



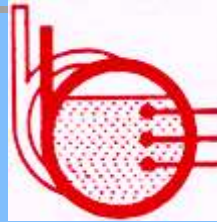
**BHAKRA BEAS MANAGEMENT BOARD**

---

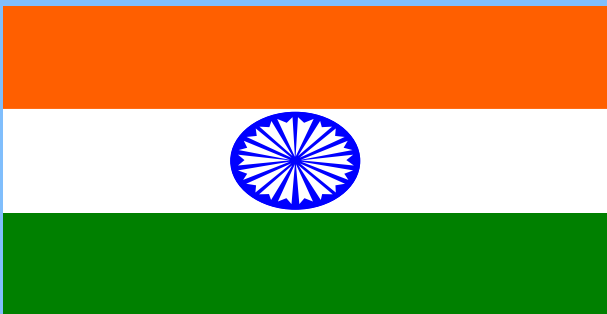
**CASE STUDY  
OF  
RMU&LE OF HYDRO POWER HOUSES  
OF BBMB**

# Bhakra Beas Management Board

Nation's Pride



BHAKRA BEAS  
NATION'S PRIDE

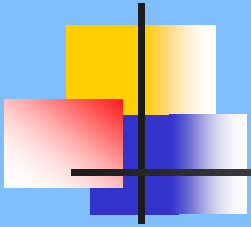


**Vision of Pt. Nehru, the first Prime  
Minister of independent India came  
true .....**

---

**With the untiring dedicated efforts  
of all the engineers and workers**

**The Bhakra project -  
*“The temple of modern India”*  
undertaken in 1948, was completed in  
1960.**



# Bhakra Beas Management Board

## What Is In The Name ...?

---

- n Originally the ***Bhakra-Nangal*** and ***Beas Projects*** were the joint ventures of Punjab and Rajasthan states of northern India.
- n After the re-organisation of Punjab state into smaller states viz. Punjab, UT Chandigarh, Haryana and Himachal, ***Bhakra Management Board*** was constituted on 1st October, 1967 to manage the operation and maintenance of ***Bhakra-Nangal*** Projects.
- n The works of ***Beas Projects*** were entrusted to ***Beas Construction Board***, and subsequently on completion, these were subsequently transferred to ***Bhakra Management Board*** in the year 1976.
- n ***Bhakra Management Board*** was renamed as ***Bhakra Beas Management Board*** on 15th May, 1976 and is popularly known today as ***BBMB*** the World over.

# Bhakra Beas Management Board

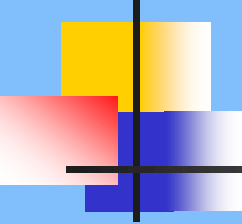
## The Born Leader

---

- BBMB has installed capacity of 2918.73 MW as on 30.11.2016 from its 28 Units.
- BBMB also transmits Power in the Northern Grid through a wide network of 400 KV, 220 KV, 132 KV and 66 KV transmission lines having circuit lengths of more than 3700 KM.
- BBMB maintains the largest reservoirs in the country viz Bhakra and Pong Dam and also operates long Hydro tunnels and Hydel channels.
- Bhakra, Nangal and Beas Dams have controlled the floods and have also brought prosperity in the partner states of Northern India.

# Bhakra Beas Management Board

## An Overview



<b>Year of Establishment</b>	<b>:</b>	<b>1967</b>
<b>Generation Capacity</b>	<b>:</b>	<b>2918.73 MW</b>
<b>Number of Power Plants</b>	<b>:</b>	<b>28</b>
<b>Beneficiary States/ Union Territories</b>	<b>:</b>	<b>Punjab, Rajasthan, Haryana, HP, Chandigarh, Delhi</b>

### Operating Projects

<b>S.No.</b>	<b>Name Of The Project</b>	<b>Capacity</b>
<b>1.</b>	<b>Bhakra Power Plant</b>	<b>1379 MW</b>
<b>2.</b>	<b>Dehar Power Plant</b>	<b>990 MW</b>
<b>3.</b>	<b>Pong Power Plant</b>	<b>396 MW</b>
<b>4.</b>	<b>Ganguwal Power Plant</b>	<b>76.39MW</b>
<b>5.</b>	<b>Kotla Power Plant</b>	<b>77.34MW</b>

# Bhakra Beas Management Board

## Generating Stations

### The Bhakra Complex



- n Bhakra Project is a marvel in engineering. The 225.55 meters high Dam is of concrete straight gravity type having a capacity of 6911 million cu m.
- n This project generates a total of 1379 MWs power as on date from its Right and Left Bank power stations.

