

# HOOVER DAM

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## Hoover Dam Statistics and Science

What type of dam is Hoover?

A **concrete arch-gravity** type, in which the **water load is carried by both gravity action and horizontal arch action.**

How tall is Hoover Dam?

It is **726.4 feet from foundation rock to the roadway on the crest of the dam.** The towers and ornaments on the parapet rise 40 feet above the crest.

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How much does Hoover Dam weigh?

**More than 6,600,000 tons.**

What is the maximum water pressure at the base of the dam?

**45,000 pounds per square foot.**

How much hydroelectric power does the Hoover Dam generate?

Hoover Dam generates, on average, about **4 billion kilowatt-hours of hydroelectric power each year** for use in Nevada, Arizona, and California - enough to serve 1.3 million people. From 1939 to 1949, Hoover Powerplant was the world's largest hydroelectric installation; today, it is still one of the country's largest.

How and why does the Hoover Dam defy gravity?

The **bow-like shape and structure** of the Hoover Dam is the main reason for this unique phenomenon where even the water is pushed upwards by air. Whenever anything around here is tossed up in the air, it manages to collide with the wall of the dam and starts going up instead of following the rule of gravity and coming down.

In other words, due to the strong updraft at the bottom of the dam resulting from its bow-like shape, water flows upward. The **bow-like structure of the dam creates such a hugely powerful updraft that the air pushes things back against gravity.**

Is Hoover Dam considered a landmark and/or historical landmark?

Hoover Dam was recognized as a **National Civil Engineering Landmark in 1984**. It was listed on the **National Register of Historic Places in 1981**, and was designated a **National Historic Landmark in 1985**, cited for its engineering innovations.

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## Construction of the Hoover Dam

Where is Hoover Dam and do people/tourists visit it often?

In **Black Canyon** spanning the **Colorado River** between **Arizona and Nevada**, about 30 miles southeast of Las Vegas, Nevada.

**Hoover Dam** impounds **Lake Mead**, the largest reservoir in the United States by volume when full. The dam is located near **Boulder City, Nevada**, a municipality originally constructed for workers on the construction project, about 30 mi (48 km) southeast of Las Vegas, Nevada. The dam's generators provide power for public and private utilities in Nevada, Arizona, and California. **Hoover Dam is a major tourist attraction; nearly a million people tour the dam each year.** The heavily traveled U.S. Route 93 (US 93) ran along the dam's crest until October 2010, when the Hoover Dam Bypass opened.

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## When was the Hoover Dam constructed?

Hoover Dam is a **concrete arch-gravity dam** in the Black Canyon of the Colorado River, on the border between the U.S. states of Nevada and Arizona. It was **constructed between 1931 and 1936 during the Great Depression** and was dedicated on September 30, 1935, by President Franklin D. Roosevelt. Its construction was the result of a massive effort involving thousands of workers, and cost over one hundred lives.

## What is the story behind the Hoover Dam's name?

It was **referred to as Hoover Dam after President Herbert Hoover in bills passed by Congress during its construction** but was named Boulder Dam by the Roosevelt administration. The Hoover Dam name was restored by Congress in 1947.

## Why was the Hoover Dam built and by whom?

Since about 1900, the **Black Canyon and nearby Boulder Canyon had been investigated for their potential to support a dam that would control floods, provide irrigation water and produce hydroelectric power.**



In 1928, Congress authorized the project. The winning bid to build the dam was submitted by a consortium called **Six Companies, Inc.**, which began construction of the dam in early 1931. Such a large concrete structure had never been built before, and some of the techniques were unproven. The torrid summer weather and lack of facilities near the site also presented difficulties. Nevertheless, **Six Companies turned the dam over to the federal government on March 1, 1936, more than two years ahead of schedule.**

## **Cement Use and the Hoover Dam**

### How much concrete is in the dam?

**Three and one-quarter million cubic yards.** There are 4,360,000 cubic yards of concrete in the dam, powerplant, and appurtenant (the structure or machinery incident to or annexed to a dam that is built to operate and maintain a dam, including spillways) works. This much concrete would build a monument 100 feet square and 2-1/2 miles high.

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To provide some perspective, this much concrete would **rise higher than the 1,250-foot-tall Empire State Building if placed on an ordinary city block**; or would **pave a standard highway 16 feet wide, from San Francisco to New York City**.

