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HOOVER DAM

By Keith Burston

A recent trip to Nevada USA provided Keith and Andrea with an opportunity to visit Boulder Dam now known as the Hoover Dam. He says you can get more information for a visitor tour from the following website and it well worth the visit :- www.usbr.gov/1c/hooverdam/service

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Hoover Dam was originally called Boulder Dam. The Colorado River has been carving its 1400 mile course from the Rockies to the Gulf of California for millions of years often flooding the low lying lands in the spring and drying up in the summer. It needed management by the seven US states and 2000 square miles of Mexico which it served. The river became the obsession of the US Bureau of Reclamation, the agency charged with finding ways to irrigate the arid West. In 1920, the Bureau embarked on an ambitious plan to dam the Colorado and distribute its water hundreds of miles in every direction. It was called the Boulder Canyon Project. Survey crews were sent down the treacherous river to look for the best place to build what would be the largest dam in America and a new wonder of the World.

After four years of surveys and tests, Bureau engineers chose Black Canyon, on the Arizona-Nevada border, as the site for Boulder Dam. In 1922 Herbert Hoover, the Secretary of Commerce and a former engineer negotiated an agreement among the seven western states that shared rights to the water to be captured by the proposed Dam. However most Americans blamed Hoover for doing nothing about the Depression, and he badly needed some good press. The dam was to bear his name but was to be the subject of dispute for the next seventeen years. In 1932 Hoover lost the White House to Franklin Roosevelt and the dam's name, reverted to being the Boulder dam – a decision certainly politically motivated by an administration with no respect for its predecessor. On April 30, 1947, President Harry S. Truman signed a resolution and passed by congress restoring the name Hoover Dam to the structure.

Tenders to a Government specification covering 100 pages of text and 76 drawings were invited but the process demanded a $2million bid bond to accompany each bid; the winner would also have to post a $5 million performance bond. A joint venture company known as Six Companies won the contract in 1931 with the lowest tender. Specification and over-run penalties were so tight only three companies' bid.

Fig.1 Aerial View

As construction activity started unemployed workers streamed to the site, numbers rising to 5,251 on the payroll at its peak and the cluster of makeshift homes that emerged near the site was known to its inhabitants as Ragtown, a living hell in the temperatures and squalor. The decision to provide suitable living arrangements for the dam workers was not only an attempt to protect health and welfare, but also to shield this very public project from the dangers that lay in an unstable workforce, the result was the formation of the new town of Boulder City. This was run really very much like a police state with great restrictions to what could and what couldn't go on, and a law enforcement that saw to it that these things were carried out. Extreme penalties of loss of employment and eviction from the community were vigorously enforced. During the contract some 21,000 workers were involved in the construction.

Hoover Dam is fed from Lake Mead the largest reservoir in the United States by volume. The dam is located near Boulder City Nevada about 30 miles southeast of Las Vegas. At the bottom of Lake Mead lies the remains of Ragtown. The management of Six Companies went on to become some of the richest contractors in the World. The Hoover Dam alone netting an $8 million profit.

Construction of the Arch Gravity dam (in which the water load is carried by both gravity action and horizontal arch action) commenced in 1931 and was completed in 1936 with the building of the two power-plant wings, two years ahead of schedule and well under budget. Its original cost was $165 million and power revenues repaid the construction costs by May 1987. Additional expenditure allocated to flood control will be repaid by 2037. The costs in human terms of the construction was a tragic 112 deaths, the first being a surveyor J.G. Tierney, who drowned in 1922 the last, co-incidentally, being his son Patrick 13 years to the day later.

Before construction the Colorado River had to be diverted around the dam site through four 50-foot-diameter tunnels, two drilled through the canyon walls on each side of the river. The tunnels, with a total combined length of about three miles, were excavated to 56 feet and lined with three feet of concrete. They could carry more than 1.5 million gallons of water per second**.** After being used for river diversion, the inner tunnels were plugged with concrete approximately one-third their length below the canyon wall inlets, and the outer tunnels were plugged approximately halfway. The two inner tunnels now contain 30-foot-diameter steel pipes (penstocks) which connect the intake towers in the reservoir with the power-plant and canyon wall outlet works. The downstream halves of the two outer tunnels are used for spillway outlets.

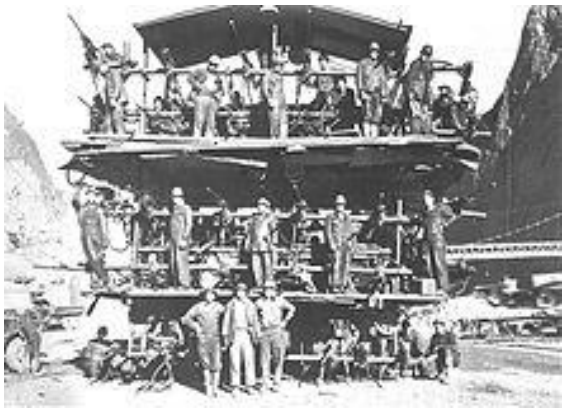

Fig.2 Construction Workers with Jumbo Rig

The dam is protected against over-topping by the two spillways. The flow over each would be about the same as the flow over Niagara Falls, and the drop from the top of the raised spillway gates to the river level would be approximately three times as great.