# Bhakra Beas Management Board

## Generating Stations

### Dehar Power House



- n Dehar Power House is a run-of-the-river scheme also having a buffer storage. The prestigious Power House is the culmination of a long water conductor system comprising two Tunnels and an open Hydel Channel connecting the mighty rivers of Beas and Satlej.
- n Despite metallurgical breakthroughs, the heavy siltation makes the operation and maintenance of this Power House a challenging task necessitating the capital maintenance of two machines a year as a regular feature.
- n This project generates a total of 990 MWs power from its power stations.



# Bhakra Beas Management Board

## Generating Stations

### Pong Power House



- n Pong Dam is a earth core gravel shell type and Power House is located in stilling basin down side of six penstocks each of 5.025 m diameter.
- n This project generates a total of 396 MWs power from its power stations.

# Bhakra Beas Management Board

## Generating Stations

### Ganguwal and Kotla



- n Ganguwal and Kotla Power Houses are run-of-the-river type basically identical power houses.
- n The Power Houses generates a total of 153.73 MWs power from its power stations.



# HYDRO ELECTRIC PROJECTS

---

Hydroelectric project development can be broadly classified as under:

- n Green field Project --- Setting up of new hydro project.
- n Brown field Project ---- Reaping enhanced life and benefits from old projects.

Setting new hydro plants has various issues and intricacies.

Necessity of optimization of existing resources has become essential.

- n life of the existing old hydro electric power projects can be enhanced by renovation process by installing equipment with modernized technology and may get benefit of uprating in case of available margins to bridge the gap between demand and supply to meet with shortage of electricity in the country.



# RM&U - ADOPTION WHERE?

---

## **Renovation, Modernization and Upgrading (RM&U) can be adopted for Units**

- n which have Outlived their normative operating life, or,
- n which have generic problems, or,
- n which have low outputs, or,
- n which have stopped giving output, or,
- n to prevent deterioration in operation to avoid premature retiring, or,
- n Upgrading margins are available (after ascertaining cost analysis with replacement cost of existing equipment)



---

**RM&U  
OF  
BHAKRA BEAS PROJECTS**



# RM&U- Applicability of terms

---

## **Renovation**

- n Ageing of machines, Appearing of cracks, wear & tear of runner blades, damage of pads, deterioration of insulation, failures and frequent trippings.

## **Modernization**

- n Due to silt damage, Due to improvements in technology, scope to replace with the latest available and more effective, sensitive and better for system stability.

## **Uprating**

- n Improvemnts in efficiency of runner, latest insulating material, improvements in ventilation and cooling methods, improvements in metallurgy

**Renovation and Modernization should run parallel.**

**If uprating is possible, it is an added advantage.**



# RM&U - Necessity

---

BBMB has been promoting the cause of Renovation, Modernization and Up-rating of old Hydro Power Houses in the country. This task was initiated for all the BBMB Power Houses one by one.

- n Ageing factor as equipment was commissioned during 1955 to 1983.
- n Reduced efficiency
- n Unplanned outages in some machines.
- n Silt erosion (only in Dehar Power house).
- n Huge shortage of peaking power and possibilities existed for Up-gradation.
- n Possibility of uprating of units keeping the same water conductor system by utilizing the technological advancements in the hydro sector in the last 40 years.
- n Modernization as per latest emerging trends.



# RM&U - Objectives of BBMB

---

- n It was found feasible to uprate the machines further within the same space and enhance the peaking capacity by technological advancements:
  - ∅ improving the turbine efficiency,
  - ∅ metallurgy,
  - ∅ better insulation materials for electrical equipment
  - ∅ Advanced numerical controls and protections.





