BHEL Overcame Unprecedented Challenges in Hydropower Project in Azerbaijan

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ABSTRACT
Mingechaur Hydro Project was the first export order in CIS (Commonwealth of Independent States) Countries won by BHEL in October 1999 against stiff global competition. The paper narrates the various challenges faced and resolved due to hostile customer, communication due to language, multiple transshipments during transportation, very tight project execution schedule. It is an interesting story of transformation of a hostile customer into a very supportive as a result of BHEL's positive attitude and professional skills in executing such a challenging export contract.

Keywords: Mingechaur Dam, Challenges in hydro power project, retrofitting in hydro power house.

I INTRODUCTION

The Mingechaurhydropower plant in Azerbaijan (Formerly a part of USSR), was originally commissioned in 1953, and a modernization project was completed in 2018. The project located about 300 km from the capital Baku is near Mingechaur city is the largest hydroelectric generation facility in the country. There is 260 feet high, 5,090-ft-long earth-fill embankment dam impounding Kura River creating reservoir. The active storage capacity of the Mingechaur dam is 7.3 million acre-feet.

Mingechaur Hydro Projectwas the first export order in CIS Countries won by BHEL in October 1999 against stiff global competition with international companies like ABB, Electrosila etc. The customer is a government company named Azerenergy. From tender stage itself, customer was pro M/s Electrosila, Russia and BHEL had won this contract which made customer very hostile and non-cooperative. Project is located near Mingechaur city which is about 300 km from Baku, the capital of Azerbaijan.

Mingechaur Hydro Electric plant was originally commissioned with six units of 60 MW each. After collapse of Soviet Union, Azerbaijan came on the world map as a sovereign country. The newly formed nation was not financially stable and they were upgrading the generating units of Mingechaur Hydro Power Project one by one through loans from European Bank and World Bank. In the first stage, customer had replaced hydro turbines of all the six units by M/s LMZ, Russia make. Subsequently, hydro generator & Auxiliaries of five units were replaced by M/s Electrosila, Russia make. For remaining one unit (Unit no. 4), the customer invited global tender as per the pre-condition of lending agency EBRD (European bank).Although, customer was keen to place the order on M/s Electrosila, the contract was won by BHEL and the customer was compelled to place order on BHEL.

The author was deputed as the Project Manager on behalf of BHEL for Mingechaur Hydro Project. The author shares his experiences on major challenges faced and how they were overcome during execution of the contract.

The Figure 1 shows an overview of the project in which penstocks, surge shafts, power house, tail race can be seen.

