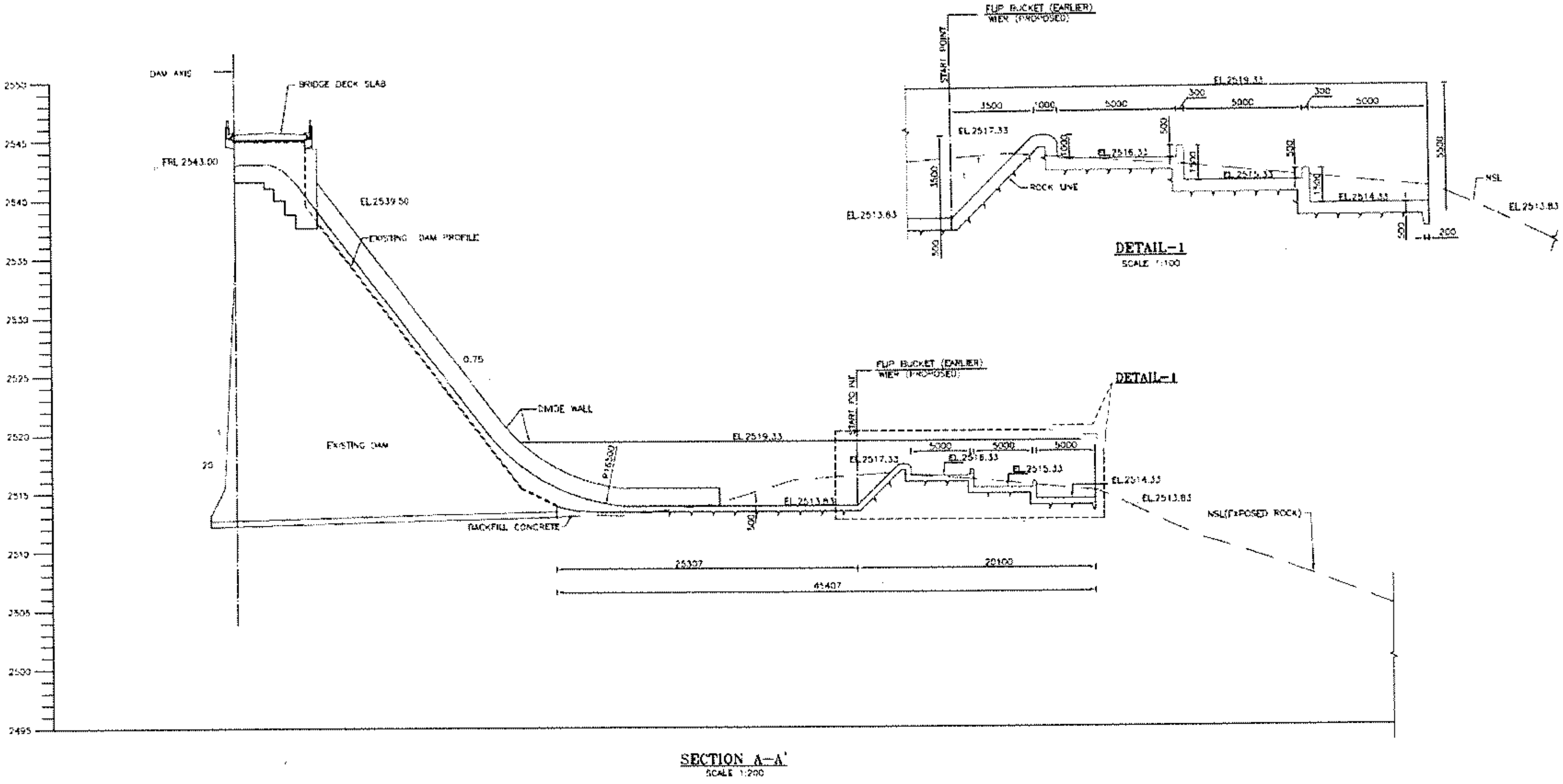
Drg. 7 n-q Sections of the rivers N-N, O-O, P-P, & Q-Q



Drg. 7 r-t Sections of the rivers R-R, S-S, & T-T



Drg. 8 Plan layout of the modified un-gated surface spillway



Drg. 9 L-section of the modified stilling basin of the un-gated surface spillway

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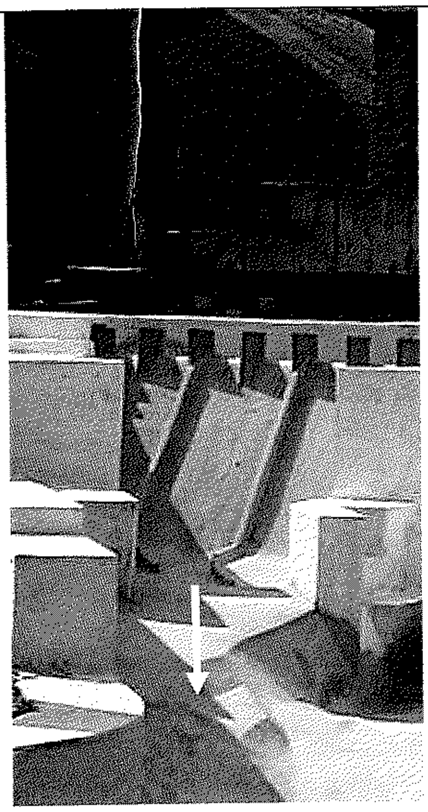
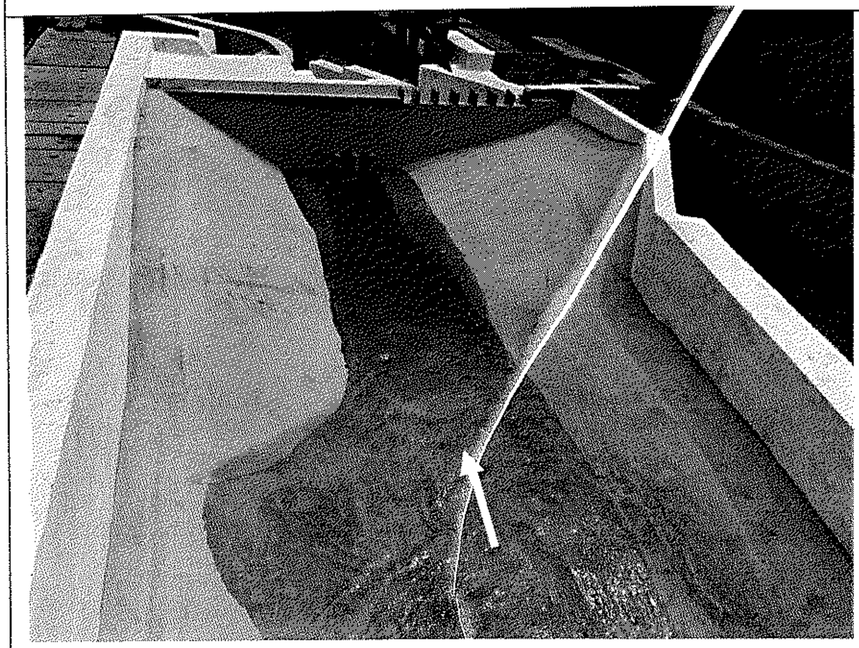
	**Plate 1** Overview of the model (without modification of un-gated surface spillway)
	**Plate 2** Upstream view of the model

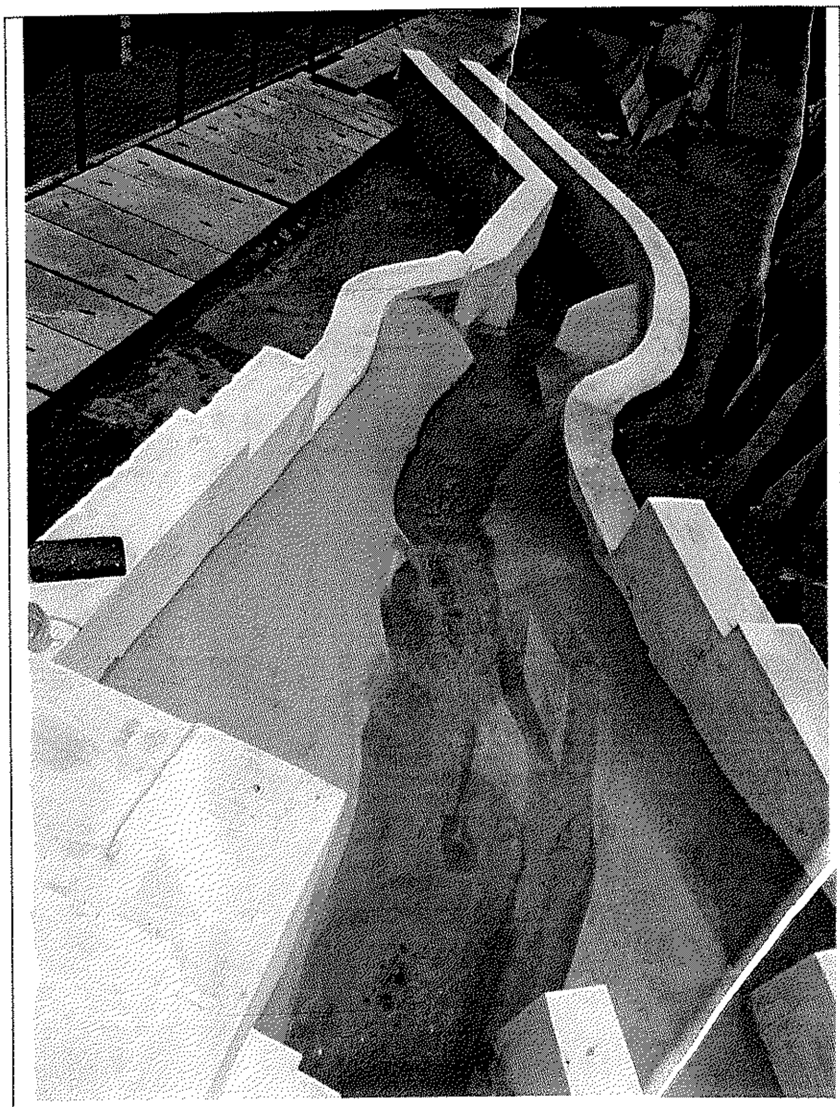


Plate 3 Downstream view of the model

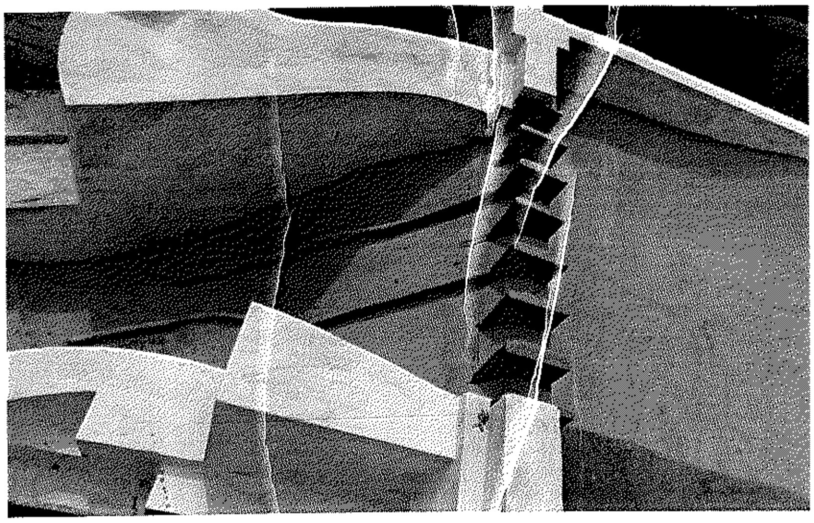


Plate 4 View of the un-gated surface spillway

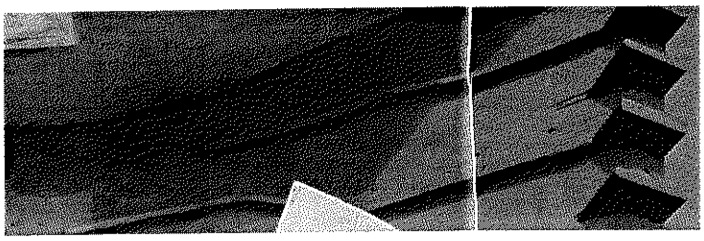


Plate 5 Pressure points on the surface of the un-gated surface spillway

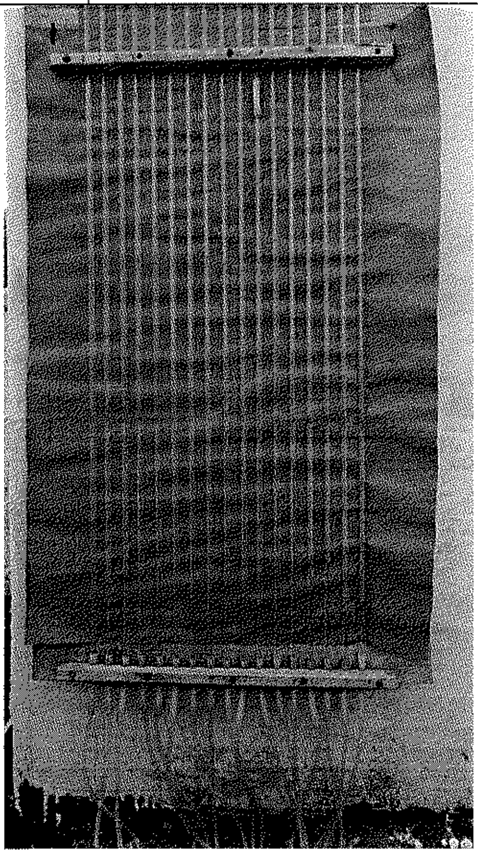


Plate 6 Manometer fitted with pressure points on the surface of the un-gated surface spillway

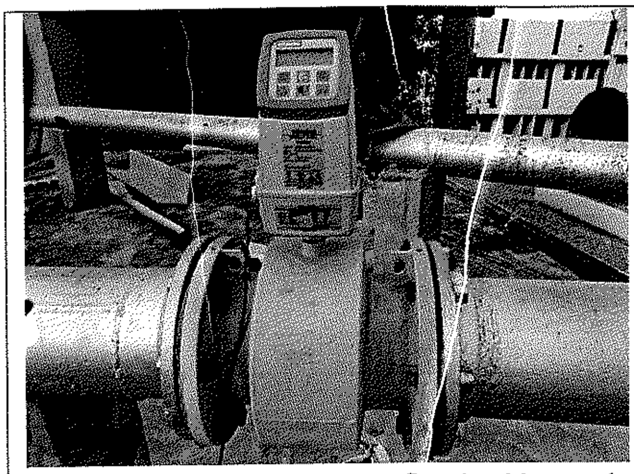


Plate 7 Magnetic flowmeter fitted with supply pipe

Plate 8 Flow measurement in supply pipe with ultrasonic flowmeter

Plate 9 Strong cross-currents in the stilling basin (Under operation of un-gated surface spillway)

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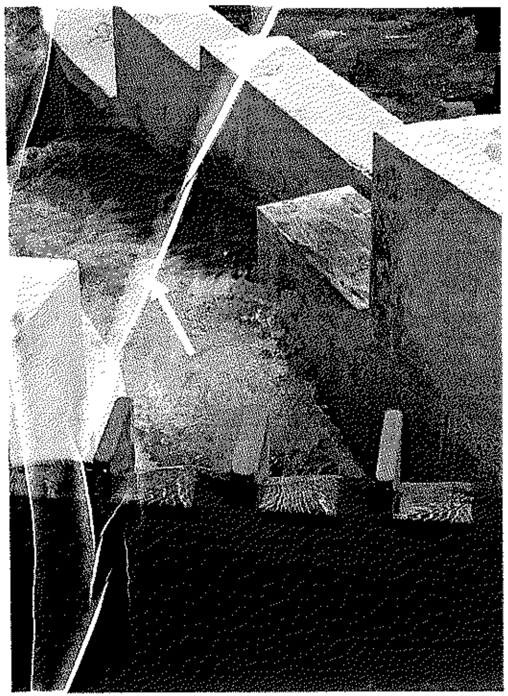

Plate 10 Partial flipping action of the flip bucket (Under operation of un-gated surface spillway)

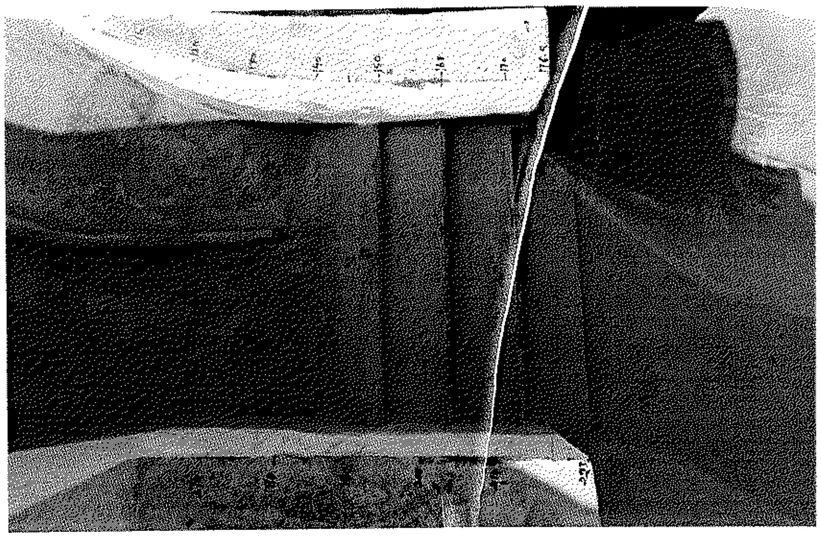

Plate 11 Modified un-gated surface spillway

Plate 12 Flow over modified un-gated surface spillway (under operation of un-gated surface spillway)

ANNEXURE-X

1.1 LOCATION:

State	Himachal Pradesh
District	Kullu
River	Malana Nallah, a tributary of Parbati River in the Beas Basin
Vicinity for Dam	Dam site located 3km up stream of Malana village at EL 2500m
Vicinity for Power House	Power House on left bank of Malana Khad immediately upstream of Malana-I HEP diversion Weir
Latitude	Between 32°02'15"N and 32°05'06"N
Longitude	Between 77°15'26"E and 77°16'51"E
Access to project by road	Via Chandigarh (325 Km),-Kiraatpur, Bhunter.
Nearest rail head	Kiraatpur (225 Km)
Nearest airport	Bhunter (25 Km)

1.2 HYDROLOGY

	Project Features	As Proposed
Catchment Area	158 Sq Km	158 Sq Km
Design discharge	20 cumecs	20 cumecs
Design flood (PMF)	650 cumecs	650 cumecs
Snow fall Catchment	76.20 km^2	76.20 km^2
Type of stream	Perennial	Perennial
Average annual rainfall	218 mm	218 mm

1.3 PROJECT STRUCTURES

1.3.1 DIVERSION STRUCTURE

(i) RESERVOIR

F.R.L	2543.00m	2543.00m
M.D.D.L.	2528.00 m	2528.00 m

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	Gross storage	0.386 M m^3	0.386 M m^3
	Live storage	0.2875 M m^3	0.2875 M m^3
	Submergence area at FRL	3.5 Ha	3.5 Ha
	Village affected	Nil	Nil
	Population affected	Nil	Nil
(ii)	**DAM**		
	Type	Concrete Gravity	Concrete Gravity
	Height above river bed	45.00 m	45.00 m
	Top of Dam	EL 2545.0m	EL 2545.00m
	Crest Length	150.0(Dam block)+63m(Key wall)	150.0(Dam block)+63m(Key wall)
	FRL	EL2543m	EL2543m
	MDDL	EL2528m	EL2528m
	Live storage	0.2875 M. cum	0.2875 M. cum
(iii)	**SPILLWAY BAYS**		
	Type & Size	Breast wall type	Breast wall + Surface type
	a) Breast wall type	2 Nos. bays of 4m x 5.5m	2 Nos. bays of 4m x 5.5m
	b) Surface	-	7 Nos. bays of 6.25m x 2.0m
	Spillway		
	a) Breast wall Type	Chute Spillway	Chute Spillway
	b) Surface Type	-	Surface Chute Spillway
	Gates		
	a) Breast wall Type	Radial Gates operated by Hydraulic Hoist	Radial Gates operated by Hydraulic Hoist
	b) Surface Type	-	Un-gated
	Crest Level		
	a) Breast wall Type	EL2514.50m	EL2514.50m
	b) Surface Type	-	EL2543.00m

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(iv) POWER INTAKE		
Intake structure	In non-overflow block no.4 on left bank	In non-overflow block no.4 on left bank
No.& size of opening	One number of 3m x 3m Bell mouth opening	One number of 3m x 3m Bell mouth opening
Trash rack Structure	In non-overflow block no.4on left bank	In non-overflow block no.4 on left bank
(v) INTAKE PIPE		
Size	One no. of 2.2m dia pipe	One no. of 2.2m dia pipe
Length	144m long	144m long
Center line of pipe	EL 2523.1m	EL 2523.1m
1.3.2 HEAD RACE TUNNEL		
Type	D-shaped, concrete and shotcrete lined	D-shaped, concrete and shotcrete lined
Size and length	2.9 m x 2.9 m D-shaped, 4.987 km long	2.9 m x 2.9 m D-shaped, 4.987 km long
Bed Slope	1 in 151.00	1 in 151.00
Invert level at portal	EL2512.812m	EL2512.812m
Design discharge	20 cumecs	20 cumecs
Velocity	2.67 m/sec.	2.67 m/sec.
Adit 1	3.5 m D-shaped, 273 m long	3.5 m D-shaped, 273 m long
Adit 2	3.5 m D-shaped, 171 m long	3.5 m D-shaped, 171 m long
Adit-3	4mx4m,105m Long	4mx4m,105m Long
Adit-3A	4.5mx4.5m,46.6m Long	4.5mx4.5m,46.6m Long
Adit 4	4.5mx4.5m,248.5m Long	4.5mx4.5m,248.5m Long
Adit 5	6mx6m,158m Long	6mx6m,158m Long
Adit 6	4.5mx4.5m,	4.5mx4.5m,180m Long

		180m Long	
	Adit 7	5mX5m,43m Long	5mX5m,43m Long
1.3.3	**SURGE SHAFT**		
	Type	Underground-simple Surge Shaft	Underground-simple Surge Shaft
	Size	6 m dia, 80m height	6 m dia, 80m height
1.3.4	**BONNET GATE CHAMBER**		
	Size	2.2m x 2.2 m	2.2m x 2.2 m
	Invert level	EL2483.978m	EL2483.978m
1.3.5	**PRESSURE SHAFT**		
	Type	Underground	Underground
	Size/length	1 no. of 2.5 m dia,	1 no. of 2.5 m dia,
	Main Pressure Shaft	747m long	747m long
	Unit Pressure Shaft	2nos. of 1.8 m dia, 40.24m and 30.73long	2nos. of 1.8 m dia, 40.24m and 30.73long
	Design Discharge	20.0 cumecs	20.0 cumecs
	Type of steel for steel liner	IS 2002-Grade 3 SAILMA 550 HI, ASTM A 517Grade F	IS 2002-Grade 3,SAILMA 550 HI, ASTM A 517 Grade F
	Thickness	10 mm – 28 mm	10 mm – 28 mm
1.3.6	**POWER HOUSE**		
	Type	Underground	Underground
	Size	67.5m(L)x17.5m(W) x35.85m(H)	67.5m(L) x 17.5m(W) x 35.85m(H)
	Transformer Bay	26.5m x 12m x 13m, Size	26.5m x 12m x 13m, Size
		EL 1912.0m, Bottom elevation of Power House	EL 1912.0m, Bottom elevation of Power House
	Power House Levels	EL 1947.85m, Top elevation of Power House	EL 1947.85m, Top elevation of Power House
		EL 1929.57m, Service bay level	EL 1929.57m, Service bay level
	Control Block	Size,12m(L) x 17.5m(W)	Size,12m(L) x 17.5m(W)
	Bus Duct	Bus duct,3 m (W) x 4 m (H), D-shaped	Bus duct,3 m (W) x 4 m (H), D-shaped

No. of Units	2	2
Type of turbines	Vertical axis Pelton wheel	Vertical axis Pelton wheel
C/L of turbines	EL1919.40m	EL1919.40m
Type of Generator	Vertical Shaft	Vertical Shaft
Terminal Voltage	11kV	11kV
Transformer Capacity	63.9 MVA	63.9 MVA
Installed capacity	100 MW (2x50MW)	100 MW (2x50MW)
Gross Head	623.60m	623.60m
Rated net Head	608m	608m

1.3.7 MAIN ACCESS TUNNEL

Main Access Tunnel	Size,6m x 6m, D-shaped Length,382m long Starting level, EL 1951.50m Slope of MAT, 1 in 17	Size,6m x 6m, D-shaped Length,382m Starting level, EL 1951.50m Slope of MAT, 1 in 17

1.3.8 TRT

Main Tail Race Tunnel	**Unit-I TRT** Length of Unit-I TRT,31.7m Size of Unit-I TRT, 2.5m (W) x 4.5m (H), D- shaped	**Unit-I TRT** Length of Unit-I TRT,31.7m Size of Unit-I TRT, 2.5m (W) x 4.5m (H), D- shaped
	Unit-II TRT Length of Unit-II TRT, 22.11 m Size of Unit-II TRT, 5m (W) x 6m (H), D-shaped	**Unit-II TRT** Length of Unit-II TRT, 22.11 m Size of Unit-II TRT, 5m (W) x 6m (H), D-shaped
	TRT cum Cable Tunnel Length of TRT cum Cable Tunnel, 255m	**TRT cum Cable Tunnel** Length of TRT cum Cable Tunnel, 255m

	Size of TRT cum Cable Tunnel,5m (W) x 6.75m (H), D-shaped	Size of TRT cum Cable Tunnel,5m (W) x 6.75m (H), D-shaped
	Slope of TRT – 1 in 1000	Slope of TRT – 1 in 1000
	Starting level, EL 1912.4m	Starting level, EL 1912.4m
Control Cable Tunnel	Control cable tunnel,3 m (W) x 3.25 m (H), D-shaped	Control cable tunnel, 3m (W) x 3.25 m (H), D-shaped

1.4 ENERGY GENERATION

Energy generation in 90% dependable year	409.77 M Kwh	409.77 M Kwh

CHAPTER - 5

ORGANIZATION REQUIRED FOR EXECUTION

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5. ORGANIZATION REQUIRED FOR EXECUTION

5.1 INTRODUCTION

The plant was successfully commissioned in 2012. This report deals only about the additional un-gated surface spillway proposed in the Non-Overflow blocks.

Now for additional un-gated surface spillway, seven bays have been proposed by using the **NOF block Nos. 6, 7, 8 and 9** with spillway crest at **El. 2543.00m.** The overall water way width proposed shall be 43.75m with the **spillway crest El.2543.00m** and the **maximum water level in the reservoir is considered as El. 2545.00m.** The crest elevation of existing NOF blocks will be **El 2545.00m**. It is proposed to connect the crest level of existing NOF blocks and the top of the bridge of newly proposed un-gated surface spillway by providing suitable transition at the dam crest.

The construction period for the above project is proposed to be around eight months as shown in the **"Annexure-5".** To achieve the set targets and cover all aspects involved in construction proposed scheme, a dedicated workforce is required so that the Project can be completed within the set targets.

5.2 SITE ORGANIZATION

The execution of additional un-gated surface spillway proposed to be carried out through, award of contract to the specialized agency(s). The site supervision/project management would be carried out through project management consultant in addition to the existing operation & maintenance staff of the Everest Power Pvt Ltd. The Whole work shall be supervised by Civil engineer Expert.

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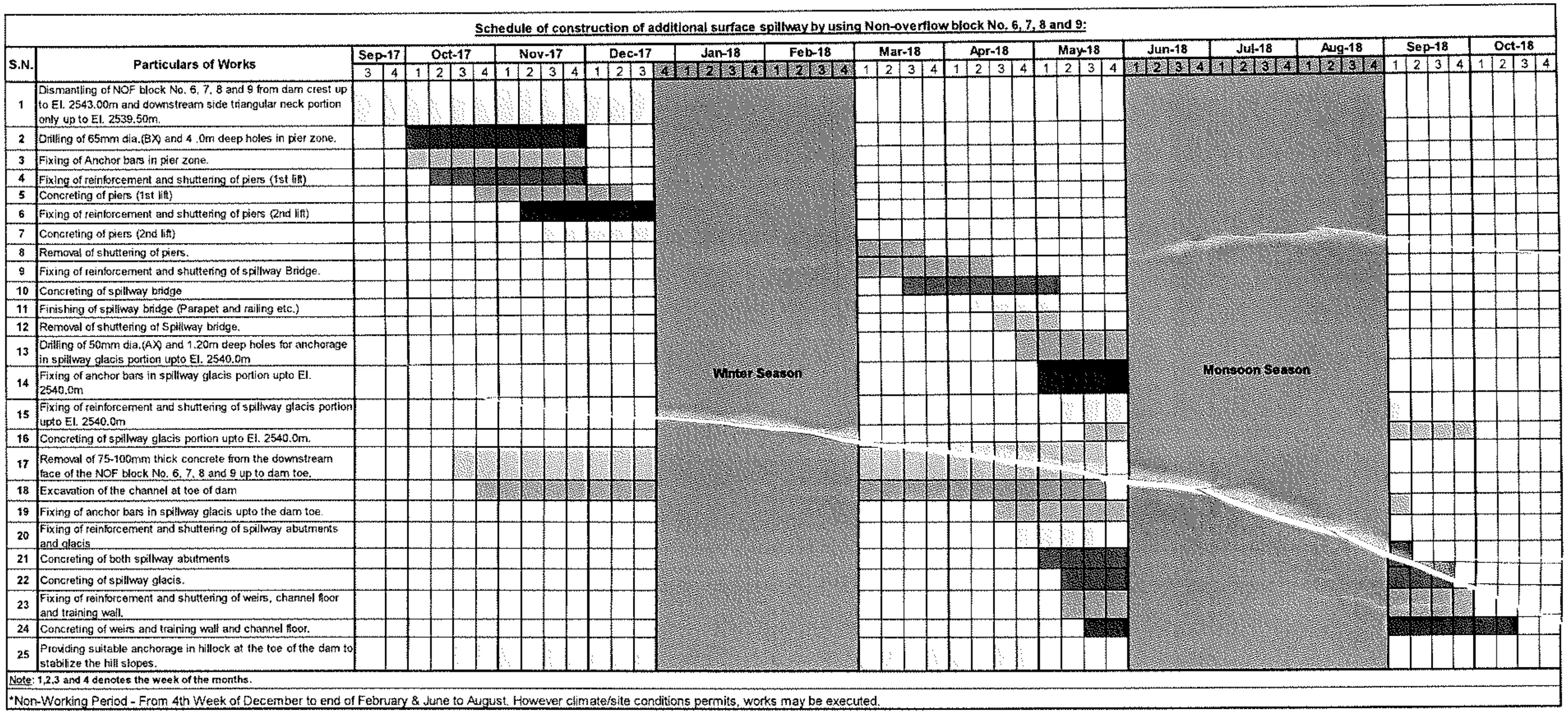
"Annexure-5"



Schedule of construction of additional surface spillway by using Non-overflow block No. 6, 7, 8 and 9:

S.N.	Particulars of Works
1	Dismantling of NOF block No. 6, 7, 8 and 9 from dam crest up to El. 2543.00m and downstream side triangular neck portion only up to El. 2539.50m.
2	Drilling of 65mm dia.(BX) and 4 .0m deep holes in pier zone.
3	Fixing of Anchor bars in pier zone.
4	Fixing of reinforcement and shuttering of piers (1st lift)
5	Concreting of piers (1st lift)
6	Fixing of reinforcement and shuttering of piers (2nd lift)
7	Concreting of piers (2nd lift)
8	Removal of shuttering of piers.
9	Fixing of reinforcement and shuttering of spillway Bridge.
10	Concreting of spillway bridge
11	Finishing of spillway bridge (Parapet and railing etc.)
12	Removal of shuttering of Spillway bridge.
13	Drilling of 50mm dia.(AX) and 1.20m deep holes for anchorage in spillway glacis portion upto El. 2540.0m
14	Fixing of anchor bars in spillway glacis portion upto El. 2540.0m
15	Fixing of reinforcement and shuttering of spillway glacis portion upto El. 2540.0m
16	Concreting of spillway glacis portion upto El. 2540.0m.
17	Removal of 75-100mm thick concrete from the downstream face of the NOF block No. 6, 7, 8 and 9 up to dam toe.
18	Excavation of the channel at toe of dam
19	Fixing of anchor bars in spillway glacis upto the dam toe.
20	Fixing of reinforcement and shuttering of spillway abutments and glacis
21	Concreting of both spillway abutments
22	Concreting of spillway glacis.
23	Fixing of reinforcement and shuttering of weirs, channel floor and training wall.
24	Concreting of weirs and training wall and channel floor.
25	Providing suitable anchorage in hillock at the toe of the dam to stabilize the hill slopes.

Note: 1,2,3 and 4 denotes the week of the months.

*Non-Working Period - From 4th Week of December to end of February & June to August. However climate/site conditions permits, works may be executed.

CHAPTER - 6

SEQUENCE OF CONSTRUCTION OF ADDITIONAL UN-GATED SPILLWAY

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6. SEQUENCE OF CONSTRUCTION OF ADDITIONAL UNGATED SURFACE SPILLWAY

6.1 GENERAL

The sequence of construction of additional un-gated surface spillway by doing modification as shown in the drawings in Non-overflow blocks shall be as under:

1. Excavation/ dismantling of **NOF block No. 6, 7, 8 and 9** as per the drawings.
2. Drilling of 50mm dia. **(AX)** and 1.5m deep holes and fixing of anchor bars in the region near the pier.
3. Drilling of 50mm dia. **(AX)** and 1.2m deep holes and fixing of anchor bars in the region away from the pier.
4. Fixing of reinforcement and shuttering of piers and crest (1st Lift)
5. Concreting of piers and spillway crest (1st lift)
6. Fixing of reinforcement and shuttering of piers (2nd lift)
7. Concreting of piers (2nd lift)
8. Removal of shuttering of piers.
9. Fixing of reinforcement and shuttering of Spillway Bridge.
10. Concreting of spillway bridge
11. Construction of Pre-cast Cement Concrete blocks masonry walls in all the six spillway openings to prevent spilling of water from reservoir.
12. Finishing of Spillway Bridge (Parapet and railing etc.)
13. Removal of shuttering of Spillway Bridge.
14. Fixing of reinforcement and shuttering of spillway glacis portion up to the piers end.
15. Concreting of spillway glacis portion up to the piers end.
16. Removal/ dismantling of weathered Concrete from the downstream surface of the NOF block No. 6, 7, 8 and 9 up to dam toe.
17. Excavation of the channel at toe of dam as per the drawings. The excavation of the downstream channel shall be completed before placement of concreting of spillway glacis.
18. Drilling of 50mm dia. **(AX)** and 1.2m deep holes and fixing of anchor bars in spillway glacis up to the dam toe.
19. Fixing of reinforcement and shuttering of spillway abutments and glacis.
20. Concreting of both spillway abutments.
21. Concreting of spillway glacis.

22. Fixing of reinforcement and shuttering of Stilling basin with broad crested weir, channel floor and training wall.
23. Concreting of Stilling basin with broad crested weir and training wall and channel floor.
24. RCC of both the spillway abutments shall be completed along with the RCC of the spillway glacis.
25. Providing suitable anchorage in hillock at the toe of the dam (downstream channel) to stabilize the hill slopes.
26. Dismantling of wall made of precast cement concrete blocks from all the seven spillway openings.

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CHAPTER - 7

COST ESTIMATE

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7. COST ESTIMATE

7.1 GENERAL

The cost of the proposed scheme has been worked out on the basis of designs and drawings as referred and annexed in the detailed Project report. Wherever possible, current costs of equipment and material have been taken from manufacturers. Unit prices have been derived in detail for all scope of works. These details include excavation in rock/soil, dismantling/cutting of concrete, Reinforcement, Grouting and concrete works etc.

7.2 PRICE LEVEL

The cost estimate has been made at the price level of February 2016. All costs have been first estimated on a per unit basis for each of the components. These have been evolved to obtain the entire project cost for the proposed scheme.

7.3 RATE ANALYSIS

The unit rates have been formulated based on market survey and prevailing rates of similar project, which have similar scope of works. The rate of equipment and machinery has been included in the unit cost rate. The detailed rate analysis of various item of works are appended at "**Annexure-6**" and hourly use rate of equipment is appended at **"Annexure-7"**

7.4 COST

Based on the rate analysis & bill of quantities derived from the drawings, the cost of the proposed scheme has been worked as under.

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ABSTRACT OF COST FOR ADDITIONAL UN-GATED SURFACE SPILLWAY

Sl. No.	Description	Unit	Quantity	Unit Rate (Rs)	Total Cost (in lakhs)
1	Excavation in rock	Cu. m.	11,605	619.00	71.83
2	Existing Concrete Dismantling/Cutting (Diamond Wire Saw Cutting)	Sqm	2570	15500.00	398.35
3	Existing Concrete Dismantling/Cutting (Circular Saw Cutting)	Sqm	290	10500.00	30.45
4	Removal of Concrete (Lifting, Loading & Transportation)*	Cu.m	1,668	2000.00	33.36
5	Concrete grade M25 A40	Cu.m.	4,700	8463.00	397.76
6	TOR Reinforcement Steel	MT	438	70038.00	306.77
7	Precast Blocks	Cu. m.	104	9840.00	10.23
8	PVC Pipe (100mm Dia)	m	45	584.00	0.26
9	Drilling of holes for Dowel Bars	m	2,575	550.00	14.16
10	Steel Plate 25mm thick for Bearing	MT	9	65000.00	5.85
11	Finishing & Placing of PVC water stop in contraction joint between blocks	m	165	582.00	0.96
12	Expansion Joint in Bridge	m	70	4000.00	2.80
13	Cement Bags for Grouting	Nos.	515	911.00	4.69
14	Shotcrete (100mm thick)	Cu. m.	171	16412.00	28.06
15	Rock bolts (25mm Dia)	m	1,915	971.00	18.59
16	Backfill concrete (M10 grade)	Cu. m.	1,602	5411.00	86.68
17	Rock Anchors (25mm Dia)	m	1,055	1460.00	15.40
18	Stone Masonry	Cu. m.	440	2000.00	8.80
19	Compacted Backfill	Cu. m.	280	450.00	1.26
20	M10 Grade - PCC	Cu. m.	25	6000.00	1.50
21	Temporary Steel Bridge with approach roads	LS	-	-	40.00
Sub Total (a)					**1477.79**
14	Contingencies	@	3.00%		44.33
15	Work Charge Establishment	@	2.00%		28.96
Total (in Lakhs)					**1549.13**
16	Consultancy Charges for Detail Engineering	LS	-	-	8.00
17	Model studies	LS	-	-	30.00
18	Project Management & Site supervision	LS	-	-	20.00
Grand Total (Lakhs)					**1609.68**

*The rate of removal of concrete including its lifting, loading and transportation up to 8km and unloading at dumping yard has been assumed as Rs. 2000/cum.

**** Statutory and Regulatory taxes will be applicable as per actual basis**

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ANNEXURE - "6"

RATE ANALYSIS OF VARIOUS CIVIL WORKS ITEMS

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Delhi

1 Cement
Unit : Bag

Amount in Rs.