# RM&U - Broad Strategies

---

**Three steps involved are:**

- n **Step-1:-**Initial Upgradation Plan:  
Optimization of design margins
- n **Step-2:-** Upgradation of Generators by  
utilizing Turbine margins
- n **Step-3:-** Upgradation of both Turbine,  
Generator and associated equipment



# RM&U- Mode for Accomplishment

---

## **MoU (Memorandum of Understanding) route**

With Original Manufacturers in case of Bhakra Right Bank, Pong Power House and 2 Units each of Ganguwal and Kotla Power Houses

## **Global tenders route**

Process of global tenders initiated in case of RM&U of Ganguwal & Kotla Power House under Phase-III and for Bhakra Left Bank Power House.

# Bhakra Beas Management Board



## RM&U-Status

---

BBMB has all along been promoting cost effective solutions for replacing the old equipment with the latest state-of-the-art technology so as to restore and up rate its capacity.

- n **Bhakra Right Bank Power House: Commissioned during 1966-68**  
5 x 120 MW (Russian make) uprated to 5 x 132 MW (Under Step-1 with nil cost in 1980s) and thereafter to 5 x 157 MW (Under Step-3 from OEM at approx cost of Rs 90 Crore) during 1996-2001. Presently, All Five Units Running Satisfactorily.
- n **Pong Power House: Commissioned during 1978-83**  
6 x 60 MW (BHEL make) uprated to 6 x 66 MW (Under Step-2 with MOU route through OEM) during 1998-2004. Besides output, benefits to grid when running on Synchronous mode with increase of MVar from 102 MVar (17 x 6) to 192 (32 x 6) Mvar. Presently, All Six Units Running Satisfactorily.

# Bhakra Beas Management Board



## RM&U-Status

---

### Ganguwal Power House

- n Oldest, Run of Canal Power House having three Units.
- n Installed Capacity: **1x29.25 MW (Propeller) + 2x24.2 MW (Kaplan)**
- n Unit Nos. 2 & 3 of Westinghouse make commissioned in 1955 whereas Unit No. 1 of Hitachi make commissioned in 1962.
- n Unit No. 1 was running at derated capacity of 25.89 MW and under **Step-3** through **Global Tender route** conducting RMU&LE works, Unit restored to **27.99 MW on 20.10.2006**. Unit No. 1 (Propeller) is running satisfactorily till date.

# Bhakra Beas Management Board



## RM&U-Status

---

### Ganguwal Power House (Contd.)

- n Unit No. 2 (changed to Propeller) and Unit No. 3 (Kaplan) were uprated to 27.63 MW and 26.70 MW respectively in 1998 through **Step-3** through **M/s BHEL** on **Single Tender basis**.
- n At uprated capacities, high vibrations/cavitation observed leading to cracks, pitting on runner blades, etc. Replaced with modified runners and Capacity restricted to 24.2 MW on 01.09.2004.
- n Modification effective in Unit No.3 (Kaplan). In Unit No. 2 (Propeller), blade stem damaged. Even after change of blade fixing design with Runner Hub, Unit stopped w.e.f. 16.09.2013 due to shearing of runner blades. **Presently, order got placed on BHEL through Tender for replacement of Runner and under Execution.**

# Bhakra Beas Management Board



## RM&U-Status

---

### Kotla Power House

- n Run of Canal Power House having three Units.
- n Installed Capacity: **1x29.25 MW (Propeller) + 2 x 24.2 MW (Kaplan)** .
- n Unit Nos. 2 & 3 of Westinghouse make commissioned in 1956 whereas Unit No. 1 of Hitachi make in 1961.
- n Unit No. 1 was running at derated capacity of 26.61 MW and under **Step-3** through **Global Tender route** conducting RMU&LE works, Unit restored to **28.94 MW on 13.04.2007**. Unit No. 1 (Propeller) is running satisfactorily till date.