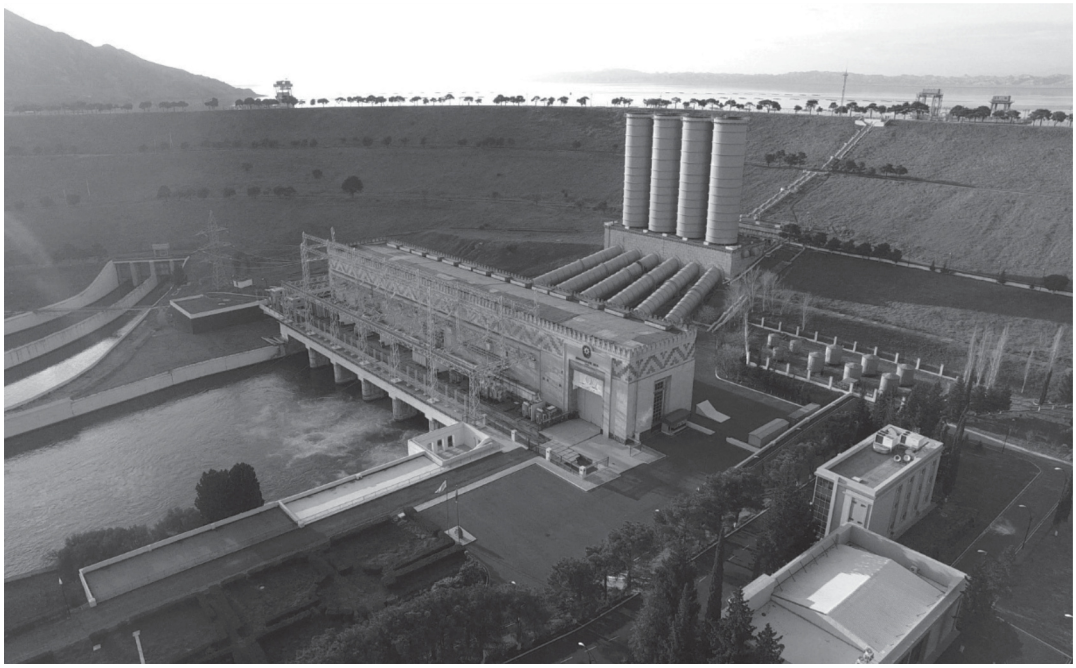

Fig. 1:Mingechaurhydropower project [1]

II BHEL's SCOPE OF WORK

The generating units of the hydropower projects depend basically on the hydraulic parameters, mainly head and discharge of the site. It makes each site unique resulting in tailor made design of turbines, and generators etc. and the station layout. In fact, the transport limitations (weight and dimensions) vary from site to site and compel to design the large assemblies in number of segments or even manufacturing and /or assembly at site. The design of hydro generators basically depends on the turbine data and the requirement of governing system to contain speed rise and pressure rise. The brief specifications of the generator supplied by BHEL to match with the M/s LMZ make vertical axis Francis turbine with a rated speed of 150rpm are as given below:

Generatorrated output	70 MW (78.2 MVA), 13.8 kV, 50 Hz, 0.9-lag
No. of stator segments	4
Bearing arrangement	Suspended (thrust bearing above rotor)
Thrust bearing	Spring mattress type with babbit lining
Excitation system	Static
Weights	
Stator assembly	180 T
Rotor assembly	200 T (Lifting by 2 cranes in tandem)
Total Generator weight	600 T

Figure 2 shows the general arrangement of generator and the scope of BHEL's work could be visualized.

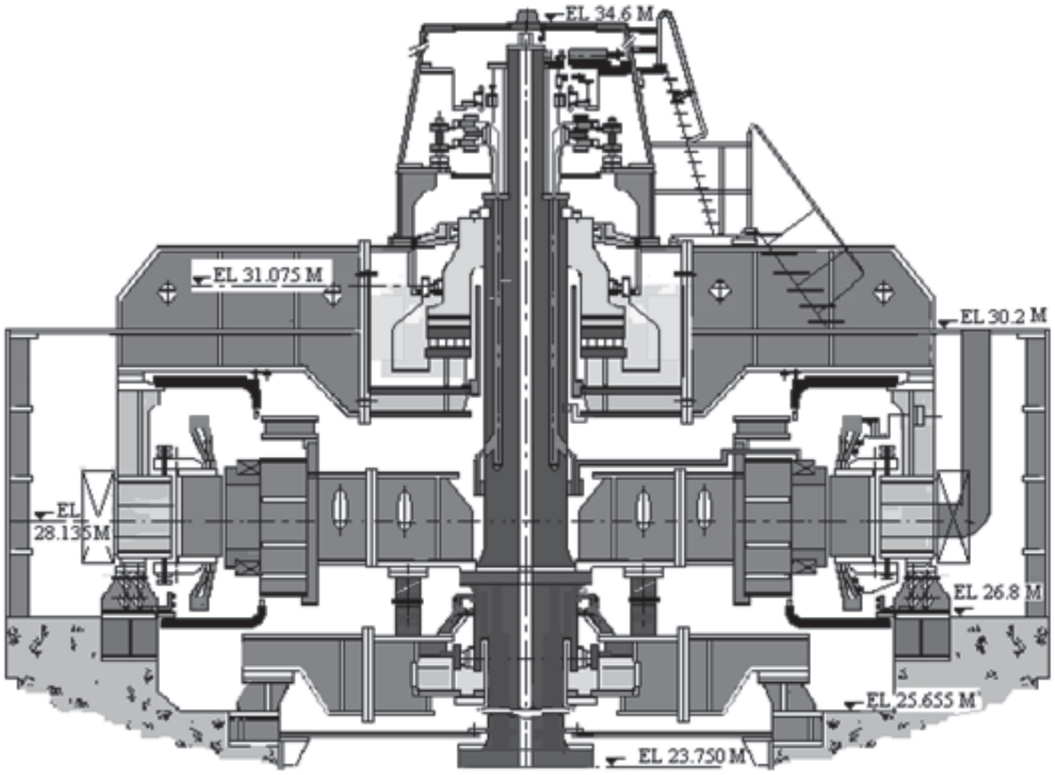

Fig. 2: Sectional arrangement of hydro generator

BHEL's scope of work involved the dismantling of existing hydro generator and associated auxiliaries viz. control panels, bus ducts, fire fighting system, generator circuit breaker, earthing switches, cabling etc.

