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Siah Bishe Pumped Storage Project - Iran

In early 2003 Colenco Power Engineering Ltd. was approached by the Iran Water & Power Resources Development Company (I.W.P.C.) for consultancy services for the construction of the Siah Bishe Pumped Storage Project in Iran. A few months later, Colenco, together with two Iranian partner companies, were assigned by I.W.P.C. to provide the complete Owner's engineering services for the design and construction of the project. The services include amongst others, assistance during tendering and contract negotiations with the contractors, review and approval of the detailed construction design, management control and construction supervision.

Concept of a Pumped Storage Plant

Thermal power plants supply the grid favorably at continuous level of power. The consumption of energy however changes during the day, month and also season of the year. The concept of pumped storage plants is to equalize loads in the grid by counter-balancing these fluctuations in power demand and supply. Pumped storage plants exhibit the same characteristic features as conventional hydroelectric power plants, uniting two different modes of operation. Water is pumped from a lower reservoir to a higher reservoir when low cost power from the grid is available. This water is then used to generate power during periods of high power demand at high energy price levels. In this way they convert the relatively low cost, off-peak energy generated in thermal plants into high value peak power. The Siah Bishe Pumped Storage Plant is the first of its kind in Iran, where based on the natural gas and oil resources, thermal power plants generate most of the country's electricity.

History of the Project

The history of the Siah Bishe Pumped Storage Project dates back to the year 1970, when the first studies of the hydroelectrical resources in the Alborz Mountains were made. The general layout was defined in the feasibility design concept of 1977. During the following years site investigations, reviews and studies have been carried out. The initial concept of the project was in principle confirmed and maintained. Some modifications on the structures, dam types, tunnel alignments and the cavern locations were made based on the better geological and geotechnical knowledge, detailed design studies and operational requirements.

Construction works started in 1985 with the excavation of the diversion tunnels, headrace tunnels and the access tunnels to the powerhouse cavern. For economic reasons the works were stopped in 1992.

The project was revived in 1999 and a review of the tender design and documents were made until 2002. A pre-qualification and the call for tenders followed in 2003. The tender for the detailed design, supply and construction was divided into two lots:

Lot A: Upper and lower dam and headrace tunnels.

Lot B: Underground civil works for shafts, caverns and tailrace tunnels, electromechanical equipment.

The contracts for both lots were awarded to two Iranian construction and engineering groups with the participation of international companies. Construction works were resumed in summer 2003.

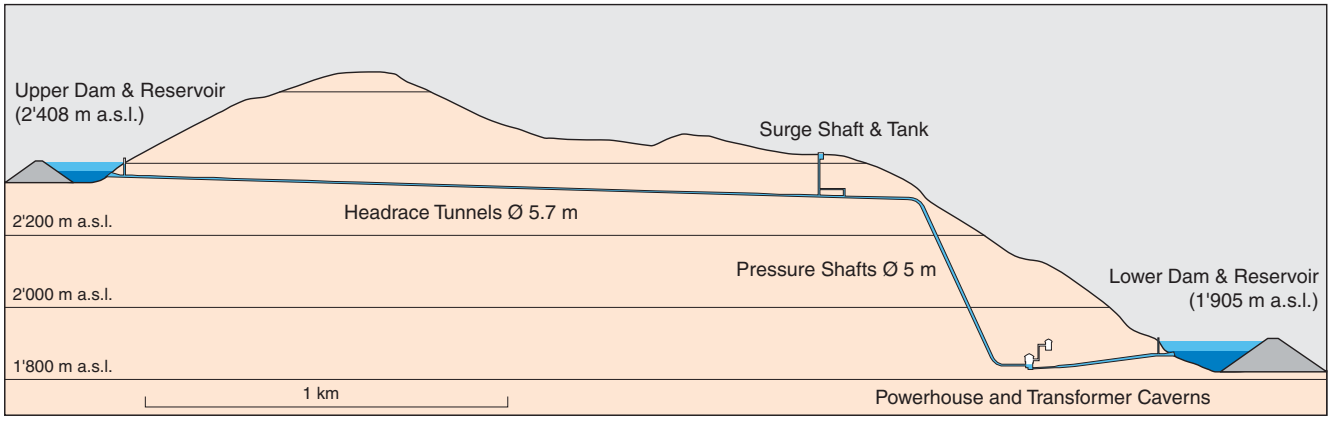
Geology and Morphology

The Siah Bishe Pumped Storage project is located in the Alborz mountain range, 125 km north of Tehran. The site can be reached on the main Chalus road, connecting Tehran with the Caspian Sea.