# Bhakra Beas Management Board



## RM&U-Status

---

### Kotla Power House (Contd.)

- n Unit No. 2 (Kaplan) and Unit No. 3 (changed to Propeller) were uprated to 27.20 MW and 28.12 MW respectively during 2000-01 through **Step-3** through **M/s BHEL** on **Single Tender basis**.
- n At uprated capacities, high vibrations/cavitation observed leading to cracks, pitting on runner blades, etc. Replaced with modified runners and Capacity restricted to 24.2 MW on 01.09.2004.
- n Modification effective in Unit No.2 (Kaplan). In Unit No. 3 (Propeller), blade stem damaged. Even after change of blade fixing design with Runner Hub, Unit stopped w.e.f. 02.08.2013 due to shearing of runner blades. **Presently, order got placed on BHEL through Tender for replacement of Runner and under Execution.**

# Bhakra Beas Management Board



## RM&U-Status

---

### Dehar Power House: Commissioned during 1978-83

Installed Capacity of 6 x 165 MW (Francis Turbine). As there is a silt issue, the Capital Maintenance is carried out after every three years besides that the old excitation system and governors of all the units have been got replaced with latest technology.

### Bhakra Left Bank Power House: Commissioned during 1960-61

- **5 x 90 MW** updated to **5 x 108 MW**.
- Presently, 3 of Units updated to 126 MW
- RMU Works on remaining two Units shall commence in 2017.
- This ongoing work is elaborated in the next Slides.





# Renovation, Modernization & Upgrading (RM&U)

---

## **BHAKRA LEFT BANK POWER HOUSE**



# RM&U-Bhakra Left Bank Power House

---

## BACKGROUND

- n Situated at the foot of Bhakra Dam on the Left side of the River Sutluj.
- n Originally Commissioned in the years 1960-61
- n **Five Units, originally designed for 90 MW continuous output.**
- n Francis type Turbines (Hitachi, Japan) and Vertical type generators (AEI, UK)
- n No Silt issue.
- n Plant Availability Factor (PAF) of Bhakra Left Bank machines is around 99.99% in view of better operational and maintenance practices have been adopted by BBMB.
- n Power requirement is based on the irrigation requirement.



# RM&U-Bhakra Left Bank Power House

---

n Initially,

Unit No. 1, 2 & 3 : 66 KV System.

Unit No. 4 & 5 : 220 KV system.

In 1980s, Unit No. 3 shifted to 220 KV due to reduction in Factory Load of NFL.

Both the systems are inter connected through 150 MVA, 66/220 KV Interlinking Transformer Bank(3x50 MVA Single Phase) installed in 220 KV Switchyard.

**NOTE: After RM&U of Unit No.1, it will be shifted to 220 KV.**



# RM&U-Bhakra Left Bank

---

## FIRST UPRATING - Under Step-II

- n 5 x 90 MW uprated to 5 x 108 MW through OEM/BHEL.
- n An increase of 20% was added to the system.
- n During 1981-85
- n By replacement of Class-B insulation of stator windings with Class-F insulation winding, enabling use of higher cross section of copper in same slots & no other changes were carried out.



# RM&U-Bhakra Left Bank

---

Conducted from various agencies since 1980 onwards viz M/s Japan Consultancy Institute (with CEA) in March, 1988, Dynamic studies by BHEL on Unit Nos. 2 & 5 and shutdown studies on Unit No. 1 in 1995-96 and M/s TPE, Russia (April 1997) to know the healthiness of the units which indicated need of R & M.

**Japan External Trade & Research Organization (JETRO)** carried out the feasibility study from 3rd October, 2000 to 8th October, 2000. Their team of engineers visited the site and conducted certain tests & held discussions with BBMB engineers. The report by JETRO in 2001 contained three proposals for uprating of machines having rated speeds as 166.7 rpm, 214.3 rpm and 187.5 rpm.

**The proposal keeping the rated speed same as of existing machines i.e. 166.7 rpm with capacity as 126 MW was considered.**



# RM&U-Bhakra Left Bank

---

## STUDIES- OPERATING HEAD REGIME

Studies of data for weighted average Reservoir levels of Bhakra Dam for previous 10 years and tail race levels at Bhakra Power House for last 20 years prior to initiation of RM&U works, it has been found that the operating Head regime is as under:

<b>EFFECTIVE HEAD</b>	<b>Before Studies</b>	<b>After Studies</b>
Maximum (ft)	512	512
Rated (ft)	400	440
Minimum (ft)	268	300

In case existing Units are continued to run in the present head regime, enormous efficiency losses would have been there. Equipment to be replaced should be designed suitable to present operating Head Regime to get the uprated output and better efficiency.