Retrofitting the new 70 MW hydro generator and auxiliary equipment in existing foundation and space as below:

(a) Hydro Generator
(b) Static Excitation System
(c) Synchronizing equipment
(d) 13.8 kV equipment: NG Equipment, Lighting Arrester, Surge Capacitor, Earthing Switches, CTs, PTs etc.
(e) Generator Protection Panel
(f) Unit Control Board
(g) Bus Ducts
(h) SF6 generator circuit breaker (M/s ABB, Switzerland make)

Time frame for design of new uprated equipment, manufacturing, transportation, dismantling of existing equipment, erection of new equipment, commissioning and completion of trial run within 18 months fromthe date of award of contract.

Specially, for hydro generator, it became anuphill task while working in a foreign land with language problem, extreme cold climatic conditions and so on.

Figure 3 showsone old unit with rotating excitation system whereas the others are the replaced new ones with static excitation system.

Fig. 3 View of power house with one old and other new generating units

III CHALLENGES

(a) Hostile customer - Azerbaijan, being a part of former USSR, customer was well conversant with Russian technology and moreover first five generating units were replaced by M/s Electrosila, Russia, hence advantage of similar machine and spare parts was affected.

(b) Non availability of basic inputs - The new equipment was to be retrofitted in the existing foundation, pit and space for which drawings were not available (or not provided) to BHEL. It multiplied the design challenge for BHEL. The only way-out was the reverse engineering. Hence, various measurements were taken and some innovative concepts were applied to facilitate proper assembly of new equipment to match with the existing foundation and turbine.

(c) Language constraints - Not even a single person from customer side was able to communicate in English. All verbal discussions and communicationwere through interpreter and it was difficult to get an expert interpreter for specialised technical communication. All the correspondence, drawings, documents and manuals were to be submitted to the customer, both in English and Russian languages.

(d) Very tight time-frame- The schedule for completion of contract including design, manufacture, transportation, dismantling of old equipment,erection,commissioning and handing over after trial runs of new equipment ***within 18 months***imposed a major challenge.

(e) Multiple transhipments - The transportation of Equipment from Bhopal to Azerbaijan site is shown in Figure 4.

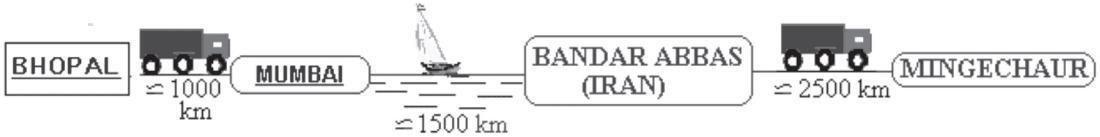

Fig. 4: Transportation route showing transhipments locations

Each stage involved loading and unloading of heavy equipment. The multiple transhipment involved risk of damage of critical items, more time consuming at a higher cost and very complex coordination with several agencies in different countries.

(f) Custom Clearance - The custom clearance of equipment was included in BHEL scopeon a specific request by customer. For this, Baku based custom clearance agency was engaged. Custom clearance activity was to be done at Iran, Azerbaijan and finally at custom clearance office near the site. The custom clearance was to be completed within 24 hours for each trailer. It necessitated very close and dynamic coordination and rapport with transporter and custom clearance agencies.

IV PROBLEMS AND RESOLUTION

(a) **Damages during transportation -** The wound Stator assembly was in four segments. Each segment weighing 50 tonnes was transported on a separate trailer. Incidentally, 3 segments toppled from trailer while negotiating sharp turning during road transportation. A wound stator segment consists of steel Stator Frame, laminated steel core, and winding. Two stator segments toppled in India were brought back to the BHEL, Bhopal for necessary repair and replacement, as required. The stator segment under repair at site is shown in Figure 5.