Cement per MT for Malana	**6300**	per MT	
Cement Cost for Malana PH (in Rs)	315.00	per bag	50 Kg
CST inclusive	0.00	per bag	
Carriage (inclusive)	0.00	per bag	
Unloading and stacking at store	3.00	per bag	
Sub Total	318.00	per bag	
Storage charges at 3%	9.54	per bag	
Loading into lorries at store	3.00	per bag	
Carriage from store to work site, distance of 12 km	12.00	per bag	
Unloading at work site	3.00	per bag	
Sub Total	27.54	per bag	
Total Cost **Rs**	**346.00**	**per bag**	

2 Sand
Unit : cum

Unit rate of coarse aggregate per cum	Rs.	1236.01
Add extra charges for unloading and misc etc @ 10%	Rs.	123.60
Total cost	Rs.	1359.61
Rate per Cum (Say)	Rs.	1359.61

3 Coarse Aggregate
Unit : cum

Unit rate of coarse aggregate per cum	Rs.	1589.16
Add extra charges for unloading and misc etc @ 10%	Rs.	158.92
Total cost	Rs.	1748.08
Rate per Cum (Say)	Rs.	**1749**

4 GELATINE- 80% (Power Gel) Per Kg.

Rate for Kullu	MT	67000
Add Central Sales Tax	@13.75%	9212.5
Carriage from Kullu to Project Site 45 km	@Rs 10 per km per MT	450
Loading & Unloading at various places		200
Sub Total		76862.50
Storage charges at Project Site	@10%	7686.25
Issue Rate per Kg		**84.55**

5 Detonator

Rate - For Kullu	per thousand	13000
Add Central Sales Tax	@4%	520
Carriage from Kullu to Project Site	@Rs 1 per km per thousand	177
Loading & Unloading at various places		20
Sub Total		13717.00
Storage charges at Project Site	@10%	1371.70
Issue Rate for each detonator	**Rs**	**15.10**

6 Drill steel with jack hammer

Unit : m **Amount in Rs.**

Considering 4m drilling,requirement of drill steel are as follows:	
(I)Av Cost of 4m drill rod at site including cost of bit	5600
Total (The above cost is inclusive of all taxes,insurance, carriage to site and	5600
Total Capital Cost	5600
Bit life =130m	
Rate/m of drill rod & bit =Cost/130	**43.08**
3. Sharpening Charges	**4.31**
Total	**48.00**

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7 Tor Steel

Unit : M.T.	Amount in Rs.
For cost at Bhuntar (in Rs.)	37000.00
CST @5%	1850.00
Total	38850.00
Loading into trucks at Bhuntar	1500.00
Carriage from Bhuntar at distance 45 km @Rs 20/km per MT	900.00
Unloading from truck & stacking in store	1500.00
Sub Total :	42750.00
Storage charges at 2%	855.00
Supervision charges at 0.5%	213.75
Loading into trucks at store	1500.00
Carriage from store to work site, distance 12 km @ Rs 25 /km per MT	240.00
Unloading charges at work site	1500.00
Total cost	47058.75
Hence rate per M.T.	**47059.00**

SUMMARY OF UNIT RATES OF VARIOUS ITEMS OF WORK

S No	Item of Work	Unit	Rate
1.	Excavation in Rock	Rs./Cum	619.00
2.	Existing concrete dismantling/cutting* (Diamond Wire Cutting)	Rs./Sqm	15500.00
3.	Existing concrete dismantling/cutting* (Circular Saw Cutting)	Rs./Sqm	10500.00
4.	Concrete Grade M25 A40	Rs./Cum	8463.00
5.	TOR Steel Reinforcement	Rs./MT	70038.00
6.	Precast Blocks	Rs./Cum	9840.00
7.	PVC Pipe*	Rs./m	584.00
8.	Drilling of holes for Dowel Bars*	Rs./m	550.00
9.	Steel Plate 25mm thick for Bearing*	Rs./MT	65000.00
10.	PVC Water Stop*	Rs./m	582.00
11.	Expansion Joints*	Rs./m	4000.00
12.	Grouting	Rs./Bag	911.00
13.	Plain Shotcrete	Rs./Cum	16412.00
14.	Rock Bolt – 25mm dia.	Rs./m	971.00
15.	Backfill Concrete	Rs./Cum	5411.00
16.	Rock Anchors – 25mm dia.	Rs./m	1460.00
17.	Stone Masonry*	Rs./Cum	2000.00
18.	Compacted Backfill*	Rs./Cum	450.00
19.	M10 Grade Concrete - PCC*	Rs./Cum	6000.00

*Note: The above item rates estimated in this report are based on the market rates obtained in the month of December 2016. The tentative rates have been considered for the item of work no. 7, 8, 9, 10, 11, 17, 18 & 19 in the above table.

1 Excavation in Hard Rock (Requiring Drilling & Blasting)

Unit : cum

I Drilling Charges (Rock drilling for excavation will be carried out by Wagon Drill & Jack Hammers).

Description	Computation/Reference	Quantity / Cost	
Equipment		Jack Hammer	
Location of drilling		Narrow Benches, inaccessible area	
Hole dia meter	=bit dia	38	mm
Hole pattern (in m)		1.5x1.5	
Area per hole		2.25	Sq. m.
Volume of rock per m drill		2.25	Cum
Volume of rock excavated per meter dill considering pull effect & angular effect(66%).	=2/3 of vol. of rock excavated / m of drill	1.49	
Considering 100% volume excamtion by jack hammer.		100%	
Drill rate m/hour		6.00	
Drilling length for 1 cum of volume considering % drilling volume.	=%volume/volume of rock ex.per m drill	0.673	
Drill Time for 1 Cum rock excavatio	=Drilling length per cum of rock/drill rate	0.11	Hrs
Use rate machinery		1159	
Machinery charge		130.08	
		Rs	**130.08**
Cost of drill steel			
Unit rate of Drill steel		**48.00**	
Cost of drill steel per cum	Unit rate of drill steelx resp. drilling length	32.32	
Total drill steel cost			**32.32**
Total Drilling Charges		**Rs**	**162.40**

II Blasting Charges

Quantity of explosive Kg/Cum.	Ref: Const. Equip planning by RL Purifoy	1.01	kg
Average quantity of explosive/cum	Sum(%volume x quantity of explosive)	1.01	
Issue Rate of Explosive (gelatine)		84.55	
Cost of gelatine per cum		**85.39**	
Average depth of hole		1.75	m
Nos. of holes per cum	Sum(%volume / av. DepthxVolume per m of drill)		0.38
Nos. of Detonator			0.17
Rate of Detonator			15.10
Cost of Detonator per cum			**2.56**
Battery wearing charge of 15% cost of Detonator			**0.38**
Stemming charges 7% of Detonator			**0.18**
Total Blasting Charges			**88.52**
Total Drilling & Blasting Charges Sl no 1.1 + Sl. No. 1.2		**Rs**	**250.92**

III Transportaion Charges for blasted material

	Description	Computation / Reference	Qty / Cost	Unit
	Machinery cost per cum			
a	**Excavator backhoe, 2.0 cum capacity**			
	Estimated production rate	For bank quantity for common earth	115	m^3 / hr
	Operating effeciency		0.83	
	Job & management factor		0.75	
	Actual production rate	Estimated production ratexBucket fill factorxJ&M fac	71.59	m^3 / hr
	Hourly use rate	Refer Analysis of Hourly use rates of m/c./Eqpt	2552.00	Rs. / hr
	Cost per cum	Hourly use rate / Actual production rate	**35.65**	Rs. / m^3
b	**Crawler dozer - 320 HP**			
	Actual production rate	Equals 2 times production rate of excavator	230	m^3 / hr
	Hourly use rate	Refer Analysis of Hourly use rates of m/c./Eqpt	5094	Rs. / hr
	Cost per cum	Hourly use rate / Actual production rate	**22.15**	Rs. / m^3
c	**Dumper - 18 T capacity :**			
	Pay load capacity		18	T
	Unit weight of coarsely blasted rock		1.992	T / m^3
	Volume of well blasted rock	Pay load capacity / Unit weight	9.04	m^3
	Swell factor		0.83	
	Actual output	Volume (loose) x Swell factor	7.50	m^3
	Dumper cycle time :			
	Average lead	Assumed minimum lead	4	km
	Loading time		3.9	min
	Spotting time		0.50	min
	Turning & dumping time		2.00	min
	Loaded haul @ 16 km / hr	(Average lead x 60) / Loaded speed	15.00	min
	Empty haul @ 20 km / hr	(Average lead x 60) / Empty speed	12.00	min
	Total cycle time		33.41	min
	Operating effeciency		0.83	
	Number of trips/hr	60xOperating effeciency / Total cycle time	1.49	times
	Quantity carried by dumper/hr	No. of trips x volume carried per trip	11.18	m^3
	Hourly use rate	Refer Analysis of Hourly use rates of M/c./ Eqpt.	1690.00	Rs. / hr
	Cost per cum	Hourly use rate / Actual production rate	**151.19**	Rs. / m^3
	Abstract of transportation charges per cum :			
	Excavator backhoe, 2.0 cum capaci	Refer S.no.:a	35.65	Rs. / m^3
	Crawler dozer - 320 HP	Refer S.no.:b	22.15	Rs. / m^3
	Dumper - 18 T capacity :	Refer S.no.:c	151.19	Rs. / m^3
	Total Transportation Charges		**208.98**	
	Abstract of cost			
1	Total Drilling & Blasting Charges		**250.92**	Rs. / m^3
2	Total transportation charges per cum		**208.98**	Rs. / m^3
	Sub Total		**459.90**	
3	Levelling and trimming of disposed material @ 5.0 % of machinery cost		**23.00**	Rs. / m^3
4	Maintenance of haul roads @ 5.0 % of machinery cost		**23.00**	Rs. / m^3
5	Electrical energy charges @ 2.0 % of machinery cost		**9.20**	Rs. / m^3
	Prime cost	S.no.: 1 + 2 + 3 + 4	515.09	Rs. / m^3
	O/h charges & Contractor's profit @20% of prime cost		103.02	Rs. / m^3
	Rate per cum		**619.00**	Rs. / m^3

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2 Concrete in Dam (M-25)
Unit: cum

(A) Materials

Sl.No.	Item	Quantities	Unit	Rate	Per	Amt(in Rs)
1	Cement	11	bag	346.00	bag	3996.30
2	Sand	0.43	Cum	1359.61	Cum	584.63
3	Coarse Aggregate	0.86	Cum	1749.00	Cum	1504.14
4	Water			LS		15.00
5	Admixtures			LS		40.00
	Total					**6140.07**

5% Wastage and incidentals to work (bag supply)

(B) Batching, Mixing and Laying of Concrete

(I) Batching & Mixing Charges

Use Rate of 30 Cum / hr B&M plant = Rs. 1970

Ideal Production of B&M Plant = 30 m^3

Actual Production =ideal production x J&M factor x plant.eff. 18 m^3

Rate per cum = Use Rate/actual production = 109.44 Rs/m^3

Taking job management factor as 0.75 and plant efficiency factor as 0.80

(ii) Transport of concrete by 2m^3 bucket loded ontipper from batching and maixing plant to pick up point.

Average lead = 0.5 Km

Bucket capacity 2

No of buckets 1

Actual production at Batching Plant 18 m^3

Cycle time

Loading time of a bucket 6.67 Min

Spotting and waiting time 1.5 Min

Loaded haul @ 10.0KmPH (0.5 x 60/10) 3 Min

Turning and unloading time 5 Min

Empty haul @ 12.0KMPH (0.5x60/12) 2.5 Min

Total Cycle time 18.67 Min

No. of trips in a 50 min working hour (50/34) 2.68 Trips

Output of one truck with 1 buckets per hour (1 x 3 x 2.47) = 5.36 m^3

Use Rate of Tipper Rs. 1083

Transport Rate per Cum =
use rate / output 202.16 Rs/m^3

(iii)	Placement of concrete by Tower Crane	
	Use Rate of crane	0 Rs.
	Output of crane/hour using 3 cum bcuekts	28.8 m^3
	Rate per Cum = Use rate of Crane / output	0.00 Rs/m^3
	Labour for placement L.S.	0 Rs/m^3
	Total (iii)	0.00 Rs.

(iv)	Vibrating the concrete				
	(i)	Vibrators	LS		15 Rs/m^3
	(ii)	Labour	LS		100 Rs/m^3
		Total (iv)		Rs.	115 /m^3

(v)	Cleaning, slurry, curing and finishing				
	(i)	Sand blasting	LS	Rs.	15
	(ii)	Cement for slurry mortai	LS	Rs.	15
	(iii)	Cleaning and washing	LS	Rs.	10
	(iv)	Curing and finishing	LS	Rs.	20
		Total (v)		Rs.	60
(vi)	Catwalks and other aids for concreting			Rs.	15

(vii)	Other charges such as Track charges, air, workshop Electricity charges for lighting	LS	Rs.	60
	Total charges for item (B)-(i) to (vii)		Rs.	561.60
(C)	Shuttering charges @ Rs.			350 Rs/m^3

Abstract of charges	Rate om Rs. Per Cum		
(A) Materials		Rs.	6140.07
(B) Batching, mixing and laying		Rs.	561.60
(C) Shuttering @ Rs.		Rs.	350
	Prime Cost		**7051.68 Rs/m^3**
Add Overhead Charges & Contractor's Profit @20% of Prime Cost		Rs.	1410.34
	Grand Total		**8462.01 Rs/m^3**
Hence rate/cum		**Rs.**	**8463.00**

3 Tor Steel Reinforcement

Unit : M.T.

A. Material:

1	Cost of Tor steel bars at site	Rs	47059.00	per MT
2	Add for wastage and incidental to work at 2.5% of 1 above	Rs	1176.48	per MT
	Total item A	Rs	48235.48	per MT

B. Handling & Placing

1	Bending & cutting @6% of A above	Rs	2894.13	per MT
2	Handling at 5% of A above	Rs	2411.77	per MT
3	Placing and welding at 5% of A above	Rs	2411.77	per MT
4	Binding wire and other materials at 5% of A above	Rs	2411.77	per MT
	Total item B	Rs	10129.45	per MT

Abstract of Charges			
A. Material	Rs	48235.48	per MT
B. Handling & Placing	Rs	10129.45	per MT
Prime Cost	Rs	**58364.92**	**per MT**
Add overheads and contractor's profit at 20% on Prime C	Rs	11672.98	per MT
Grand Total	Rs	70037.91	per MT
Hence rate per MT	**Rs**	**70038**	

4 Precast Blocks

Unit: cum

I Rate of materials

S.No.	ITEM	QUANTITY	WASTAGE %	UNIT	RATE	AMOUNT
1	Cement	11.5	5	Bag	346.00	4177.95
2	Sand	0.42		Cum	1359.61	571.04
3	Coarse Aggregates	0.84		Cum	1749	1469.16
4	Water	L.S.				15.00
5	Admixture					100.00
	Total					**6333.15**

II	Cost of Reinforced Steel (2.5% of cement quantity) (=11.5x50x2.5%=14.375 kg)	676.47

III	i	Vibrating charges/cum	45.00
	ii	Cleaning, slurry, curing and finishing per cum	70.00
	iii	Winches, gantry and other aids for Lagging per cum	150.00
	iv	Other charges electricity, workshop and track charges	25.00
	v	Misc. supplies such as hose pipes, air and small tools etc.	100.00
		Total of 3 (i+ii+iii+iv+v)	390.00

IV	Transportation to Site	500.00

V	Erection on site		300.00
	Total Cost		8199.62
	Prime Cost		8199.62
	Add overhead charges and contractor's profit at 20% of prime cost		1639.92
	Rate per cum	Rs	**9840.00**

5 Grouting

Unit : Bag

I Material Cost

S.No.	ITEM	QUANTITY	WASTAGE %	UNIT	RATE	AMOUNT
1	Cement	1	5	BAG	346.00	363.30
2	Sand (1:2 mix)	0.071		Cum	1359.61	96.53
4	Water	L.S.				10
5	Admixture	L.S.				20
	Total					**489.83**

II Washing the hole

Cost of equipment (L.S.)	Rs	15
Cost of labour (L.S.)	Rs	15
Total	Rs	30

III Grouting maching charges

Hourey use rate of grouting machine	Rs	1512.09	
Progress of grouting Machine/Hr.		8	bags cem.
Grouting charges per bag of Cement	Rs	189.01	
Cost of Labour (L.S.)	Rs	20	
Total	Rs	209.01	

IV

Other misc. items such as G.I. Pipe fittings and pressure testing,etc.(L.S.)	Rs	30	
Prime Cost	**Rs**	**758.84**	**per bag**
Add for overheads & contractor's profit at 20% of prime cost		151.77	
Grand Total		910.61	
Hence rate of grouting per bag of cement	**Rs**	**911.00**	

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6 Shotcrete
Unit: cum

A Material

S.No.	ITEM	QUANTITY	WASTAGE %	UNIT	Rate	Amount
1	Cement	1	5	Bag	346.00	363.30
2	Sand	0.1355		Cum	1359.61	184.23
3	Coarse Aggregates	0.0435		Cum	1749.00	76.08
4	Water	L.S.				15.00
5	Admixture	L.S.				125.00
6	Silica fumes	4		kg	30	220.00
	Total					**983.61**

Total of material per cum	8.75	bags	9836.1

B Charges for mixing of materials per bag:

Batching & Mixing Charges (refer: Analysis of rate for concrete M25 grade)		Rs	109.44 per cum

C Transport of mix to site per bag

Tranportation charges (refer: Analysis of rate for concrete M25 grade)	0.5 km	Rs	**202.16 per cum**

D Placement charges :

Use rate of shortcrete machine per hour	Rs	483.00	
Output/hr.	cum	2	
Efficiency factor		0.8	
Cost of application =483/(2x0.8)		Rs	301.88

E	**Lighting,Workshop charges & other miscellaneous items**	Rs.	70.00

Sub Total :		10519.58

Wastage due to rebound @30%		3155.87
Prime cost		13675.45
Add contractor's profit @20% of prime cost		2735.09
Hence Rate of shotcreting per bag of cement consumption :	Rs	16410.54 per cum
HENCE RATE PER CUM.	**Rs**	**16412.00**

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7 Rock Bolt(25mm)

Unit : Rm

A Installation of Bolts

The rock bolts in tunnel will be installed by Bolting Jumbo, which carried out complete operation of drilling, fixing, grouting, and tightening.

Hourly use rate of rock bolt drill jumbo	Rs	4906.08	
Average installtion for 4 m length roc bolt rate per hour		5	No./hr
Length of rock bolt		4.00	m
Rate of drilling & installation with out supplies		245.30	
Total installation	**Rs**	**245.30**	

B Cost of Drill Steel & Supplies

Cost of drill rod per metre drilling			117.52	
Lighting, ventilation and workshop charges, L.S.			50.00	
Cost of 25 mm tor steel	25 mm	Rs	47.06	per kg
Weight per meter			3.85	
Cost of I m of 25 mm Rock bolt			181.18	
Wastage in cutting 2.5% of 1 above			4.53	
Cutting and making tip, L.S.			10.00	
Threading, L.S.			10.00	
Cost of nut and plate, L.S.			15.00	
Cost of rasin capsules etc.			150.00	
Cost of Grouting Material, LS			10.00	
Miscellaneous work L.S.			15.00	
Total Drill Steel and supplies cost		**Rs**	**563.22**	

Prime Cost	**Rs**	**808.53**	/m
Add contractor's profit at 20% of prime cost		161.71	
Grand Total	Rs	970.23	/m
Hence rate per metre	**Rs**	**971.00**	

8 Concrete in Dam (M-10)
Unit: cum

(A) Materials

Sl.No.	Item	Quantities	Unit	Rate	Per	Amt(in Rs)
1	Cement	4	bag	346.00	bag	1453.20
2	Sand	0.43	Cum	1359.61	Cum	584.63
3	Coarse Aggregate	0.86	Cum	1749.00	Cum	1504.14
4	Water			LS		15.00
5	Admixtures			LS		40.00
	Total					**3596.97**

5% Wastage and incidentals to work (bag supply)

(B) Batching, Mixing and Laying of Concrete

(I) Batching & Mixing Charges

Use Rate of 30 Cum / hr B&M plant = Rs 1970

Ideal Production of B&M Plant = 30 m^3

Actual Production =ideal production x J&M factor x plant.eff. 18 m^3

Rate per cum = Use Rate/actual production = 109.44 Rs/m^3

Taking job management factor as 0.75 and plant efficiency factor as 0.80

(ii) Transport of concrete by 2m^3 bucket loded ontipper from batching and maixing plant to pick up point.

Average lead	=	0.5 Km
Bucket capacity		2
No of buckets		1
Actual production at Batching Plant		18 m^3
Cycle time		
Loading time of a bucket		6.67 Min
Spotting and waiting time		1.5 Min
Loaded haul @ 10.0KmPH (0.5 x 60/10)		3 Min
Turning and unloading time		5 Min
Empty haul @ 12.0KMPH (0.5x60/12)		2.5 Min
Total Cycle time		18.67 Min
No. of trips in a 50 min working hour (50/34)		2.68 Trips
Output of one truck with 1 buckets per hour (1 x 3 x 2.47) =		5.36 m^3
Use Rate of Tipper		Rs. 1083

Transport Rate per Cum =
use rate / output 202.16 Rs/m^3

(iii) Placement of concrete by Tower Crane

Use Rate of crane	0 Rs.
Output of crane/hour using 3 cum bcuekts	28.8 m^3
Rate per Cum = Use rate of Crane / output	0.00 Rs/m^3
Labour for placement L.S.	0 Rs/m^3
Total (iii)	0.00 Rs.

(iv) Vibrating the concrete

(i)	Vibrators	LS		15 Rs/m^3
(ii)	Labour	LS		100 Rs/m^3
	Total (iv)		Rs.	115 /m^3

(v) Cleaning, slurry, curing and finishing

(i)	Sand blasting	LS	Rs.	15
(ii)	Cement for slurry mortar:	LS	Rs.	15
(iii)	Cleaning and washing	LS	Rs.	10
(iv)	Curing and finishing	L.S	Rs.	20
	Total (v)		Rs.	60

(vi)	Catwalks and other aids for concreting		Rs.	15
(vii)	Other charges such as Track charges, air, workshop Electricity charges for lighting	LS	Rs.	60
	Total charges for item (B)-(i) to (vii)		Rs.	561.60

(C) Shuttering charges @ Rs. 350 Rs/m^3

Abstract of charges	Rate om Rs. Per Cum	
(A) Materials	Rs.	3596.97
(B) Batching, mixing and laying	Rs.	561.60
(C) Shuttering @ Rs.	Rs.	350
Prime Cost		**4508.58** **Rs/m^3**
Add Overhead Charges & Contractor's Profit @20% of Prime Cost	Rs.	901.72
Grand Total		**5410.29** **Rs/m^3**
Hence rate/cum	**Rs.**	**5411.00**

ANNEXURE - “7”

HOURLY USE RATE OF EQUIPMENT

1 **Tipper, 4.5 cum/ 10 T**

	Cost of Equipment (Rs.)			1050000		
	Scheduled Life in years			8		
	Scheduled Life in hours			10000		
	Life time repair provision (% of Cost of Equipment)			175		
	Estimated annual operational hours			2200		
(a)	**Depreciation**					
	Hourly dereciation wrt life in years			53.69		
	Hourly dereciation wrt life in hours			94.50		
	Average hourly dereciation (Rs.)				**74.10**	
(b)	**Hourly Repair Charges**					
	Average over lifetime (Rs.)				**183.75**	
(c)	**O & M Crew Charges**	**Nos.**	**Wages(Rs.)**	**Amount (Rs.)**		
	Regular					
	Foreman	*0.00*	*10849*	0.00		
	Operator	*0.00*	*7442*	0.00		
	Driver	*2.00*	*7442*	14884.60		
	Mechanic	*0.25*	*9525*	2381.25		
	Electrician	*0.00*	*7442*	0.00		
	Supervisor	*0.00*	*12473*	0.00		
	Chowkidar	*0.33*	*6569*	2167.65		
	Total Monthly Wages of Regular Crew			19433.50		
	Casual					
	Helper	*2.00*	*4050*	8100.00		
	Cableman	*0.00*	*3000*	0.00		
	Beldar	*0.00*	*2550*	0.00		
	Total Monthly Wages of Casual Crew			8100.00		
	Total Direct Crew Charges/year			330401.96		
	Indirect Crew Charges (Regular-80%, Casual-55%)			240021.56		
	Total Crew Charges/year (Rs.)			570423.52		
	Hourly Crew Charges (Rs.)				**259.28**	
(d)	**POL and Energy Charges**					
	F.H.P. of Engine		*130*			
	Hourly fuel consumption (in litres) C1=	*0.3*	8.58			
	C2=	*1.0*				
	Rate of Diesel (Rs./litre)		**51.00**			
	Cost of Diesel (Rs.)			437.58		
	Power of Electric Motor (KW)		*0*			
	Hourly Energy consumption (KWH) C1=	*0*	0.00			
	C2=	*0*				
	Rate of Electricity (Rs./KWH)		**4.00**			
	Cost of Electricity (Rs.)			0.00		
	Lubricants- 25% of fuel and 30% of elecricity charges			109.40		
	Hourly POL and Energy Charges (Rs.)				**546.98**	
(e)	**Miscellaneous Charges** (10% of Repair Charges)				**18.38**	
	Hourly Use Rate of the Equipment					**1082.48**
	[(a) + (b)+ (c) + (d) + (e)]				**Say**	**1083**

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2 Batching & Mixing Plant, 30 cum/hr capacity

	Cost of Equipment (Rs.)			6000000		
	Scheduled Life in years			18		
	Scheduled Life in hours			30000		
	Life time repair provision (% of Cost of Equipment)			75		
	Estimated annual operational hours			3000		
(a)	**Depreciation**					
	Hourly dereciation wrt life in years			100.00		
	Hourly dereciation wrt life in hours			180.00		
	Average hourly dereciation (Rs.)				**140.00**	
(b)	**Hourly Repair Charges**					
	Average over lifetime (Rs.)				**150.00**	
(c)	**O & M Crew Charges**	**Nos.**	**Wages(Rs.**	**Amount (Rs.)**		
	Regular					
	Foreman	*1.50*	*10848.75*	16273.13		
	Operator	*6.00*	*10000.00*	60000.00		
	Driver	*0.00*	*7442.3*	0.00		
	Mechanic	*1.50*	*9525*	14287.50		
	Electrician	*1.50*	*7442.3*	11163.45		
	Supervisor	*0.00*	*12472.5*	0.00		
	Chowkidar	*3.00*	*6568.625*	19705.88		
	Total Monthly Wages of Regular Crew			121429.95		
	Casual					
	Helper	*9.00*	*4050*	36450.00		
	Cableman	*0.00*	*3000*	0.00		
	Beldar	*9.00*	*2550*	22950.00		
	Total Monthly Wages of Casual Crew			59400.00		
	Total Direct Crew Charges/year			2169959.40		
	Indirect Crew Charges (Regular-80%, Casual-55%)			1557767.52		
	Total Crew Charges/year (Rs.)			3727726.92		
	Hourly Crew Charges (Rs.)				**1243.00**	
(d)	**POL and Energy Charges**					
	F.H.P. of Engine		*0*			
	Hourly fuel consumption (in litres) C1=	*0*	0.00			
	C2=	*0*				
	Rate of Diesel (Rs./litre)		**51.00**			
	Cost of Diesel (Rs.)			0.00		
	Power of Electric Motor (KW)		*90*			
	Hourly Energy consumption (KWH) C1=	*0.8*	72.00			
	C2=	*1.0*				
	Rate of Electricity (Rs./KWH)		**4.50**			
	Cost of Electricity (Rs.)			324.00		
	Lubricants- 25% of fuel and 30% of elecricity charges			97.20		
	Hourly POL and Energy Charges (Rs.)				**421.20**	
(e)	**Miscellaneous Charges** (10% of Repair Charges)				**15.00**	
	Hourly Use Rate of the Equipment					**1969.20**
	[(a) + (b)+ (c) + (d) + (e)]				**Say:**	**1970.00**

3 Air Compressor, 500 cfm Diesel

Cost of Equipment (Rs.)	1060000
Scheduled Life in years	10
Scheduled Life in hours	12000
Life time repair provision (% of Cost of Equipment)	100
Estimated annual operational hours	3000

(a)	**Depreciation**	
	Hourly depreciation wrt life in years	31.80
	Hourly depreciation wrt life in hours	79.50
	Average hourly depreciation (Rs.)	**55.65**

(b)	**Hourly Repair Charges**	
	Average over lifetime (Rs.)	**35.33**

(c)	**O & M Crew Charges**	**Nos.**	**Wages(Rs.)**	**Amount (Rs.)**	
	Regular				
	Foreman	0.38	10848.75	4068.28	
	Operator	3.00	7442.3	22326.90	
	Driver	0.00	7442.3	0.00	
	Mechanic	1.50	9525	14287.50	
	Electrician	0.00	7442.3	0.00	
	Supervisor	0.00	12472.5	0.00	
	Chowkidar	0.75	6568.625	4926.47	
	Total Monthly Wages of Regular Crew			45609.15	
	Casual				
	Helper	3.00	4050	12150.00	
	Cableman	0.00	3000	0.00	
	Beldar	0.00	2550	0.00	
	Total Monthly Wages of Casual Crew			12150.00	
	Total Direct Crew Charges/year			693109.80	
	Indirect Crew Charges (Regular-80%, Casual-55%)			518037.84	
	Total Crew Charges/year (Rs.)			1211147.64	
	Hourly Crew Charges (Rs.)				**403.72**

(d)	**POL and Energy Charges**					
	F.H.P. of Engine			148		
	Hourly fuel consumption (in litres)	C1=	1	32.56		
		C2=	1.0			
	Rate of Diesel (Rs./litre)			**51.00**		
	Cost of Diesel (Rs.)				1660.56	
	Power of Electric Motor (KW)			0		
	Hourly Energy consumption (KWH)	C1=	1	0.00		
		C2=	1.25			
	Rate of Electricity (Rs./KWH)			**4.50**		
	Cost of Electricity (Rs.)				0.00	
	Lubricants- 25% of fuel and 30% of elecricity charges				415.14	
	Hourly POL and Energy Charges (Rs.)					**2075.70**

(e)	**Miscellaneous Charges** (10% of Repair Charges)		**3.53**
	Hourly Use Rate of the Equipment		**2518.3**
	[(a) + (b)+ (c) + (d) + (e)]	**Say:**	**2518**

4. Air Compressor, 1000 cfm, Electric

Cost of Equipment (Rs.)	1200000
Scheduled Life in years	20
Scheduled Life in hours	30000
Life time repair provision (% of Cost of Equipment)	80
Estimated annual operational hours	3000

(a)	**Depreciation**		
	Hourly dereciation wrt life in years	18.00	
	Hourly dereciation wrt life in hours	36.00	
	Average hourly dereciation (Rs.)		27.00
(b)	**Hourly Repair Charges**		
	Average over lifetime (Rs.)		**32.00**

		Nos.	Wages(Rs.)	Amount (Rs.)	
(c)	**O & M Crew Charges**				
	Regular				
	Foreman	*0.38*	*10848.75*	4068.28	
	Operator	*3.00*	*7442.3*	22326.90	
	Driver	*0.00*	*7442.3*	0.00	
	Mechanic	*1.00*	*9525*	9525.00	
	Electrician	*1.50*	*7442.3*	11163.45	
	Supervisor	*0.00*	*12472.5*	0.00	
	Chowkidar	*0.75*	*6568.625*	4926.47	
	Total Monthly Wages of Regular Crew			52010.10	
	Casual				
	Helper	*3.00*	*4050*	12150.00	
	Cableman	*0.00*	*3000*	0.00	
	Beldar	*0.00*	*2550*	0.00	
	Total Monthly Wages of Casual Crew			12150.00	
	Total Direct Crew Charges/year			769921.20	
	Indirect Crew Charges (Regular-80%, Casual-55%)			579486.96	
	Total Crew Charges/year (Rs.)			1349408.16	
	Hourly Crew Charges (Rs.)				**449.80**

(d)	**POL and Energy Charges**				
	F.H.P. of Engine				
	Hourly fuel consumption (in litres) C1=	*0*			
	C2=	*0.0*			
	Rate of Diesel (Rs./litre)		**31.66**		
	Cost of Diesel (Rs.)			0.00	
	Power of Electric Motor (KW)		*180*		
	Hourly Energy consumption (KWH) C1=	*1*	225.00		
	C2=	*1.25*			
	Rate of Electricity (Rs./KWH)		**4.00**		
	Cost of Electricity (Rs.)			900.00	
	Lubricants- 25% of fuel and 30% of elecricity charges			270.00	
	Hourly POL and Energy Charges (Rs.)				**1170.00**
(e)	**Miscellaneous Charges** (10% of Repair Charges)				**3.20**

Hourly Use Rate of the Equipment		**1682.00**
[(a) + (b)+ (c) + (d) + (e)]	**Say:**	**1682**

Everest Power Private Ltd.

Everest Power Private Ltd.

5 Name of Equipment **Compressed Air (100% Diesel)**

At work site where the requirement is concentrated, diesel compressors are to be provided at these locations. Further, at the locations where the drilling is spre like in dam excavation,spillway channel etc only diesel compressor will be provided for flexibilty and redundancy.

For calculating air charges, a composite rate for 100 cfm air from diesel has been worked out.

Hourly use rate of 500 cfm diesel air compressor	2518	
Rate for 100 cfm including losses		553.96
Hourly use rate of 1000 cfm electric air compressor	1682	
Rate for 70 cfm		129.514
Composite rate	Rs	684

6 Jack Hammer, 120 cfm

Cost of Equipment (Rs.)	42000
Scheduled Life in years	10
Scheduled Life in hours	10000
Life time repair provision (% of Cost of Equipment)	80
Estimated annual operational hours =	2200

(a)	**Depreciation**		
	Hourly dereciation wrt life in years	1.72	
	Hourly dereciation wrt life in hours	3.78	
	Average hourly dereciation (Rs.)		**2.75**
(b)	**Hourly Repair Charges**		
	Average over lifetime (Rs.)		**3.36**

		Nos.	Wages(Rs.)	Amount (Rs.)	
(c)	**O & M Crew Charges**				
	Regular				
	Foreman	*0.00*	*10848.75*	0.00	
	Operator	*2.00*	*7442.30*	14884.60	
	Driver	*0.00*	*7442.30*	0.00	
	Mechanic	*0.25*	*9525.00*	2381.25	
	Electrician	*0.00*	*7442.30*	0.00	
	Supervisor	*0.00*	*12472.50*	0.00	
	Chowkidar	*0.25*	*6568.63*	1642.16	
	Total Monthly Wages of Regular Crew			18908.01	
	Casual				
	Helper	*2.00*	*4050.00*	8100.00	
	Cableman	*0.00*	*3000.00*	0.00	
	Beldar	*0.00*	*2550.00*	0.00	
	Total Monthly Wages of Casual Crew			8100.00	
	Total Direct Crew Charges/year			324096.08	
	Indirect Crew Charges (Regular-80%, Casual-55%)			234976.86	
	Total Crew Charges/year (Rs.)			559072.94	
	Hourly Crew Charges (Rs.)				**254.12**

(d)	**POL and Energy Charges**				
	F.H.P. of Engine		*0*		
	Hourly fuel consumption (in litres) C1=	*0*	0.00		
	C2=	*0*			
	Rate of Diesel (Rs./litre)		**51.00**		
	Cost of Diesel (Rs.)			0.00	
	Power of Electric Motor (KW)		*0*		
	Hourly Energy consumption (KWH) C1=	*0*	0.00		
	C2=	*0*			
	Rate of Electricity (Rs./KWH)		**4.50**		
	Cost of Electricity (Rs.)			0.00	
	Cost of air for 100 cfm		684.00		
	Cost of air for 120 cfm (with 10% losses)			902.88	
	Lubricants- 20% of cost of air			180.58	
	Hourly POL and Energy Charges (Rs.)				**1083.46**
(e)	**Miscellaneous Charges** (10% of Repair Charges)				**0.34**
	Hourly Use Rate of the Equipment				**1344.03**
	[(a) + (b)+ (c) + (d) + (e)]			**Say:**	**1345**

7 Shotcrete Machine., 2 cum./hr

Cost of Equipment (Rs.)	350000
Scheduled Life in years	5
Scheduled Life in hours	6000
Life time repair provision (% of Cost of Equipment)	100
Estimated annual operational hours =	2200

(a)	**Depreciation**		
	Hourly dereciation wrt life in years	28.64	
	Hourly dereciation wrt life in hours	52.5	
	Average hourly dereciation (Rs.)		**40.57**
(b)	**Hourly Repair Charges**		
	Average over lifetime (Rs.)		**58.33**

		Nos.	Wages(Rs	Amount (Rs.)
(c)	**O & M Crew Charges**			
	Regular			
	Foreman	0.25	10848.75	2712.19
	Operator	2.00	7442.3	14884.60
	Driver	0.00	7442.3	0.00
	Mechanic	1.00	9525	9525.00
	Electrician	0.00	7442.3	0.00
	Supervisor	0.00	12472.5	0.00
	Total Monthly Wages of Regular Crew			27121.79
	Casual			
	Chowkidar	0.50	5574.38	2787.19
	Helper	2.00	4050.00	8100.00
	Cableman	0.00	3000.00	0.00
	Beldar	0.00	2550.00	0.00
	Total Monthly Wages of Casual Crew			10887.19

Total Direct Crew Charges/year	456107.70	
Indirect Crew Charges (Regular-80%, Casual-55%)	332224.60	
Total Crew Charges/year (Rs.)	788332.30	
Hourly Crew Charges (Rs.)		**358.33**

(d)	**POL and Energy Charges**				
	F.H.P. of Engine		0		
	Hourly fuel consumption (in litres)	C 0.25	0.00		
		C2= 1			
	Rate of Diesel (Rs./litre)		**51.00**		
	Cost of Diesel (Rs.)			0.00	
	Power of Electric Motor (KW)		25		
	Hourly Energy consumption (KWH)	C 0.75	3.30		
		C2= 0.8			
	Rate of Electricity (Rs./KWH)		**4.50**		
	Cost of Electricity (Rs.)			14.85	
	Rate of 100 cfm air		**0.00**		
	Cost of air for 250 cfm			0.00	
	Lubricants- 25% of fuel and 30% of elecricity charges			4.46	
	Hourly POL and Energy Charges (Rs.)				**19.31**
(e)	**Miscellaneous Charges** (10% of Repair Charges)				**5.83**

Hourly Use Rate of the Equipment		**482.37**
[(a) + (b)+ (c) + (d) + (e)]	**Say:**	**483**

8 **Crawler Dozer, 320 HP**

Cost of Equipment (Rs.)	14000000
Scheduled Life in years	12
Scheduled Life in hours	16000
Life time repair provision (% of Cost of Equipment)	240
Estimated annual operational hours	1200

(a)	**Depreciation**		
	Hourly dereciation wrt life in years	875.00	
	Hourly dereciation wrt life in hours	787.50	
	Average hourly dereciation (Rs.)		831.25
(b)	**Hourly Repair Charges**		
	Average over lifetime (Rs.)		2100.00