# RM&U-Bhakra Left Bank

---

## TECHNO – ECONOMIC APPROVAL

- n On **23.05.01**, Power Sub Committee (Technical Members of Partner States) approved.
- § On the basis of JETRO report and as per suggestions of CEA, Detailed Project Report (DPR) prepared with Estimated cost of the R,M&U works: Rs.441 Crores without IDC component of Rs.47 crores.
- § On **21.02.2002**, Full Board accorded Administrative Approval, Approved DPR and Approval to float Global Tenders.



# RM&U-Bhakra Left Bank

---

## INITIATING R, M & U WORKS

- n On 19.09.2002, Global tenders floated.
- n On 26.6.2003, Technical part (Part-I) opened and on 23.12.2003, Commercial part (Part-II) opened and price offers opened on 12.4.2004.
- n On 11.08.2004, Letter of Intent was issued to L-1 i.e.M/s BHEL.
- n On 18.04.2005, Contract agreement signed with BHEL.
- n After signing of the contract, BHEL failed in ensuring compliance of the contractual obligations. Contract was terminated.
- n On 20.01.2006, Fresh Global re-tendering floated excluding M/s. BHEL from participation in the tendering process.
- n Extension in NIT for 7 times, Technical-cum-Commercial part (Part-I) of the only offer of M/s. Sumitomo Corporation, Japan (Consortium) comprising members as M/s Hitachi, Ltd., Japan and M/s Andritz Hydro GmbH, Austria opened on 29.9.2006. and price offer opened on 31.07.2007.





# RM&U-Bhakra Left Bank

---

## SALIENT POINTS

### n **Contracts (Global Tendering)**

1. Supply by M/s Sumitomo Corporation, Japan of Turbine equipment manufactured by M/s Hitachi, Ltd., Japan
2. Supply of Generator and allied equipment by M/s Andritz Hydro GmbH, Austria and later assigned to their Indian subsidiary.
3. On shore Services for Turbine Portion by M/s Hitachi, Ltd., Japan
4. On shore Services for Generator Portion by M/s Andritz Hydro GmbH, Austria and later assigned to their Indian subsidiary.

### n **Contracts (Separate Tendering)**

Purchase Order placed on

1. M/s CGL for supply of 4 no. Generator Transformers,
2. M/s ABB for five sets of Numerical Protection Panels.

### n **Estimated Cost: Rs 489.77 Cr (except IDC of Rs 150.31 Cr, bank/legal/finance charges)**



# RM&U-Bhakra Left Bank

---

## **SALIENT POINTS (contd.)**

- n **Effective Date of Contract: 2<sup>nd</sup> January, 2008**
- n **Contractual Completion Period: 59 months thereof (November, 2012)**
- n **Work on first Unit to commence wef 01-01-2010** with shutdown period of **Seven months (210 days)** per machine, taking one unit at a time and thereafter other units.
- n **Contractual Commissioning Schedule**

1 <sup>st</sup> Unit	July, 2010
2 <sup>nd</sup> Unit	Feb, 2011
3 <sup>rd</sup> Unit	Sep, 2011
4 <sup>th</sup> Unit	April, 2012
5 <sup>th</sup> unit	Nov, 2012



# RM&U-Bhakra Left Bank

---

- n **Expenditure till 31.08.2016: Rs 329.57 Cr**
- n **Cost per MW: Rs 77.74 lacs.** (Rs 48977 lacs/630 MW)
- n **Funding: To be arranged by Partner states** through their own resources and PFC/REC. Punjab, Harayana and Himachal Pradesh are taking loan from REC and Rajasthan from PFC.
- n **Simple payback period: 8 years**, including construction period of approximately 5 years. Spent Amount can be recovered within **3 years** of Completion of RM&U scheme.