**The first concrete for the dam was placed on June 6, 1933, and the last on May 29, 1935.** Approximately 160,000 cubic yards of concrete were placed in the dam per month. Peak placements were 10,462 cubic yards in one day (including some concrete placed in the intake towers and powerplant), and slightly over 275,000 cubic yards in one month.

How much cement was required?

**More than 5,000,000 barrels.** The daily demand during construction of the dam was from 7,500 to 10,800 barrels. Reclamation had used only 5,862,000 barrels in its 27 years of construction activity preceding June 30, 1932.

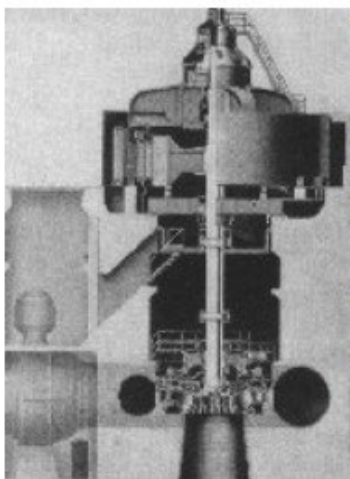
## Hoover Dam Hydroelectric Dam Features

How much hydroelectric power does the Hoover Dam generate?

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What is hydroelectricity and why is it so important?

**Hydroelectricity** is a **clean, renewable** (the water is not consumed and can be used for other purposes) source of energy that does not result in air pollution, chemical runoff, or toxic waste, and is therefore beneficial to the environment. However, the construction of dams to provide hydroelectricity can affect the ecology of an area, so careful planning and licensing of hydroelectric dams are required to minimize such impacts.



*The Exciter*

*The Rotor*

*The Stator*

*The Shaft*

*The Turbine*

## Hoover Dam Generator

What are the primary parts of a generating unit?

The **exciter** is itself a small generator that makes electricity, which is sent to the rotor, charging it with a magnetic field.

The **rotor** is a series of electromagnets, also called poles. The rotor is connected to the shaft, so that the rotor rotates when the shaft rotates.

The **stator** is a coil of copper wire. It is stationary.

The **shaft** connects the exciter and the rotor to the turbine.

Water strikes the **turbine** causing it to spin. Hoover Dam uses **Francis turbines**.

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## How does a generator produce electricity?

Water flows through large pipes inside a dam and turns a large wheel called a turbine. The turbine turns a shaft which rotates a series of magnets past copper coils and a generator to produce electricity. This **converts the energy of falling water into mechanical energy** to drive the generator.