		Nos.	Wages(Rs.)	Amount (Rs.)	
(c)	**O & M Crew Charges**				
	Regular				
	Foreman	0.25	10848.75	2712.19	
	Operator	1.00	10000.00	10000.00	
	Driver	0.00	7442.30	0.00	
	Mechanic	0.25	9525	2381.25	
	Electrician	0.00	7442.3	0.00	
	Supervisor	0.00	12472.5	0.00	
	Chowkidar	0.25	6568.625	1642.16	
	Total Monthly Wages of Regular Crew			16735.59	
	Casual				
	Helper	1.00	4050	4050.00	
	Cableman	0.00	3000	0.00	
	Beldar	0.00	2550	0.00	
	Total Monthly Wages of Casual Crew			4050.00	
	Total Direct Crew Charges/year			249427.13	
	Indirect Crew Charges (Regular-80%, Casual-55%)			187391.70	
	Total Crew Charges/year (Rs.)			436818.83	
	Hourly Crew Charges (Rs.)				364.02

(d)	**POL and Energy Charges**					
	F.H.P. of Engine			320		
	Hourly fuel consumption (in litres)	C1=	0.57	40.13		
		C 2=	1			
	Rate of Diesel (Rs./litre)			**31.66**		
	Cost of Diesel (Rs.)				1270.62	
	Power of Electric Motor (KW)			0		
	Hourly Energy consumption (KWH)	C1=	0	0.00		
		C2=	0			
	Rate of Electricity (Rs./KWH)			**4.00**		
	Cost of Electricity (Rs.)				0.00	
	Lubricants- 25% of fuel and 30% of elecricity charges				317.66	
	Hourly POL and Energy Charges (Rs.)					1588.28
(e)	**Miscellaneous Charges** (10% of Repair Charges)					210.00

Hourly Use Rate of the Equipment		**5093.54**
[(a) + (b)+ (c) + (d) + (e)]	**Say**	**5094**

9 Excavator, 2.0 cum bucket

Cost of Equipment (Rs.)	8000000
Scheduled Life in years	12
Scheduled Life in hours	15000
Life time repair provision (% of Cost of Equipment)	125
Estimated annual operational hours =	2200

(a) **Depreciation**

Hourly dereciation wrt life in years	272.73	
Hourly dereciation wrt life in hours	480.00	
Average hourly dereciation (Rs.)		**376.36**

(b) **Hourly Repair Charges**

Average over lifetime (Rs.)	**666.67**

(c) **O & M Crew Charges**

	Nos.	Wages(Rs.)	Amount (Rs.)	
Regular				
Foreman	*0.50*	*10848.75*	5424.38	
Operator	*2.00*	*10000.00*	20000.00	
Driver	*0.00*	*7442.3*	0.00	
Mechanic	*0.50*	*9525*	4762.50	
Electrician	*0.00*	*7442.3*	0.00	
Supervisor	*0.00*	*12472.5*	0.00	
Chowkidar	*0.50*	*6568.625*	3284.31	
Total Monthly Wages of Regular Crew			33471.19	
Casual				
Helper	*2.00*	*4050*	8100.00	
Cableman	*0.00*	*3000*	0.00	
Beldar	*0.00*	*2550*	0.00	
Total Monthly Wages of Casual Crew			8100.00	
Total Direct Crew Charges/year			498854.25	
Indirect Crew Charges (Regular-80%, Casual-55%)			374783.40	
Total Crew Charges/year (Rs.)			873637.65	
Hourly Crew Charges (Rs.)				**397.11**

(d) **POL and Energy Charges**

F.H.P. of Engine		*240*		
Hourly fuel consumption (in litres) C1=	*0.5*	26.40		
C2=	*1*			
Rate of Diesel (Rs./litre)		**31.66**		
Cost of Diesel (Rs.)			835.94	
Power of Electric Motor (KW)		*0*		
Hourly Energy consumption (KWH) C1=	*0*	0.00		
C2=	*0*			
Rate of Electricity (Rs./KWH)		**4.00**		
Cost of Electricity (Rs.)			0.00	
Lubricants- 25% of fuel and 30% of elecricity charges			208.98	
Hourly POL and Energy Charges (Rs.)				**1044.92**

(e) **Miscellaneous Charges** (10% of Repair Charges)		**66.67**
Hourly Use Rate of the Equipment		**2551.73**
[(a) + (b)+ (c) + (d) + (e)]	**Say:**	**2552**

265

10 Dumper 18/20 T

Cost of Equipment (Rs.)	4000000
Scheduled Life in years	10
Scheduled Life in hours	12000
Life time repair provision (% of Cost of Equipment)	175
Estimated annual operational hours =	2200

(a)	**Depreciation**		
	Hourly dereciation wrt life in years	163.64	
	Hourly dereciation wrt life in hours	300.00	
	Average hourly dereciation (Rs.)		231.82
(b)	**Hourly Repair Charges**		
	Average over lifetime (Rs.)		583.33

(c) **O & M Crew Charges**

	Nos.	Wages(Rs.)	Amount (Rs.)	
Regular				
Foreman	*0.25*	*10848.75*	2712.19	
Operator	*0.00*	*7442.3*	0.00	
Driver	*2.00*	*7442.3*	14884.60	
Mechanic	*0.33*	*9525*	3143.25	
Electrician	*0.00*	*7442.3*	0.00	
Supervisor	*0.00*	*12472.5*	0.00	
Chowkidar	*0.33*	*6568.625*	2167.65	
Total Monthly Wages of Regular Crew			22907.68	
Casual				
Helper	*2.00*	*4050*	8100.00	
Cableman	*0.00*	*3000*	0.00	
Beldar	*0.00*	*2550*	0.00	
Total Monthly Wages of Casual Crew			8100.00	
Total Direct Crew Charges/year			372092.21	
Indirect Crew Charges (Regular-80%, Casual-55%)			273373.76	
Total Crew Charges/year (Rs.)			645465.97	
Hourly Crew Charges (Rs.)				293.39

(d) **POL and Energy Charges**

F.H.P. of Engine		*200*		
Hourly fuel consumption (in litres) C1=	*0.3*	13.20		
C2=	*1.0*			
Rate of Diesel (Rs./litre)		**31.66**		
Cost of Diesel (Rs.)			417.97	
Power of Electric Motor (KW)		*0*		
Hourly Energy consumption (KWH) C1=	*0*	0.00		
C2=	*0*			
Rate of Electricity (Rs./KWH)		**4.00**		
Cost of Electricity (Rs.)			0.00	
Lubricants- 25% of fuel and 30% of elecricity charges			104.49	
Hourly POL and Energy Charges (Rs.)				522.46

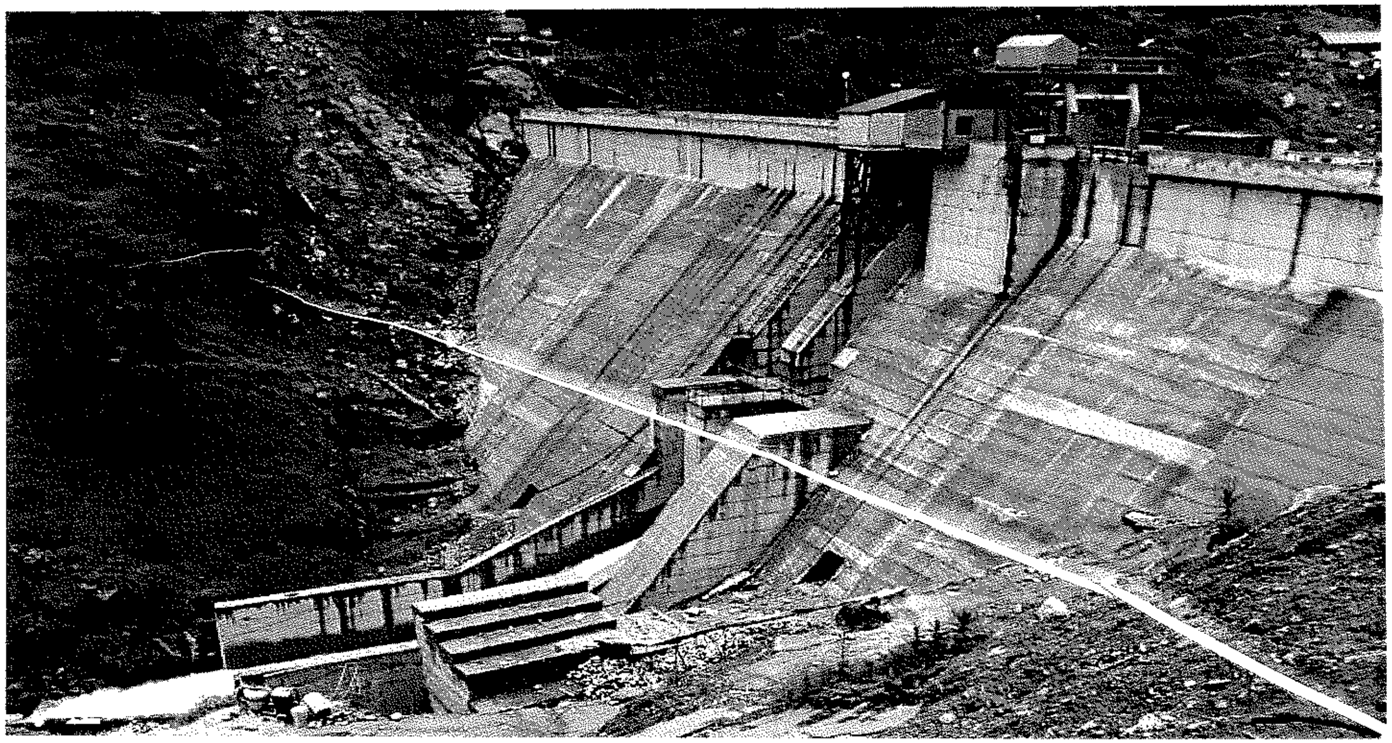
(e)	**Miscellaneous Charges** (10% of Repair Charges)	58.33	
	Hourly Use Rate of the Equipment		**1689.34**
	[(a) + (b)+ (c) + (d) + (e)]	Say:	**1690**

EVEREST POWER PRIVATE LIMITED

(2X50MW MALANA STAGE-II HYDRO ELECTRIC PROJECT)

CONSTRUCTION OF ADDITIONAL UNGATED SURFACE SPILLWAY CONVERTING NON-OVERFLOW BLOCKS INTO OVERFLOW BLOCKS

DETAILED PROJECT REPORT



PROJECT DRAWINGS
(VOLUME – II)

OCTOBER – 2017

AQUAGREEN
Engineering Management (P) Ltd.

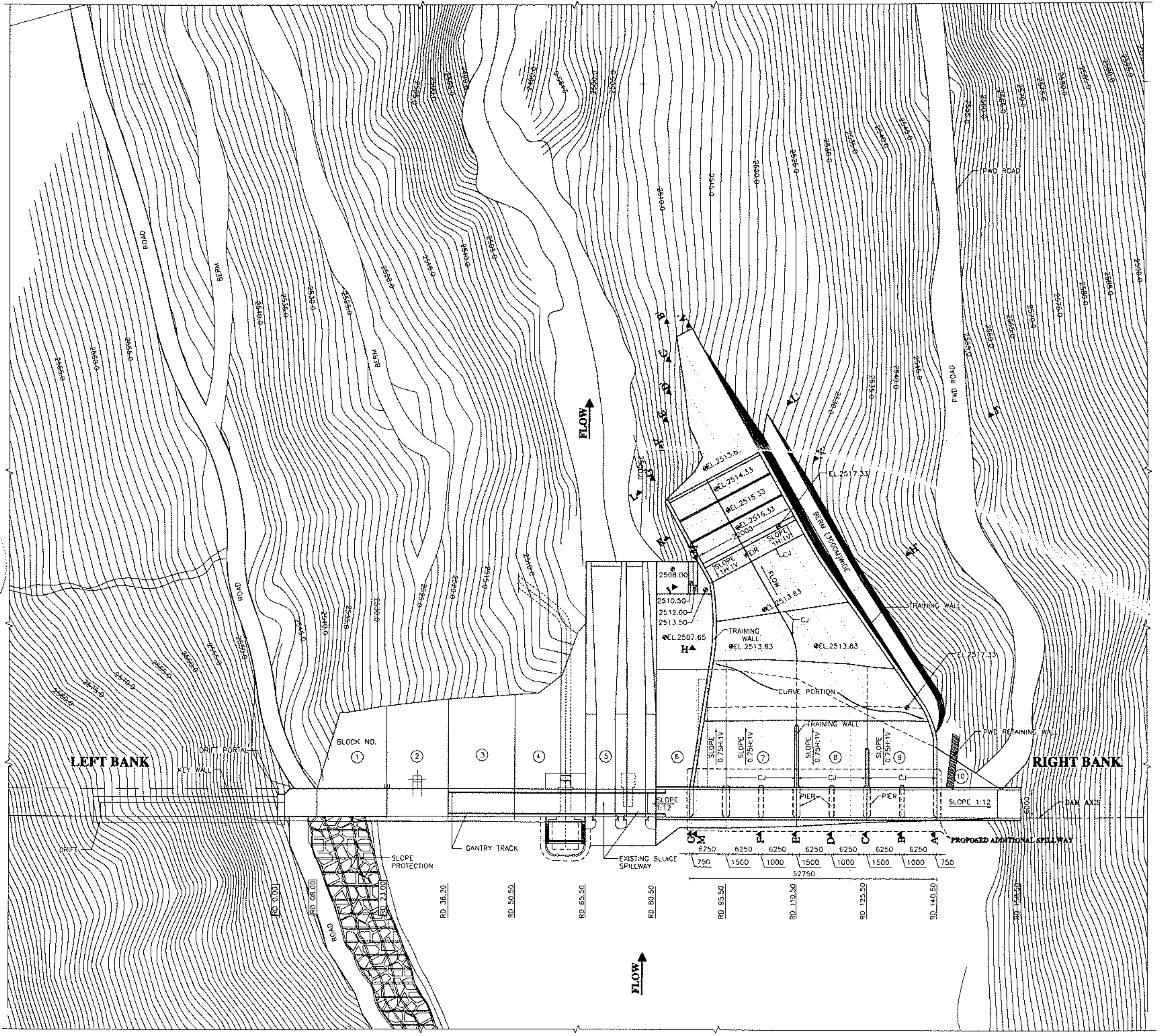
AQUAGREEN ENGINEERING MANAGEMENT PVT. LTD.
143-144, UDYOG VIHAR, PHASE –IV, GURGAON -122015

Malana-II Hydro Electric Project

Construction of Additional Ungated Surface Spillway converting Non-overflow Blocks into Overflow Blocks on Right Bank of Malana-II Dam

List of Drawings

S.NO.	PARTICULARS OF DRAWINGS	DRAWING NO.
1.	General Layout Plan - Additional Ungated Surface Spillway	324-CDC-03A-001
2.	L – Section A – A'	324-CDC-03A-002
3.	L – Section B – B'	324-CDC-03A-003
4.	L – Section C – C'	324-CDC-03A-004
5.	L – Section D – D'	324-CDC-03A-005
6.	L – Section E – E'	324-CDC-03A-006
7.	L – Section F – F'	324-CDC-03A-007
8.	L – Section G – G'	324-CDC-03A-008
9.	Cross Section H – H'	324-CDC-03A-009
10.	Cross Section J – J'	324-CDC-03A-010
11.	Cross Section K – K' & L-L'	324-CDC-03A-011
12.	Cross Section M - M'	324-CDC-03A-012
13.	Additional Ungated Surface Spillway - Plan and Section	324-CDC-03A-013
14.	Section – B (End Pier)	324-CDC-03A-014
15.	Section – C (Intermediate Pier)	324-CDC-03A-015
16.	Section – D (Section along Center of Bay of Spillway)	324-CDC-03A-016
17.	Spillway Bridge – Plan and Section (Sheet 1/3)	324-CDC-03A-017
18.	Spillway Bridge – Plan and Section (Sheet 2/3)	324-CDC-03A-018
19.	Spillway Bridge – Plan and Section (Sheet 3/3)	324-CDC-03A-019
20.	Details of temporary wall in Spillway	324-CDC-03A-020



PLAN

NOTES: -

1. THE DAM GENERAL LAYOUT PLAN FOR ADDITIONAL UNGATED SURFACE SPILLWAY PROVISION IN NOF BLOCK-6,7,8&9 HAVE BEEN SHOWN THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
3 NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
4. FOR PLAN AND SECTION OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CDC-03A-012.
5. FOR DOWNSTREAM CHANNEL, FLIP BUCKET AND BRIDGE DETAILS, REFER RELEVANT DRAWINGS.
6. FOR REINFORCEMENT DETAILS REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

SCALE-1:400
0 4 8 12 16 20 40m

CLIENT: EVEREST POWER PRIVATE LIMITED

PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

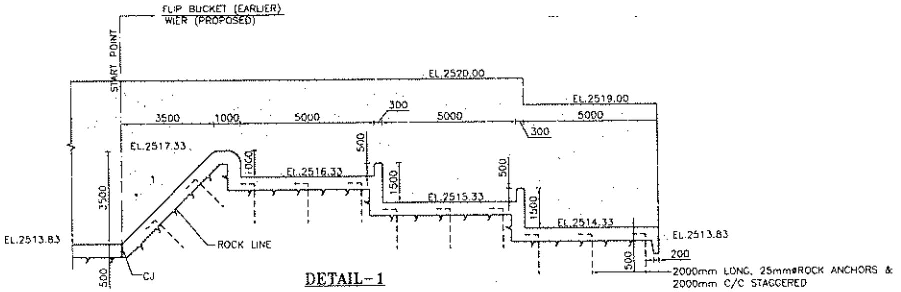
TITLE: **GENERAL LAYOUT PLAN - ADDITIONAL UNGATED SURFACE SPILLWAY**

DRAWING NO. 324-CDC-03A-001
DATE: OCT-2017
SHEET SIZE: A1

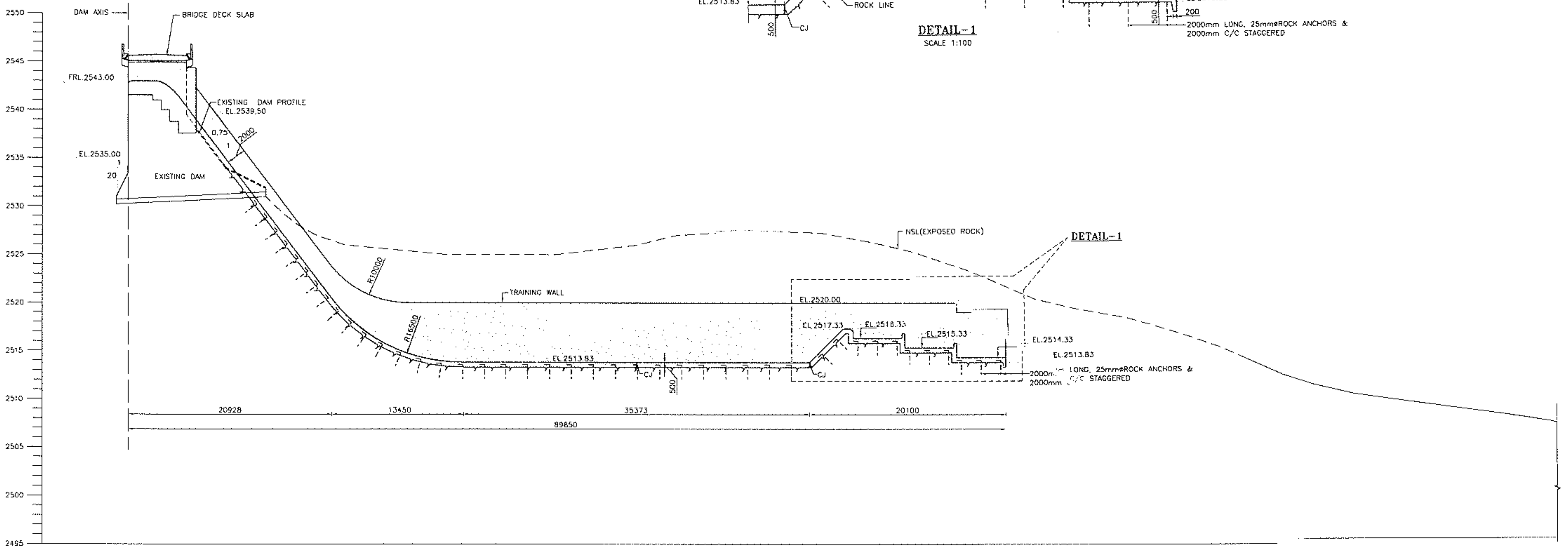
269

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



DETAIL-1
SCALE 1:100



SECTION A-A'
SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:100
0 1 2 3 4 5 10m

SCALE:- 1:200
0 2 4 6 8 10 20m

CLIENT:
EVEREST POWER PRIVATE LIMITED

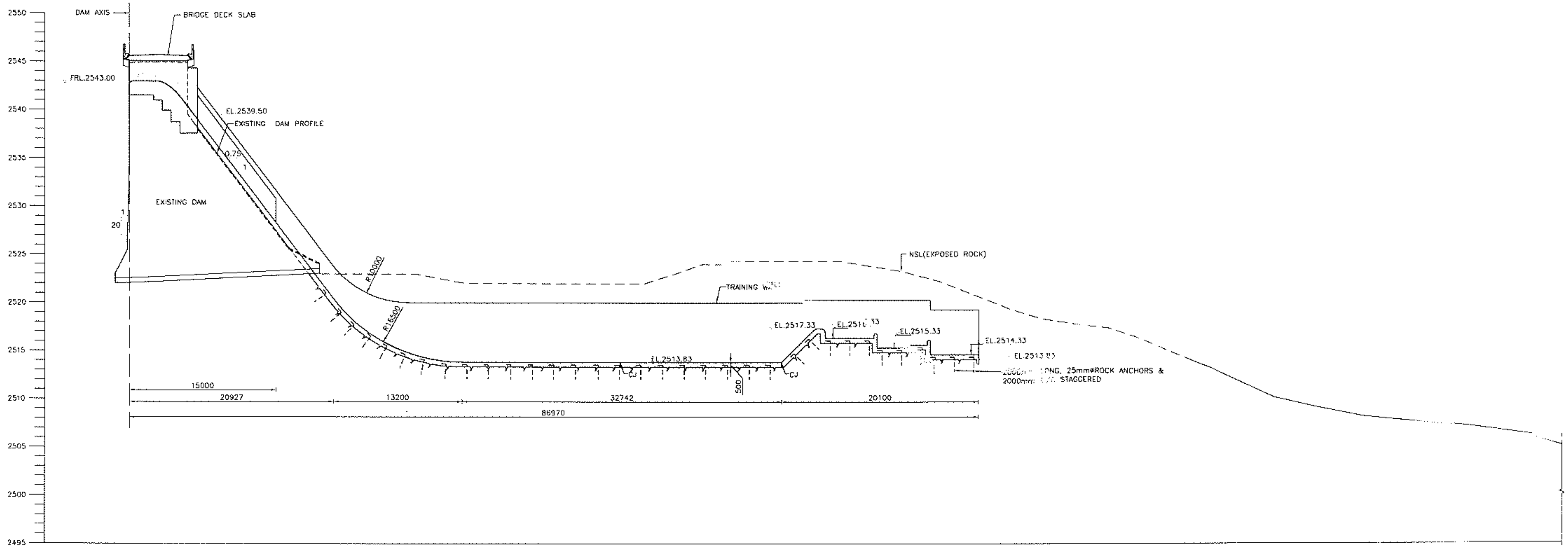
PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

TITLE:
L - SECTION A-A'

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-002	OCT-2017	A1

NOTES: -

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION B-B'

SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:200

0 2 4 6 8 10 20m

CLIENT: EVEREST POWER PRIVATE LIMITED

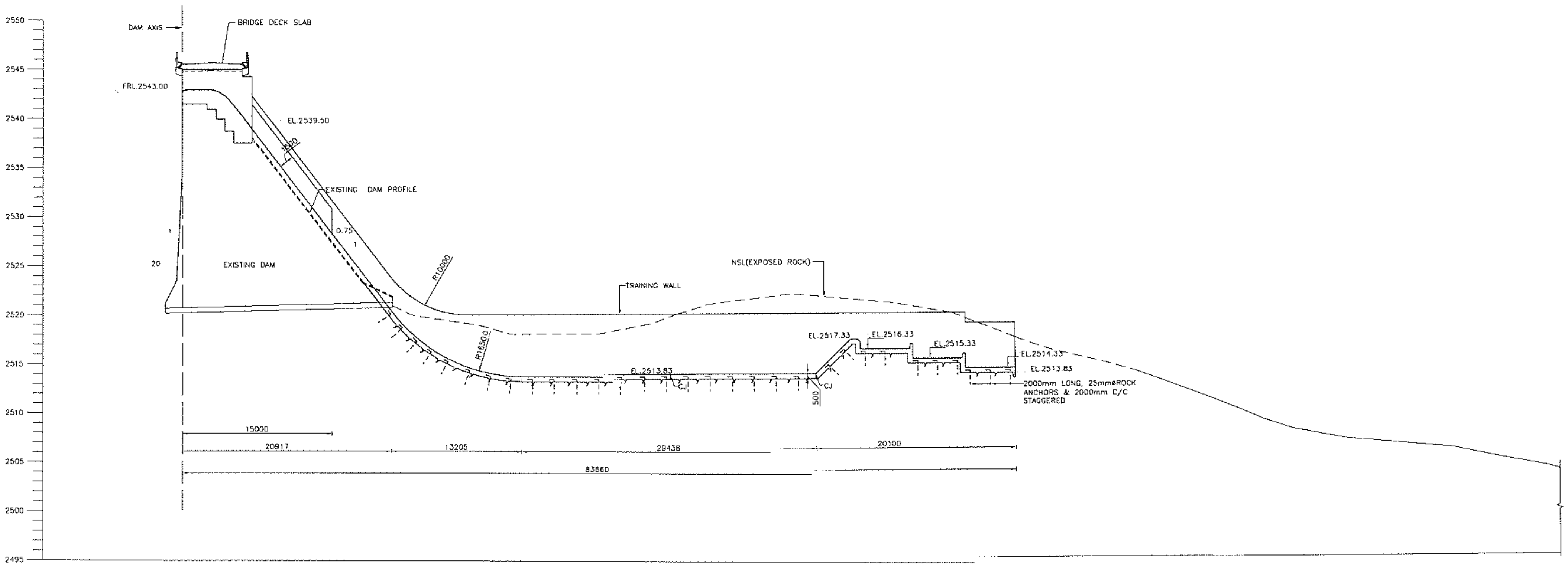
PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

TITLE: **L - SECTION B-B'**

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-003	OCT-2017	A1

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION C–C'
SCALE 1:200

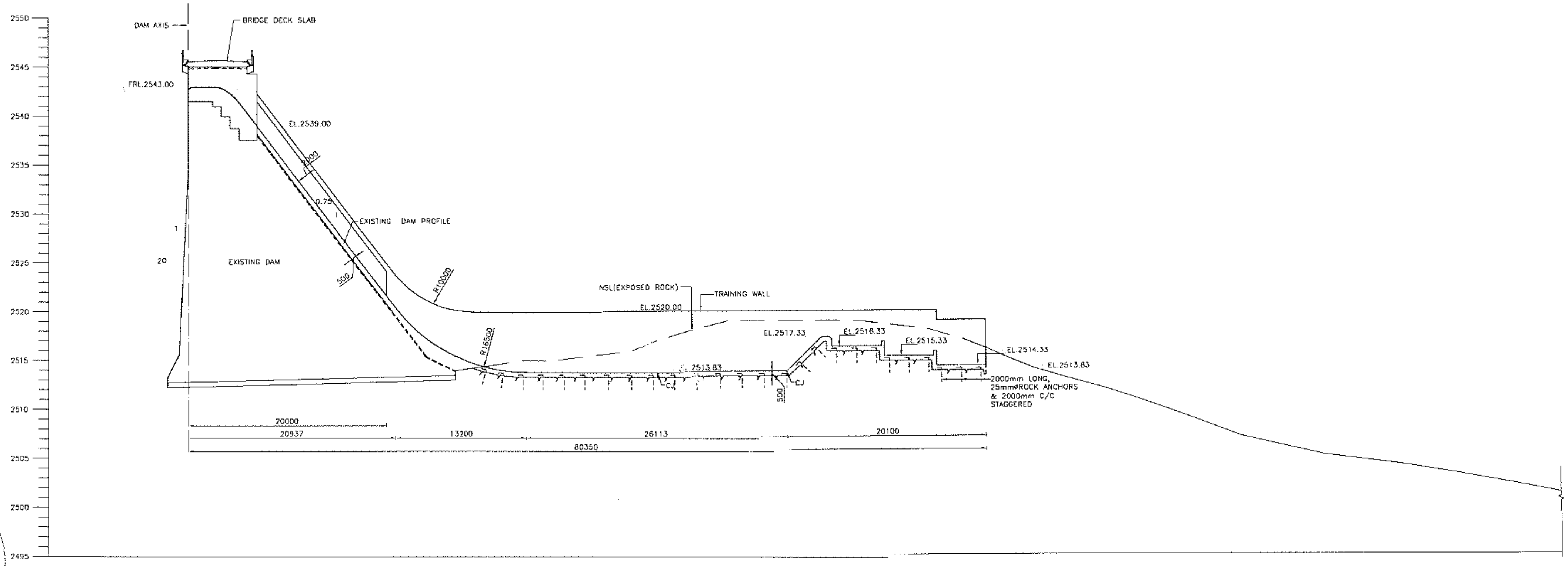
FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:200
0 2 4 6 10 20m

CLIENT:	EVEREST POWER PRIVATE LIMITED
PROJECT:	MALANA-II HYDRO ELECTRIC PROJECT
TITLE:	L - SECTION C-C'
DRAWING NO	324-CDC-03A-004
DATE:	OCT-2017
SHEET SIZE:	A1

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION D-D'
SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:200
0 2 4 6 8 10 20m

CLIENT: EVEREST POWER PRIVATE LIMITED

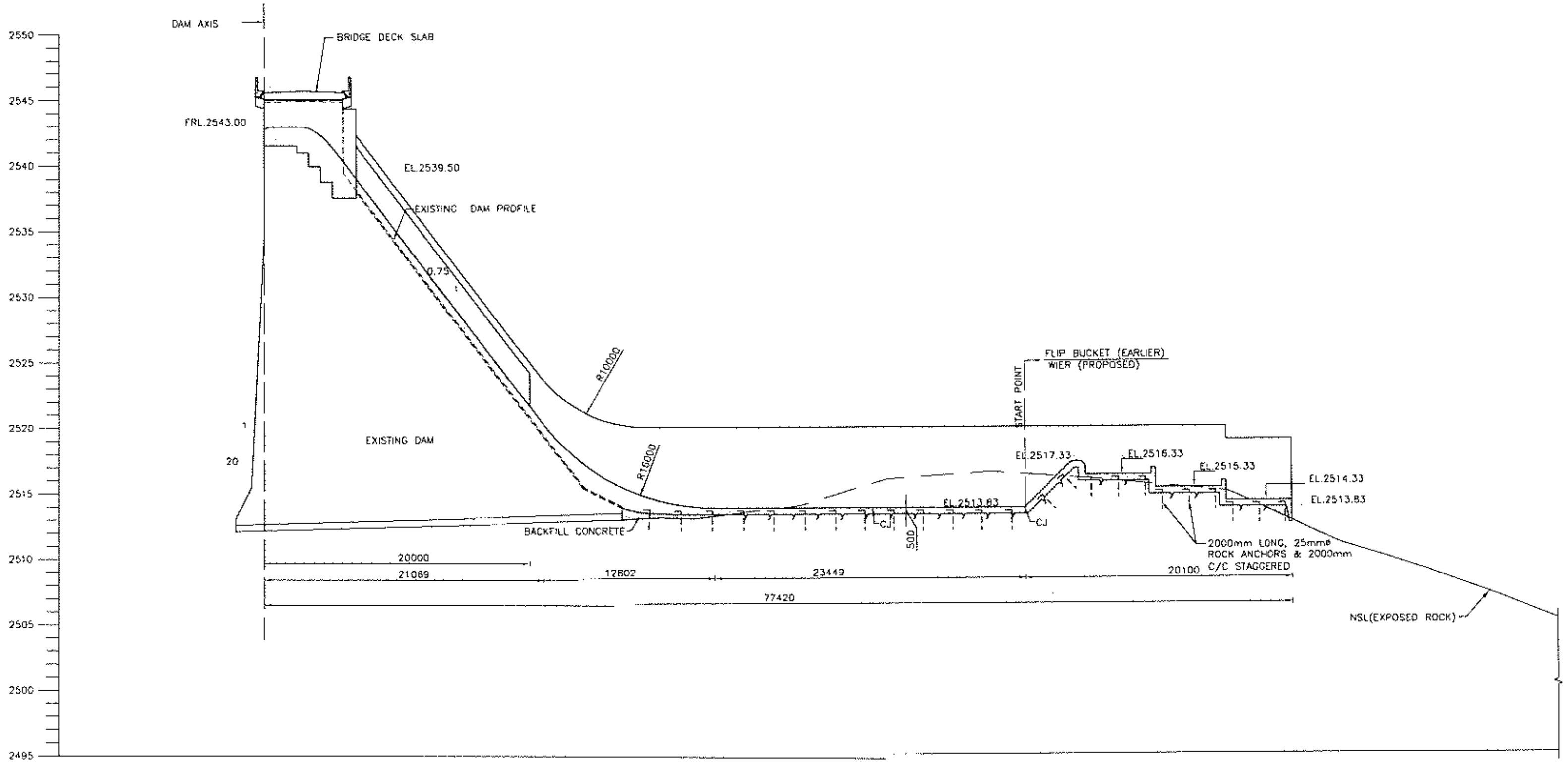
PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

TITLE: **L - SECTION D-D'**

DRAWING NO	DATE:	SHEET SIZE:
324-CDC-03A-005	OCT-2017	A1

NOTES: –

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION E–E'

SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

0 2 4 6 8 10 20m

CLIENT: EVEREST POWER PRIVATE LIMITED

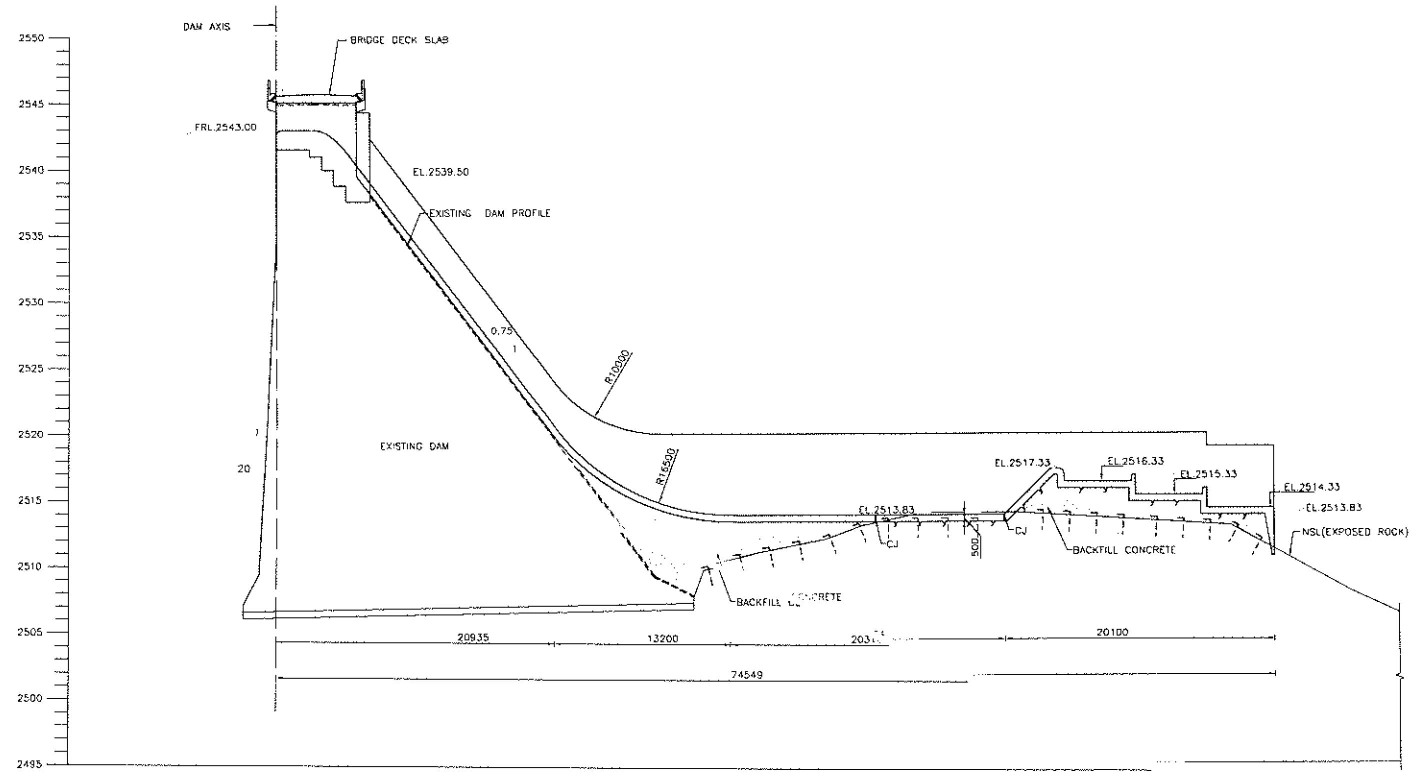
PROJECT: MALANA-II HYDRO ELECTRIC PROJECT

TITLE: L - SECTION E-E'

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-006	OCT-2017	A1

NOTES: –

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION F-F'
SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

SCALE 1:200
0 2 4 6 8 10 20m

CLIENT: EVEREST POWER PRIVATE LIMITED

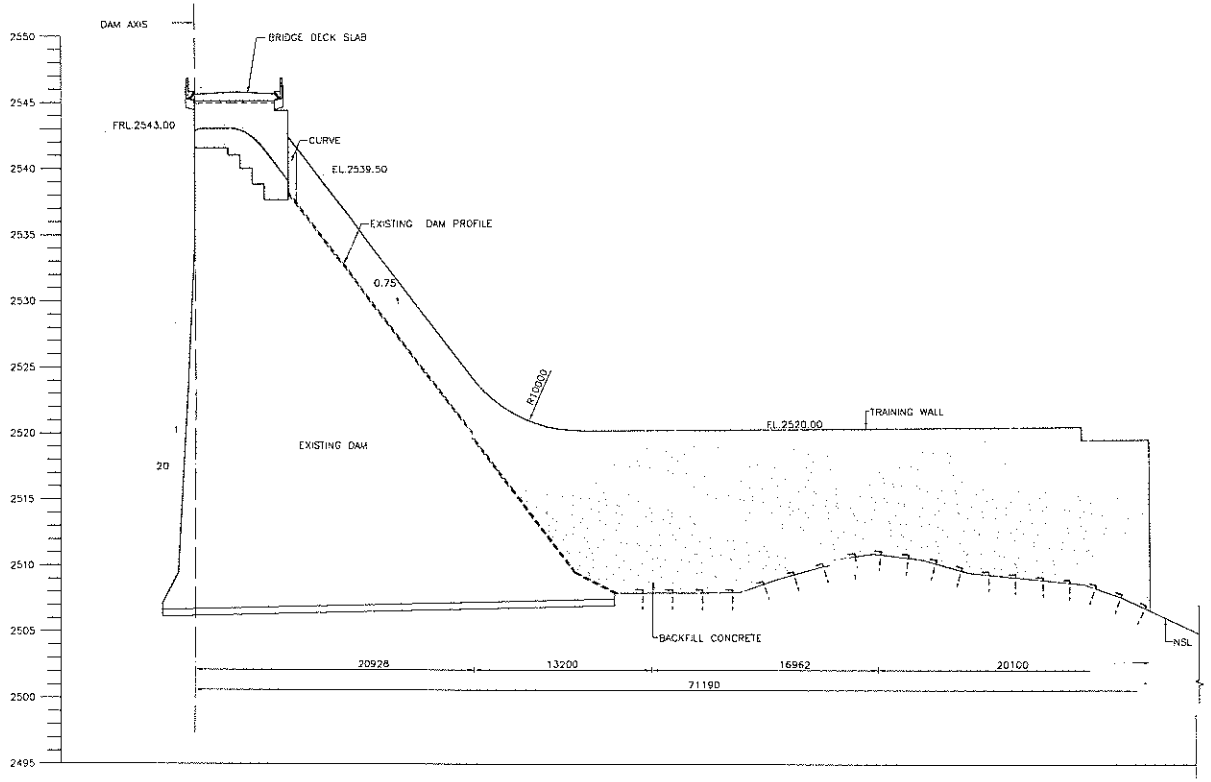
PROJECT: MALANA-II HYDRO ELECTRIC PROJECT

TITLE: L - SECTION F-F'

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-007	OCT-2017	A1

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION G-G'
SCALE 1:200

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:200

CLIENT: EVEREST POWER PRIVATE LIMITED

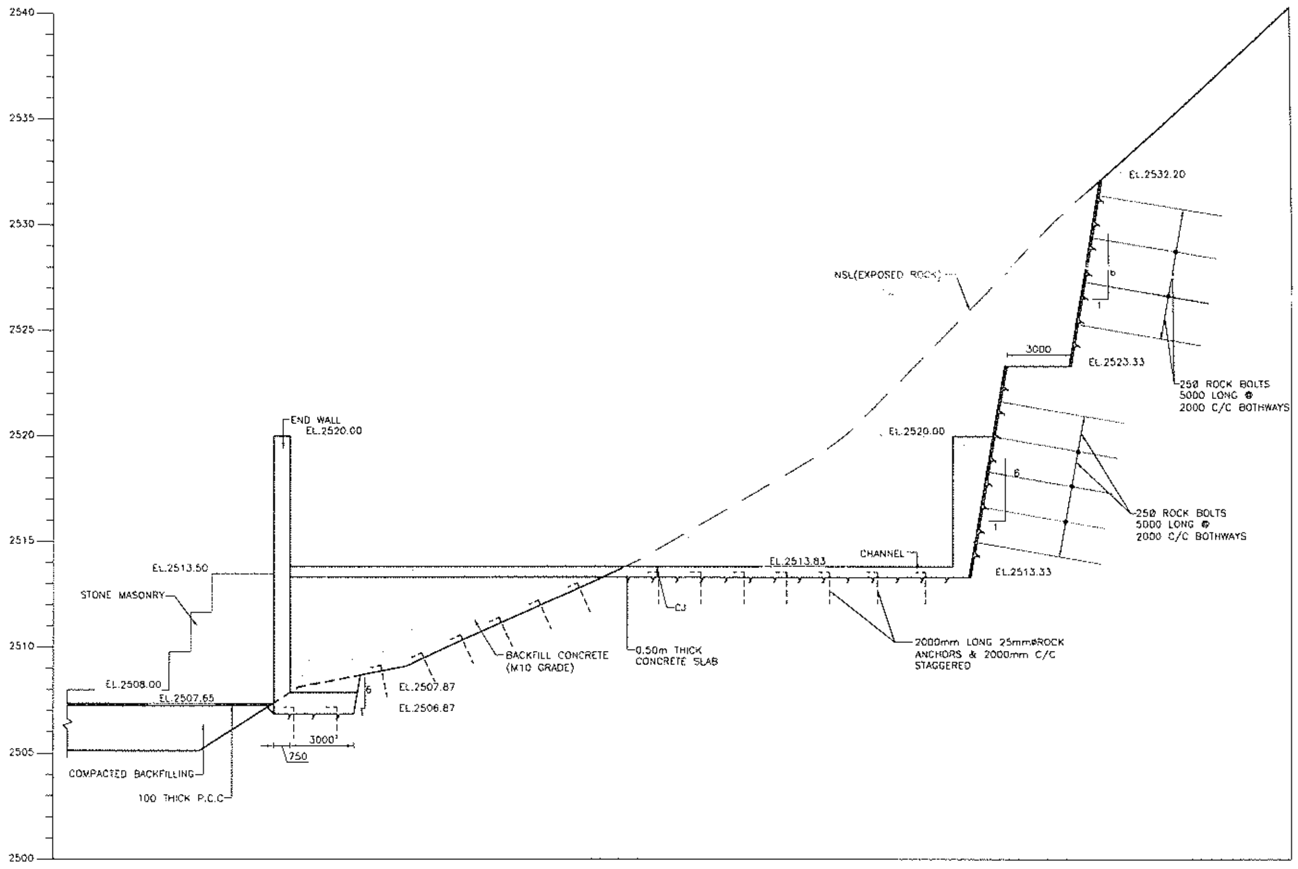
PROJECT: MALANA-II HYDRO ELECTRIC PROJECT

TITLE: L - SECTION G-G'

DRAWING NO	DATE:	SHEET SIZE:
324-CDC-03A-008	OCT-2017	A1

NOTES: -

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.