# RM&U-Bhakra Left Bank

---

## **SCOPE OF WORK**

**Through Global Tendering (M/s Sumitomo Corporation, Japan-Consortium)**

**a) Turbine**

Replacement of Runner Assembly, Guide Vanes (with keys and Bushings), Guide Vane Operating Mechanism, Head Cover Liner and Other Liners, Governor Oil Pressure Motor Pump, Shaft Seal, Shaft Sleeve, TGB Pads with Cooling Coil, Air Compressor with motor, Vibration equipment, Aeration Pipe, Instrument Panel, Flow Meter and Water Level Measurement, etc.

**b) Generator**

Replacement of Rotor Poles, Pole Key Sets, Brake Track, Stator Frame, Bars and Stator Core, Air Water Coolers (with pipings), Thrust Bearing Pads & Coolers, Thrust Head and Runner Disc, Slip Ring with brush gear, Upper Bracket, Lower Bracket, Braking Equipment, UGB & LGB Pads & Coolers, TG Gauge Panel, Static Excitation Equipment, UCB Panels, Partial Discharge, Vibration monitoring equipment, NGTR, etc

**c) Aux.**

New SCADA system, Main and Auxiliary bus bars with CTs, PTs etc. LAVT cubicle, control cables etc.



# RM&U-Bhakra Left Bank

---

## REPLACEMENTS WITH IMPROVEMENTS TURBINE

- a) New Runners and guide vanes with improved profile and material.
- b) Ensuring interchangeability of Runners.
- c) Making provision of Runner Templates
- d) Replacement of grease lubricated bearings with self lubricated bearings
- e) Replacement of Rubber Seal with provision to replace without de-watering of the unit
- f) Use of Guide Vane Shear pin detector



# RM&U-Bhakra Left Bank

---

## REPLACEMENTS WITH IMPROVEMENTS

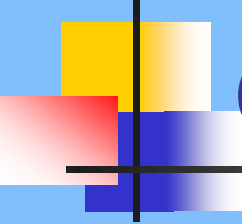
### **GENERATOR**

- a) Latest technologies adopted in Stator windings, core punchings, etc
- b) Thrust Pads of Teflon instead of Babbitt material.
- c) Conventional DC type Pilot type Excitation System replaced with Static Excitation System
- d) SCADA system adopted for control and protection.
- e) On line Partial Discharge monitoring, on line vibration monitoring, air gap measurements.



# RM&U-Bhakra Left Bank

Description	Existing Particulars			As per signed Contract (VALUES) <i>is actual tested values</i>		
	512 Max	400 Rated	268 Min.	512 Max	440 Rated	300 Min.
Net Head (feet)	512 Max	400 Rated	268 Min.	512 Max	440 Rated	300 Min.
Turbine Output (MW)	111.9	111.9	52.9	128.63	128.63	73.89
Discharge (cfs)	2840	3610	2710	3176 <b>(3167)</b>	3637 <b>(3640)</b>	3154 <b>(3153)</b>
Turbine Efficiency (%)	91.1	91.6	86.3	93.52 <b>(94.02)</b>	95.03 <b>(95.19)</b>	92.24 <b>(92.60)</b>
Run Away Speed (rpm)	338			338 <b>(311.5)</b>		
Hydraulic Thrust (ton)	370			370 <b>(266.5)</b>		
GENERATOR EFFICIENCY (%)	98.17			98.76		



# RM&U-Bhakra Left Bank- Commissioning Schedule - Actual

---

**It slipped due to various problems as mentioned in next slides.**

UNIT NO.	Contractual Commissioning	Actual Start dates	Actual Date of Completion
1 <sup>st</sup> Unit (Unit No. 2)	July, 2010	26.04.2010	18.07.2013
2 <sup>nd</sup> Unit (Unit No. 5)	Feb, 2011	11.04.2011 As mechanical spinning of 1 <sup>st</sup> Unit was nearing and due to shutdown of 2nd Unit (unit No. 5) 2nd Unit was also taken for RM&U works	02.10.2013
3 <sup>rd</sup> Unit (Unit No. 4)	Sep, 2011	22.11.2013	05.08.2015
4 <sup>th</sup> Unit (unit No. 3)	April, 2012	<b>December, 2017:</b> Unit shall be taken on shutdown after successful performance of the modified runner of Power House Unit No. 2 and lowering of Rotor of Unit No. 5 with new Generator Shaft and Spider	<b>July, 2018</b>
5 <sup>th</sup> unit (unit No. 1)	Nov, 2012	<b>August, 2018:</b> Unit shall be taken after commissioning of 4 <sup>th</sup> Unit	<b>Feb, 2019</b>