In addition to new roads, coffer dams and other pre-construction civil works, erection of a 222-mile-long power transmission line from San Bernardino, California, to the dam site was undertaken, to supply energy for construction. This transmission was a single circuit 88kV 60Hz but insulated to 132kV which was to be the operating voltage when the dam was finished to supply power to Los Angeles California (LA). In total there are now 2700 miles of transmission lines sending electricity from Hoover Dam to LA.

An electrically operated cableway of 150 tons rated capacity, with a 1,200-foot span across the canyon, lowered all heavy and bulky equipment. The cableway is still in existence and used when necessary.


Fig.3 Dam Wall

Water intake towers consist of four reinforced-concrete structures (82 foot diameter and 395ft high) located above the dam, two on each side of the canyon, each control one-quarter of the supply of water for the power-plant turbines**.** These towers are connected to the power-plant by 30-foot-diameter penstocks (pipes) installed in 37- and 50-foot diameter concrete-lined tunnels. The intake towers control water flow through two cylindrical gates, each 32 feet in diameter and 11 feet high. One gate is near the bottom and the other near the middle of each tower. The penstocks are connected to the turbines by sixteen 13-foot-diameter plate steel penstocks installed in 18-foot-diameter concrete-lined tunnels.

There are 17 main turbines in the Power-plant -- nine on the Arizona wing and eight on the Nevada wing In the latter half of 1936, water levels in Lake Mead were high enough to permit power generation, and the first three Allis Chalmers built Francis turbine-generators all on the Nevada side, began operating. In March 1937, one more Nevada generator went online and the first Arizona generator by August. By September 1939, four more generators were operating, and the dam's power plant became the largest hydroelectricity facility in the world. The final generator was not placed in service until 1961, bringing the maximum generating capacity to 1345 megawatts at the time. Original plans called for 16 large generators, eight on each side of the river, but two smaller generators were installed instead of one large one on the Arizona side for a total of 17. Only two other Companies have supplied Turbine-generators to the Dam over the years – Westinghouse and Chalmway Electric. The present contracts for the sale of electricity expire in 2017.

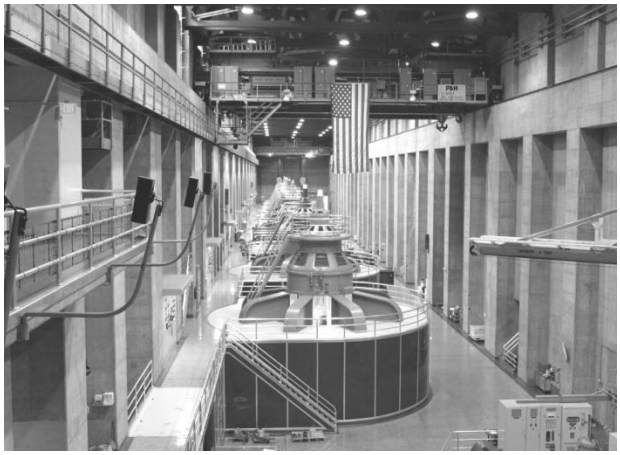
Fig.4 Main Turbine Hall

In 1939, when the final one of Hoover's original nine generators was installed and placed in operation, the capacity of Hoover's power-plant was 704,800 kilowatts, making it the largest hydroelectric power-plant in the world – a distinction held until surpassed by Grand Coulee Dam in 1949.

The original turbines were replaced through an uprating program between 1986 and 1993. The plant now has a nameplate capacity of about 2,080 megawatts. This includes the two Pelton turbine generators station-service units (small generating units that provide power for plant operations), which are rated at 2.4 megawatts each. The Hoover Dam generates more than 4 billion kWh a year enough to serve 1.3 million people.

Principal customers for the electrical energy are: -

1.Metropolitan Water District of Southern California 28.53%
2.State of Nevada 23.37%
3.State of Arizona 18.95%
4.Los Angeles California15.42%

The remainder are allocated to other cities and entities.

Fig.5 Six Turbines up close

Architect Gordon Kaufmann, gave the dam its futuristic style. He transformed ordinary concrete surfaces into modern art deco designs. The electrical transformers took on the look of a 1930s Buck Rogers space movie. The intake towers rose out of the lake like rockets to the moon. And the streamlined spillways gave the huge mass a constant sense of motion.

The Colorado River serves as one of the most vital water sources in the United States, providing water to nearly 40 million people in the West. While the Hoover Dam supplies water for 22 million people and electricity for 7 million users; Drought conditions have gripped the Western States of America since 2000, by 2017, officials have said there is a greater-than-50-percent probability of a shortage, according to the computer models if water levels fall low enough in the reservoir due to sustained drought or other reasons, electricity cannot be made by the dams turbines - the lost electricity will either need to be obtained elsewhere or the users who typically get that electricity would need to move toward rolling blackouts for conservation reasons. Even now, Lake Mead, is at historic water-level lows. And, it takes 2-years annual flow of the Colorado River to fill Lake Mead without withdrawals of any kind. Since a large portion of Los Angeles' electricity comes from the Colorado River, we could be on the verge of historic dire events.