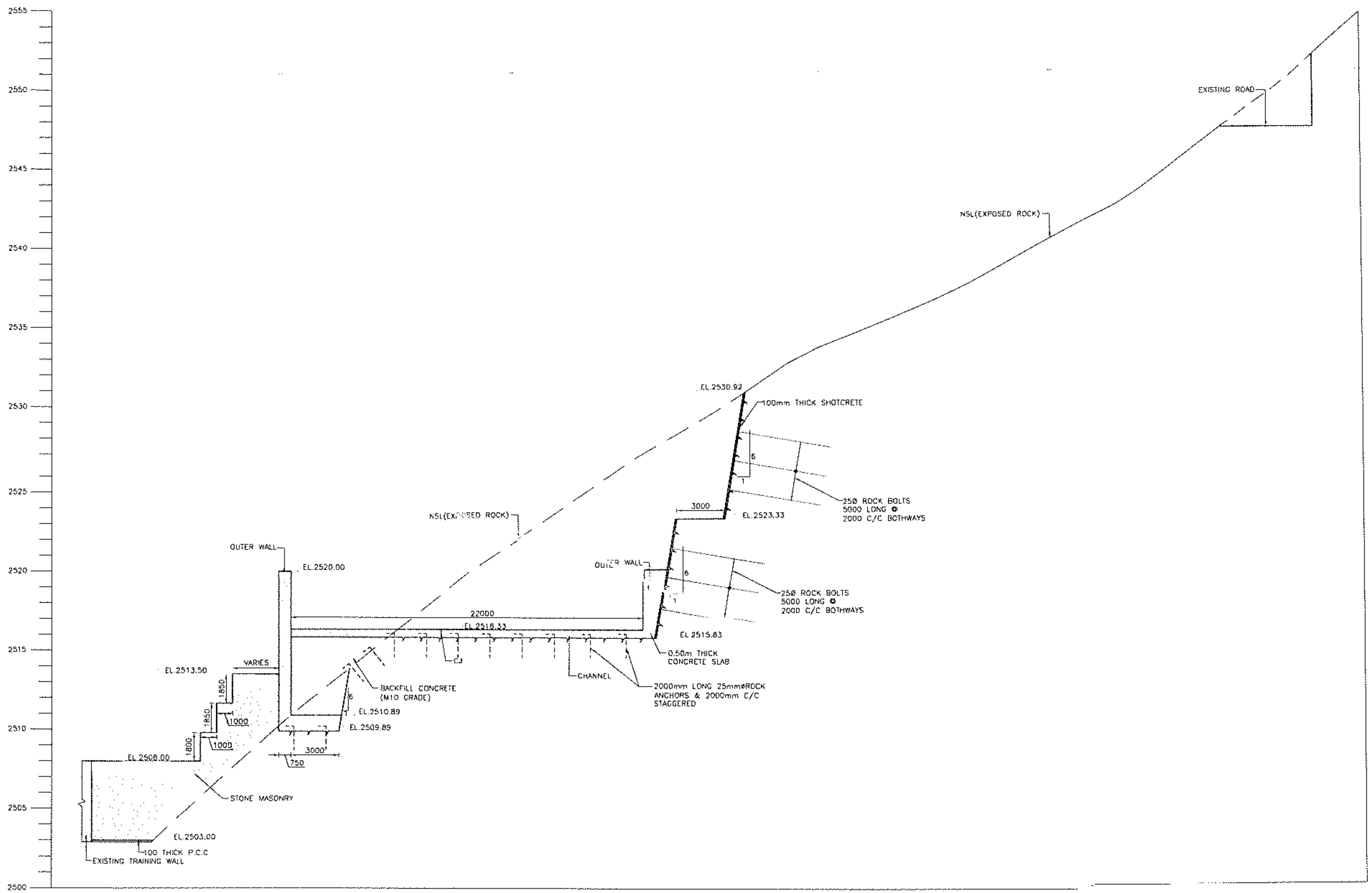


SECTION H-H'
SCALE 1:125

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:125
0 1.25 2.50 3.75 5.0 6.25 12.5m

CLIENT:
EVEREST POWER PRIVATE LIMITED
PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT
TITLE:
CROSS - SECTION H-H'
DRAWING NO: 324-CDC-03A-009
DATE: OCT-2017
SHEET SIZE: A1



SECTION J-J'
SCALE 1:125

SCALE:- 1:125
0 1.25 2.50 3.75 5.00 6.25 12.5m

FOR DETAILED PROJECT REPORT ONLY

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.

EVEREST POWER PRIVATE LIMITED

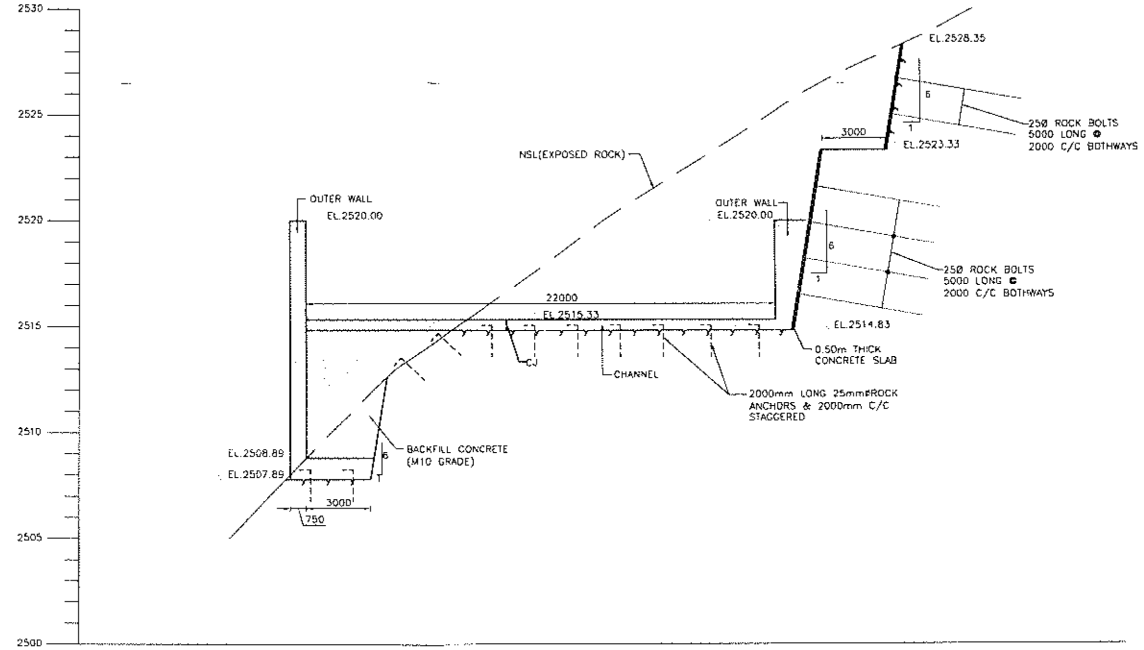
PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

TITLE:
CROSS - SECTION J-J'

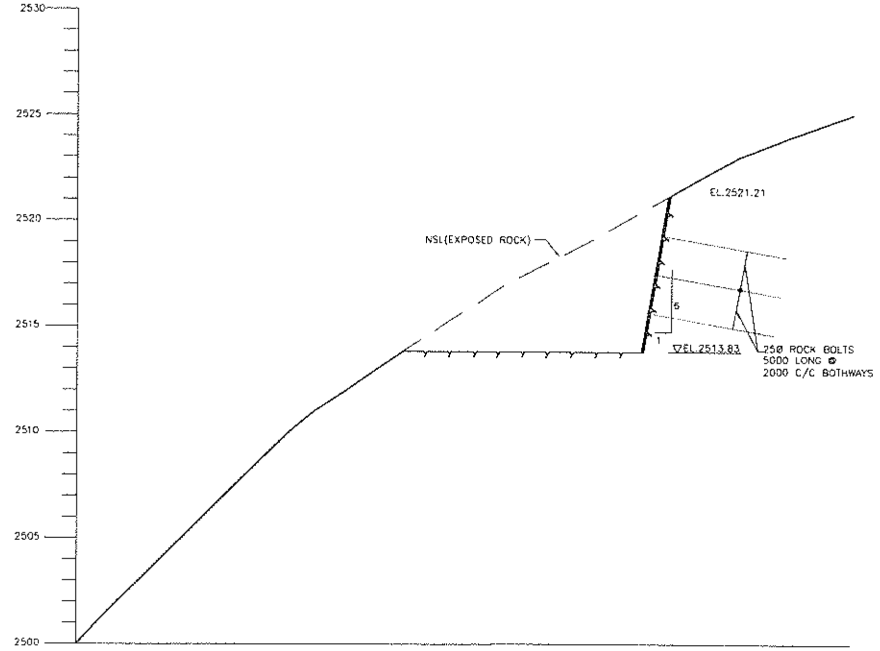
DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-010	OCT-2017	A1

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION K-K'
SCALE 1:125



SECTION L-L'
SCALE 1:125

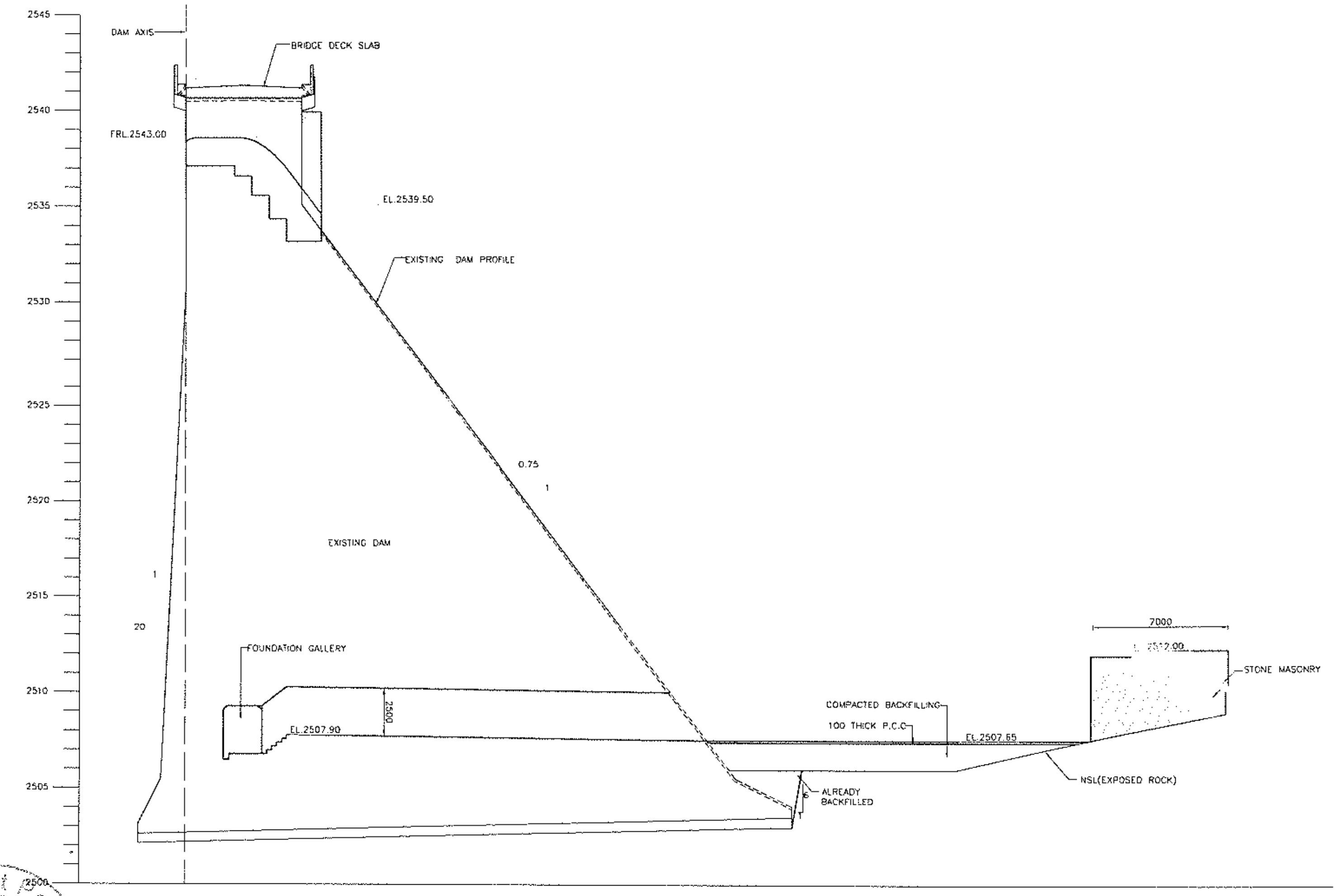
FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:125
1.25 2.50 3.75 5.0 6.25 12.5m

CLIENT:	EVEREST POWER PRIVATE LIMITED
PROJECT:	MALANA-II HYDRO ELECTRIC PROJECT
TITLE	CROSS - SECTION K-K' & L-L'
DRAWING NO. 324-CDC-03A-011	DATE: OCT-2017 SHEET SIZE: A1

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED.



SECTION M-M'
SCALE 1:125

FOR DETAILED PROJECT REPORT ONLY

SCALE:- 1:125
0 1.25 2.50 3.75 5.0 6.25 12.5m

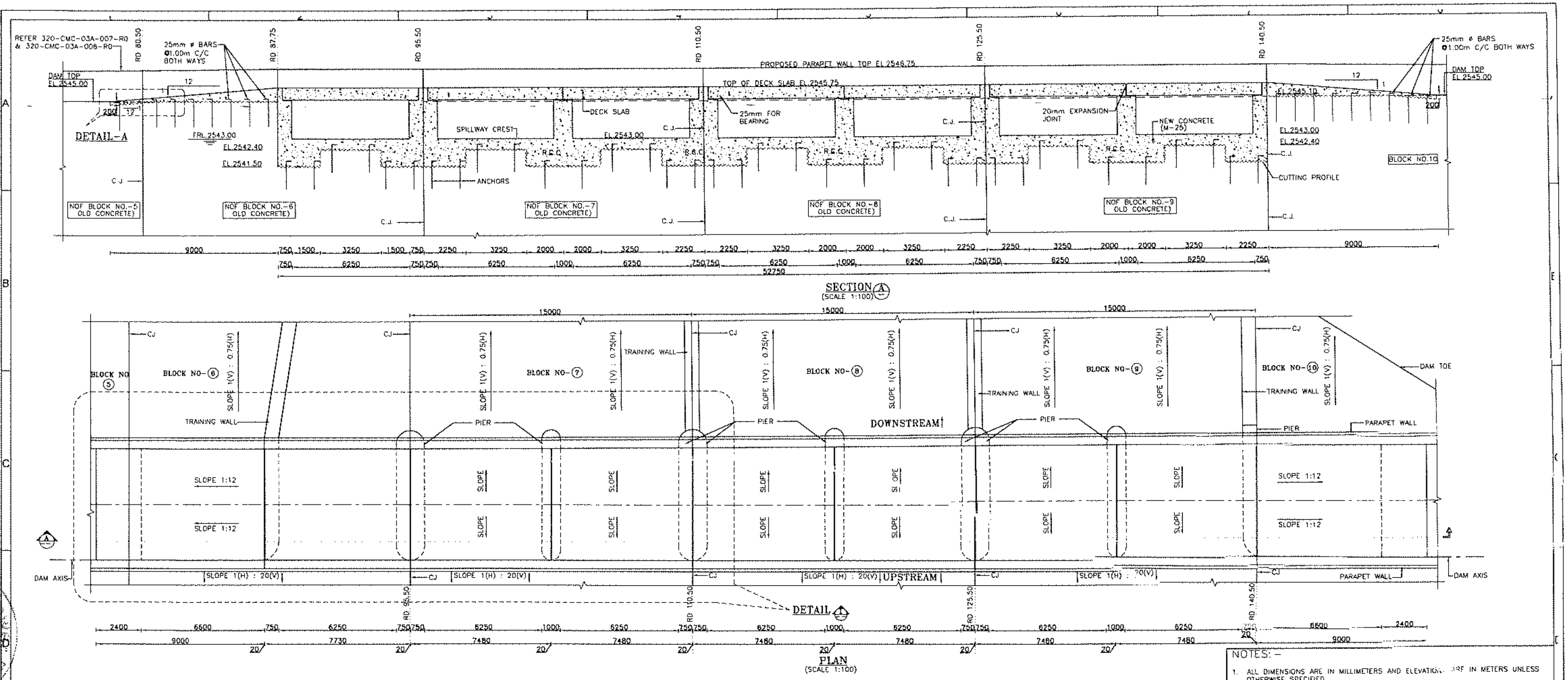
CLIENT: EVEREST POWER PRIVATE LIMITED

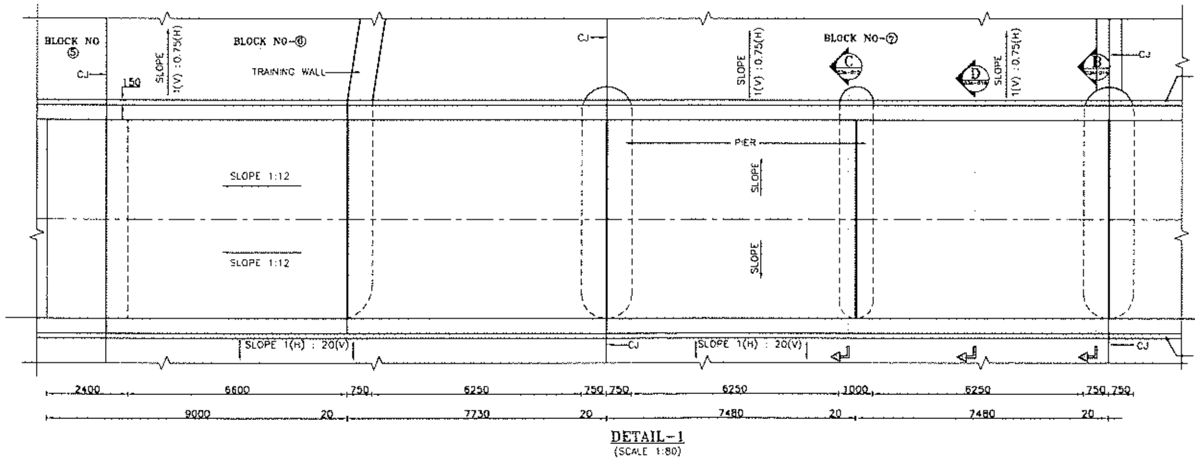
PROJECT: MALANA-II HYDRO ELECTRIC PROJECT

TITLE: CROSS - SECTION M-M'

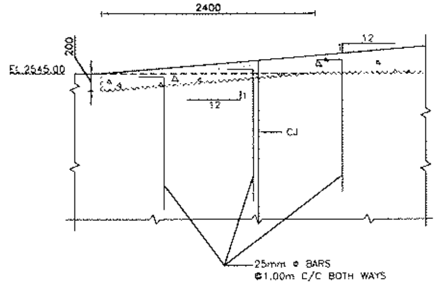
DRAWING NO	DATE:	SHEET SIZE:
324-CDC-03A-012	OCT-2017	A1

280





DETAIL-1
(SCALE 1:80)



DETAIL-A
(NOT TO SCALE)

LEGEND:-
▨ NEW CONCRETE (M-25)
CONCRETE ROUGH SURFACE

SCALE:- 1:80
0 0.8 1.6 2.4 3.2 4.5 8.0m

SCALE:- 1:100
0 1 2 3 4 5 10m

NOTES: –

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THIS DRAWING, ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR GENERAL LAYOUT PLAN OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CDC-03A-001.
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER, INTERMEDIATE PIER, SECTION OF CENTER OF BAY OF SPILLWAY, TRAINING WALL AND BRIDGE DETAILS, REFER RELEVANT DRAWINGS.
10. FOR REINFORCEMENT DETAILS REFER RELEVANT DRAWINGS.

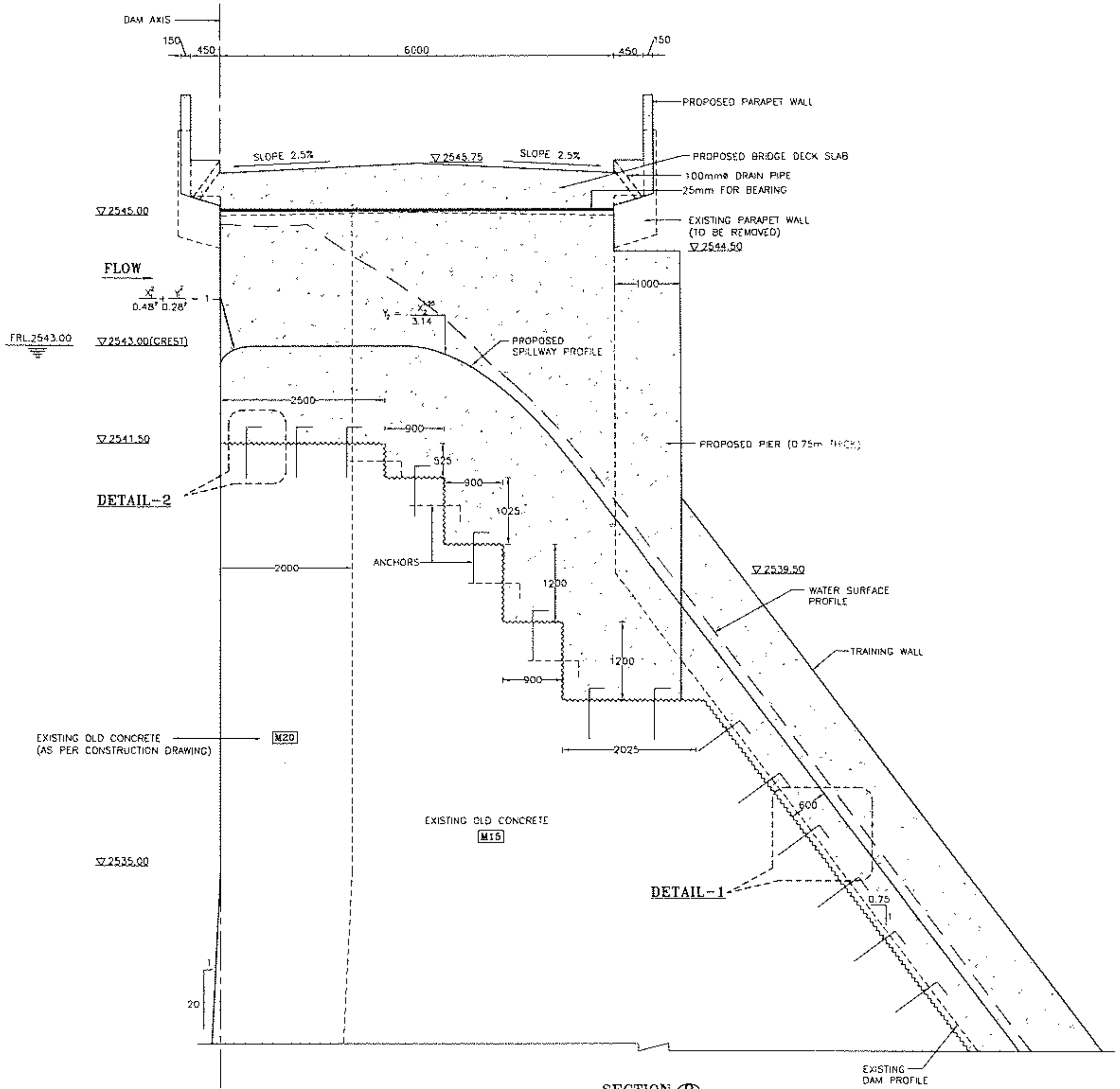
FOR DETAILED PROJECT REPORT ONLY

CLIENT: EVEREST POWER PRIVATE LIMITED

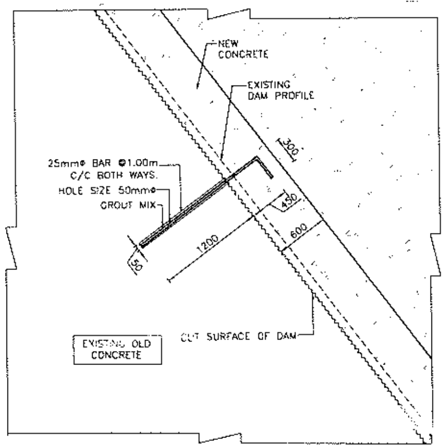
PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

TITLE: **ADDITIONAL UNGATED SURFACE SPILLWAY - PLAN AND SECTION**

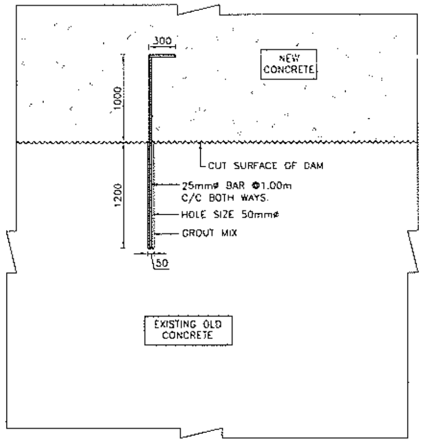
DRAWING NO. 324-CDC-03A-013
DATE: OCT-2017
SHEET SIZE: A1



SECTION B
(SECTION NEAR THE END PIER)



DETAIL-1
(NOT TO SCALE)



DETAIL-2
(NOT TO SCALE)

NOTES: –

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THIS DRAWING, ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR PLAN AND SECTION OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CMC-03A-013
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR INTERMEDIATE PIER, SECTION ALONG CENTER OF BAY OF SPILLWAY, TRAINING WALL AND BRIDGE DETAILS, REFER RELEVANT DRAWINGS.
10. FOR REINFORCEMENT DETAILS REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

LEGEND: –

☐ NEW CONCRETE (M-25)
〰 CONCRETE ROUGH SURFACE

SCALE: - 1:40
0 0.4 0.8 1.2 1.6 2.0 4.0m

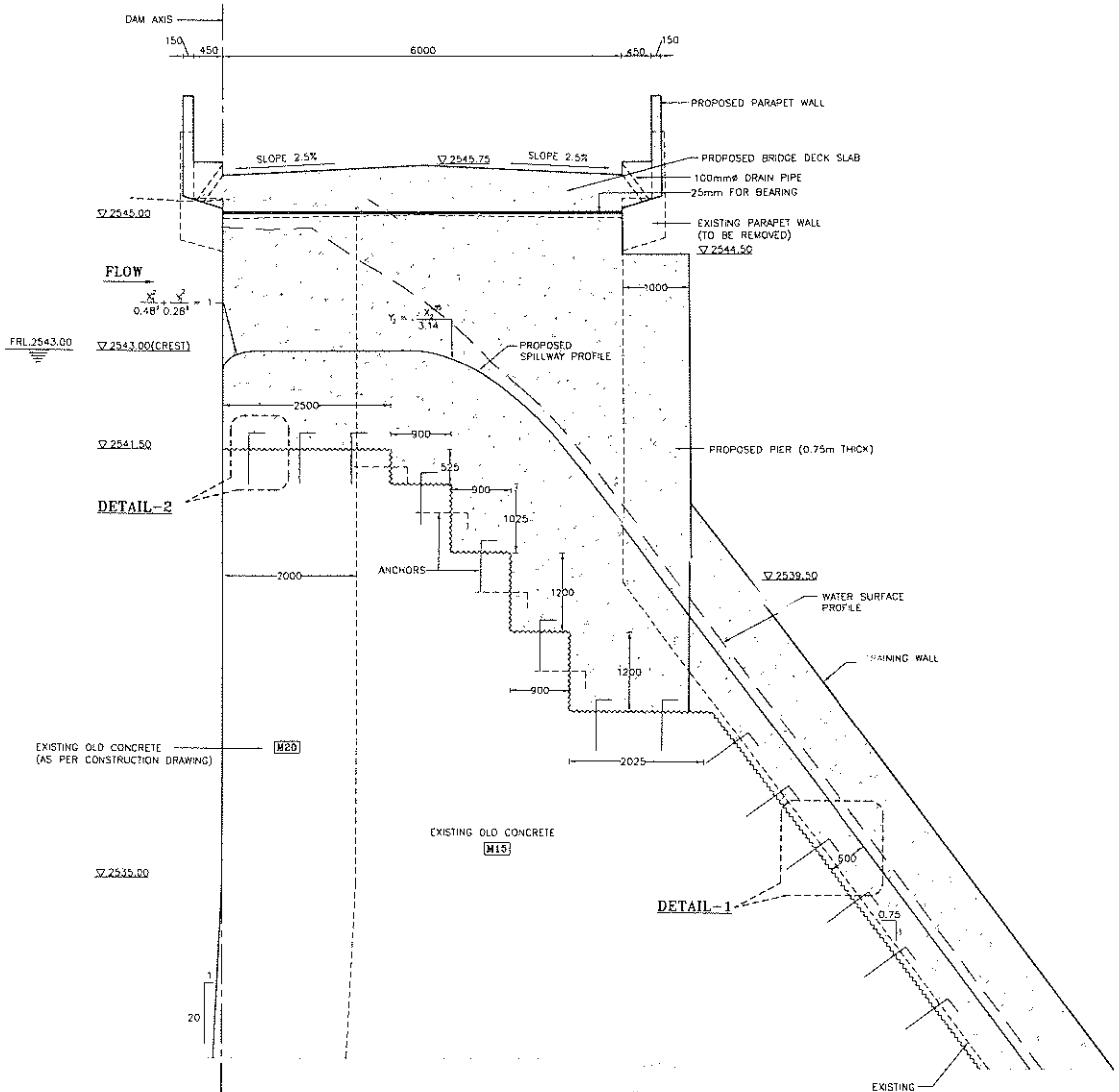
CLIENT:
EVEREST POWER PRIVATE LIMITED

PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

TITLE:
SECTION - B
(END PIER)

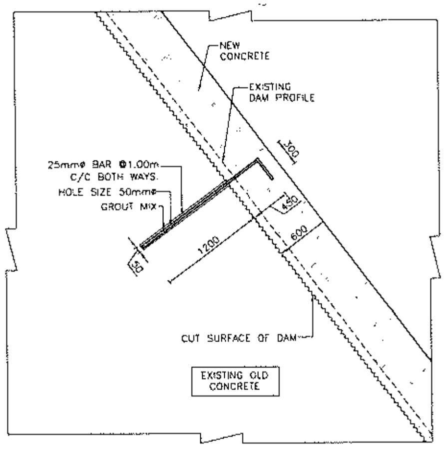
DRAWING NO.: 324-CDC-03A-014
DATE: OCT-2017
SHEET SIZE: A1

282

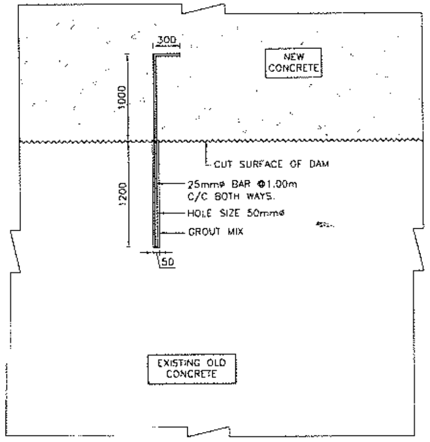


SECTION (C)

(SECTION NEAR THE INTERMEDIATE PIER)



DETAIL-1
(NOT TO SCALE)



DETAIL-2
(NOT TO SCALE)

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THIS DRAWING. ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR PLAN AND SECTION OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CMC-03A-013.
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER, SECTION ALONG CENTER OF BAY OF SPILLWAY, TRAINING WALL AND BRIDGE DETAILS, REFER RELEVANT DRAWINGS.
10. FOR REINFORCEMENT DETAILS REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

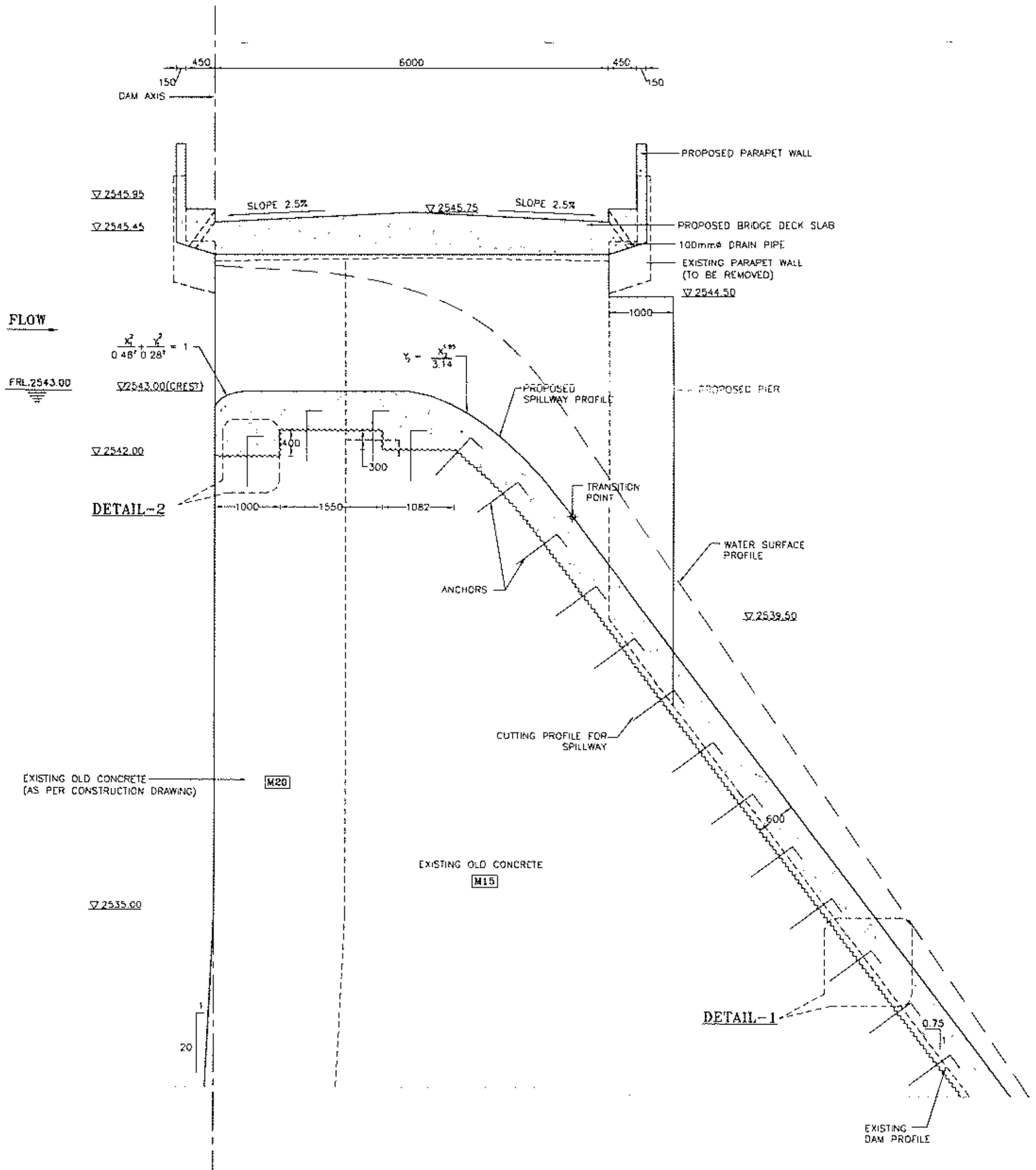
LEGEND:-

▭	NEW CONCRETE (M-25)
▨	CONCRETE ROUGH SURFACE

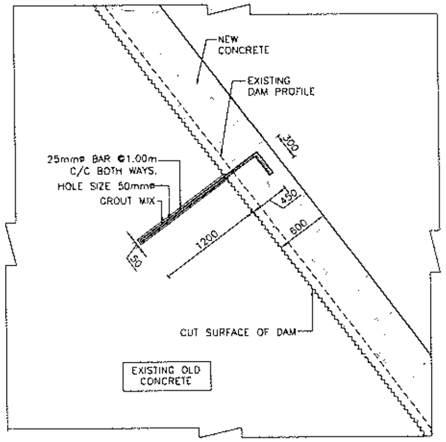
SCALE:- 1:40
0 0.4 0.8 1.2 1.6 2.0 4.0m

CLIENT: EVEREST POWER PRIVATE LIMITED
PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**
TITLE: **SECTION - C**
(INTERMEDIATE PIER)
DRAWING NO. 324-CDC-03A-015
DATE: OCT-201
SHEET SIZE: A1