The project area lies in the southern part of the Paleozoic-Mesozoic Central Range of the alpine Alborz mountain chain. The rock sequences in the project area consist of massive limestones, detrital series (sandstones, shales) and volcanic rocks of Permian formations, Triassic dolomites and Jurassic (Lias) formations with black shales and sandstones. Several tectonic faults are crossing the project alignment.

The Kandavan fault, a 15 km long and seismically active fault lies approx. 3 km south of the project area and builds the tectonic boundary between the Paleozoic-Mesozoic Central Range in the North and the Central Tertiary Zone in the South.

The catchments areas of both reservoirs are of mountainous character with practically no vegetation. Based on the different strength of the geological formations, the slopes in the area of the upper dam and the headrace tunnel are generally smooth, while the lower project area lies within steep rock ridges built up by limestone and volcanic rocks.



Layout of the Siah Bishe Pumped Storage Project

Project Requirements

The Siah Bishe Pumped Storage Plant is designed to produce a rated capacity of 4 x 260 = 1040 MW peak energy. Two dams will be constructed in the Chalus valley for the water storage. Both dams are designed as concrete faced rockfill dams. With an upstream surface sealing, the rockfill is kept dry, eliminating unfavorable water pressure in the dam body and in the abutments and avoiding stability problems during an earthquake. Continuous grout curtains are required along the upstream plinth and from galleries in the abutments to eliminate water seepages.

Two separate water conveyance systems will connect the upper and lower reservoir. They comprise an upper intake structure, the headrace tunnels, surge tanks, pressure shafts, upper and lower manifolds, tailrace tunnels and outlet structures. A powerhouse and a transformer cavern will be excavated in the mountain to accommodate all machinery and equipment for power generation and pumping.
The mechanical equipment consists of 4 reversible Francis type vertical pump-turbines each coupled to a generator motor.

General view of the Alborz mountain range and the Chalus valley with the project area in the center of the picture. The Caspian Sea lies to the North (right) Tehran to the South (left).

Project Data

Owner:	Iran Water & Power Resources Development Co. Tehran
Upper Dam & Reservoir:	Concrete Faced Rockfill Dam, Height 85 m,
	Crest Elevation 2410.14 m a.s.l.
	Dam Volume 1.4 million m³
	Reservoir live volume: 3.5 mio m³
Headrace Tunnels:	Two Tunnels: L = 2015 m and 1973 m, Ø = 5.70 m, concrete lined
Surge Tanks:	one for each tunnel, surge range = 87 m
	Tanks: 2 x 23 m deep, 20 m wide, circular concrete tank
	Shafts: 2 x 65 m deep, Ø 6.5 m vertical shafts, concrete lined
Pressure Shafts:	Two Shaft: L = 2 x 760 m, Ø = 5 m, steel lined
	Shaft inclination 67°
Design Flow:	2 x 130 m³/s in turbine operation
	2 x 100 m³/s in pump operation
Gross Head:	Max. 520.8 m, Min. 470.8 m
Powerhouse Cavern:	L = 130.0 m, W = 22.0 m, H = 42.9 m
	4 vertical Francis Turbines
	Turbine rated output: 4 x 260 MW = 1040 MW
Transformer Cavern:	L = 198 m, W = 14 m
	4 connecting bus-bar galleries and vertical shafts
Tailrace Tunnels:	2 tunnels Ø 6.0 m, concrete lined
Lower Dam & Reservoir:	Concrete Faced Rockfill Dam, Height 106.5 m
	Crest Elevation 1911.50 m a.s.l.
	Dam Volume 4.93 million m³
	Reservoir live volume: 3.6 mio m³
Construction Period:	2003 - 2009
Estimated Costs:	380 Million USD

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