# RM&U-Bhakra Left Bank- PROBLEMS AND ACTION TAKEN

<b>ISSUES FACED ON 1<sup>st</sup> UNIT (Unit No. 2)</b>	<b>Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5</b>
Metallurgy issue (Silicon content) in Runner Crown and Runner Band (for 1 <sup>st</sup> Unit) found more than the own specified limits of the Contractor.	Matter taken up with CEA and as per advice given by National Metallurgical Institute, Jamshedpur, through NDT (100%) of Runner carried out of Runner to check presence of any kind of Blow-Holes and Contractor submitted 15 years of extended Warranty for Runner Crown and Band for this Unit.
Lower Bracket- Angle between Arms were not as per site requirements, as such there was mismatching of arms with sole plates by around 40 mm.	Contractor supplied new Lower Bracket
Upper Bracket - Quality issues - High points on mating plates, machining led to change in thickness of mating plates.	Contractor supplied new Upper Bracket

# RM&U-Bhakra Left Bank-

## PROBLEMS AND ACTION TAKEN

ISSUES FACED ON 1 <sup>st</sup> UNIT (Unit No. 2)	Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5
Mismatching in Bus Duct sections.	Contractor supplied the fouling Bus Sections with new ones.
<ul style="list-style-type: none"><li>• Mechanical Spinning carried out on 10.07.2011 and found that old washers in the Rotor body groove underneath Rotor Pole not removed.</li><li>• After removal of washers, spin again carried out on 01.08.2011 but Oil leakage observed in Lower Guide Bearing.</li><li>• After provision of seal ring of PTFE material, third spinning carried out on 05.10.2011 but at 50% speed abnormal sound observed due to fouling of bolts of Brake Dust with Spider</li></ul>	<ul style="list-style-type: none"><li>• Washers Removed.</li><li>• PTFE Seal Ring provided</li><li>• Damaged Seal and Bearings replaced.</li></ul>



# RM&U-Bhakra Left Bank- PROBLEMS AND ACTION TAKEN

ISSUES FACED ON 1 <sup>st</sup> UNIT (Unit No. 2)	Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5
<ul style="list-style-type: none"> <li>On 07.10.2011, mechanical spinning again carried out, however at 90-95% speed, brakes again applied due to high vibration and high LGB temperatures. Seal and Bearing got damaged.</li> <li>Before next mechanical spinning, metallic particles found deposited in Generator.</li> <li>After removal of Stator from pit, Stator assembly found damaged. Top Bars removed. Core induction being carried out around four times but one point persisted. Dent also found in Bottom Bar.</li> </ul>	<ul style="list-style-type: none"> <li>On detection of metallic particles, Unit again dismantled.</li> <li>Stator Assembly of Second Unit put in the first Unit.</li> <li>Cleaning/repair/rectification/replacement of most of the other Generator equipment was necessitated.</li> <li>Various equipment viz Lower guide bearings, Upper guide Bearings, Thrust Bearings, Upper Bracket, Jacks, Air Coolers, Cooling water pipes, valves, winding air shield, Thrust Head Assembly, etc returned back.</li> <li>All these components are replaced with new components with better quality and improvised design in Jacks, Thrust Head Assembly, Air Shield, Upper Bracket, etc.</li> </ul>