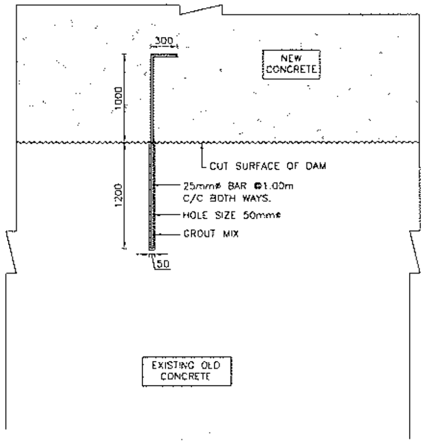
283



SECTION (D)
(SECTION ALONG CENTER OF BAY OF SPILLWAY)
(AWAY FROM THE PIER ZONE)



DETAIL-1
(NOT TO SCALE)



DETAIL-2
(NOT TO SCALE)

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THIS DRAWING, ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3.- FOR PLAN AND SECTION OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CDC-03A-013.
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER, INTERMEDIATE PIER, TRAINING WALL AND BRIDGE DETAILS, REFER SEPARATE DRAWINGS.
10. FOR REINFORCEMENT DETAILS REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

LEGEND:-
▭ NEW CONCRETE (M-25)
▭ CONCRETE ROUGH SURFACE

SCALE:- 1:40
0 0.4 0.8 1.2 1.6 2.0 4.0m

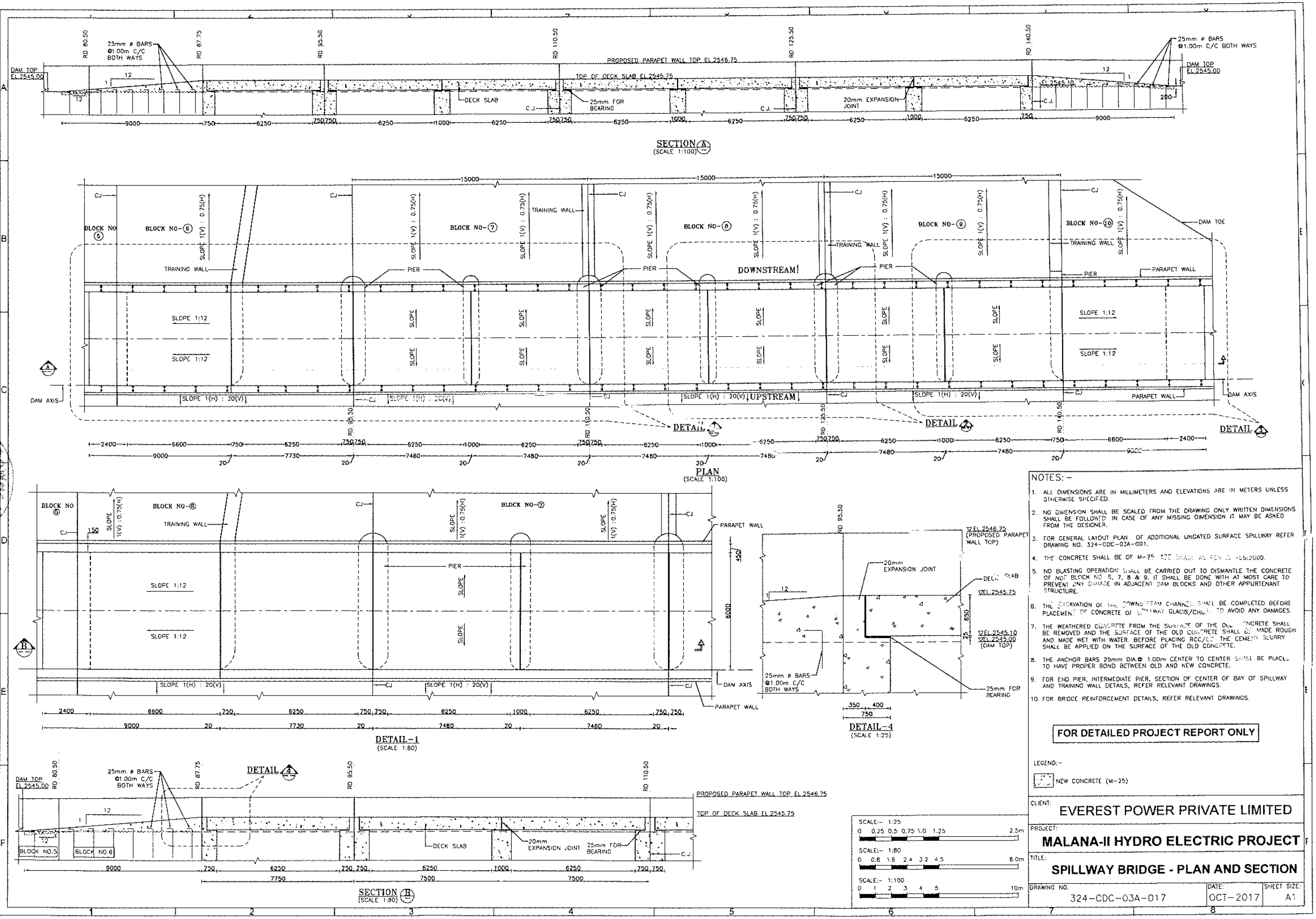
CLIENT:
EVEREST POWER PRIVATE LIMITED

PROJECT:
MALANA-II HYDRO ELECTRIC PROJECT

TITLE:
SECTION - D
(SECTION ALONG CENTER OF BAY OF SPILLWAY)

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-016	OCT-2017	A1

284



NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR GENERAL LAYOUT PLAN OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CDC-03A-001.
4. THE CONCRETE SHALL BE OF M-25 RCC GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER, INTERMEDIATE PIER, SECTION OF CENTER OF BAY OF SPILLWAY AND TRAINING WALL DETAILS, REFER RELEVANT DRAWINGS.
10. FOR BRIDGE REINFORCEMENT DETAILS, REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

LEGEND:-

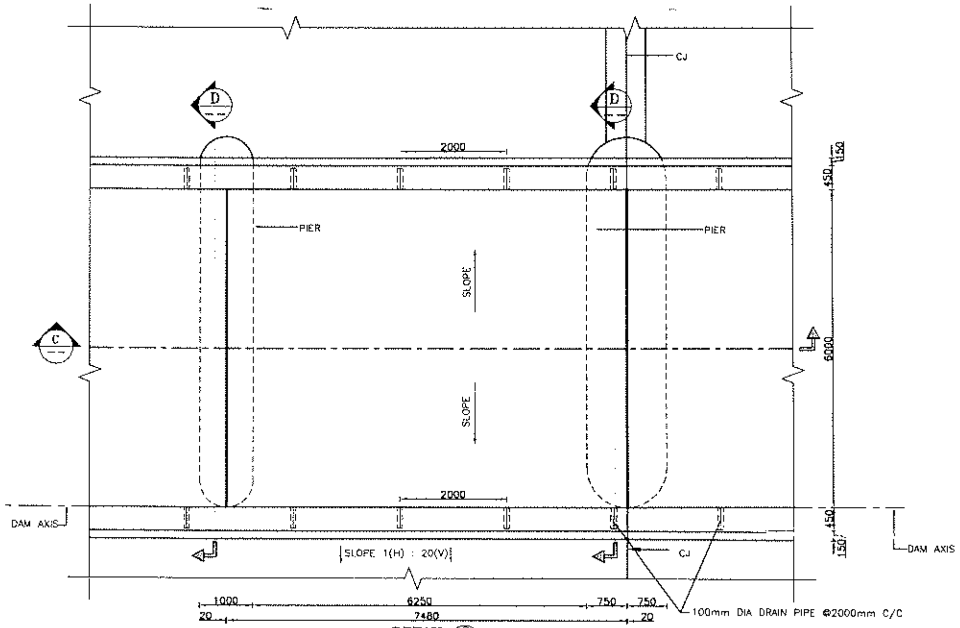
▨ NEW CONCRETE (M-25)

CLIENT: EVEREST POWER PRIVATE LIMITED

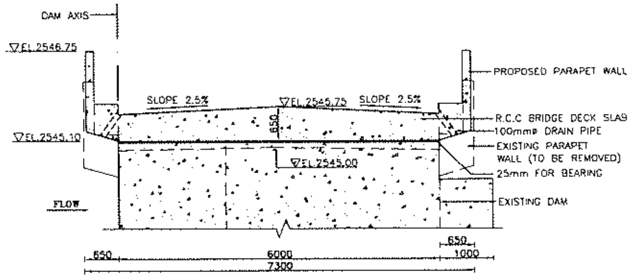
PROJECT: MALANA-II HYDRO ELECTRIC PROJECT

TITLE: SPILLWAY BRIDGE - PLAN AND SECTION

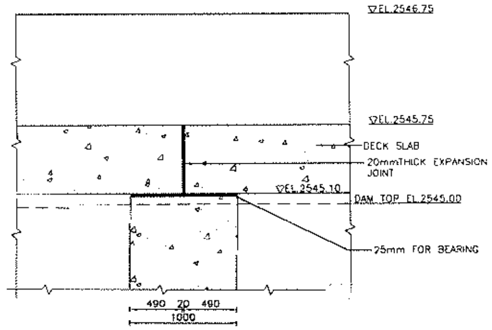
DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-017	OCT-2017	A1



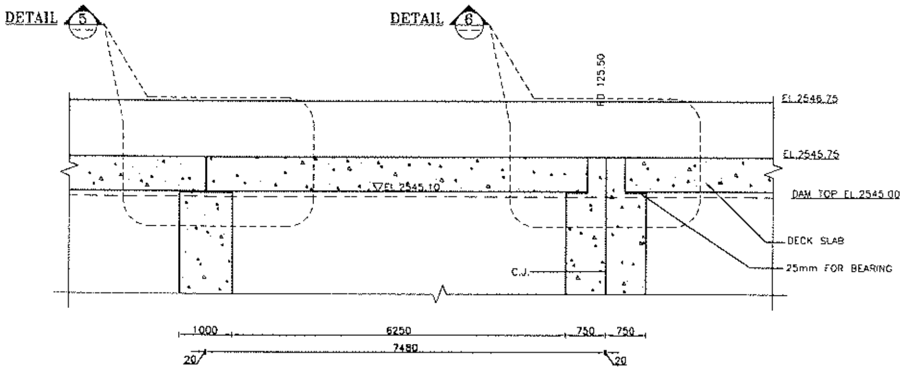
DETAIL (2) (SCALE 1:50)



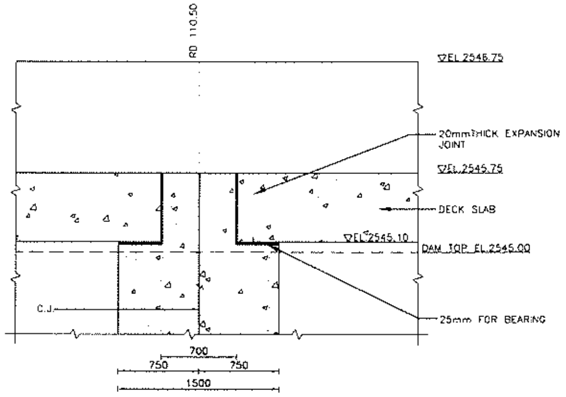
SECTION (D) (SCALE 1:50)



DETAIL-5 (SCALE 1:25)



SECTION (C) (SCALE 1:50)



DETAIL-6 (SCALE 1:25)

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE IF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR SPILLWAY BRIDGE PLAN AND SECTION REFER DRAWING NO. 324-CDC-03A-017.
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER, BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA.@ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER, INTERMEDIATE PIER, SECTION ALONG CENTER OF BAY OF SPILLWAY AND TRAINING WALL DETAILS, REFER RELEVANT DRAWINGS.
10. FOR BRIDGE REINFORCEMENT DETAILS, REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

LEGEND:-

▨ NEW CONCRETE (M-25)

SCALE:- 1:25
0 0.25 0.5 0.75 1.0 1.25 2.5m

SCALE:- 1:80
0 0.8 1.6 2.4 3.2 4.5 8.0m

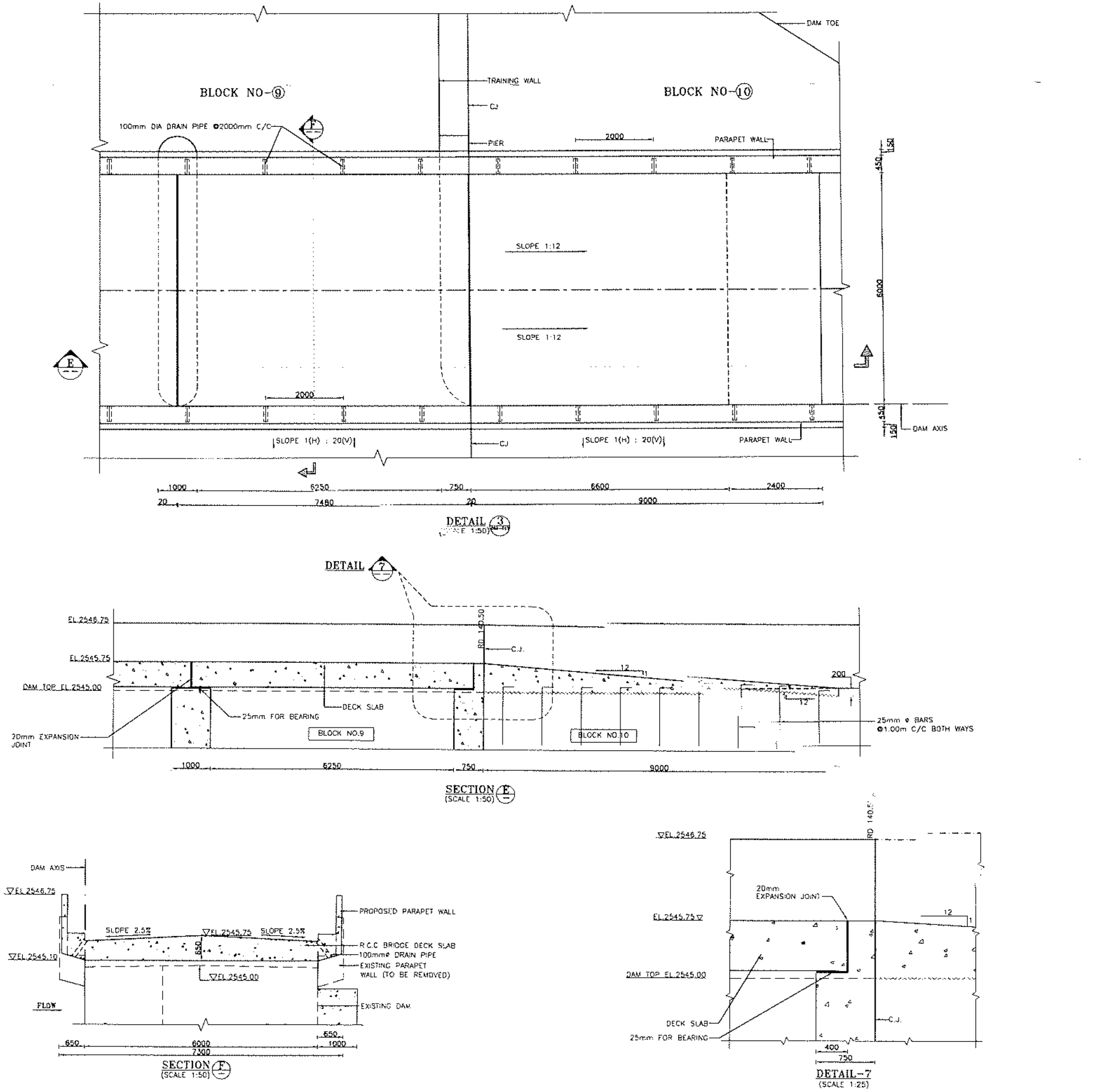
CLIENT: EVEREST POWER PRIVATE LIMITED

PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

TITLE: **SPILLWAY BRIDGE - PLAN AND SECTION**

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-018	OCT-2017	A1

286



NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR SPILLWAY BRIDGE PLAN AND SECTION REFER DRAWING NO. 324-CDC-03A-017.
4. THE CONCRETE SHALL BE OF M-25, A20 GRADE AS PER IS 456:2000.
5. NO BLASTING OPERATION SHALL BE CARRIED OUT TO DISMANTLE THE CONCRETE OF NOF BLOCK NO. 6, 7, 8 & 9. IT SHALL BE DONE WITH AT MOST CARE TO PREVENT ANY DAMAGE IN ADJACENT DAM BLOCKS AND OTHER APPURTENANT STRUCTURE.
6. THE EXCAVATION OF THE DOWNSTREAM CHANNEL SHALL BE COMPLETED BEFORE PLACEMENT OF CONCRETE OF SPILLWAY GLACIS/CHUTE TO AVOID ANY DAMAGES.
7. THE WEATHERED CONCRETE FROM THE SURFACE OF THE OLD CONCRETE SHALL BE REMOVED AND THE SURFACE OF THE OLD CONCRETE SHALL BE MADE ROUGH AND MADE WET WITH WATER. BEFORE PLACING RCC/CC, THE CEMENT SLURRY SHALL BE APPLIED ON THE SURFACE OF THE OLD CONCRETE.
8. THE ANCHOR BARS 25mm DIA @ 1.00m CENTER TO CENTER SHALL BE PLACED TO HAVE PROPER BOND BETWEEN OLD AND NEW CONCRETE.
9. FOR END PIER,MID PIER, SECTION ALONG CENTER OF BAY OF SPILLWAY AND TRAINING WALL DETAILS, REFER RELEVANT DRAWINGS.
10. FOR BRIDGE REINFORCEMENT DETAILS, REFER RELEVANT DRAWINGS.

FOR DETAILED PROJECT REPORT ONLY

LEGEND:-

▨ NEW CONCRETE (M-25)

SCALE:- 1:25
0 0.25 0.5 0.75 1.0 1.25 2.5m

SCALE:- 1:80
0 0.8 1.6 2.4 3.2 4.5 8.0m

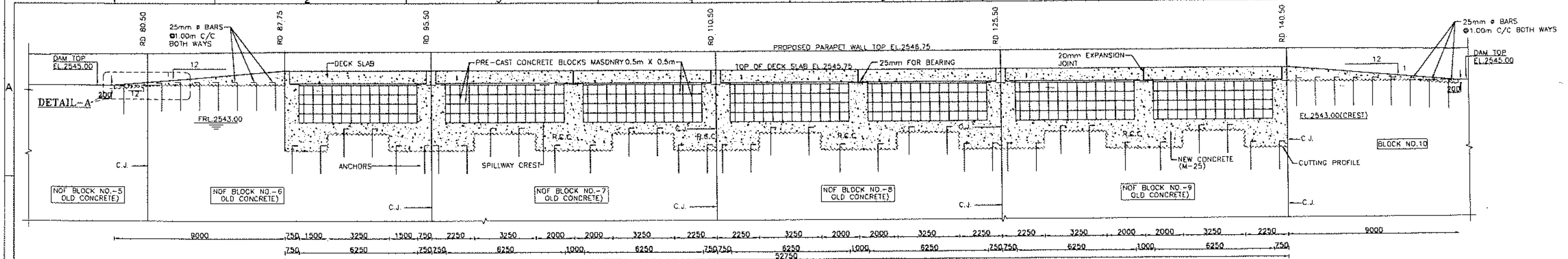
CLIENT: EVEREST POWER PRIVATE LIMITED

PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

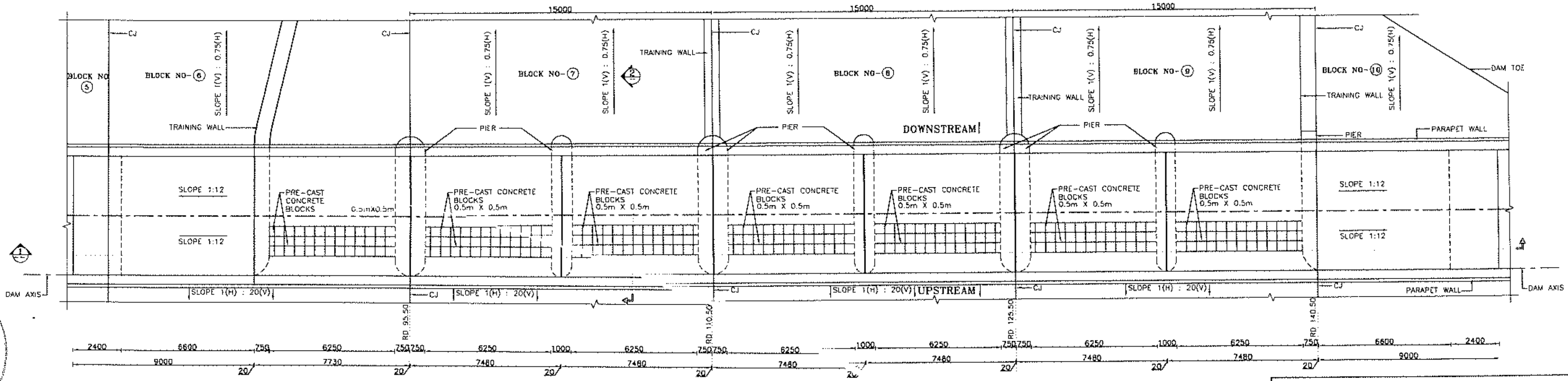
TITLE: **SPILLWAY BRIDGE - PLAN AND SECTION**

DRAWING NO.	DATE:	SHEET SIZE:
324-CDC-03A-019	OCT-2017	A1

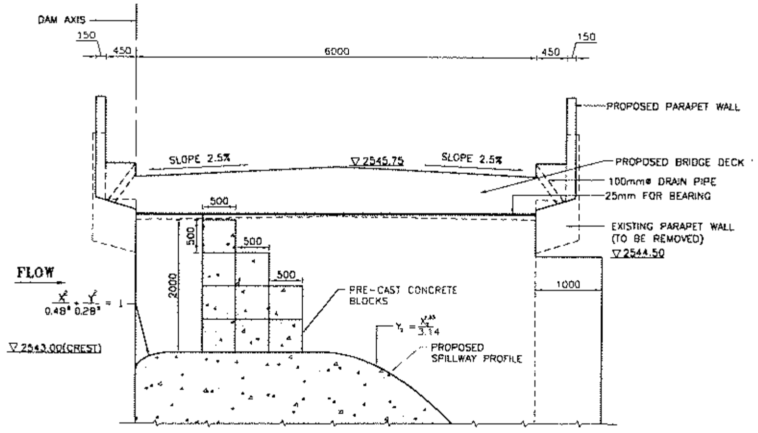
287



SECTION ①
(SCALE 1:100)



PLAN
(SCALE 1:100)



SECTION ②
(SCALE 1:40)

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE SCALED FROM THE DRAWING ONLY WRITTEN DIMENSIONS SHALL BE FOLLOWED. IN CASE OF ANY MISSING DIMENSION IT MAY BE ASKED FROM THE DESIGNER.
3. FOR LAYOUT PLAN OF ADDITIONAL UNGATED SURFACE SPILLWAY REFER DRAWING NO. 324-CDC-03A-001.

FOR DETAILED PROJECT REPORT ONLY

LEGEND:-

NEW CONCRETE (M-25)

SCALE:- 1:40
0 0.4 0.8 1.2 2.0 4.0m

SCALE:- 1:100
0 1 2 3 4 10m

CLIENT: EVEREST POWER PRIVATE LIMITED

PROJECT: **MALANA-II HYDRO ELECTRIC PROJECT**

TITLE: **DETAILS OF TEMPORARY WALL IN SPILLWAY**

DRAWING NO	DATE:	SHEET SIZE:
324-CDC-03A-020	OCT-2017	A1

Annexure - 8

No. J-12011/21/2005-IA-I (R) Pt.
Government of India
Ministry of Environment, Forest & Climate Change
(IA. I Division)

Indira Paryavaran Bhawan
3rd Floor, Vayu Wing
Jor Bagh Road
New Delhi-110 003

Dated: 05th August 2019

To
M/s Everest Power Private Limited
First House, Bhumian Estate,
Nav Bahar Bhumian Road
Chotta Shimla, Shimla-171002

Sub: 100 MW Malana II HEP, Kullu, Himachal Pradesh by M/s Everest Power Private Limited at Himachal Pradesh – regarding amendment in Environmental Clearance.

Sir,

This has reference to your online application No. IA/HP/RIV/94369/2005 dated 05.02.2019 and letter dated 27.11.2018 on the above-mentioned subject.

2. The Malana – II Hydroelectric Power Project is an operational Run-of the River scheme, located in the Malana Nallah, a tributary of Parbati River in the Beas Basin, near the Malana village of Kullu District, State of Himachal Pradesh, India. The Ministry of Environment, Forest & Climate Change has accorded Environmental Clearance (EC) to Malana-II Hydroelectric Project (100 MW) on 21st June, 2005.

3. In view to provide additional safety measures in the existing dam structure due to flash floods on account of changing climatic conditions, Directorate of Energy (DoE), Government of Himachal Pradesh (GoHP) directed Everest Power Private Ltd (EPPL) for preparation of Detailed Project Report for execution of additional spillway. DPR, along with the Physical Model Study carried out by IIT, Roorkee for additional spillway was submitted to DoE, GoHP in November, 2017. Subsequently, DOE has approved the DPR for construction of the additional spillway without changing the salient features of the project vide its letter dated 02.02.2018. Therefore, following amendment in EC dated 21.06.2005 is requested from MoEF&CC:

Components	**Project Features**
(iii) Spillway Bays	
a) Type & Size	
1. Breast wall type	2 nos of bays (4m x 5.5 m)
2. Surface type	**7 bays (6.25m x 2 m)**
b) Spillway:	
1. Breast wall type	Chute Spillway
2. Surface type	**Chute Spillway**
c) Crest Level:	

Components	Project Features
1. Breast wall type	EL. 2514.50m
2. Surface type	**El 2543.00m**
d) Type of Gates:	
1. Breast wall type	Radial gates operated by Hydraulic
2. Surface type	**Un-gated**

4. Your proposal for an amendment in EC dated 21.06.2005, in view of construction of additional spillway to provide additional safety measures in the existing dam structure was considered by the Environment Appraisal Committee (EAC) for River Valley and Hydro Electric Power Projects (RV&HEP) in its 23rd meeting held on 23.04.2019. The EAC duly considered the relevant documents submitted by you and have recommended for an amendment in EC with respect to additional Spillway as mentioned in para no. 3 above. Accordingly, the Ministry hereby accords an amendment in EC dated 21.06.2005 with following additional conditions:

i. 18500 m^3 of muck so generated to be disposed of only at the designated muck disposal sites (AMDS-2).
ii. Construction work to be carried out during daytime only and less noisy equipment be used for construction work so as to not to disturb any wildlife in the area.
iii. Other statutory permissions/clearances as required for the construction work be obtained from other Statutory Authorities.
iv. Minimum e-flow be maintained as per the recommendation of Beas River Basin Studies.

5. All other terms and conditions as stipulated in environmental clearance letter No. J-12011/21/2005-IA-I (R) dated 21.6.2005 shall remain unchanged.

6. This issues with approval of the Competent Authority.

Yours faithfully,

(Dr. S. Kerketta)
Director, IA.I

Copy to:

1. The Secretary, Ministry of Power, Shram Shakti, Bhawan, Rafi Marg, New Delhi-1.
2. The Secretary, Ministry of Jal Shakti, Shram Shakti Bhawan, Rafi Marg, New Delhi -3.
3. The Addl. PCCF(Central), Regional Office, Ministry of Environment, Forest & Climate Change, Bays No 24-25, Sector - 31 A Dakshin Marg, Chandigarh – 162 022.
4. The Member Secretary, Himachal Pradesh Pollution Control Board, Phase-III, Him Parivesh, New Shimala -171009.
5. Sr. PPS to JS (GM)
6. NIC Cell – for uploading in MOEF's website.
7. Guard File.

(Director, IA.I)

6

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Annexure -9

भारत सरकार / Government of India
विद्युत मंत्रालय / Ministry of Power
केंद्रीय विद्युत प्राधिकरण / Central Electricity Authority
प्रणाली योजना एवं परियोजना मूल्यांकन विभाग /
System Planning & Project Appraisal Division
सेवा भवन, आर के पुरम / Sewa Bhawan, R.K. Puram
नई दिल्ली / New Delhi – 110 066
वेबसाइट / Website : www.cea.nic.in

[ISO: 9001: 2008]

No. 1/9/SP&PA-1 2 / Dated: 04/02/2013-

As per list enclosed-

Sub: Minutes of the 31st Standing Committee meeting on Power System Planning of Northern Region held on 2nd January 2013

Sir,

The 31st meeting of the Standing Committee on Power System Planning of Northern Region was held on 02.01.2013 at POWERGRID, Gurgaon. The minutes of the meeting has been uploaded on CEA website : www.cea.nic.in (path to access - wing specific document /power system related reports / standing committee on power system planning / northern region).

The minutes of the connectivity and long term open access meeting held on 02.01.2013 shall be given separately and uploaded shortly.

Yours faithfully

4/2/13

(B. K Sharma)

Director (SP&PA)

Everest Power Private Limited

List of Addresses-

1 - Member Secretary
NRPC
18-A Shajeed Jeet
Singh Sansanwal Marg,
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(Fax-01 1-26865206)

2. Director (Projects)
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3. Director (Technical)
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Sector - 33, NHPC,
Faridabad - 121 003
(Fax-0129-2277941)

4. Director (Projects)
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Saudamini,
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Gurgaon-122 001
1Fax-0124-2571932'

5.
Director (Technical)
RRVPNL, Vidyut
Bhawan, Jaipur
Pin - 302 005.
Fax 0141-2740794

6. Director(Technical)
HPSEB Ltd.
Vidyut Bhawan,
SHIMLA-171004
(Fax-01 77-2813554)

7. Director (Transmission)
UPPTCL, Shakti Bhawan
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Lucknow - 226 001
(Fax-0522-228841 0)

8. Director (Projects)
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Campus, Kanwali Road
Dehradun- 248001.
Uttarakhand
(Fax-0135-2763431)

9. Director (Operations)
Delhi Transco Ltd.
Shakti Sadan, Kotla Marg,
New Delhi - 11 0 002
(Fax-01 1-23234640)

10. Director(Technical)
Punjab State
Transmission corporation
Ltd. (PSTCL), Head Office
The Mall
Patiala - 147 001
(Fax-0 1 75-230401 7)

1 1. Director (Technical)
HVPNL
Shakti Bhawan,
Sector -6
Panchkula - 134 109
(Fax-01 72-2560640)

12. Director(Technical)
THDC Ltd.
Pragatipuram,
Bypass Road,
Rishikesh- 249201
Uttaranchal
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13. Development
Commissioner (Power),
Civil Secretariat,
JAMMU - 180 001
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2530265)

14. Member (Power)
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Madya Marg,
Chandigarh-1 60019
(Fax-01 72-2549857)

15. Chief Engineer
(Transmission)
NPCIL,9- S-30
Vikram Sarabhai Bhawan,
Anushakti Nagar,
Mumbai - 400 094
(Fax-022-25993570,
25563350)

16. Chief Engineer
(Operation)
Ministry of Power, UT
Secretariat, Sector-9 D
Chandigarh - 161 009
(Fax-01 72-2637880)

17. Managing Director,
HP PowerTransmission
Corporation Ltd.
Barowalias, Khalini,
SHIMLA-171002
(Fax-01 77-2623415

Minutes of 31st Standing Committee Meeting on Power System Planning of Northern Region held on 2nd January 2013 at POWERGRID, Gurgaon

List of participants is enclosed.

Member (PS), CEA welcomed the participants of 31st Standing Committee Meeting of Power System Planning of Northern Region and thanked them for their presence in the meeting. He asked Director (SP& PA), & CTU to take up the agenda items for discussion.

1. Confirmation of minutes of 30th Standing Committee Meeting held on 19.12.2011

Director (SP&PA) stated that Minutes of 30th meeting were uploaded on CEA website and intimation in this regard was sent to members vide CEA letter no. 1/9/SP&PA-12/ dated 20/1/12. He mentioned that the observation of RRVPN regarding LILO of an existing ISTS line for providing connectivity to new generation project, has been included in the agenda and would be discussed later in the meeting along with the other agenda issues.

Regarding NLDC observation on adequacy of interim arrangement agreed for evacuation of unit –I of Rihand-III (2x500 MW) TPS under N-1 contingency, Director (SP&PA), CEA informed that minutes clearly indicate that agreed system is adequate for evacuation of unit-1 generation under normal operating conditions only.

Director (Projects), Powergrid stated that NTPC must provide proper SPS on Rihand Generation station to take care of N-1 contingency. NTPC agreed for the same.

NTPC requested that Rihand-III may be treated on par with other ISGS generation in Singrauli-Rihand generation complex and schedule of all generations may be done proportionately. Members agreed to the request.

NLDC had also observed that augmentation of ICTs at Ludhiana and Moga would result in transformation capacity of more than 1000 MVA at both substations and new substations should be planned instead of augmenting ICTs at existing substations. In this regard, Member (PS), CEA mentioned that augmentation of transformation capacity is more than 1000MVA at certain locations due to non-availability of land and due to high concentrated load growth in this area.

As no other comment was received from members, the minutes of 30th Standing Committee meeting were confirmed.

2. Reliability of Power Supply to J&K

Director (SP&PA), CEA stated that presently the power supply to the Valley is through Kishenpur-Wagoora 400kV D/c, Kishenpur-Pampore 220kV D/c and Udhampur-Pampore 132kV D/c and there was a complete collapse of power supply to

Kashmir Valley on 6th & 7th Jan. '12 due to heavy snowfall and breakdown / tripping of all three existing links between Jammu region & Kashmir valley.

In this regard, PDD, J&K informed that all the existing and under construction lines are routed through Udhampur – Batote – Banihal- Peerpanjal pass. The common corridor of existing transmission lines is highly prone to snow storms, landslides and other natural calamities making power supply to the Kashmir valley very vulnerable. Last year the valley was plunged into darkness for 72 hours due to one such snow storm. Further PDD, J&K representative also stated that power supply to Jammu and Kashmir is basically through 400/220 kV Kishenpur substation and there is immediate need for providing an alternate route for transfer of power from Jammu region to Kashmir valley. In addition, PDD J&K had informed that high load growth is anticipated in northern part of Kashmir and to cater to projected loads, a 400/220 kV substation at Amargarh (in North Kashmir area) may be planned.

Keeping above in view following transmission system was proposed:

- Jullandhar – Samba 400 kV D/c
- Samba –Amargarh 400 kV D/c
- LILO of both circuits of Uri – Wagoora 400 kV D/c line at Amargarh
- Establishment of 2x315 MVA (7x105 MVA), 400/220 kV GIS S/s at Amargarh

PDD, J&K proposed that the new 400 kV D/c line may be routed through a different corridor i.e. via Akhnoor, Rajouri and Mogul Road. This would have dual benefit i.e. the line would be constructed through a different corridor which is away from the existing line corridor as well when the demand in Akhnoor / Rajouri increases, the new 400 kV substation can be established by LILO of proposed 400 kV Samba – Amargarh line.

Director (SP&PA), CEA informed that as decided during the 30th SCM, a committee comprising of CEA, POWERGRID, NHPC, PDD J&K and JKSPDC visited J&K to assess the feasibility of transmission corridors for evacuation of power from the generation projects located in Chenab valley. The committee also looked into the feasibility of implementing a new transmission corridor through Moghul Road. It was observed that a wild life sanctuary located near Shopian is enroute of the Moghul Road. Further, the mountains have loose rocks and construction would be difficult.

Member (PS), CEA mentioned that the proposed transmission works would be implemented through Tariff Based Competitive Bidding (TBCB) route. He requested PDD, J&K to extend all the possible assistance to the implementing agency.

PDD, J&K assured that they would provide all the necessary assistance and support for obtaining requisite clearances form J&K Government.

RVPN stated that the proposed scheme should be implemented by PDD, J&K. Director (projects), POWERGRID explained that the proposed scheme is necessary to provide reliable feed to J&K from the grid and therefore members may consider this scheme under ISTS. He also mentioned that keeping in view the difficulties in construction of the 400 kV Samba –Amargarh D/c, the scheme may be taken up in two parts for ease of execution. He further stated that Amargarh was close to Uri and getting corridor for LILO would be difficult. Accordingly it was agreed that multi-circuit towers would be used near Amargarh substation for LILO work and new line termination.

It was discussed and decided that considering the above works to be implemented through Tariff Based Competitive Bidding route it would be taken as a system strengthening scheme of NR as given below:

NRSS-XXIX

- LILO of both circuits of Uri – Wagoora 400 kV D/c line at Amargarh
- Establishment of 7x105 MVA, 400/220 kV GIS substation at Amargarh
- Jullandhar – Samba 400 kV D/c
- Samba –Amargarh 400 kV D/c routed through Akhnoor & Rajouri

Members agreed with the above proposal.