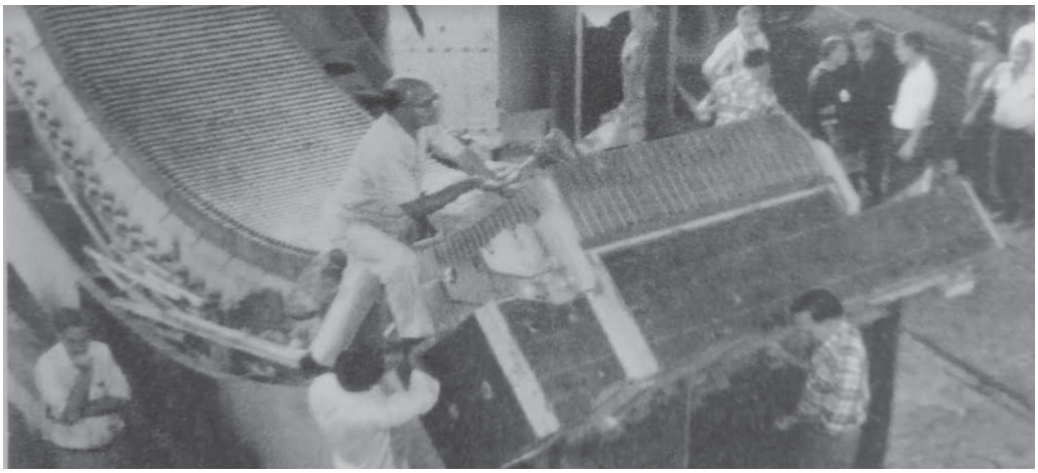

Fig. 5 Repair of stator winding segment at site

One segment that toppled down in Iran and was brought to site by transporter was a major challenge. The customer was very annoyed and asked BHEL to take back the segment to BHEL works, Bhopal. Transportation time of one segment, to and fro was four months at a costof US$ 1,00,000. It was a herculean task but BHEL finally succeeded in convincing the customer for agreeing for repair at site itself. Finally, after arranging additional materials and skilled manpower, the segment was successfully repaired and tested at site which resulted in saving of crucial time and money.

(b) **Coupling of Turbine and Generator Shaft -** Turbine was supplied by M/s LMZ, Russia.The turbine shaft and generator shaft were to be coupled through number of coupling bolts withinvery tight tolerance. It imposed severe challenge in absence of a common drill jig to achieve required accuracy. To overcome this problem, an innovative technology had to be evolved in collaboration with M/s LMZ. The coupling bolts were manufactured to the size of existing turbine shaft and generator shaft coupling holes of bigger size were made. The circular gap was filledwith special epoxy material. This process was fast and well suited at site.