# RM&U-Bhakra Left Bank- PROBLEMS AND ACTION TAKEN

ISSUES FACED ON 1 <sup>st</sup> UNIT (Unit No. 2)	Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5
<ul style="list-style-type: none"><li>• While removal of Thrust Head during again dismantlement, lot of difficulty was experienced.</li><li>• Mechanical Run carried out on 10.12.2012 and Unit synchronized on 19.12.2012, however, Thrust Bearing Pad damage occurred in January, 2013.</li><li>• Mechanical Run conducted on 20.06.2013, Synchronization on 23.06.2013</li><li>• <b>Unit No. 2 actually taken over on 18.07.2013</b></li></ul>	<ul style="list-style-type: none"><li>• Modification work of Thrust Bearings, removal of HP Lubrication System and provision of Oil Baffles carried out.</li></ul>



# RM&U-Bhakra Left Bank- PROBLEMS AND ACTION TAKEN

<b>ISSUES FACED ON 1<sup>st</sup> UNIT (Unit No. 2)</b>	<b>Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5</b>
<ul style="list-style-type: none"><li>• During Cavitation Guarantee Check (operation of 7550 hours) on 5th June, 2014, cavitation at leading edge was observed. The loss of cavitation weight was within guaranteed values of 10 kg.</li><li>• The cavitated areas were weld repaired by Hitachi. Further in November, 2015 after operation of 8922.5 hours, the same cavitation pattern was observed, but within limits. The cavitated areas were weld repaired by Hitachi.</li></ul>	<ul style="list-style-type: none"><li>• Management held meetings with Consortium on 13.01.2016 and 02.03.2016 to resolve the issue and agreed that:</li><li>• M/s Hitachi would modify Unit No. 2 runner profile through solid piece welding at site. (Completed by 10<sup>th</sup> June, 2016.)</li><li>• Overall Unit performance shall be checked after operation for period of about 6,400 hours or till 31<sup>st</sup> January, 2017 whichever is later.</li><li>• After the successful performance of the post modification runner and other parts of the Unit during test period, the runner modification work and its implementation in other Units would be accepted by BBMB with the approval of Board.</li></ul>



# RM&U-Bhakra Left Bank- PROBLEMS AND ACTION TAKEN

<b>ISSUES FACED ON 1<sup>st</sup> UNIT (Unit No. 2)</b>	<b>Action taken on Unit No. 2 and corresponding corrective actions taken on Unit No. 5</b>
<p>Weld defects observed in retained rotor rim (Unit No. 4). Scratches observed on Generator shaft of Unit No. 4.</p>	<p>Weld work carried out on existing Rotor Spider. Polishing of minor scratches on shaft in Vertical position at site itself got carried out</p>
<p>After repeat NDT of Generator Shaft of Unit No. 5 after commissioning of the Unit in April, 2016 by CPRI, Bangalore, observed progression of Cracks near to surface and recommended to replace the shaft.</p>	<p>Unit No. 5 stopped. Order already placed in 2014 for Spare Shaft. Alongwith new Generator Shaft, order for new Spider Assembly placed on Contractor. New Components expected to reach site by August, 2017. After rotor assembly works at Site, lowering of Rotor in December, 2017, next Unit shall be taken on shutdown. However, Stator Assembly work shall commence on receipt of shaft at Site.</p>



# RM&U-Bhakra Left Bank

---

## MAJOR CORRECTIVE ACTIONS BEING TAKEN

1. **Design and Quality aspects of all the components reviewed by Parent Company.**
2. **New Supply of all the components afresh having better quality.**
3. **All site & manufacturing activities and Witness Inspections being conducted strictly under supervision of experts from their Parent Company**



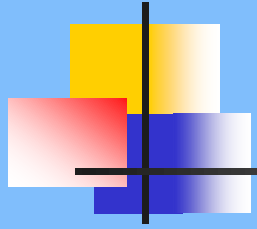
# Thanks

---

*Presented by*  
*BBMB*

**Abha Saini, Chief Engineer/System Operation**  
**M.K. Puri, Dy.Chief Engineer/P&D(PPs)**  
**H.S. Manocha, Deputy Director/Bhakra-II Cell**  
(For any queries email at [ceso@bbmb.nic.in](mailto:ceso@bbmb.nic.in), [dirpd@bbmb.nic.in](mailto:dirpd@bbmb.nic.in),  
[ddppbh2@bbmb.nic.in](mailto:ddppbh2@bbmb.nic.in))





**Jai Hind**