3. Delinking of RAPP – Shujalpur 400 kV D/c line with RAPP 7&8 generation RAPP

Director (SP&PA), CEA stated that RAPP – Shujalpur 400 kV D/c line was approved as the associated transmission system of RAPP-7&8 in the 29th SCM held on 29/12/10. After the grid collapse of July 2012, it was observed that strengthening of West – North interconnections are required to be taken up on priority. As such it is proposed to delink RAPP – Shujalpur 400kV D/c line from RAPP 7&8 generation for its early implementation.

RRVPNL informed that RAPP/Kota area already experiences high voltages and addition of lines without generator may further aggravate the high voltage problem.

POWERGRID informed that 50 MVAR line reactors have been proposed at both ends of 400kV RAPP-Shujalpur D/c and the line would be adequately compensated. The line reactors at Shujalpur and bays for termination of the line at Shujalpur end would be taken up by POWERGRID while reactor and bays for termination of line at RAPP end are in the scope of M/s NPCIL.

NPCIL informed that the bays and 125 MVAR bus reactors at RAPP generation switchyard would be available by June'15 and RAPP generation is now expected by Feb'16.

Member (PS), CEA stated that the above line is being implemented under Tariff Based Competitive Bidding and likely to be commissioned by Feb 2016.

Members noted the above.

4. Provision of 400 kV line bays at Srinagar S/s (PTCUL) for terminating 400 kV Srinagar-Tehri pooling point D/c line

Director (SP&PA), CEA stated that 400kV Srinagar (PTCUL)- Tehri pooling station D/c (Quad) line was agreed during the 29th SCM as regional strengthening scheme and the line was to be taken up through Tariff based Competitive bidding route. While processing the scheme for implementation, it was gathered that there are space constraints at Srinagar substation of PTCUL and to assess the availability of space, a joint visit of CEA and POWERGRID was undertaken on 11-12th Apr.'12 to study the feasibility of construction of 400kV line bays at Srinagar substation for termination of the line. He also informed that during the site visit, it was observed that at Srinagar 400/220 kV substation (under construction) of PTCUL, sufficient space is not available in the switchyard for accommodating two nos of 400 kV AIS line bays. Two nos. 400 kV line bays can however be accommodated in available space, if the same are constructed as GIS bays. Under such scenario bus extension through GIS duct would be required.

Director (Projects), Powergrid mentioned that the generation projects in Uttarakhand are delayed and in view of this, the above line is deferred for the time being.

Members noted the above.

5. Construction of four (4) nos. 400 kV line bays at 400/200 kV Sub-station of PTCUL at Kashipur

Director (Projects), POWERGRID stated that the construction of 400 kV Bareilly-Kashipur D/c line & 400 kV Kashipur- Roorkee D/c line was agreed as a part of NRSS-XXI during 27th SCM of Northern Region held on 30.05.09. For termination of these lines, four (4) nos. 400 kV bays are to be constructed at 400/220 kV Kashipur substation of PTCUL. These transmission lines are under construction whereas the MOU for construction of 400 kV bays at 400/220 kV Kashipur sub-station could not be finalized till date in spite of regular interactions with PTCUL. It was further informed that PTCUL had proposed that the bays may be constructed by POWERGRID and 15% of total cost may be paid to them as supervision charges.

POWERGRID stated that the entire works of design, engineering, procurement & erection of above bays at Kashipur S/s will be done by POWERGRID and as such PTCUL should not ask for any charges for this work.

Member (PS), CEA advised PTCUL not to ask for any overhead charges for the line terminating bays to be implemented under ISTS scheme by POWERGRID, as the scheme is for the benefit of State. He further mentioned that PTCUL may modify its practices to be followed for the ISTS system planned in the state to this effect. PTCUL agreed for the same.

POWERGRID also informed that 400 kV D/c Bareilly-Kashipur & 400 kV D/c Kashipur-Roorkee line sections are in advanced stage of construction and implementation of bays at Kashipur may take some time and therefore proposed to directly, connect Bareilly-Kashipur 400 kV D/c & Kashipur-Roorkee 400 kV D/c line sections, temporarily bypassing Kashipur till the time, bays at Kashipur are implemented. With the commissioning of bays at Kashipur LILO of the line at Kashipur would be taken up.

Members agreed for the above proposal.

6. Evacuation of Power from Malana-II

Director (SP&PA), CEA stated that the evacuation of power from Malana-II HEP was planned by LILO of one circuit of AD HEP – Nalagarh 220 kV D/c line of M/s AD Hydro at 220/132kV Chhaur substation of M/s Everest Power Pvt. Ltd.(EPPL) and power from generation project was to be injected at Chhaur S/s through a 132 kV D/c line. Further, AD HEP – Nalagarh 220 kV D/c line is not adequate for reliable evacuation of power from both the projects especially under contingency condition. In the 30th Standing Committee Meeting of Northern Region, it was agreed to construct a 220 kV D/c line from 220/132kV Chhaur to Parbati Pooling Station enabling injection of power from Malana-II HEP at Parbati Pooling Station (ISTS). From Parbati Pooling Station, power can be evacuated over ISTS system. It was also decided to provide 2 nos. of 400/220 kV, 315 MVA ICTs (7x105 MVA single phase units) alongwith 4 nos. of 220 kV line bays (2 bays for M/s EPPL and 2 bays for HPPTCL).

He further mentioned that HPPTCL had informed that only one 220 kV line could be constructed from Chhaur to Parbati Pooling Station due to ROW constraints and HPPTCL also intends to inject about 170 MW power from Small HEPs at Chhaur substation for its further transfer to Parbati Pooling station. As such, HPPTCL proposed that they would construct the 220kV D/c line from Chhaur substation to Parbati Pooling station for which funds are also being tied up with ADB. Further, HPPTCL would also take up the ownership of 132/220 kV Chhaur S/s from M/s EPPL to make it a part of their STU system.

Member (PS), CEA enquired HPPTCL about the expected commissioning schedule of the above 220kV line. HPPTCL informed that the same would be ready by 2015.

POWERGRID stated that Malana-II generation is directly connected to ISTS grid, for which Long Term Open Access has been processed and granted by CTU. Incase this line is constructed by HPPTCL (STU), the direct connectivity of Malana-II with ISTS would be lost and M/s EPPL would have to bear STU charges in addition to PoC charges.

Member (PS) stated that under proposed proposal Malana-II would be treated as State-embedded generator and would have to pay applicable charges accordingly. He enquired M/s EPPL for their consent to the above proposal.

M/s EPPL informed that they are agreeable to the proposal and they would sort out all commercial issues with HP.

While finalizing the proposal it was also decided that **400/220 kV, 2x315 MVA ICTs (7x105 MVA single- phase units) along with the associated bays and 2 nos. of 220 kV line bays would be provided at Parbati pooling station (PG) under ISTS scheme and since it is augmentation work in existing switchyard of POWERGRID S/s, the same would be carried out by POWERGRID.**

Members agreed to the above proposal.

7. LILO of Gladini – Hiranagar S/c line at Samba 400/220 kV substation

POWERGRID stated that 220 kV Sarna – Jammu (Gladini) S/c line was implemented as a part of Salal transmission system (ISTS) and subsequently, LILO of this line at Hiranagar was carried out by PDD J&K at their cost. POWERGRID informed that PDD J&K intends to LILO Gladini – Hiranagar section of this line at 400/220 kV Samba substation of POWERGRID for meeting load requirement of the area. As this line is a part of ISTS system, therefore the proposal to LILO Gladini – Hiranagar section of the line at 400/220 kV Samba substation of POWERGRID was put up to Standing Committee for consideration.

Members agreed to the proposal.

8. Space at 400/220 kV Roorkee (Puhana) substation(POWERGRID) for establishing 220/33 kV substation of PTCUL

Director (SP&PA), CEA stated that during the 30th SCM , PTCUL had informed that there are severe Right- of- Way constraints in the vicinity of the 400 kV Roorkee substation, due to which it was not possible to construct 220kV double circuit line from this substation and therefore PTCUL had proposed to set up their 220/33 kV, 2x50 MVA S/s in the premises of POWERGRID's 400/220 kV Roorkee substation. A team of representatives from CEA, DTL, RVPNL, PTCUL and POWERGRID visited Roorkee 400/220 kV substation and observed the following:

- It is not feasible to accommodate the two nos. of 220/33 kV transformers along with 33 kV bays and control facilities in the vacant land available outside switchyard area within the boundary of POWERGRID substation.

- Committee also looked into the feasibility of taking out 220 kV overhead feeders & found that the 220 kV overhead line is not feasible even with gantry structure & pipe bus as adequate clearances are not available.

- The only feasible option is to take 220 kV outlets through 220 kV underground cables. The laying of cable would involve crossing State owned Roorkee – Dehradun Road adjacent to 400/220 kV POWERGRID substation. The width required for laying 2 circuits of 220 kV cable would be approx. 1.6 meter. Committee does not envisage any constraint in implementation of this option.

PTCUL informed that they had revisited the proposal and is of the view that space is available for 220/33 kV Transformers within Roorkee substation.

RVPNL stated that during the site visit the team had analyzed the overall feasibility and thereafter suggested PTCUL to go for 220 kV cables for immediate take off of outlets from 400/220 kV S/s.

Member (PS), CEA stated that the available space at 400/220 kV Roorkee S/s(PG) should not be consumed for accommodating 33kV distribution feeders. He advised PTCUL to take up outlets through 220kV cables in the immediate vicinity of 400 kV substation and thereafter 220 kV overhead line could be taken up to their 220/33 kV substation. Further, in case of non-availability of adequate land, PTCUL may establish 220/33 kV substation as GIS.

Members agreed to the above.

9. Taking up of Transmission system of Singrauli-III TPS (1x500 MW) as System Strengthening Scheme

Director (SP&PA), CEA stated that during the 29th Standing Committee Meeting of Northern Region, following transmission system was planned for evacuation of power from Singrauli –III TPS (1x500 MW)

- Singrauli – Allahabad 400 kV S/c (due to ROW constraints, about 50 km section of Singrauli-Allahabad line to be strung on existing 400 kV D/c tower from Singrauli end)
- Allahabad - Kanpur 400 kV D/c

POWERGRID informed that NRLDC had raised concerns for transmission constraints in the existing Rihand / Singrauli / Anpara /Obra complex. Additionally, from Meja TPS one 400 kV D/c line was planned only up to Allahabad, considering that Allahabad – Kanpur 400 kV D/c line would be available in the matching time frame which would facilitate power evacuation from Meja also.

Member (PS), CEA stated that considering the requirement of transmission system from Singrauli/Rihand/Obra/Anpara complex as well as power transfer requirement beyond Allahabad, the above identified transmission scheme may be taken up as system strengthening scheme.

Accordingly, following was agreed **under Northern Region System Strengthening Scheme- NRSS XXX**:

- Singrauli – Allahabad 400 kV S/c (due to ROW constraints, about 50 km section of Singrauli-Allahabad line to be strung on existing 400 kV D/c tower from Singrauli end.). Strengthening of existing towers, wherever required shall also be carried out
- Allahabad - Kanpur 400 kV D/c

It was further agreed that the above scheme may be implemented by POWERGRID as its BPTA was agreed before the cut-off date of Tariff Based Competitive Bidding and now only the name of the scheme is changed.

Members agreed to the proposal.

10. System strengthening to overcome constraints in Northern Region

a) High loading in Nathpa Jhakri - Nalagarh lines:

POWERGRID stated that from the operation experience, it has been observed that during the paddy season loading on 400 kV Nathpa Jhakri – Nalagarh – Patiala lines remains on the very high side i.e. in the range of 800 MW per circuit and outage of one circuit in this corridor results in the overloading on the remaining circuit, thus endangering the grid security whereas loading on Nathpa Jhakri – Panchkula – Abdullapur line remains on the lower side. To alleviate this problem, it is necessary to provide alternate supply to Patiala.

Studies were carried out with Panchkula – Patiala 400 kV D/c line to meet this requirement. From the results of the studies, it is observed that this line provides a relief to Nathpa Jhakri – Nalagarh lines as well as help during the contingency of outage of one circuit Nathpa Jhakri – Nalagarh 400 kV line. **The study results are given at ANNEX-III.**

POWERGRID informed 400 kV Karcham Wangtoo – Abdullapur D/c line is constructed with Quad conductor and in order to increase loadability of this line for better sharing of load, **it was proposed to provide 40% series compensation on 400 kV Karcham Wangtoo – Abdullapur D/c line. This would not only improve the loadability of Karcham Wangtoo – Abdullapur 400 kV D/c but also help in reducing the oscillations.**

HVPNL stated that there might be R-o-W issue for this line and they have also planned 220kV lines from Panchkula. There is already constraint in the area as forest area fall en-route of lines from Panchkula S/s.

The scheme was discussed and it was agreed that multi circuit towers for 400 and 220kV lines emanating from Panchkula S/s would be considered to optimally utilize the R-o-W, in consultation with HVPNL (here it is to mention that 220 kV line to UT Chandigarh is also being planned which may also be taken up on the Multicircuit towers in forest area depending upon the requirement & feasibility).

NLDC stated that this line is an urgent requirement for reliable evacuation of power from Karcham Wangtoo / Nathpa Jhakri complex and **should be implemented on priority by Powergrid on compressed time schedule.**

Members agreed to the above proposal.

b) Constraint in 400 kV Unnao-Panki S/C line

Director, CEA explained that 400 kV Unnao-Panki S/c line forms a vital link in the several grand loops of EHV lines from Kanpur-Panki-Unnao- Lucknow in the Central U.P. and Moradabad- Muradnagar –Muzaffarnagar -Meerut- Mandaula -Bawana-Bamnauli-Ballabhgarh. As informed by NLDC the loading on the line often remains to 600-700 MW.

POWERGRID mentioned that 400 kV Lucknow substation (PG) is connected strongly with Unnao S/s and 400 kV Kanpur S/s(PG) with 400 kV Panki S/s of UPPTCL. Both Kanpur and Panki S/s are important for import of power from Eastern Region. A strong inter-connection between Kanpur and Lucknow S/s would improve the reliability of the grid. Accordingly, POWERGRID proposed Lucknow (PG)-Kanpur (New) (PG) 400kV D/c line. **The study results are given at ANNEX-IV.** NRLDC stressed that the proposed line is very much required for reliable Grid Operation.

Member (PS), CEA stated that considering the Lucknow(PG)-Kanpur (New)(PG) 400kV D/c line is necessary from Grid security point of view and therefore it **should be taken up urgently by POWERGRID on compressed time schedule.**

Members agreed to the above proposal.

c) Additional Corridor to Amritsar

CEA stated that 400/220 kV Amritsar substation is having 2x315 MVA transformation capacity and considering the load growth in Amritsar area, augmentation of transformation capacity by 1x500 MVA is under implementation. At present Amritsar S/s is being fed by a 400 kV S/c line from Jullandhar and is also going to be connected with Parbati Pooling station by a 400 kV D/c line. In addition, as part of PSTCL system, 400 kV Makhu – Amritsar D/c line is being constructed for providing connectivity of STU grid with ISTS grid.

POWERGRID stated that although, Amritsar S/s is planned to be connected to Parbati Pooling station and Makhu (PSTCL substation), however the power supply to Amritsar area would be mainly through Jullandhar 400kV substation as during winters the generation of hydro projects would reduce to very low levels as well as in case of low generation at Talwandi Saboo TPS, Makhu S/s may also draw power from Amritsar. It is therefore necessary that power supply arrangement to Amritsar S/s is augmented. It was further stated, HVDC station at Kurukshetra is being established for supply of power from pit head generating stations of Chattisgarh. Accordingly, for augmenting power supply to Amritsar S/s, following transmission works were proposed to be implemented through **Tariff Based Competitve Bidding as System strengthening scheme of NR:**

- 400 kV Kurukshetra – Malerkotla D/c line
- 400 kV Malerkotla – Amritsar D/c line

RVPNL enquired about the availability of space at Amritsar substation. POWERGRID informed that space is available and if required they would implement 400kV GIS bays for extension in Amritsar station.

Members agreed to the above proposal.

e) Augmentation of Transformation capacity at 400/220 kV Ballabhgarh substation

POWERGRID informed that a review of loading pattern of 400/220 kV ICTs at Ballabhgarh sub-station of POWERGRID during last one year has revealed that loading on all the ICTs operating at this substation had exceeded 250 MW on several occasions and maximum loading on each ICT at the sub-station had gone up to 292 MW during January 2012.

In view of such increased loading pattern and to meet any eventuality in the event of failure of anyone of the ICTs at the above sub-station, POWERGRID proposed for augmentation of transformation capacity by replacing 3x315 MVA ICTs by 3x500 MVA ICTs to cater to N-1 contingency of ICT and to avoid cascade tripping of remaining ICTs in service. The dismantled 315 MVA ICTs was proposed to be maintained as Regional spare after refurbishment.

CEA explained that the above requirement of augmenting the transformation capacity is to cater to the present load considering N-1 contingency of outage of one 500 MVA ICT. **It was suggested that all four ICTs may be replaced with 500MVA ICTs.**

RVPNL representative enquired about the adequacy of 220 kV bus capacity and 220kV outlets to utilize the proposed augmentation. HVPNL also enquired about the bus capacity of Ballabgarh 220kV bus of BBMB.

Powergrid explained that augmentation of transformation capacity is being provided to meet the growing power drawl on existing 220kV lines. Subsequently, the same was checked and as per information quad tarantula conductor has been used for 220kV bus of Ballabgarh (BBMB) S/s which has adequate capacity considering above augmentation work. Regarding equipment rating no problem is envisaged and in case of any modification required the same would be taken care during detailed engineering.

After discussions, Members agreed to the above proposal.

f) Augmentation of Transformation capacity at 400/220 kV Mandola substation

During 30th meeting of the Standing Committee on Power System Planning of Northern Region held on 19/12/11, augmentation of transformation capacity at Mandola substation by 1x500MVA ICT was approved.

POWERGRID informed that due to the space constraint at the above substation, this augmentation is not feasible. However looking into the load growth, it was proposed to replace existing 3 nos. of 315 MVA ICTs with 3x500 MVA ICTs. The dismantled 315 MVA ICTs were proposed to be maintained as Regional spare after refurbishment. POWERGRID mentioned that most of the ICTs at present are very old now and may need to be replaced. During the discussions it was deliberated that all **the 4 ICTs at Mandaula should be replaced in line with the replacement of ICTs at Ballabhgargh.** It was also agreed that these ICTs may be kept as spare after refurbishment. RVPNL suggested that in future, if required, these spare ICTs may be given to states. POWERGRID stated that these ICTs shall be kept as regional spares and shall be available for use by any NR constituent.

Members agreed to the above augmentation at Mandaula S/s.

POWERGRID further informed that during the last Standing Committee Meeting augmentation of Transformation capacity by 3x105 MVA 400/220 kV transformers was agreed at Samba S/s. However 3 phase 315 MVA ICT capacity would be provided at Samba S/s instead of 3x105 MVA, as the substation is close to National Highway and there are no transportation constraints. This would reduce the overall cost of ICT.

Members noted the same.

AGM (OS), POWERGRID also informed that with the increase in transformation capacity at Wagoora, Kishenpur, Moga and Hissar, the 220 kV bus are required to be replaced. After detailed deliberations it was agreed that POWERGRID may replace the 220 kV buses as per requirement in line with augmented 400/220 kV transformation capacity at the above substations.

f) 220 kV BTPS – Ballabhgarh D/C

POWERGRID explained that 220 kV Ballabhgarh-Badarpur D/c line is a vital link between BTPS and Ballabhgarh, which is used for inter-state power transfer. During summer/ monsoon months the line is overloaded due to heavy import by Delhi to feed South Delhi area. During winter off-peak period the line is overloaded due to export of surplus generation in Delhi. The line overloading has been highlighted by NLDC.

POWERGRID proposed that to take care of above, additional feed to South Delhi is required to be planned directly from 765/400 kV Jhatikara S/s or some other suitable source so as to reduce dependency of South Delhi load on 220 kV Ballabhgarh – Badarpur line. Accordingly, Powergrid proposed a Voltage Source converter station of 500MW connected through HVDC cable from 765/400 kV Jhatikara S/s.

DTL proposed a 400kV substation at Mehrauli to feed south Delhi area.

POSOCO stated that Samaypur-Mehrauli was planned earlier, but could not be implemented due to severe R-o-W constraints. POSOCO further stated that while carrying out the studies all old units of BTPS within Delhi should be considered as de-commissioned and studies may be carried out.

Member, CEA explained that Delhi has been requesting for evolving a composite scheme for supply of power up to 2022. Member, CEA directed DTL to provide the load, generation and system data on priority so that a comprehensive scheme is evolved.

NTPC informed that BTPS units trip due to unbalanced loading this may also be addressed in the studies.

It was decided that CEA, CTU and DTL would carry out further studies & identify the space availability and submit the detailed proposal in the next meeting.

Keeping above (point 10 (a to f)) and para 6, 11 17, 36 & 41 in view, following transmission works were proposed as Northern Regional System Strengthening scheme

NRSS-XXXI (Under Tariff Based Competitive Bidding)

- Establishment of a 2X315MVA, 400/220 kV substation at Kala Amb **(refer para no-17)**
- LILO of both circuits of Karcham Wangtoo – Abdullapur 400 kV D/c line at Kala Amb **(refer para no-17)**
- 40% Series Compensation on 400 kV Karcham Wangtoo – Kala Amb D/c line
- 400 kV Kurukshetra – Malerkotla D/c line
- 400 kV Malerkotla – Amritsar D/c line
- Bay extension at existing / under construction substations of POWERGRID, shall be carried out by POWERGRID

NRSS-XXXII: By POWERGRID

- 400 kV Panchkula – Patiala D/c line (with 10 km on multi-circuits towers in forest area near Panchkula for accommodating 220 kV D/c line for power supply to Chandigarh)
- 400 kV Lucknow (PG) – Kanpur (New)(PG) D/c line
- LILO Dadri-Malerkotla line at Kaithal S/s (PG) **(refer para no.41)**
- LILO of both circuits of RAPP – Kankroli 400 kV D/c line at Chittorgarh 400/220 kV substation of RRVPNL **(refer para no.36)**
- Conversion of 50MVAR line reactors at Kankroli end of RAPP-Kankroli 400kV line into bus reactor (Subject to space confirmation by RVPN) **(refer para no.36)**

- Augmentation of transformation capacity at 400/220 kV Ballabhgarh substation by replacing existing 4x315 MVA ICTs with 4x500 MVA ICTs. The 4x315 MVA ICTs were agreed be kept as regional spares after refurbishment.
- Augmentation of Transformation capacity at Mandola by replacing 4x315 MVA ICTs with 4x500 MVA ICTs. The dismantled 315 MVA ICTs were agreed to be maintained as regional spares after refurbishment.
- Provision of 7x105 MVA, 400/220 kV ICT at Parbati Pooling station along with associated bays and two nos. of line bays. (**refer para no. 6)**
- Augmentation of 400/220kV, transformation capacity by 500MVA ICT(4th)at Sector-72 Gurgaon (PG) Substation **(refer para no. 11)**

In case of space constraint for bay extension in any of the existing substation, the substation extension works would be carried out with GIS equipment.

Members concurred the above proposal.

11. Absorption/ transfer of power from Jhajjar Complex

CEA informed that Haryana has tied up about 3300MW power to be injected in Jhajjar/ Mohindergarh/ Daulatabad area.

S.No.	Generation available in Jhajjhar complex	Haryana Allocation
1	Adani Power to be injected at Dhanonda Substation by Feb. 2013	1424 MW
2	50% of IGSTPS (Jhajjhar-I) (3X 500MW)	693 MW
3	MGSTPS(CLP Jhajjhar) (2X660MW)	1188MW
		3305MW

Presently, there are constraints in absorption of available generation/injection in Jhajjar area (which is likely to continue in next 2-3 years) due to which power is being injected into ISTS network. To mitigate the problem, joint studies were carried out by CEA, POWERGRID and HVPNL and accordingly, the following system strengthening was agreed to be implemented by HVPNL:

- Establishment of a new 400/220kV, 2X315 MVA substation near Farukhnagar area of Gurgaon by LILO of both circuits of 400kV Dhanonda- Daulatabad D/c line

- Augmentation with 400/220kV, 1X315MVA, ICT (3rd) at Kaboolpur(Rohtak) & ICT (4th) at Daulatabad S/s - To meet outage of ICT

- LILO of 400kV Bahadurgarh - Bhiwani(PG) line at Kaboolpur(HVPN) S/s and 400 kV Dhanonda- Bhiwani(PG) D/c line in place of already approved 400 kV Kaboolpur- Bhiwani(PG) D/c line - To be implemented on priority)

Member (PS), CEA enquired about the status of ongoing 400kV lines in Jhajjar complex. HVPNL informed that 400kV Dhanoda-Daultabad 400kV D/c line shall be completed in 15-20 days and 400kV Daultabad-Gurgaon 400kV D/c line shall be completed by June'13.

In addition to the above, to meet ICT outage, augmentation with 400/220kV, 500MVA ICT (4th) at Sector-72 Gurgaon (PG) Substation was agreed to be implemented by POWERGRID as ISTS system strengthening under **NRSS-XXXII.**

Members agreed with the above proposal.

12. 220kV Transmission line from NTPC Faridabad- Provision of 2 no. of 220kV bays at Faridabad Gas Power Project (Agenda by HVPNL)

CEA stated that presently evacuation from Faridabad CCGT (430 MW) is at 220 kV. There are 2 nos. of 220 kV D/c lines, one D/c line towards 220 kV Samaypur Substation of BBMB and other line towards 220 kV Palla S/S of HVPNL. During the 27th SCM of NR, NTPC had proposed that one of the 220 kV Samaypur- Ballabgarh line be bypassed at Samaypur and connected directly to one of the 220 kV Faridabad - Samaypur line, thus creating an alternative route, as Faridabad GPP has witnessed several station blackouts on account of major failure at Samaypur S/s. During that meeting, HVPNL had informed that they would be establishing 400/220 kV Nawada substation which would be connected to 220 kV Palla substation via intermediate 220 kV substations. Hence, this would provide desired outlets for reliable evacuation of power from Faridabad GPP even under line contingency condition. Hence, the proposal of NTPC was dropped. CEA asked HVPNL to present the agenda further.

HVPNL representative stated that the planned system of HVPNL from 400/220 kV Nawada S/s includes:

- 220 kV Nawada-A5 D/c line
- 220 kV A5-A3(Palla) D/c line

- LILO of one ckt. of 220kV A5-A3 D/c at A4

HVPNL informed that 220 kV Nawada-A5 D/c line and A5-A4 sections of 220kV line are in progress. However there are severe right -of -way constraints between A4 and A3 (Palla) section due to reserve forest area.

Accordingly, HVPNL proposed the following works:

- LILO of one circuit of 220 kV A5-A4 D/c line at Faridabad generating station
- LILO of one circuit of 220 kV Faridabad Generation station-A3 (Palla) D/c line at BPTP S/s
- .LILO of other circuit of 220 kV A5-A4 D/c line at BPTP substation

HVPNL stated that the proposed arrangement would provide additional connectivity to Faridabad generation.

The proposal of HVPNL was discussed and agreed by the members.

13. Transmission System for transfer of power from IPPs of SR to WR/ NR

CEA stated that the following transmission corridors were finalized for transfer of power from SR and WR IPPs to Western and Northern Region:

i) Solapur-Pune 765 kV S/c (2nd) line

ii) Jabalpur Pooling station - Orai 765 KV D/c line

iii) Orai – Bulandshahar 765kV D/c line

iv) Buandshahar – Sonipat 765kV D/c line

v) Orai – Orai(UPPCL) 400kV D/c (Quad) line

vi) Sonipat - Kurushetra 400 KV D/c (Quad) line

vii) Sonipat (New) - Sonipat 400 KV D/c (Quad) line

Sonipat (New) - Kaithal

viii) Bulandshahar-Hapur (UPPCL) 400 KV D/c (Quad) line

ix) 2x1000MVA, 765/400 KV substation at Orai by LILO of one circuit of Satna-Gwalior 765 KV D/c line

x) 2x1500MVA, 765/400KV S/s at Bulandshahar by LILO of Agra-Meerut 765 kV S/c line

xi) 2x1500MVA, 765/400KV S/s at Sonipat by LILO of Bhiwani-Meerut 765 kV S/c line

POWERGRID stated that Solapur-Pune 765 kV S/c (2nd) line was deferred which has been mentioned as deleted in the agenda note due to typographical error.

POWERGRID informed that for implementation of above transmission system regulatory approval from CERC was taken. However, considering the slow progress of generation projects in southern region, the above transmission scheme was not taken up for implementation. From the present generation scenario it was observed that more and more generation is coming up in Western region and imports from Western region to Northern region are increasing. During the recent two grid disturbances it was observed that there is a need to provide strengthening between Northern and Western regions.

In addition to above following was observed:

- UP is establishing 765 kV substation at Greater Noida under PPP mode and already awarded the works. It was gathered that the site identified for 765 kV Greater Noida and Bulandshahar S/s are in close proximity. Establishment of two 765 kV substations in close proximity is not desirable.
- Kanpur – Jhatikara 765 kV S/c line is under construction, which is about 450 km long and for smooth operation it is desirable to LILO this line at some substation to reduce its length.
- Earlier a 765/400 kV substation at Sonipat was planned, however with the coming up of CLP Jhajjar & Aravali Jhajjar generations as well as considering the injection of power from Adani at Mohindergarh, there was a need to review the requirement of establishment of 765/400 kV substation at Sonipat.

Considering the above, it was proposed that the establishment of 765/400 kV substation at Bulandshahar be shifted to Aligarh and LILO of Kanpur – Jhatikara 765 kV S/c line also be carried out at Aligarh. Further, it was also proposed that instead of taking 765 kV D/c line from Aligarh to Sonipat, 765 kV D/c line may be taken towards Hapur substation.

Considering the revised scenario it was deliberated that at present scheme may be implemented only upto Aligarh and the transmission scheme beyond Aligarh may be taken up later as per the system requirement. Accordingly it was agreed that initially the Aligarh substation may be a 765 kV switching station with 765 kV interconnections to Agra, Meerut, Kanpur and Jhatikara. Subsequently 765/400 kV transformation capacity may be provided in future as per the system requirement. The space may be acquired considering the development of 765/400 transformation capacity and 400 kV switchyard in future. Further the new 765 kV station at Aligarh may be constructed as GIS.

Accordingly, it was decided that the following transmission would be taken up as Inter-regional System Strengthening Scheme for NR & WR:

a) Solapur-Pune 765 kV S/c (2nd) line
b) Jabalpur Pooling station - Orai 765 KV D/c line
c) Orai – Aligarh 765kV D/c line
d) Orai – Orai(UPPTCL) 400kV D/c (Quad) line
e) LILO of one circuit of Satna-Gwalior 765 KV line at Orai S/s
f) 2x1000MVA, 765/400KV substation at Orai S/s
g) LILO of Agra-Meerut 765 kV S/c line at Aligarh S/s
h) 765KV Switching Station at Aligarh (GIS)
i) LILO of Kanpur – Jhatikara 765 kV S/c at Aligarh S/s

Regarding implementation of the above scheme it was deliberated that POWERGRID has already taken the regulatory approval for implementation of the scheme, however this scheme is (with some minor modifications) now delinked with the earlier identified generation projects and is to be taken up on priority. After detailed deliberations, it was decided that the scheme may be taken up by POWERGRID, and the same may be informed to Secretary (CERC).

Members agreed to the above proposal.

14. 125 MVAR Bus Reactor at Koteshwar

CEA stated that during the 30th SCM of NR, it was deliberated that transmission system in Tehri area is frequently experiencing over voltages under light load conditions and it was agreed to provide 125 MVAR bus reactor at Koteshwar switchyard. POWERGRID had informed that Koteshwar is a commissioned project and bus reactor at Koteshwar generating station was proposed due to space constraints at Tehri Pooling station. THDC, during the 25th NRPC meeting had proposed that the above mentioned 125 MVAR bus reactor at Koteshwar may be provided by POWERGRID. After detailed deliberations, the implementation of Reactor by POWERGRID was agreed in the 25th NRPC meeting.

Members noted the above.

15. Establishment of 400/220 kV substation at Patran

CEA stated that a 400/220 kV substation was approved in the 30th Standing Committee Meeting of Power System Planning of Northern region. This substation is being developed through Tariff Based Competitive Bidding.

Considering the fact that the substation is located in a very fertile area of Punjab where the acquisition of land would be a challenging task, it is proposed to develop this substation as Gas Insulated substation.

Members agreed to the above proposal.

16. Evacuation of Power from Sainj HEP (100 MW)

CEA stated that the evacuation of power from Sainj HEP was discussed during the 30th SCM of NR and it was stated that injection of Sainj HEP of HPPCL shall be through LILO of Parbati-II – Parbati-III 400 kV line however, in case of outage of one circuit, 10% overload generation, 0.9 pu voltage and 0.9 power factor there may be certain constraints and generation would have to be backed down.

NHPC informed that enhancement of current carrying capacity of 400 kV XLPE cable is not possible and hence evacuation of power of Sainj through XLPE cable provide at Parbati-III HEP is not feasible.

Member (PS), CEA had informed to NHPC that cable limitation may come in case of outage of one circuit, 10% over generation, 0.9 pu voltage and 0.9 power factor and possibility of occurrence of above contingency was very remote and HPPCL had agreed to back down the generation at Sainj, if required with a view to prevent the overloading of the XLPE cable of Parbati-III switchyard. Considering the above, HPPCL was advised to implement LILO of 400 kV Parbati-II – Parbati-III line for evacuation of power from Sainj HEP.

Subsequently, NHPC informed that backing down of generation at Sainj HEP does not safeguard the overheating of XLPE cable provided at Parbati-III switchyard and as such the arrangement is not acceptable to NHPC. HPPTCL stated that due to severe R-o-W issues it is not possible to plan independent line from the generation project.

After deliberations, Member (PS) decided that a committee consisting of CTU, CEA, HPPTCL, HPPCL & NHPC would be formed to solve the issue and if required joint site visit may be undertaken.

Members agreed to the above proposal.

17. Establishment of 2x315 MVA 400/220 kV substation at Kala Amb

POWERGRID stated that HPPTCL has informed that the present load in Kala Amb / Poanta / Giri area is about 350 MVA, which is likely to increase to about 500 MVA by 2015-16 whereas the available generation and transmission network in the area is not adequate to meet the present load.

In order to meet the present and future load requirement of the area, HPPTCL had proposed for establishment of a 400/220/132 kV substation at Kala Amb by LILO of one circuit of either N'Jhakri – Abdullapur or Karcham Wangtoo – Abdullapur 400 kV line. The matter was analysed and it was observed that N'Jhakri – Abdullapur 400 kV D/c line has already been looped in looped out at Panchkula and LILO of the same line has been approved at Sainj (near Simla). Considering the capacity of the line, it would not be desirable to LILO the N'Jhakri – Abdullapur line at Kala Amb. Further, as Karcham Wangtoo – Abdullapur 400 kV D /c line is also passing in close proximity to Kala Amb area and to meet the loads in the area, the LILO of the Karcham Wangtoo – Abdullapur 400 kV D/c was proposed to be carried out at Kala Amb. HPPTCL had proposed to LILO only one circuit 400 kV line however LILO of one circuit would result into unbalanced loading, it was therefore proposed that LILO of both the circuits may be carried out at Kala Amb.

Considering the issues of hilly terrain & scarcity of land in Himachal Pradesh, it was proposed to establish this substation as GIS station. HPPTCL had proposed the substation as 400/220/132 kV substation, however it was decided that the substation be established as 400/220 kV under ISTS and further works of 220kV and 132kV may be carried out by HPPTCL as per their requirement. **It was also agreed that LILO may be carried out on Multi-circuit Towers to conserve R-o-W.**

The constituents agreed to take up the above proposed works as Northern Regional System Strengthening Scheme- NRSS-XXXI.

18. Constraints in NR GRID as per NLDC

POWERGRID stated that NLDC have informed constraints in Grid Operation in Northern Region. Remedial measures for most of these constraints in ISTS network have already been planned / are being planned. The details of these constraints were given in the agenda. The states were advised to take up adequate action to address the constraints being observed in state transmission system. The brief of the discussions on this agenda item, is summarized below:

a) **Tehri – Koteshwar Evacuation**: Evacuation of Tehri (4x250 MW) and Koteshwar (4x100 MW) HEP is through 765 kV series compensated double circuit line from Tehri pooling point to Meerut. This line is presently charged at 400 kV. On 10th September 2012 when the generation in the complex was 1350 MW (1050MW at Tehri and 300 MW at Koteshwar), one circuit of Tehri pooling point – Meerut (ckt-1) tripped and oscillations were observed. All the four units of Tehri and three units of Koteshwar power station tripped. The FSC of the line was not in service. However the availability of FSC is not visible to the operator in the NRLDC control room. Similar oscillations were observed on 3rd February 2011 whenever generation at Tehri exceeded 700 MW and only one circuit of 400 kV Tehri-Meerut was available. For evacuation of power from Tehri-I, Tuning of PSS was recommended in year 2003 by CEA and CTU. Considering the quantum of power, Series comp was proposed with Koteshwar. Now the PSS tuning has been carried out.

b) **220 kV system in Uttar Pradesh (220kV Lucknow - Chinhat S/c, 220kV Mainpuri- Harduaganj and 220 kV Mainpuri- Ferozabad)** – UPPTCL stated the problem of overloading of Lucknow – Chinhat line would be mitigated after the commissioning of 400/220 kV Sohawal S/s as the load of Barabanki and Ramsnehighat would be diverted to be fed from Sohawal S/s. About the critical loading of other 220 kV lines, UPPTCL stated they would analyse and shall revert back. UPPTCL was requested to send the details after analysis.

c) **220 kV system in Haryana (220kV Samaypur- Ballabhgarh (3 circuits) 220kV Ballabhgarh –Charkhi Dadri 220kV Samaypur –Charkhi Dadri)** : NRLDC stated that these circuits form a parallel path from Ballabhgarh to Hissar. Due to the outage of 400/220kV, 500MVA ICT at Bhiwani (BBMB) and inadequate 220kV outlets from Manesar, Gurgaon, Daulatabad, Kabulpur, Deepalpur the existing 220kV lines in the corridor are heavily loaded. Outage of these circuits is likely to cause interruption in power supply in southern Haryana. BBMB informed that 400/220 kV ICT at Bhiwani has been commissioned recently. CTU stated that HVPNL needs to draw adequate 220 kV outlets from the already commissioned 400/220 kV substations in Haryana. Members (PS), CEA requested Haryana to send the complete details of 220 kV feeders to be connected from these new substations alongwith their status and target commissioning schedule.

Member (PS), CEA advised constituents to implement the 220 kV outlets from the new ISTS substations and asked them to submit the details of 220 kV feeders along with their commissioning schedule.

d) **Singrauli – Anpara 400 kV S/c:** CTU stated that they are aware of criticality of this line. However there are severe R-o-W constraints and it is very difficult to construct the line in this area. Further there are space constraints at Singrauli generation switchyard. NTPC stated that there is no additional space for construction of 400 kV bay for a new line. CTU suggested that feasibility of connecting Rihand with Anpara may be explored. In this regard, NTPC and UPPTCL were requested to confirm about the availability of 2 nos. of 400 kV bays and POWERGRID was requested to look into the availability of corridor from Rihand to Anpara.

e) **400/220 kV ICT at Bhiwani :** BBMB informed that ICT has already been commissioned

19. Use of HTLS conductor on 400 kV lines at Kurukshetra S/s

CEA stated that establishment of HVDC terminal station at Kurukshetra was planned as part of High Capacity Transmission Corridor for IPPs in Chattisgarh. While acquiring the land for Kurukshetra, it was suggested that the transmission lines near the Kurukshetra substation may be taken up as multi-circuit lines considering the present and future provision and it was also suggested that LILO of Sonipat-Abdullapur 400 kV D/c line may also be carried out on multi-circuit towers. Accordingly, following lines have been taken up on multi-circuit towers:

- 400 kV Kurukshetra – Jullandhar D/c (Quad) – about 5 km portion on multi-circuit
- LILO of 400 kV Abdullapur – Sonipat D/c (Triple) at Kurukshetra – about 16 km on multi-circuit

CEA informed that while finalizing the conductor configuration for the above lines, techno-economic comparison of conventional ACSR conductor v/s HTLS conductor was carried out by POWERGRID and it was observed that use of HTLS conductor with multi-circuit towers would be techno-economically a better option compared to 400 kV D/c (Triple Snowbird / Quad Moose) on multi-circuit towers.