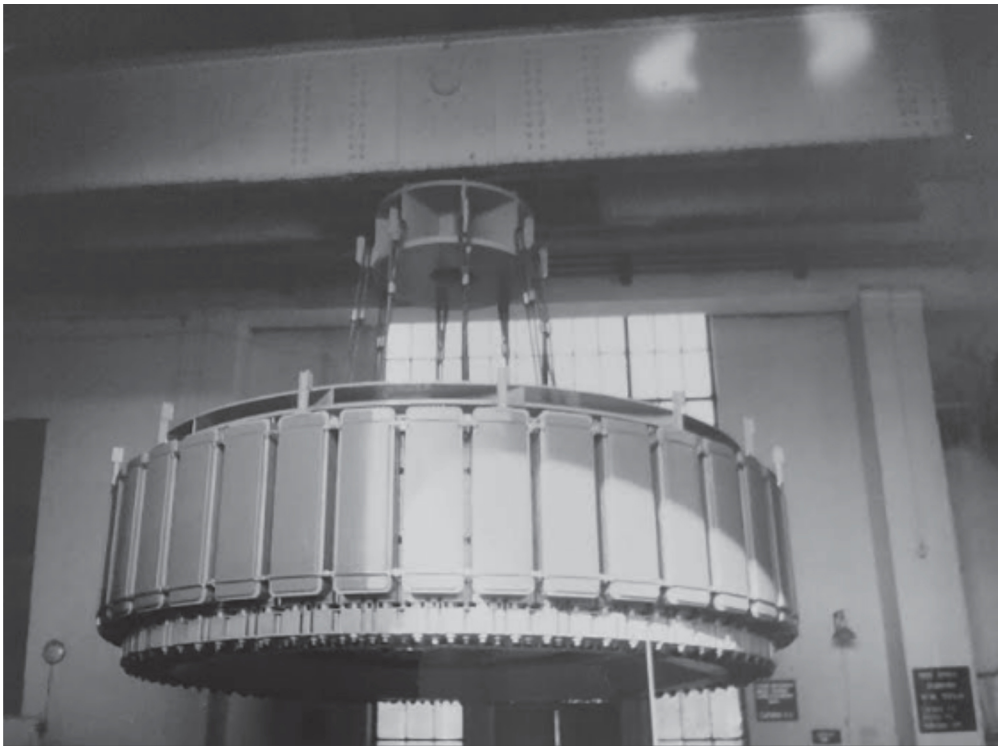

Fig. 6 lowering of the rotor assembly

(c) **Jamming of the Dam Gate -** After completion of installation of generator and other auxiliaries, it was ready for spinning. However, due to the prolonged shutdown, the Dam Gate (same as penstock gate) were closed for a long period resulting in jamming of the gates. Since the gates could not be opened, special divers were arranged by the customer for opening of these gates. This delayed the spinning by a week.

(d) **Dry out of stator winding -** The dry out took 14 days since stator windings were drenched in water during sea transportation from Mumbai to Iran. It was necessary to achieve the required insulation resistance and polarization index by dry out before conducting the destructive high voltage test. It was not possible to dry the stator winding by external heating. Hence, heating of winding insulation was done bybuilding-up the voltage and flowing the current in the short circuited stator winding. The temperature of the stator winding was maintained at 90-100^{o} C. It took 14 days running of unit to dry out completely and finally HV test was successfully conducted.

(e) **Damage of Thrust Bearing Pads -** The thrust bearings are designed to withstand the load of rotating parts of turbine and generating besides the hydraulic thrust which are transferred to the generator foundation. The total load on thrust bearing was 800 tonnes. It is a pre-requisite to have levelling, surface matching, aligning within tight permissible limits besides freedom of bearing oil from foreign materials. After completion of the pre-commissioning activities, unit was loaded in steps of 10 MW. As load increased, vertical load on thrust bearing also increased and thrust pads got damaged. All Thrust pads were dismantled and replaced by the spare set of 12 nos. thrust padsafter bedding and blue matching of the bearing surfaces. This activity took 7 days. Subsequently, unit was commissioned followed by 72 hours successful trial run.

V WINNING CUSTOMER CONFIDENCE

(a) The customer was very hostile and non-cooperative since the very beginning. However, BHEL maintained positive attitude with due regard to customer, sincerity and hard work. Slowly customer realized BHEL's strength and appreciated the dedicated efforts.

(b) During the course of execution, customer's confidence was fully built-up in BHEL.

(c) Local media gave good coverage in news papers and television. There was paradigm shift in Customer's behaviour. They became so supportive that ABB make SF6 Circuit Breakers could be commissioned without the supplier. Similar was the case with Fire fighting Equipment which resulted in substantial reduction in time and cost. The customer also helped in procurement of bearing oil (14,000 litres) directly from factory at 1/4th of the market price.

(d) After completion of work, a fresh order worth Rs. 4.0 Crores was placed on BHEL for supply and installation of bus-ducts,

earthing switches, cabling etc. for other units.

Figure 7 shows the inauguration of the unit jointly by the Ambassador of India and Mayor of Mingechaur.

Fig. 7: Inauguration of the generating unit

V CONCLUSION

It was a happy and confidence boosting contract for BHEL. In-spite of various challenges and problems faced, the generating unit was commissioned in April 2001 in a ***record time of 18 months*** from the date of award of contract with full satisfaction of customer. Innovative ideas and applying out of box solutions to overcome all the design and installation problems, was the key to the success. The customer was delighted and placed a new order for the supply of additional equipment worth Rs. 4 Crore. It was a landmark achievement to close the contract within a month of commissioning which otherwise in some cases lingers on for years.

REFERENCE

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