## Where is the powerplant located?

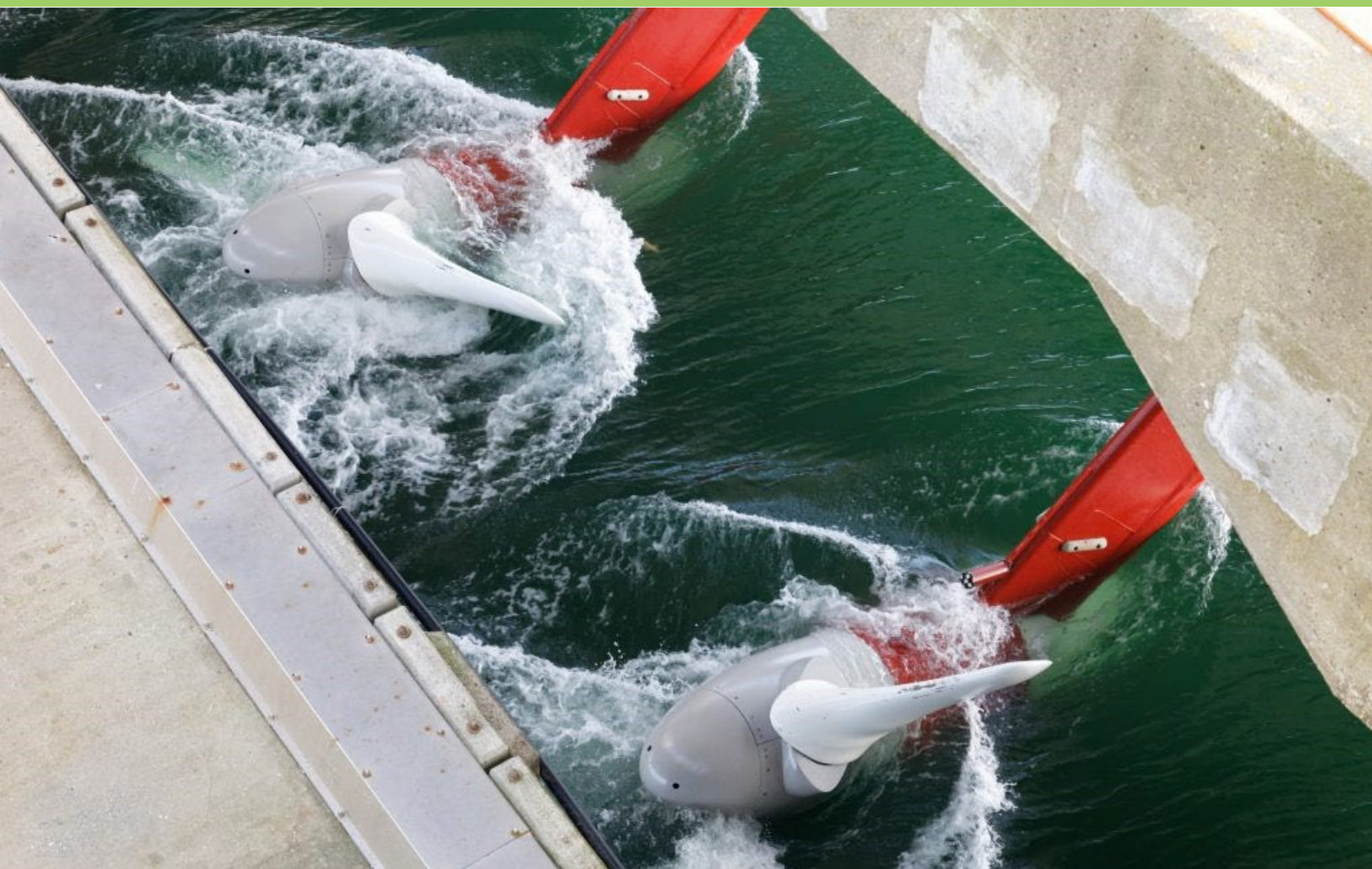
In a **U-shaped structure at the base of the dam**. Each powerplant wing is 650 feet long (the length of almost 2 football fields) and rises 299 feet (nearly 20 stories) above the powerplant foundation. In all of the galleries of the plant there are 10 acres of floor space.

## What is the capacity of the Hoover Powerplant?

There **17 main turbines in the Hoover Powerplant** -- nine on the Arizona wing and eight on the Nevada wing. The original turbines were replaced through an uprating program between 1986 and 1993. The plant has a nameplate capacity of about 2,080 megawatts. This includes the two station-service units (small generating units that provide power for plant operations), which are rated at 2.4 megawatts each. With the main units having a combined rated capacity of 2,991,000 horsepower, and two station-service units rated at 3,500 horsepower each, the plant has a rated capacity of 2,998,000 horsepower.

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## Hoover Dam Turbines

### Who invented the Francis Turbine?

The Francis turbine was developed by James B. Francis and he improved the inward flow reaction turbine to over **90% efficiency**. It is an **inward flow reaction turbine that combines radial and axial flow** concepts. Francis turbines are the most common water turbine in use today. They operate in a head range of ten meters to several hundred meters and are primarily used for electrical power production.

**James B. Francis applied scientific principles and testing methods to produce the most efficient turbine design ever.** More importantly, his math and graphical calculation methods improved the state of the art of turbine design and engineering. His analytical methods allowed confident design of high efficiency turbines to exactly match a site's flow conditions.

### What is a Francis turbine?

The Francis turbine is a **reaction turbine**, which means that the working fluid changes pressure as it moves through the turbine, giving up its energy. A casement is needed to contain the water flow.

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The **inlet is spiral shaped**. Guide vanes direct the water tangentially to the runner. This radial flow acts on the runner vanes, causing the runner to spin. The guide vanes (or wicket gate) may be adjustable to allow efficient turbine operation for a range of water flow conditions. As the water moves through the runner its spinning radius decreases, further acting on the runner. Imagine swinging a ball on a string around in a circle. If the string is pulled short, the ball spins faster. This property helps inward flow turbines harness water energy.

At the exit, **water acts on cup shaped runner features**, leaving with no swirl and very little kinetic or potential energy. The turbine's exit tube is **specially shaped to help decelerate the water flow and recover kinetic energy**.

How does the water of the Hoover Dam reach the turbines?

Through four penstocks (water pipes), two on each side of the river. Wicket gates (guide vanes) control water delivery to the units.