Keeping above in view, it was informed that POWERGRID is going ahead with HTLS conductor instead of conventional ACSR conductor.

Members agreed and noted the same.

20. Modifications in the Transmission System for Phase-I IPPs in Jharkhand & West Bengal

CEA stated that the transmission system for evacuation of power from Phase-I IPPs in Jharkhand & West Bengal was earlier approved and grouped into Part-A, Part-B & Private Sector. The same is enclosed at **Annexure-1**. Subsequently, following minor modification in the scheme were informed by the POWERGRID:

(i) Re-Grouping of Scope of Works

According to the progress of the phase-I generation projects, scope of work has been re-grouped in three groups viz. Part-A1, Part-A2 and Part-B.

(ii) Change from AIS sub-station to GIS sub-station

In view of the land acquisition problems, 400 kV Jharkhand pooling station, 765/400kV Varanasi sub-station and 765/400kV Kanpur sub-station are being constructed as GIS sub-stations.

(iii) Balia – Varanasi 765kV S/c line in place of 'LILO of Gaya – Balia 765 kV S/c line at Varanasi'

As part of the above transmission scheme, LILO of Gaya – Balia 765 kV S/c line at Varanasi was planned for onward transfer of power from Gaya as well as for providing 765 kV interconnection between Balia and Varanasi. After site selection of Varanasi substation, it had been observed that the estimated LILO distance of Gaya – Balia 765 kV S/c line at Varanasi comes to about 110 km and for implementing this LILO, 110 km of 765 kV D/c line would have to be constructed. This lengthy LILO would result into unbalanced loading on Gaya – Varanasi 765 kV lines. Further, it was also mentioned that the LILO tapping point of Gaya – Balia line is close to Balia substation. Keeping above in view, it was proposed to implement Varanasi – Balia 765 kV S/c direct line instead of above mentioned LILO. This would provide necessary connectivity between two major pooling stations i.e. Balia and Varanasi. Further, with the direct 765 kV interconnection instead of construction of 110 km of 765kV D/c line, the overall cost of the project would reduce and modified arrangement would lead to overall optimization. Considering these modifications, the final scheme as agreed is enclosed at **Annexure-2**.

Members noted the same.

21. Spare ICT 500 MVA

POWERGRID stated that one no. of spare ICT of 400/220 kV, 500 MVA was approved in 26th NRPC meeting. This ICT is proposed to be kept at Neemrana. It was proposed to include the above spare ICT either in a planned strengthening scheme or shall be taken up as a part of new strengthening scheme.

Members agreed to the above.

22. Evacuation of power from Chenab Basin Projects in J&K – Perspective Scheme

CEA stated that during the 30th Standing Committee Meeting of Power System Planning for Northern Region, the issue of evacuation of power from various hydro projects located in Chenab Basin of J&K was discussed and it was decided that a task force may be constituted with participation from J&KSPDC, PDD J&K, CEA & POWERGRID to undertake a site visit and plan the comprehensive transmission system for implementation in phased manner matching with the generation commissioning schedule for the evacuation of power.

Based on the discussions with NHPC, J&KSPDC and PDD, J&K the status of the identified generation projects was informed as under:

a) **Kirthai-I HEP (240 MW):** This would be a State Sector Project. It was informed that the power potential studies are under revision and the project capacity would be 350 MW instead of 240 MW. In the meeting, it was informed that the project capacity would be 390MW. Also, it was informed that the DPR has been prepared and TEC is expected by end 2013. Implementation period for the project is 5 years from investment approval date. EIA studies were completed for 240 MW which needs to be revised due to revised power potential. Regarding land availability, it was informed that part of land has already been acquired and balance acquisition in progress. Project is expected to be commissioned during 13th Plan.

b) **Kirthai-II HEP (990 MW):** DPR submitted to CEA for concurrence. The same was discussed and necessary changes to be made in DPR were informed to JKPDC. The revised DPR is under preparation. The Project would be executed on EPC basis and tendering activities have been taken up. Pre-constructions activities are in progress. Project is expected to be commissioned during 13th Plan.

c) **Generation Projects of Chenab Valley Power Projects Limited (CVPPL):** It was informed that Kiru HEP (600 MW), Kwar HEP(520 MW) and Pakaldul HEP(1000 MW) are being executed by a JV company of J&KSPDC, NHPC & PTC named as CVPPL . The JV Company has been formed and Promoter agreement has been signed.

- **Pakal Dul HEP (1000 MW):** TEC of the project has been obtained earlier by NHPC. The same would be transferred to CVPPL. Forest clearance had been obtained from Forest Deptt. J&K. MoEF has accorded environment clearance. Construction activities have started. Tenders have been floated for civil works. Land acquisition is in progress and tenders have already been floated. Commissioning schedule of the project is 72 months from investment approval. Project is expected to be commissioned during 13th Plan.

- **Kiru HEP (660 MW):** DPR is to be resubmitted to CEA after revision. MoEF has accorded clearance for pre-construction activities and TOR for EIA studies has been finalized. Forest proposal is likely to be submitted soon. Commissioning schedule of the project is 54 months from the date of Government approval. Project is expected to be commissioned during 13th Plan.

- **Kwar HEP (560 MW):** Power potential has been revised to 560 MW. DPR is submitted to CEA for concurrence. MoEF has accorded clearance for pre-construction activities and TOR for EIA studies has been finalized. The commissioning schedule of the project is 54 months from the date of Government approval. Project is expected to be commissioned during 13th Plan.

d) **Bursar HEP (1020 MW):** It is a central sector project which would be executed by NHPC. 500 Ha forest land in Kishtwar high altitude national Park is involved. NOC for National park is yet to be obtained. DPR of the project is under preparation by NHPC. It was gathered that the location and capacity of the project may change. The project is in survey & investigation stage.

e) **Sawalkot HEP (1856MW):** As per the information, the project size is being revised to 1856 MW. Hydrology of the project is yet to be approved. At present there is no access road upto the project. For reaching project site, tunnel is to be constructed. Generation project is to be developed by JKSPDC. Access Road is under construction. Revised DPR is under preparation and is likely to be submitted to CEA by Mid 2013.

f) **Ratle HEP (850 MW):** This is an IPP being developed by M/s GVK. The concurrence of CEA was accorded on 22.10.2012. The evacuation system for the generated power has been approved by SCM of NR. The Developer has applied for Connectivity and LTA from CTU.

CTU informed that except for Ratle HEP, none of the Developers of the above projects had applied for connectivity/LTA. Until the connectivity / LTA application is received by CTU, the transmission system for evacuation of power from these projects cannot be finalized. However, a perspective plan has been evolved which may require revision /updation depending on the progress / time frame of the generation projects.

Major observations of site visit were:

- Serious Right-of-Way constraints due to difficult mountainous terrain were observed en-route to Kirthai-I to Kwar HEPs. It was concluded that maximum two transmission corridors can be accommodated between these locations.
- The generation projects in the Chenab basin would be coming up in a widespread time frame from early 13th Plan period nd beyond. Accordingly, it was considered prudent that two 400 kV high capacity corridors of about 3000 MW and 2300 MW capacity having switchgear rating of 4000 Amps respectively may be planned in the Chenab basin to cater to various identified generation projects. It was mentioned that about 1500 MW power of generation projects located in HP and J&K border area will also be evacuated through the high capacity transmission corridor planned for Kirthai-I and Kirthai-II HEPs.
- It was informed that the Task force visited the site for establishing 765/400 kV Pooling station at Kishtwar. Prima facie, the site appeared to be in order.
- It was observed that Pakaldul HEP is likely to be commissioned first considering its physical progress.
- Based on the above, the transmission system alongwith the phasing of the works was conceptualized.

Perspective Transmission System alongwith Phased development for Hydro projects located in Chenab Basin J&K

High capacity common corridor-I:

This corridor would be merged with the corridor planned with Himachal Pradesh hydro projects of 1500 MW capacity located in Chandrabhaga basin. The total capacity of this corridor would be about 3000 MW.

- **Kirthai-I HEP(350 MW):**
    - LILO of one circuit of 400 kV D/c (Twin HTLS Conductor –Equivalent to about 1500MW) line from Reoli Dugli HEP (HP) – Kirthai-II generation switchyard
    - Switchyard Capacity etc. must be able to handle about 1500MW power generated by the generation projects located in upstream of the Kirthai-II generation project. It is proposed that the GIS switchyard equipment and XLPE cables provided may be designed for carrying 3000 Amps current.

- 400 kV, 80 MVAR Bus Reactor

- **Kirthai-II HEP(990 MW) :**
  - 400 kV D/c (Quad HTLS Conductor –Equivalent to about 3000MW) line from Kirthai-II HEP (HP) – Kishtwar Pooling station
  - Termination of 400 kV D/c (Twin HTLS Conductor –Equivalent to about 1500MW) line from Reoli Dugli HEP (HP) at Kirthai-II generation switchyard
  - Switchyard Capacity etc. must be able to handle about 3000MW power generated by the generation projects located in upstream of the Kirthai-II generation project. It is proposed that the GIS switchyard equipment and XLPE cables provided may be designed for carrying 4000 Amps current.
  - 400 kV, 125 MVAR Bus Reactor

High capacity common corridor-II:

- **Kiru HEP(660 MW) :**
  - 400 kV D/c (Triple HTLS Conductor –Equivalent to about 2300MW) line from Kiru HEP – Kishtwar Pooling station (High capacity common corridor-II)
  - Switchyard Capacity etc. must be able to handle about 2300MW power generated by the generation projects located in downstream of the Kiru HEP. It is proposed that the GIS switchyard equipment and XLPE cables provided may be designed for carrying 4000 Amps current.
  - 400 kV, 125 MVAR Bus Reactor

- **Kwar HEP(560 MW) :**
  - LILO of one circuit of 400 kV D/c (Triple HTLS Conductor –Equivalent to about 2300MW) line from Kiru HEP – Kishtwar Pooling station
  - Switchyard Capacity etc. must be able to handle about 2300MW power generated by the generation projects located in downstream of the Kiru

HEP. It is proposed that the GIS switchyard equipments and XLPE cables provided may be designed for carrying 4000 Amps current.

- ➢ 400 kV, 125 MVAR Bus Reactor

- **Pakaldul HEP(1000 MW) :**
  - ➢ LILO of one circuit of 400 kV D/c (Triple HTLS Conductor –Equivalent to about 2300MW) line from Kiru HEP – Kishtwar Pooling station
  - ➢ Establishment of 400 kV switching station at Kishtwar (establishment of Kishtwar pooling station has also been proposed with Himachal Projects).
  - ➢ Establishment of 400/220 kV, 2x315 MVA substation near Gurdaspur/Sirhand by LILO of both circuits of 765 kV (operated at 400 kV) Kishenpur – Moga S/c lines.
  - ➢ 765 kV Kishtwar- Gurdaspur/Sirhand D/c line (to be operated at 400 kV initially)
  - ➢ Switchyard Capacity etc. must be able to handle about 2300MW power generated by the generation projects located in downstream of the Kiru HEP. It is proposed that the GIS switchyard equipment and XLPE cables provided may be designed for carrying 4000 Amps current.
  - ➢ 400 kV, 125 MVAR Bus Reactor

- **Bursar HEP (1020 MW):** It was informed that there is a national park issue in the vicinity.
  - ➢ 400 kV D/c (Twin HTLS Conductor –Equivalent to about 1200MW) line from Bursar HEP – Kishtwar Pooling station.
  - ➢ 400 kV, 125 MVAR Bus Reactor

- **Sawalkote HEP(1856 MW):**
  - ➢ LILO of both circuits of 400 kV Kishenpur-Wagoora D/c line at Sawalkote
  - ➢ LILO of both circuits of 400 kV Kishenpur-New Wanpoh D/c line at Sawalkote

- Charging of Kishenpur – Gurdaspur/ Sirhind 2 xS/c lines at 765 kV level
- Establishment of 765/400 kV 2x1500 MVA Kishenpur substation
- Establishment of 765/400 kV 2x1500 MVA Gurdaspur/ Sirhind S/s
- 400 kV, 125 MVAR Bus Reactor

Tentative Phasing of System

POWERGRID informed that Pakaldul project will be the first to come in Chenab basin. Accordingly, initially a 400 kV D/c (Triple HTLS Conductor –Equivalent to about 2300MW) line from Pakaldul HEP – Kishtwar Pooling station shall be constructed and extended to upstream side projects as per their commissioning schedule. The upgradation of Kishtwar pooling station to 765/400 kV, 2 x1500 MVA and operation of Kishtwar-Gurdaspur/Sirhand D/c line at 765 kV will be taken up matching with the next project commissioning in Chenab basin. In this time frame, charging of Gurdaspur/Sirhind – Moga 765 kV lines shall also be taken up. Further, with coming up of more generation, an additional 765 kV D/c line shall also be planned from Gurdaspur / Sirhind to some suitable location. With the coming up of Sawalkot generation charging of Kishenpur - Gurdaspur/Sirhind lines at 765 kV level shall be taken up.

With the addition of more generation the augmentation of Kishtwar pooling station by additional 2x1500 MVA, 765/400 kV ICTs and implementation of 2nd 765 kV D/c line from Kishtwar to Punjab area (exact location to be decided later on) will be taken up as per the requirement matching with the commissioning schedule of upstream projects in Chenab basin.

It was agreed that 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. It was also informed that it is necessary that the project developers apply to CTU for the connectivity & LTA so that the above plan can be firmed up.

Member (PS), CEA stated that the scheme is tentative and shall be firmed up only after the receipt of applications from the perspective developers. He also advised to upload the above perspective transmission plan on CEA website.

Members agreed to the above perspective plan & noted the same.

23. Rihand-III Transmission system:

CEA stated that for immediate evacuation of power from Rihand-III, 765 kV Rihand III -Vindhyachal Pooling Point D/c line (to be initially operated at 400 kV) had been planned. This line traverses through protected forest in Uttar Pradesh and both reserved and protected forest in MP. The line is expected by September'2013. The first unit of Rihand-III generation project is expected to be commissioned in December'12. NTPC representative informed that the second unit is expected to be commissioned by July/Aug'13. The power from Unit-1 may be evacuated by utilising existing margins in the transmission system under normal operating conditions. For unit-2 evacuation, it is proposed that power may be transferred to existing Vindhyachal 400kV Bus through HVDC Back to Back.

Presently first unit of Vindhyachal-IV has been commissioned. The Vindhyachal-IV generation is connected with existing generation Vindhyachal generation bus and is being evacuated over existing 400kV lines. NTPC representative informed that the second unit of Vindhyachal-IV is expected to be commissioned by Sep.'13. POWERGRID informed the status of various elements proposed in the area as below:

S no.	Elements	Commn. Schedule
Transmission Line		
1	Rihand III -Vindhyachal Pooling Point 765 kV D/c (to be initially operated at 400 kV)	September'13
2	Vindhyachal-IV – Vindhyachal pooling stn 400kV D/c	Forest clearance awaited. Exp. by December'13
3	Vindhyachal pooling stn- Sasan 400kV D/c	Ready for charging
4	Sasan - Satna 765kV 2x S/c	1 ckt.- Nov.'12 2nd ckt.- Feb/Mar'13 (Forest clearance awaited)
5	Satna-Bina 765kV 2xS/c	Commissioned
Substation		
1	Vindhyachal pooling station	Land Acquisition in progress. Land by Dec'12

2	Sasan	1x1000MVA trf. installed.
3	Satna & Bina	765/400 kV commissioned

It was agreed that with the commissioning of 2nd unit of Rihand-IV, power from the generation may be evacuated to existing Vindhyachal generation bus though HVDC back to back depending on the available system margins.

NTPC suggested that the possibility of early commissioning of 2nd 765/400 kV 1000 MVA ICT at Sasan may be explored by Powergrid as the same would help in evacuation of generation. Member (PS) advised CTU to explore the feasibility of above proposal .

NTPC requested that Rihand-III may be treated at par with other ISGS generation in Singrauli-Rihand generation complex and schedule of all generations may be done proportionately. Members agreed to the request.

Members agreed & noted the above.

24. Proposal for Static VAR Compensators (SVC) in Northern Region.

CEA stated that in the recent past, major grid disturbances had been experienced in NEW grid on 30-07-2012 and 31-07-2012. The Enquiry Committee was constituted by Ministry of Power to analyze the causes of these disturbances and to suggest measures to avoid recurrence of such disturbance in future. Based on the analysis of these grid disturbances the committee recommended the following:

" Reactive Power Planning : *In order to avoid frequent outages / opening of lines under over voltages and also providing voltage support under steady state and dynamic conditions, installation of adequate static and dynamic reactive power compensators should be planned*". The committee has recommended 6 months time frame for this reactive power planning in all the regions.

In view of the above recommendation, the system studies considering All- India transmission system were carried out with POWERGRID to ascertain the quantum of dynamic reactive power compensation required in Northern Region. Based on these studies, SVC at Fatehpur was proposed.

CTU stated that subsequent to the joint studies they had carried out additional studies which also includes peak hydro scenario and based on the studies, four locations had been identified for providing dynamic reactive compensation. The maximum & minimum voltages observed at the four identified locations for the last year based on data from POSOCO is:

a) Northern Region:

Substation	Jul'11	Aug'11	Sep'11	Oct'11	Nov'11	Dec'11	Jan'12	Feb'12	Mar'12	Yearly Max.
Maximum Voltage (kV)										
Hissar	415	416	418	431	417	424	416	430	424	431.4
Nalagarh	424	438	423	436	433	431	432	429	431	438.2

Substation	Mar'12	Apl'12	May'12	Jun'12	Jul'12	Aug'12	Sep'12	Oct'12	Nov'12	Yearly Max.
Lucknow	428	429	429	427	430	429	431	429	429	431
Fathepur	424	425	424	428	429	431	433	429	430	432.5

Substation	Jul'11	Aug'11	Sep'11	Oct'11	Nov'11	Dec'11	Jan'12	Feb'12	Mar'12	Yearly Min.
Maximum Voltage (kV)										
Minimum	381	383	383	371	362	359	355	362	376	351.2
Nalagarh	377	388	388	402	402	401	401	401	401	377.2

Substation	Mar'12	Apl'12	May'12	Jun'12	Jul'12	Aug'12	Sep'12	Oct'12	Nov'12	Yearly Min.
Lucknow	419	418	418	416	417	421	418	420	421	416
Fathepur	386	393	391	390	390	405	405	402	404	386

- **Nalagarh 400/220kV substation:** Nalagarh is connected to Nathpa Jhakri (1500MW) & Karcham Wangtoo (1000 MW) generation complexes through 400kV lines. In addition it was informed that Rampur HEP would be coming up next 2 years and for evacuation of power from Rampur no additional line has been planned. Such large generation in a small pocket has created many difficulties during operation. As per NRLDC report on Operational feedback for October 2012, there had been sudden closure of all generating units at Karcham Wangtoo and Jhakri HEP on account of silt flushing and there was a generation loss of 2800MW. This had been experienced on more than one occasion. The sudden dropping of units results light loading of 400kV lines and causes grid operational constraints. In future, generation from Koldam HEP (800MW) & Parbati HEPs (1320 MW) would also be pooled at Nalagarh. This may cause operational constraint due to high voltage in area due to offloading of lines and occurrence of oscillations in the grid which may affect other generations connected to it. SVC at Nalagarh would help in both damping and controlling voltage in the area. **In view of the above, SVC having rating of ± 400 MVAR is proposed at Nalagarh.**

- **Interconnection points of inter-regional lines**: The load demand in Northern region is growing at a fast pace and power has to be imported from other regions to meet the peak demand. The large interconnected grid poses the challenge of operation of lines under various seasonal and operational conditions. This is particularly true for Northern region because as an importer of energy from other regions based on market forces, the flow of energy from other regions may change resulting in high or light loading of lines. The region from which power is to be imported and the quantum will vary widely. Operational experience has indicated that multiple contingency is a reality. Under such conditions, system stabilizing controls should be available for the grid operator. Accordingly, static compensators SVC having **rating of ± 400 MVAR** proposed at Lucknow S/s and Fatehpur S/s. Lucknow S/s is connected to Balia and Gorakhpur substations while Fatehpur S/s is connected to Gaya S/s and Sasaram S/s by 765kV lines through which power from ER is imported. The dynamic compensators at these locations would help in damping any inter-regional oscillations and during black start.

- Hissar 400/220kV substation: Hissar is an important grid substation connecting the Southern part of NR with Northern part. It is connected to important substations like Bhiwadi, 765/400kV Bhiwani and Moga. These substations experience wide variation in voltage due to wide seasonal load variation. During peak load conditions when agriculture demand is very high the voltage variation is very large. Accordingly, It was proposed to provide SVC having **rating of ± 400 MVAR** at Hissar substation.

After detailed deliberations, it was decided to provide SVC of ± 400 MVAR at Nalagarh and Lucknow in the first phase and SVC at Fatehpur, & Hissar may be firmed up later with additional studies with All-India network and put up to Standing committee again. The dynamic stability study results for SVC at Nalagarh and Lucknow are enclosed at Annex.-V and VI.

Members agreed with the above proposal.

25. Common Data Base among STUs, CTU and CEA

CEA informed that CTU as a part of capacity building initiative has taken up the initiative of providing the system study software (PSS/E) to the state utilities. The software is world renowned software and being used by CTU, CEA & RLDC. POWERGRID has provided software to all state utilities, State Load dispatch centers and State Regulatory commission. The software is being distributed along with laptops in phased manner along with training. This initiative by POWERGRID would provide a common platform for all utilities to exchange system studies and details of transmission system.

Presently, States usually model their transmission system in detail, however their inter-connections with Regional grid at boundaries are being modeled as lumped load or generator due to lack of data or due to differences in data-base format maintained by different utilities. Such assumptions drastically affect the studies particularly while planning Intra-state and Inter-state EHV system. It was therefore necessary that a common standard format for the data-base may be followed by all utilities to enable free exchange of data. This would also help in carrying out system studies in a better manner. In view of above, it was agreed that a team at regional level may be formed with members from CEA, CTU, RLDC, RPC and Northern region state transmission utilities. This team would develop a data-base for Transmission Planning for Northern region for present and year wise till 2016-17. This data-base can be posted on the website of CEA, CTU and STUs. Integration of the regional data-base with other regions to create a National Database would be created by another team consisting of members of CEA and CTU. It was agreed that CTU would co-ordinate this activity.

Member (PS) advised CTU to convene a separate meeting of the constituents for detailed discussions & formulation of the methodology for developing the proposed Data-base.

Members agreed to the same.

26. Establishment of 220/66 kV substation at U.T Chandigarh and connectivity with ISTS through Panchkula 400/220 kV S/s of POWERGRID (Agenda by UT Chandigarh)

CTU stated that the maximum peak load of Chandigarh is about 363 MW and the projected max. load is 439 MW by 2016-17. Presently the load of Chandigarh is being fed from three different sources namely Kishangarh (3x100 MVA Power Transformers), Mohali (Load restricted to 2x80 MVA) & 66 kV D/c line from Dhulkote.

Load Flow Studies had been carried out by CTU for U.T Electricity Board (Chandigarh) for their 220/66kV Transmission System for present as well as for future scenarios. It had been observed from load flow studies that under normal and contingency conditions, some of the system elements get critically loaded. Therefore, the strengthening of transmission system is required at various points at U.T. Chandigarh.

Chandigarh mentioned that presently there is no ISTS inter-connection available to the Chandigarh's transmission system. The connectivity of Chandigarh transmission system with ISTS would help in providing reliable power supply to this area.

In view of the above, it was proposed to take up the following transmission works as System Strengthening Scheme of NR:

- A 220 kV D/c line from Sector-47 S/s to Panchkula 400/220 kV Substation of POWERGRID
- Establishment of 2X160 MVA, 220/66 kV substation at Sector-47

HVPN stated that there could be severe R-o-W constraints in Panchkula area (also mentioned at para no.-10 (a) in regards to proposed Panchkula – Patiala 400 kV D/c line).

Member (PS), CEA proposed that constituents may agree for in-principle approval of the above scheme and the scheme may be fine tuned later after discussions with Chandigarh, HVPNL and CTU.

Members agreed to the above.

27. Provision of PMU's under URTDSM Project

CEA informed that the Unified Real Time Dynamic State Measurement (URTDSM) Project was approved in the Joint Standing Committee Meeting held on 5th March 2012. In line to approval, the Detailed Project Report (DPR) had been finalized and petition had also been filed with CERC for Regulatory Approval. As per advice of CERC, the project details had also been discussed in the RPC forums of WR, NR, ER & SR. The project details would be discussed in the upcoming NERPC meeting.

Broadly the scope under the DPR is as follows:

- Installation of 1739 PMUs
- Computer hardware and software at SLDC/RLDC/NLDCs.
- Installation OPGW based communication system (approx 10667km)
- Development of analytics.
- Consultancy services.

The estimated Project Cost as per DPR is Rs.655.98 Crores. As per discussions, the installation of PMUs and associated communication system at IPPs had also been included in the DPR. The NIT for this would be issued shortly.

It was informed that as per Joint Standing Committee approval, 15% of the PMUs to be installed under this project are to be manufactured in India. Subsequent to this approval, during the discussion with prospective Bidders, it had emerged that 15% of PMU quantity may not attract the Vendors to establish manufacturing facility in India. Hence, this percentage was agreed to be enhanced. This enhanced provision shall help establish indigenous manufacturing and utilities shall also have O&M support available within India. Therefore, **provision for 30% PMUs to be manufactured & supplied from India was agreed to be kept under URTDSM Project.**

Members agreed to the above.

28. Connectivity of New Generating Stations through LILO arrangement (Agenda by RRVPNL)

RRVPNL had informed that as per accepted practice CTU is responsible for development of evacuation system for Inter-State Generating Stations from the switchyard of the generating station.. It had been further stated that PGCIL is routinely recommending LILO of existing transmission lines for providing connectivity to new generating stations seeking LTOA to ISTS. Though provided in CERC Regulations, LILO connectivity should be allowed only in exceptional cases as it compromises the redundancy & power dispatch from existing generating stations whose evacuation system is to be shared by new generating plant. RRVPNL had requested for suitable guidelines to allowing LILO connectivity to new generating stations either temporarily or permanently and for sharing of transmission charges and losses without adversely impacting the existing ISTS customers.

After detailed deliberations it was agreed that **LILO should be avoided as far as possible. However in exceptional case where no other feasible option emerges even after thorough deliberations in the SCM, it could be allowed with the consent of all constituents**

Members agreed to the above.

Minutes of the meeting in respect of additional agenda items:

29. Power Supply to M/s Noida Power Company Limited (NPCL)

CTU stated that NPCL had applied for connectivity for drawl of 500MW power for distribution in Greater Noida area in Uttar Pradesh. The issue of providing connectivity was discussed during the LTA/connectivity meeting held on 19/12/11, wherein it was proposed to LILO Dadri –G. Noida 400 kV circuit at Greater Noida (New) along with the establishment of a new 2x500 MVA, 400/220 kV substation at Greater Noida (new) for providing connectivity. As UPPTCL was not present in that meeting it was decided that observations / concurrence of UPPTCL would be taken in this regard.

UPPTCL had communicated their concurrence subject to identification of strengthening & supply to their Greater Noida is not affected.

Member (PS), CEA mentioned that M/s NPCL had executed a Long Term PPA with M/s Essar Power (Jharkhand) Ltd for procurement of 240 MW power from April 2014 for 25 years and CTU had already granted Long Term Access of 400 MW (for Target Beneficiaries) in Northern Region to M/s Essar Power (Jharkhand) Ltd and they have requested to approve / provide LTA of 240 MW to NPCL being the actual beneficiary, out of total approved 400MW LTA in NR.

CEA explained that presently 400/220 kV, 3x315MVA transformers are installed at Greater Noida and the transformers are loaded heavily and to meet the future power demand another substation is required in the area. It was also mentioned that NPCL has submitted a letter from Greater Noida Authority informing earmarking of land for new 400 kV substation in Sector-Knowledge Park-V in Surajpur area.

CTU mentioned that the Dadri – Ballabhgarh 400 kV D/c line had already been Looped in Looped out at three major substations of NCR i.e. Maharani Bagh, Greater Noida and Nawada and therefore establishment of one additional substation on the same line at Greater Noida would not be appropriate as it would result into over loading of the lines. In view of this and considering the concentration of growing loads in NCR area it is proposed to have a separate 2x500MVA 400/220kV substation along with 400kV line from Dadri/ Ballabhgarh to meet their requirement. However due to R-o-W constraints for constructing line from Dadri, it is proposed to provide direct connectivity to the proposed 400/220 kV Greater Noida (new) S/s from Ballabhgarh 400/220 kV substation through a 400 kV D/c line. This new 400/220 kV substation would be catering to both Uttar Pradesh and M/s NPCL and would be taken up as a ISTS strengthening scheme.

Members raised the issue of R-o-W constraints in Ballabhgarh area. After discussions it was agreed to use multi-circuit towers in 5 km stretch of the above proposed line from Ballabhgarh end.

Member (PS), CEA mentioned that the above proposal would be **taken up under Tariff Based competitive bidding**

Keeping all above in view, following transmission works were proposed as Northern Regional System Strengthening scheme-XXXIII. The scheme would be taken up under Tariff Based competitive bidding:

NRSS-XXXIII:

- Ballabhgarh – Greater Noida (New) 400 kV D/c (5 km from Ballabhgarh S/s on multi-circuit towers)
- Establishment of 2x500 MVA, 400/220 kV GIS substation at Greater Noida (New) with a short circuit current rating of 50 kA.

Members agreed to the above proposal.

30. 400kV Power Evacuation System of Gidderbaha TPS (2640MW) and Mansa TPS (1320MW)

Member (PS), CEA enquired about the status of Gidderbaha TPS (4x660MW) and Mansa TPS (2x660MW).

NTPC informed that the Gidderbaha generation project is on hold and they would revert back when there is a progress. PSTCL informed that Mansa TPS (1320MW) is also on hold for the time being.

Accordingly, it was **agreed that the evacuation system of these projects may be deferred till the schedule of generation gets firmed up.**

31. Procurement of Spare 765/400 kV ICTs for Northern Region

Powergrid proposed to procure three (3 units of 765/400 kV, 500 MVA (single-phase) ICTs and one (1) unit of 765/400 kV, 333 MVA (single-phase) ICT as spares for Northern region.

Member (PS), CEA enquired about the number of 765kV transformers presently installed.

AGM (OS), POWERGRID informed that fifty four (54) units of 500 MVA and seven (7) units of 333 MVA, 765/400 kV ICTs are in operation at Ballia, Lucknow, Fatehpur, Agra, Moga, Bhiwani and Jhatikara Sub-stations. Further, additional six (6) units of 500 MVA, 765/400kV ICTs are likely to be commissioned by 31.03.2013 at Meerut S/s. He further mentioned that any major failure of these ICTs would necessitate repairs in their off-shore works only, which is time consuming because of long time taken in transportation of the unit from site to works & back and manufacturing of winding. Any failure of these units may cause overloading of the other units operating in parallel and result in transmission constraint at 765 kV level especially in view of ensuing commissioning of various power projects in the Region. In view of the above, it was proposed to procure three (3) nos. single phase 765/400 kV ICTs of 500 MVA capacity and one (1) no. single phase 765/400 kV ICT of 333MVA capacity as spare for Northern Regional Grid.

Considering above, following ICTs were agreed to be procured under "Spare transformers for 765/400KV ICTS in Northern Region" scheme:

- Three (3) nos. single phase 765/400 kV ICTs of 500 MVA capacity as spare ICTs (to be kept in ready for charging condition)
- One (1) no. single phase 765/400 kV ICT of 333MVA capacity as spare ICT (to be kept in ready for charging condition)

Members agreed to the above proposal.

32. Replacement of Bus Reactors under Additional Capitalization at Agra & Muradnagar

CTU stated that the replacement of 02 nos. of 50 MVAR Bus Reactors installed at Agra & Muradnagar S/s with 80 MVAR bus reactors under renovation & modernization was approved by CERC for smooth & reliable operation of Grid. However CERC desired that since there is change in capacity, the matter be discussed with beneficiaries at NRPC level and technical requirement of appropriate capacity of the reactor may be finalized after detailed study. Accordingly, the matter was discussed in the 27th NRPC meeting held on 30/11/2012. During the meeting POWERGRID had proposed to replace 50 MVAR old reactors with 125 MVAR reactors instead of replacing the 50 MVAR reactors with 80 MVAR reactors (as proposed in CERC).

It was also informed that the studies indicated the reduction of voltage at Agra and Muradnagar S/s is of the order of about 0.5 kV with 50 MVAR bus reactors and about 2 kV with 125 MVAR bus reactors.

Considering the above, CTU proposed to replace the existing 50 MVAR Bus reactors with 125 MVAR Bus Reactors at Agra and Muradnagar (UPPTCL). It was also proposed to maintain the 50 MVAR reactors as regional spares after refurbishment. Accordingly, it was agreed to under replacement of bus rectors in Northern region following is proposed under **"Replacement of bus rectors in Northern region" scheme:**

- 125 MVAR bus reactors at Agra and Muradnagar
- Refurbishment of existing 50MVAr reactors at Agra and Muradnagar and using them as regional spares.

Members concurred with the above proposal.

33. Drawl of power from 220 kV level of Agra (POWERGRID) 765/400/220 kV substation

CTU informed that 4x105 MVA, 400/220 kV ICTs are provided at Agra (POWERGRID) substation. For supply of power to UP, two nos. of 220 kV line bays are also being constructed which may be utilised by UPPTCL for meeting the load demand in nearby area. UPPTCL was advised to plan 2 nos. of 220 kV feeders from this substation.

UPPTCL informed that they would utilize the above bays for LILO of Agra-Shamsabad 220kV S/c line.

Members agreed to the above proposal.

34. Construction of four (4) nos. 400 kV Bays at 400/200 kV sub-station of PTCUL at Kashipur

Already mentioned in para no.-5.

35. Construction of two (2) nos. 400 kV Bays of POWERGRID at Rajpura substation for termination of LILO of Dehar – Bhiwani 400 kV S/c line associated with NRSS-XXVII

CTU stated that implementation of LILO of Dehar – Bhiwani 400 kV S/c line at Rajpura substation (PSTCL) was agreed as part of NRSS-XXVII. For completion of these works, two nos. of 400 kV bays were to be implemented at Rajpura substation of PSTCL. For carrying out the works on deposit basis, as a practice being followed amongst other utilities & POWERGRID, normally 15% overhead charges are paid. The scope of deposit work includes tendering, placement of awards, engineering, supervision etc. However, PSTCL had intimated that the implementation of 400 kV bays at Rajpura may be carried out by POWERGRID and 12.5% departmental charges of the total project cost may be paid to PSTCL.

Member (PS), CEA stated that Dehar-Panipat and Dehar-Bhiwani lines belong to BBMB. To control the over voltage at Dehar generating station during low hydro condition, LILO of these long lines at intermediate substations was approved. Originally the LILO of Dehar-Panipat at Panchkula and LILO of Dehar-Bhiwani at Rajpura were to be carried out by Haryana and Punjab respectively. As the works were required to be carried out to ensure reliable operation of the grid it was agreed in earlier SCM that Powergrid would carry out these works. As such, it is not justified on the part PSTCL to ask 12.5% charges for extension of bays in Rajpura S/s. He advised PSTCL to allow POWERGRID to carry out the extension works in Rajpura S/s without any charges. **PSTCL agreed for the same.**

Members agreed to the above proposal.

36. High Voltage conditions in RAPP area

CTU intimated that the issue of high voltage conditions prevailing in RAPP area under light load condition was discussed in 27th NRPC meeting where in NPCIL informed that some relief in overvoltage conditions was observed after the commissioning of 125 MVAR bus reactor at Kankroli. However, the voltages in RAPP area are still high (about 420 kV). During the deliberations RRVPNL suggested that 400kV RAPP – Kankroli D/c line might be looped in looped out at Chittorgarh substation which is en-route to this line (LILO length is only about 5-10 km). This would result into smaller line sections and provide additional anchoring at

Chittorgarh. Accordingly, studies were carried out and it was observed from study results that the proposed LILO at Chittorgarh would reduce the voltage by 5 kV in the RAPP area. It was also mentioned that after the above LILO of the RAPP – Kankroli D/c line , the line reactors at Kankroli end could be gainfully utilized as bus reactors at Kankroli S/s.

As the Line belongs to POWERGRID and since the size of work is also small, it was agreed that the works can be carried out by POWERGRID as part of some new or ongoing scheme of POWERGRID.

Accordingly, following was agreed to be included under **NRSS-XXXII** works:

- LILO of both circuits of RAPP – Kankroli 400 kV D/c line at Chittorgarh 400/220 kV substation of RRVPNL.
- Conversion of 50MVAR line reactors at Kankroli end of RAPP-Kankroli 400kV line into bus reactor (Subject to space confirmation by RVPN)

Members discussed and agreed to the proposal.

Member (PS), CEA enquired about the status of bus reactor installation by various generators at their station.

NTPC informed that bus reactor at Rihand is under implementation. NPCL informed that bus reactor at RAPP would be available by June'15.

Member (PS), CEA stated that the reactors had been planned looking into the system requirements and needed to be taken up on priority. He asked all the generating stations to intimate immediately the status of reactor installation in their generating switchyard to CEA & CTU.

Members agreed to the above.

37. Review of Transmission Planning Criteria

CEA stated that the Enquiry Committee headed by Chairperson, CEA for grid events in July 2012 has recommended that transmission planning criteria needs to be reviewed in the context of market scenario within three months. In this regard, a note on the issues relating to "Review of Planning Criteria" has been prepared. A copy of this note and the existing "Manual on Transmission Planning Criteria" are available on CEA website.

Members of the Standing Committee on Power System Planning of Northern Region were requested to furnish their comments/ suggestions regarding review of transmission planning criteria to the undersigned along with a soft-copy mailed to cea.sppa@yahoo.in.

Members agreed to give their views/observations in regard to review of Transmission Planning Criteria.

38. Integrated planning for State transmission system:

CEA & CTU stated that as per section- 39 of the Electricity Act, STUs need to carry out their planning function related to intra-state transmission in coordination with the CEA and CTU. There have been a few instances in the past where, the STU has planned important transmission system or allowed connectivity to large generation capacities without involving CEA and CTU and this may result in congestion/operational difficulties for the ISTS/national grid. To start with, it was agreed that STU should evolve following of their systems involving CEA and CTU, which would subsequently be firmed up through the Standing Committee forum:-

(a) 220 kV and above system

(b) Large scale harnessing of renewable generation

(c) System for evacuation of power from a complex having generation capacity of 250 MW and above in case of conventional and 50 MW and above in case of renewable.