In the past 14 years, there have been only three years where the river flows have either been normal or slightly above normal. The last above-average year was 2011, when inflows in Lake Powell were 130 percent of average. The US and Mexico signed a treaty in 1944 governing the allocation of resources from the Colorado River, but in the ensuing decades, population growth, increased industry and farming, as well as droughts have put pressure on the river. The latest accord, which runs until 2017, is a major amendment of the original treaty and stipulated that the US must send a set amount to Mexico, enough to supply some three million homes, no matter how low the river level. This environmental problem is now beginning to impact on political relationships unlikely to be resolved by current conservation measures.

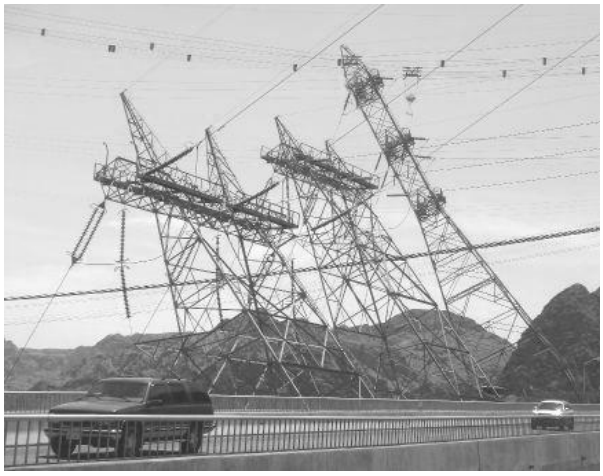

Fig.6 Massive Pylons taking Power away

There are three other major storage dams on the main stem of the Colorado River. The dam 370 miles upriver from Lake Mead and north of the Grand Canyon is Glen Canyon Dam/Lake Powell. 67 miles south of Hoover Dam is Davis Dam/Lake Mohave. And 155 miles south of Hoover is Parker Dam/Lake Havasu. There are over 53 dams on the Colorado River and its tributaries. All these dams use much of the same water and work together to control floods, irrigate crops, supply drinking water, make places for recreation, create habitat for wildlife, and of course — generate electricity.

There are many myths associated with the dam perhaps the two most quoted are:

Workers Buried in Hoover Dam: Not true. This long-standing urban myth relates the story that on a number of occasions workers slipped, fell, or were covered by concrete as it was being poured. Actually, the dam was poured in relatively small sections, so all a fallen worker had to do was to stand up. The 112 construction deaths do not include 42 more that were attributed to pneumonia - workers alleged that this diagnosis was a cover up for a death from carbon monoxide poisoning, brought on by the use of gasoline-fuelled vehicles in the diversion tunnels., These vehicles were banned by Nevada Law, but the contractors claiming the job was under federal jurisdiction, so used the vehicles anyway and the construction company avoided paying compensation claims.

Concrete poured during construction is still drying out today: Not true.
Bureau of Reclamation engineers calculated that if the dam was built in a single continuous pour, the concrete would take 125 years to cool and the resulting stresses would cause the dam to crack and crumble. Instead, the ground where the dam was to rise was marked with rectangles, and concrete blocks in columns were poured. Each five-foot form contained a series of 1 inch (25 mm) steel pipes through which first cool river water, then ice-cold water from a refrigeration plant was run. Once an individual block had cured and had stopped contracting, the pipes were filled with grout used to fill the hairline spaces between columns, which were grooved to increase the strength of the joints.

While the project was an undoubtable success what is relatively unknown, having been kept from the media, was that as the lake began to fill large numbers of significant leaks into the dam caused the Bureau of Reclamation to investigate. It found that the work had been incompletely done, based on less than a full understanding of the canyon's geology. Concrete grouting at joint intersections failed due to lack of diligence. It took nine years (1938–47) under relative secrecy to complete the supplemental grout curtain!

Construction continued on and around the dam, with the building of a new visitor center and a 2,000-foot-long Hoover Dam bypass (the Mike O'Callaghan-Pat Tillman Memorial Bridge). Construction started in 2005 and the World's highest concrete twin ribbed arch bridge was completed in October 2010 within an overall budget of $240 million. ($114 million being spent on the bridge itself). Before the bridge, travellers between Arizona and Nevada on U.S. Route 93 crossed the Colorado River on the dam itself, via a crowded, white-knuckle two-lane road riddled with hairpin turns, high winds and zero visibility. With added post- 9/11 Homeland Security concerns, officials from both states finally found the resources to bypass the dam with a straighter, safer highway with a new Colorado River bridge crossing as its central engineering challenge.


Fig.7 Hoover Dam New Bypass Road