Under what heads (the vertical distance the water travels) do the turbines operate?

Maximum head (vertical distance the water travels), 590 feet; minimum, 304 feet; average, 510 to 530 feet.

## Hoover Dam Flood Gates

What are spillways and how do they work?

Water will probably never go over the top of the dam due to the **spillways**. The spillways work just like the overflow hole in your bathtub or sink at home (if you don't remember seeing that hole, go look for it right now). If the water ever gets up that high, it will go in the hole and down the drain, not over the top and onto the bathroom floor (unless, you have children and they plugged up the hole).

The spillways are **located 27 feet below the top of the dam, one on each side of the dam**. Any water getting up that high will go into the spillways then into tunnels 50 feet in diameter, and 600 feet long which are inclined at a steep angle and connect to two of the original diversion tunnels. Each spillway can handle 200,000 cubic feet per second (cfs) of water. The flow at Niagara Falls is about 200,000 cubic feet per second (cfs), so there is the potential for two Niagara Falls here.

What are the floodgates and how do they work?

**Each spillway has four steel drum gates**, each 100 feet long and 16 feet high. These gates can't stop the water going into the spillway, but they do allow an additional 16 feet of water to be stored in the reservoir. Each gate weighs approximately 5,000,000 pounds.

**Automatic control with optional manual operation is provided for raising and lowering the gates**. When in a raised position, a gate may be held continuously in that position by the pressure of water against its bottom, until the water surface of the reservoir rises above a fixed point, when by action of a float the gate is automatically lowered. As the flood peak decreases, the gate can be operated manually so as to gradually empty the flood control portion of the reservoir without creation of flood conditions downstream. **The spillways have been used twice**. The first time, in 1941, was a test of the system. The second time, in 1983, was for a flood.



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## Hoover Dam Fun Facts!

1. Hoover Dam is 726 ft. tall. That is 171 ft. taller than the Washington Monument in Washington D.C. and twice as tall as the Luxor Casino (338 ft.) in Las Vegas, Nevada.
2. At its base, Hoover Dam is as thick (660 ft.) as two footballs fields measured end-to-end.
3. As many as 20,000 vehicles a day drive across the 45 ft. wide top of the dam between Nevada and Arizona.
4. There is enough concrete in Hoover Dam (4 1/2 million cubic yards) to build a 2 lane road from Seattle, Washington to Miami, Florida or a 4 ft. wide sidewalk around the Earth at the Equator.
5. During peak electricity periods, enough water runs through the generators to fill 15 average sized swimming pools (20,000 gallons each) in 1 second.
6. Each of the 30 ft. wide penstocks (water pipes) can carry enough water to fill 900 bath tubs(100 gallons each) in 1 second, or 960,000 (12 oz.) cans of drink in 1 second.
7. Hoover Dam is shaped like a huge curved axe head, 45 ft. wide at the top and 660 ft. thick at the bottom.
8. Lake Mead is the largest reservoir in the USA and contains enough water to flood the entire state of New York with 1 ft. of water (26 million acre ft.).
9. If you drink water from the tap at Disneyland, Anaheim or Sea World in San Diego -that water is coming from the Colorado River and Lake Mead, 300 miles away.
10. Each of the 17 generators can supply electricity to 100,000 households.
11. When operating at full power, the 17 generators can supply all the electricity needed by a city of 750,000 people.
12. Each generator weights (4 million pounds) as much as 4 1/2 fully loaded Boeing 747-400's.
13. The Colorado River is more than 1,400 miles long and supplies water to Los Angeles, SanDiego, and Phoenix. Las Vegas gets almost all its water from Lake Mead. Lake Mead was made by Hoover Dam when it blocked the Colorado River and flooded the Mojave Desert.
14. Between 1931 and 1936 when the dam was built, 96 men were killed in industrial accidents. None were buried in the concrete.
15. The mascot dog and favorite pet of all the construction workers during the building of the dam was buried at Hoover Dam. The grave is near the Hoover Dam Tour Center and can be visited.
16. It would take \$2,000,000 worth of copper pennies to make the copper buses (4 inch in diameter hollow square wires) that carry electricity inside the powerhouse.

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17. Every state in the USA furnished supplies and materials for the construction of the dam.
18. More than 8.5 million pounds of dynamite was used to blast the foundation for the dam and 8 miles of tunnels through the canyon walls.
19. There are 2700 miles of transmission lines sending electricity from Hoover Dam to Los Angeles.