Members agreed to provide above information within a month.

39. State wise assessment of the Load Generation Scenario of Northern Region.

CEA stated that in order to make the assessment of load generation scenario, all STUs of Northern Region should provide the seasonal load and generation data in prescribed format as given in the agenda.

Members agreed to provide above information within a month.

40. Proposal of 10 kM LILO of one circuit of PGCIL's 220 kV D/C Dausa-Anta line at RRVPNL's proposed 220 kV GSS Lalsot (Agenda by RVPNL)

CEA stated that Lalsot is a load center in Rajasthan presently being fed at 132kV radially from Dausa. To meet the growing power demand RRVPNL has proposed establishment of 220kV S/s in Lalsot by LILO of Anta-Dausa 220kV Line.

It was also intimated that Anta Gas (419MW) is a generating station of M/s NTPC located in Rajasthan. It is presently connected to the grid through following 220kV lines:

(i) Anta –Bhilwara 220kV D/c
(ii) Anta-Sakatpura 220kV S/c
(iii) Anta – Dausa 220kV D/c wiht one circuit via Sawaimadhopur
(iv) Anta-RAPP 220V S/c
(v) Anta-Dahra 220V S/c

RRVPNL has proposed LILO of Anta-Dausa 220kV direct line at Lalsot. As per the Load flow study the loading on the lines would be about 130-150MW/ckt. RRVPNL had also furnished the loading on Anta-Dausa 220kV line during 2012-13 is as follows:

Name of Transmission line	April-12	May-12	June-12	July-12	Aug-12	Sep-12	Oct-12	Nov-12
220 kV S/C Anta GTPS-Sawaimadhopur	130	145	145	145	130	119	148	137
220 kV S/C Anta GTPS-Dausa	125	115	135	135	100	100	100	100
220 kV S/C Sawaimadhopur-Dausa	74	93	95	95	74	55	45	45

CTU stated that proposed LILO of 220 kV Anta-Dausa line (one circuit) at Lalsot S/s is in order.

After deliberations, Members agreed for the above proposal of RRVPNL.

41. LILO of Dadri-Malerkotla line at Kaithal.

CTU stated that Dadri-Malerkotla 400kV S/c is a 300km long line and under certain conditions, the Malerkotla end had experienced high voltages upto 430kV resulting in difficulty in maintaining this line in operation. This problem has also led to over fluxing of ICTs at Malerkotla as reported by PSTCL. In view of above, CTU proposed to **LILO Dadri-Malerkotla line at Kaithal S/s (PG) under ISTS regional strengthening scheme-NRSS-XXXII.**

Members agreed to the above proposal.

42. Evacuation of Lalitpur STPS (3x660 MW) and Jawaharpur STPS (3x660 MW)

Lalitput STPS is located in western part of Uttar Pradesh near Jhansi and Jawaharpur STPS is located near Etah. UPPTCL has proposed following transmission system for evacuation of power from Lalitpur and Jawaharpur STPS for consideration in Standing Committee Meeting:

Lalitpur STPS (3x6600MW)

- Lalitpur- Agra (UP) 765kV S/c – 400km
- Lalitpur- Jawaharpur 765kV S/c – 400km
- Establishment of 765/400kV 2x1500MVA substation at Agra (UP)
- Establishment of 765/220kV 2x300MVA substation at Lalitpur
- 220kV D/c Lalitpur-Jhansi -90km
- Lalitpur-Bina 765kV S/c -50kM (for stable operation)

Jawaharpur STPS (3x6600MW)

- Jawaharpur- Agra (UP) 765kV S/c – 110km
- Agra(UP)-Agra (PG) 765kV S/c - 50km
- LILO of Mainpuri-G Noida 765kV S/c at Jawaharpur-10km
- LILO of both circuits of Mainpuri-Aligarh 400kV D/c at Jawaharpur-15
- LILO of Panki-Muradnagar 400kV S/c at Jawaharpur-15km
- Establishment of 765/400kV substation at Jawaharpur

Other associated Strengthening works:

- LILO of one circuit of Agra-Agra(PG) at Agra (UP) 765kV S/s-10km
- Establishment of Agra (South) 400/132kV S/s
- Agra(UP)-Agra (south) 400kV S/c -30km
- LILO of Agra-Muradnagar at Agra (UP) 765kV-20km
- LILO of Agra-Muradnagar at Mathura -30km
- Establishment of Mathura 2x315MVA, 400/220kV S/s.
- LILO of Unnao-Agra at Firozabad-30km
- Establishment of Firozabad 2x315MVA, 400/220kV S/s.
- Agra (South)-Firozabaad 400kV s/c
- Establishment of 2x200MVA, 400/132kV S/s at Farrukhabad
- LILO of one circuit Mainpur-Aligarh at Farrukhabad.
- LILo of Bara-Mainpuri 400kV 765kV, 2xS/c at Unnao

- Noida (sec-148) –Noida(123) 400kV D/c monopole line-20km
- Establishment of 400/132kV GIS substation at Noida-123

As per UPPTCL Lalitpur STPS is under construction and is expected by 2014. The system studies were carried out by CEA & CTU considering the above proposal and discussions were held with UPPTCL representatives on 21/12/2012. Bina is an important substation in WR-NR inter-regional link. Interconnection of Lalitpur to Bina would affect the WR-NR power flow. Hence connection of Lalitpur to Bina is not possible. As per above system Lalitpur would be radially connected to Agra(UP) through two nos of 765kV line of 400km long. Radial connection of generator through such long distance lines is not desirable.

Considering the above, CEA and CTU proposed following modifications to the UPPTCL proposal:

Lalitpur STPS (3x6600MW)

- Lalitpur- Auraiya(UP) 765kV 2xS/c – 260km
- Auraiya(UP) -Agra(UP-765kV) 765kV S/c – 200km
- Auraiya(UP)-Mainpuri 765kV S/c -120km
- Agra(UP-765kV)-Hapur 765kV S/c –120km
- LILO of Orai-Mainpuri (UP) at Auraiya(UP)
- Establishment of 765/400kV 2x1500MVA substation at Agra (UP)
- Establishment of 765/220kV 2x1500MVA substation at Auraiya(UP)
- 220kV D/c Lalitpur-Jhansi -90km

Jawaharpur STPS (3x6600MW)

- Jawaharpur –Hapur 765kV S/c -210km
- Jawaharpur –Mainpuri 765kV S/c -70 km
- LILO of Mainpuri-G Noida 765kV S/c at Jawaharpur-10km
- LILO of Agra-Hapur 765kV S/c at Jawaharpur-10km
- LILO of both circuits of Mainpuri-Aligarh 400kV D/c at Jawaharpur-15 km
- LILO of Panki-Muradnagar 400kV S/c at Jawaharpur-15km
- Establishment of 765/400kV substation at Jawaharpur

Beyond Hapur, Hapur-Meerut 765kV line alongwith establishment of 765/400kV s/s at Meerut with 400kV interconnection has been proposed. The results of load flow study considering the alternate proposal was also shared with UPPTCL during the meeting on 21/12/2012.

UPPTCL stated that they had certain apprehensions in agreeing to the above proposal for evacuation of power from Lalitpur and Jawaharpur STPS and needed time to examine the same.

Member (PS) advised UPPTCL to have another meeting with CEA and CTU after examination of the above proposal so that the evacuation system for Lalitpur and Jawaharpur STPS could be firmed up. UPPTCL agreed for the same.

Members agreed to the above.

Meeting ended with thanks to chair.

Thereafter the meeting for connectivity and Long Term Open Access was held. The minutes of this meeting are being prepared separately and uploaded shortly.

List of participants for the 31st Standing Committee Meeting on Power System Planning in NR held alongwith on 2.1.2013 at POWERGRID, Gurgaon

	Name	Designation
CEA		
1.	Sh. Ravinder	Member (PS)
2.	Sh. K.K. Arya	Chief Engineer I/c (SP&PA)
3.	Sh. B.K. Sharma	Director (SP&PA)
4.	Anita Gehlot	Dy. Director
5.	Manjari Chaturvedi	Dy. Director
6.	NRLK Prasad	Dy. Director
NRPC		
7.	Sh. P.K. Pahwa	Member Secretary
PGCIL		
8.	Sh. I.S. Jha	Director(Projects)
9.	Sh. Y.K. Sehgal	COO (CTU)
10.	Sh. R.K. Chauhan	GM (CTU)
11.	Sh. Kamal Sarkar	AGM(OS)
12.	Sh. Mukesh Khanna	DGM(CTU)
13.	Sh. S.K. Tyagi	DGM (OS)
14.	Sh. V. Thiagarajan	CDE (CTU)
15.	Sh. A.V.S. Ramesh	Manager(OS)
16.	Ms. R.P. Joshi	Sr. Engineer(CTU)
17.	Ms. Ankita Singh	Engineer(CTU)
18.	Ms. Shruti Tiwari	Engineer(OS)
NTPC		
19.	Sh. Dinkar Devate	GM (Elect.)
20.	Sh. S.S. Mishra	AGM (Engg.)
21.	Sh. P.K. Goyal	AGM (PP&M.)
22.	Sh S.K. Sharma	AGM(Comm.)
23.	Ms. Sagarika Mohanty	DGM(PE-Elect.)
24.	Sh. Amit Arora	Manager (Comm.)
25.	Ms. Shilpa Agarwal	Manager(Comm.)
NHPC		
26.	Sh. Nain Singh	ED
27.	Sh. R.M. Agarwal	AM
DTL		
28.	Sh. Bhupender Nath	GM(Plg.)
29.	Sh. Saruda Prasanna Routray	Manager(Plg.)
PTCUL		
30.	Sh. Gurcharan Singh	CE(P)
31.	Sh. A.K. Agarwal	SE(Engg.)

HPPTCL		
32.	Sh. V.K. Kaprate	Director
33.	Sh. Sandeep Sharma	Sr. Manager(Plg/IT)
HPPCL		
34.	Sh. B.S.Negi	DGM
PTC		
35.	Sh. S.S. Sharma	Advisor
HPSEB Ltd.		
36.	Sh. M.L. Sharma	Sr. XEN
HVPNL		
37.	Sh. R.K.Arora	Director(Technical)
38.	Sh. J.K. Juneja	CE(Plg)
39.	Sh. S.B. Moudgil	Chief Engineer
40.	Sh. Gulshan Nagpal	SE, Plg.(NCR)
RVPNL		
41.	Sh L.N. Nimawat	CE(MM)
42.	Ms. Sona Shishodia	XEN(PSS)
J&K PDD		
43.	Sh. Manzoor Salroo	Dev. Comm.(P)
44.	Sh. T.K. Koul	Consultant
45.	Sh. Sanjay Sharma	E.E
NPCIL		
46.	Sh. K.P. Singh	CE
NLDC		
47.	Sh. S.R. Narasimhan	DGM
48.	Sh. M. Pradeep Reddy	Engineer
NRLDC		
49.	Sh. V.V. Sharma	GM
50.	Sh Rajiv Porwal	Chief Manager
UPPTCL		
51.	Sh. S.K. Garg	Director(Trans.)
52.	Sh V.P. Tiwari	SE(Trans. & Planning)
53.	Sh. Hriday Prakash	EE
PSTCL		
54.	Sh. Rachhpal Singh	CE
55.	Sh. Sunil Puri	Dy. CE
56.	Sh. Kuldeep Singh	Addl. SE

UT CHANDIGARH

57.	Sh. Sunil Sharma	Executive Engineer
58.	Sh. Khushwinder Singh	Astt. Executive Engineer
59.	Sh. M.P. Singh	SE

EPPL

60.	Sh. Himanshu V.	V.P.
61.	Sh. M.P. Chakarvarty	Sr. DGM
62.	Sh. Atchibabu G.	Dy. Manager

NPCL

63.	Sh. S.S. Rizvi	GM
64.	Sh. Rajeev Goyal	DGM

Annexure-1

Transmission System for Phase-I Generation Projects in Jharkhand & West Bengal

I. Transmission System for Phase-I Gen. Projects in Jharkhand & West Bengal: Part-A

(i) Ranchi – Gaya 400 kV (Quad) line via pooling station proposed near Essar / Corporate generation projects

(ii) Ranchi New (765/400kV S/s) - Dharamjayagarh / near Korba 765kV S/c

(iii) Establishment of 400kV Pooling Station (Jharkhand Pool) near Essar and Corporate generation projects. This will be a switching station without ICTs

(iv) New 2x1500 MVA, 765/400 kV substation at Varanasi

(v) Gaya – Varanasi 765 kV S/c

(vi) LILO of Gaya - Balia 765 kV S/c line at Varanasi

(vii) 400kV connectivity for new 765/400kV S/s at Varanasi

   i. Varanasi - Sarnath (UPPCL) 400kV D/c (quad)
   ii. LILO of Sasaram - Allahabad 400kV line at Varanasi

II. Trans. System for Phase-I Generation Projects in Jharkhand & West Bengal: Part-B

(i) New 2x1500 MVA, 765/400 kV substation at Kanpur

(ii) Varanasi – Kanpur 765 kV D/c

(iii) Kanpur – Jhatikra 765 kV S/c

(iv) 400kV connectivity for new 765/400kV S/s at Kanpur

   i. Kanpur (765/400kV) - Kanpur (Existing) 400kV D/c (quad)

III. Private Sector line: In addition to the above work to be undertaken by PGCIL,

In addition to the above work to be undertaken by PGCIL, Dharamjaygarh – Jabalpur 765kV D/C line (2nd line) would be under the scope of private sector. Associated 765kV line bays at Dharamjaygarh and Jabalpur sub-station would be under the scope of POWERGRID.

Annexure-2

I. Transmission system for Phase-I generation projects in Jharkhand and West Bengal (WB) - Part-A1:

1.Establishment of 400kV GIS Jharkhand Pooling Station near Essar and Corporate generation projects (depending upon progress of Essar and Corporate IPPs). This will be a switching station without ICTs.

2.Ranchi – Gaya 400 kV D/C Quad line via proposed Jharkhand Pooling Station near Essar/ Corporate generation projects

II. Transmission system for Phase-I generation projects in Jharkhand and West Bengal - Part-A2:

1. Ranchi New (765/400kV S/s) – Dharamjayagarh/near Korba 765kV S/C line

2.New 2x1500 MVA, 765/400 kV GIS substation at Varanasi

3.Gaya – Varanasi 765 kV S/C

4.Varanasi- Balia 765 kV S/C

III. Transmission system for Phase-I generation projects in Jharkhand and West Bengal - Part-B:

1. New 2x1500 MVA, 765/400 kV GIS substation at Kanpur

2.Varanasi – Kanpur 765 kV D/C

3.Kanpur – Jhatikra 765 kV S/C

4.765/400 kV Kanpur – Kanpur(Existing) 400 kV D/C Quad line

5.400kV connectivity for new 765/400kV S/s at Varanasi

6. Varanasi - Sarnath (UPPCL) 400kV D/C Quad line

7. LILO of Sasaram - Allahabad 400kV line at Varanasi

8. Opening of LILO of one circuit of Sasaram-Allahabad 400kV D/C line at Sarnath.

IV. Private Sector line:

In addition to the above work to be undertaken by PGCIL, Dharamjaygarh – Jabalpur 765kV D/C line (2nd line) would be under the scope of private sector. Associated 765kV line bays at Dharamjaygarh and Jabalpur S/S would be under the scope of POWERGRID.

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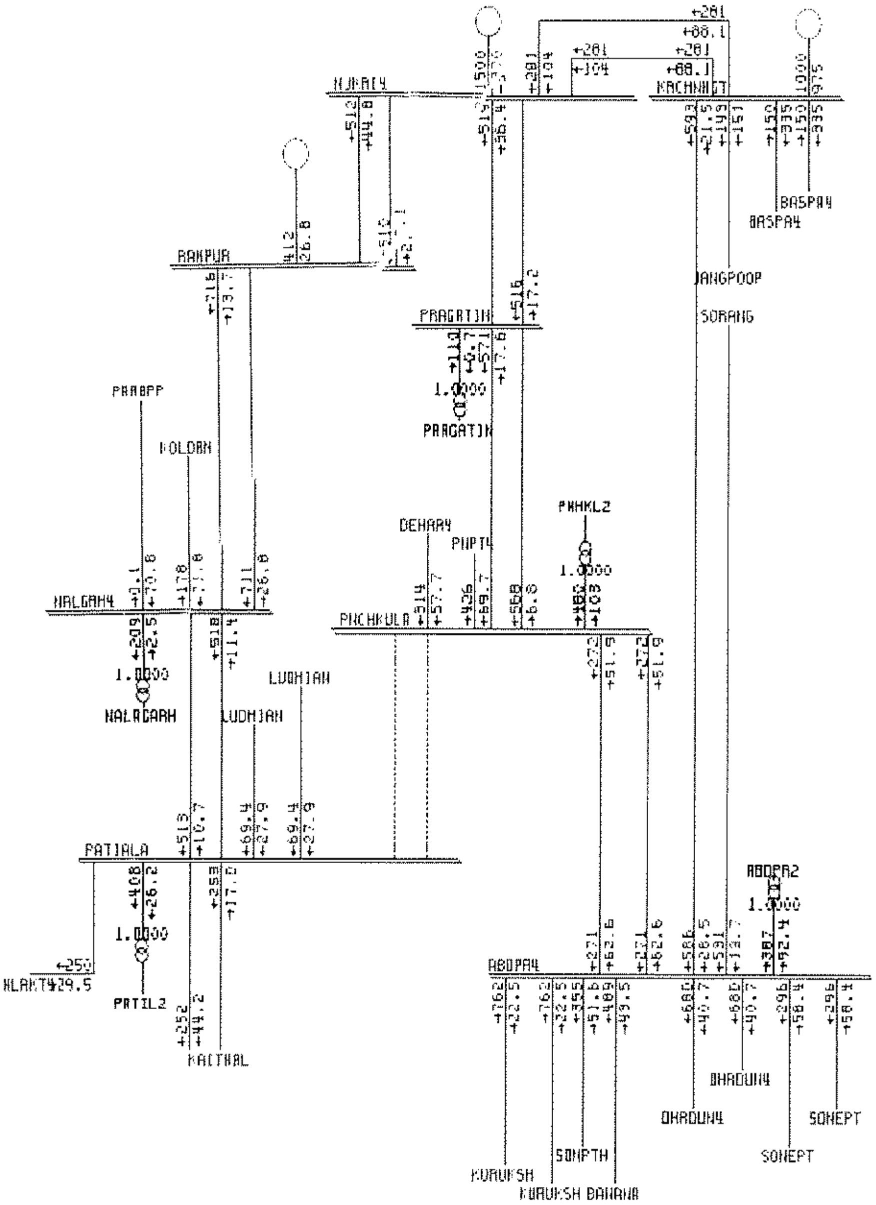
ANNEX-III

High loading in Nathpa Jhakri - Nalagarh Lines

(i) Present arrangement



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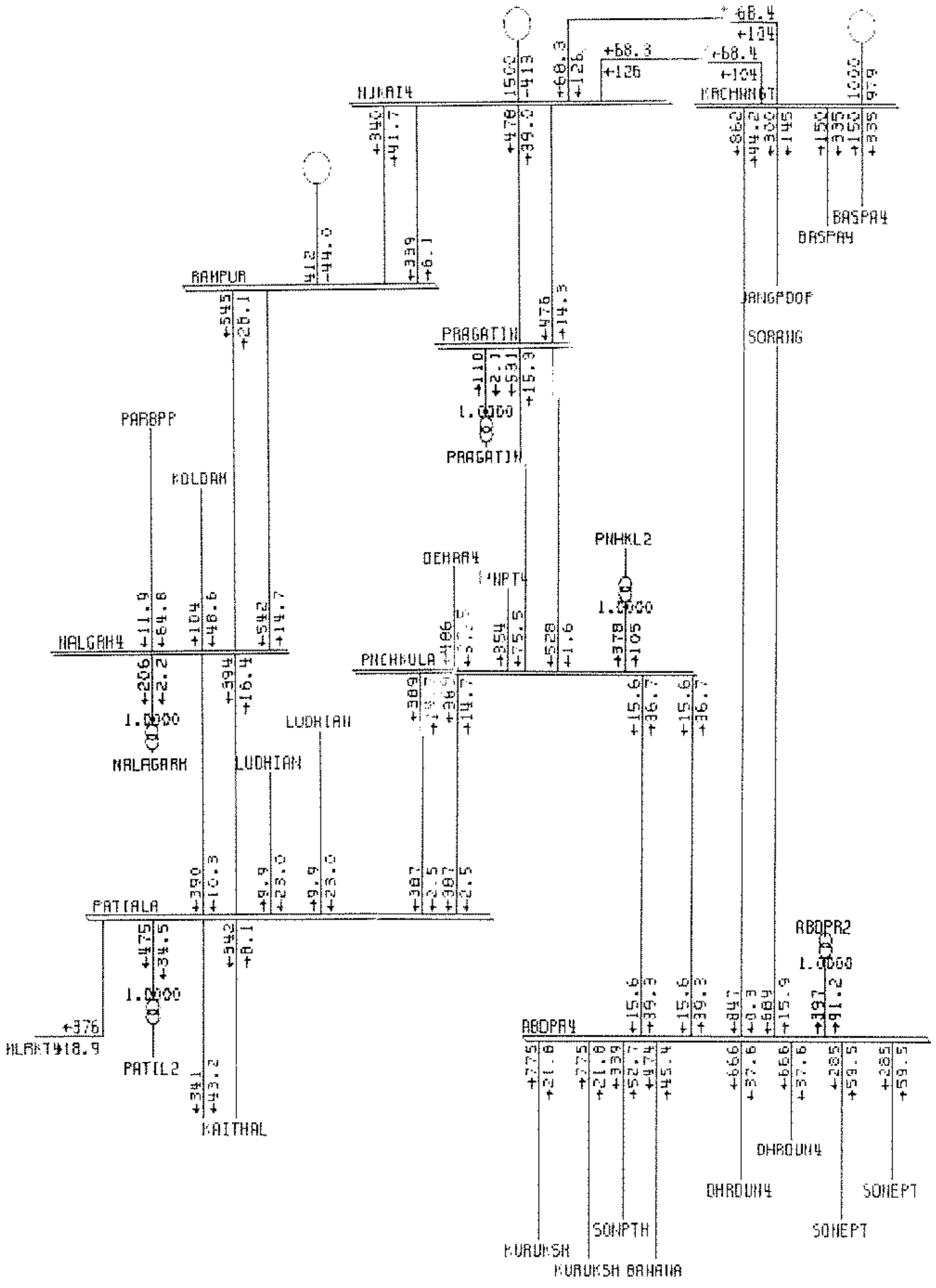
ANNEX-III

(ii) Proposed Arrangement



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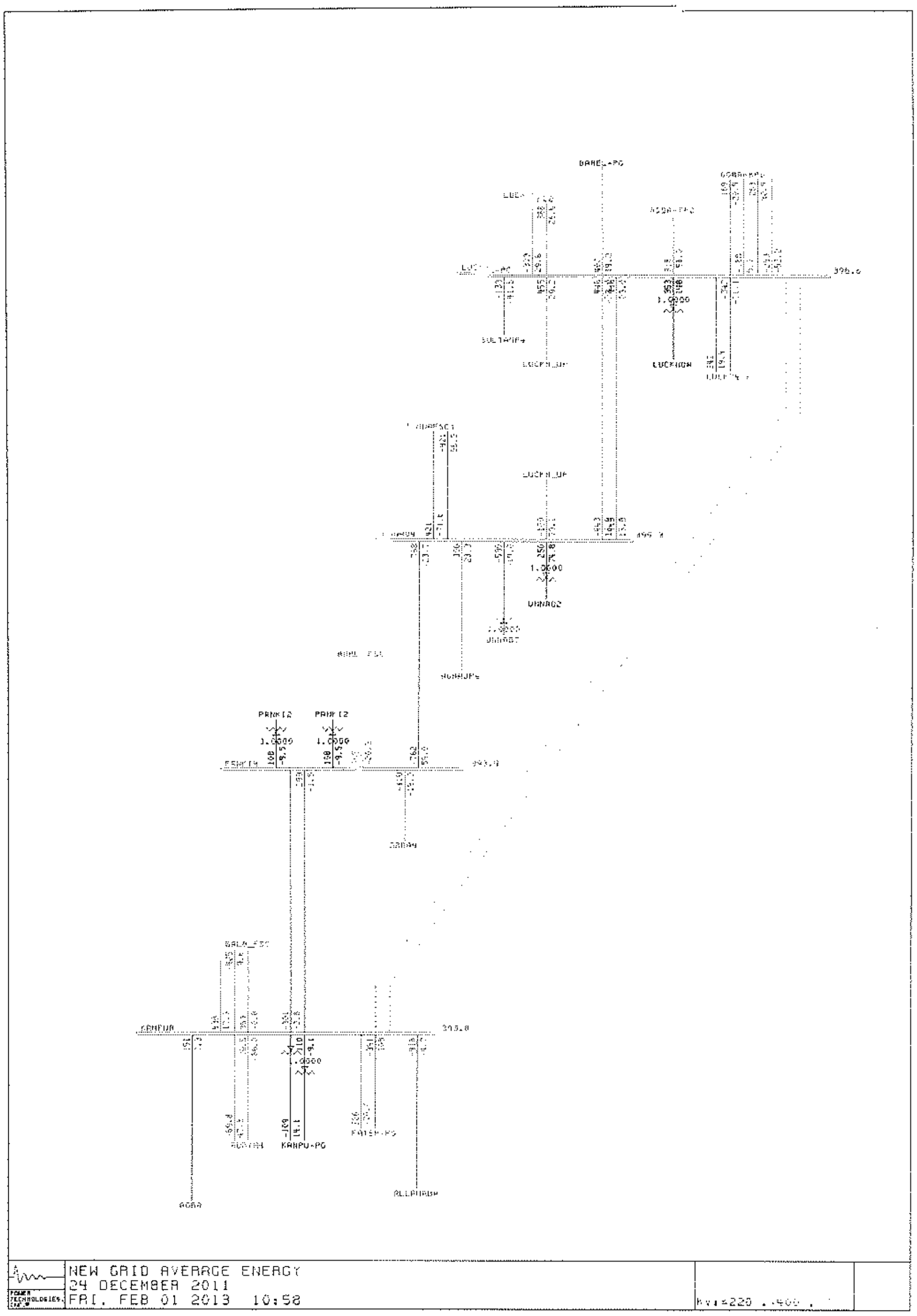
ANNEX-IV

Unnao-Panki over loading:

(i) Present arrangement



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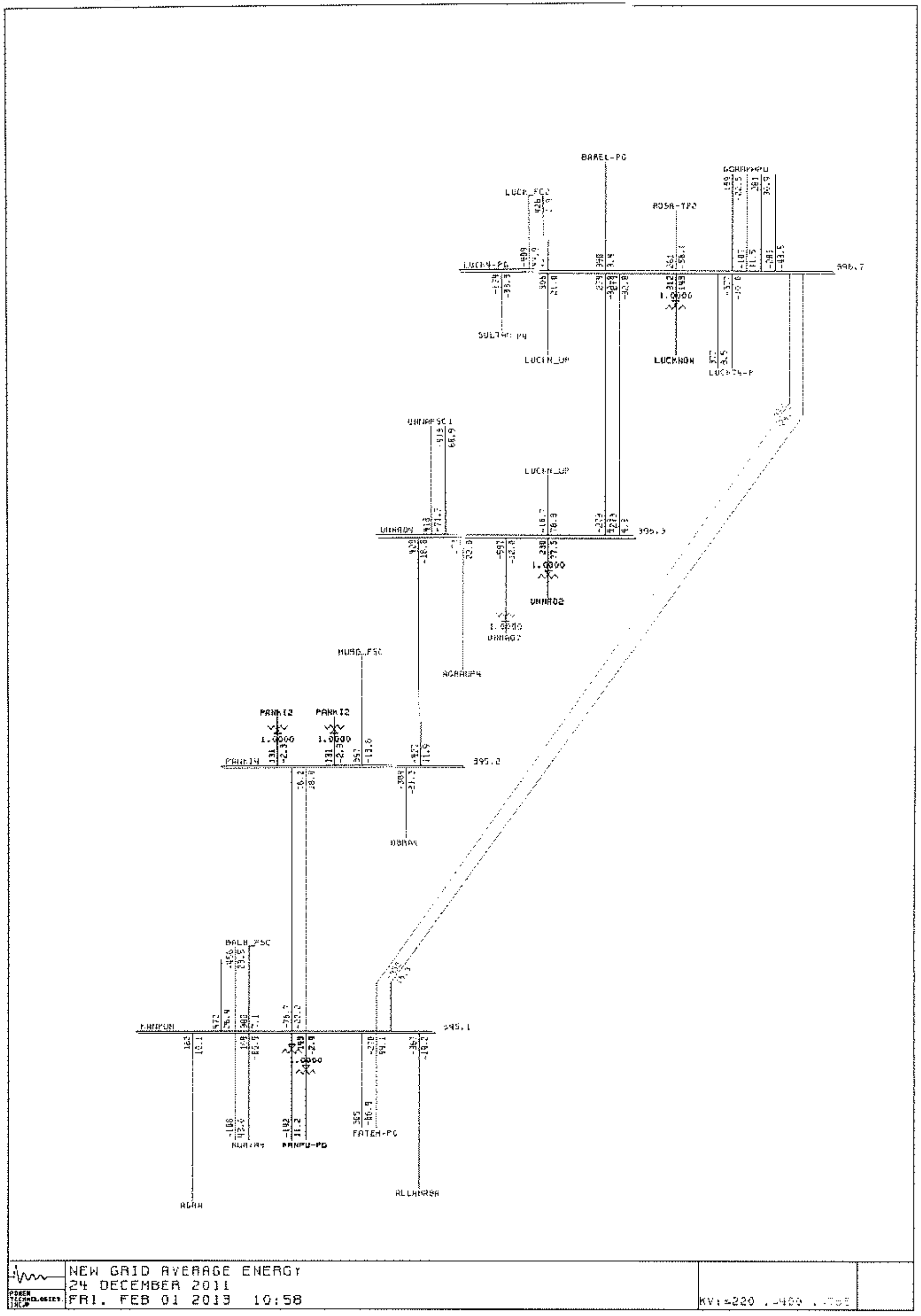
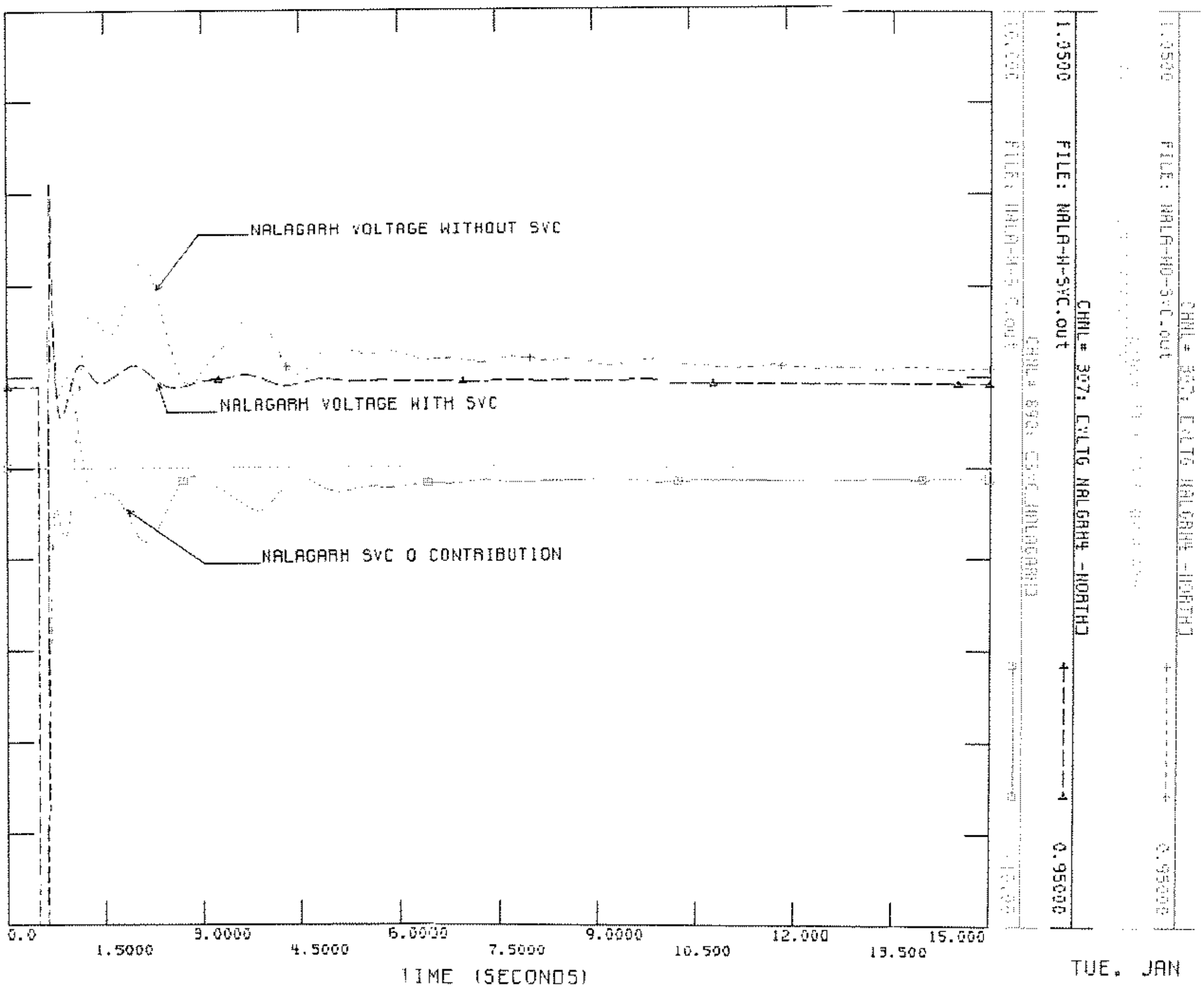
ANNEX-IV

(ii) With proposed Lucknow-Kanpur line.



ANNEX-V

SVC at Nalagarh



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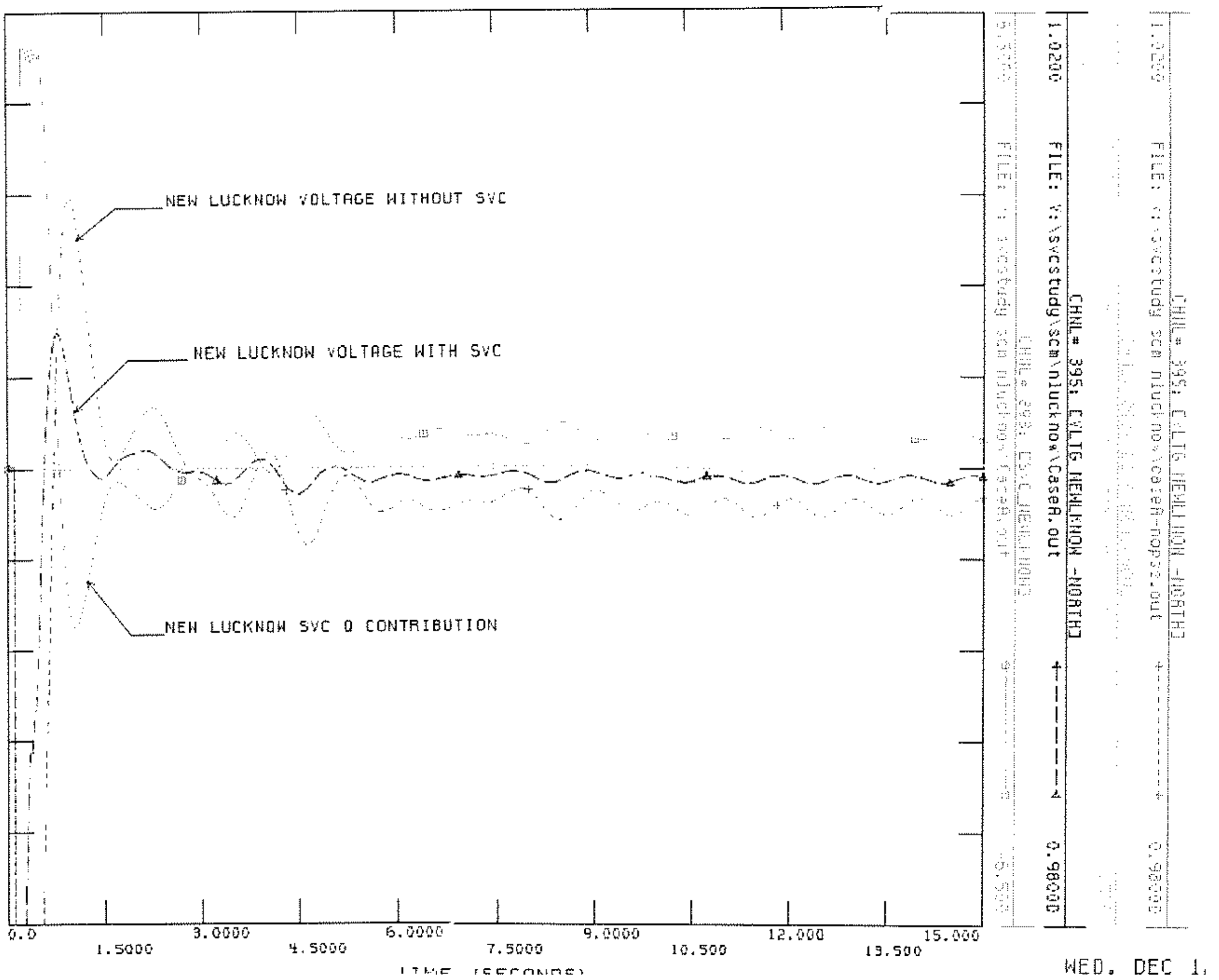
ANNEXX-VI

SVC at Lucknow



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Annexure - 10

DIRECTORATE OF ENERGY
GOVERNMENT OF HIMACHAL PRADESH
SHANTI BHAWAN PHASE-III SECTOR-6 NEW SHIMLA-9
Phone/ Fax No: 0177-2673553, Email: ceenergy09@gmail.com

No. HPDOE/CE/Authority/ Dam Safety (Vol-VII)/ 2018- 12801- 809 **Dated:** 28/02/19

To

M/s Everest Power Pvt. Ltd.,
Malana-II HEP, First House, Bhumian Estate, Nav Bahar,
Bhumian Road, Chotta Shimla- 171002

Subject: **Enhanced Security of Dam Hydro Projects in the State of Himachal Pradesh.**

Sir,

I have been directed to state that in the wake of the present National Security Concerns, the security of Dam Hydro projects and other related vital installations in the State are required to heighten. You are, therefore, requested to take immediate necessary steps for ensuring effective security of your project to meet any emergency situation, under intimation to this office. If security plans are already in place the same may be reviewed and updated with all precautionary measures and made effective with immediate effect.

Matter most urgent.

Yours faithfully,
28/02/2019
Director,
Directorate of Energy, GoHP.

Copy to:

1. The Private Secretary to the Chief Secretary, GoHP, Shimla-171002 for favour of kind information of the Chief Secretary to GoHP, Shimla.
2. The Principal Secretary (MPP & Power), to the GoHP, Shimla-171002 for kind information please.
3. The Deputy Commissioner / Superintendent of Police (SP) of District Kullu for information and necessary action please.

28/02/2019
Director,
Directorate of Energy, GoHP.