California State Parks

Video Transcript

More Power!: The Story of Folsom Powerhouse State Historic Park

Hello, my name is Stan Newell. And I am a docent here at the Folsom Powerhouse State Historic Park. The powerhouse went online in 1895, and it was probably one of the first things that really gave power to the common man. Similar things might be the Wright brothers' flight, Ford's Model A, things we’re doing on the space station today in the line of medicine and technology, and that kind of thing. Because, before that, all we knew about was direct current power. And direct current power really wasn't that adaptable to private residences and the common man. You had to have batteries, you had to have the kinds of things that really weren't available and useful. So that's why we had gas lamps, and we had candles, and we had all that kind of thing. Now, when power could be sent a distance, which happened with alternating current (a distance from let's say here to Sacramento), then the public could tap into it and could enjoy the ability of having power in their homes. This is really a turning point along the technology path through history.

The American Society of Civil Engineers felt that this powerhouse was so important that it deemed it the most important in the world of 1895 . Others of other years were the Panama Canal, the Eiffel Tower, the Brooklyn Bridge, things of this stature. And to have the Folsom Powerhouse believed to be the most important in 1895 was really quite important.

So now I'd like to talk about the actual history of this powerhouse. How it evolved, how it came to be, and its life. So we can go over to the picture board, and we'll talk from there.

Now I'd like to tell you a little bit about the history of this powerhouse. It all started with a man named Horatio Gates Livermore, who came out from Livermore, Maine in 1850 to start a new commercial adventure. He was 50 years old at the time and he'd already done one lifetime, and wanted to try another. He settled in the town, or the area, that was to become Folsom, and his idea was to put in a sawmill. He could see that need here in this area. So he began. If we could look over here at the aerial photo of where we are, here are the two forks of the American River coming down, and they connected off the end of the peninsula, came down through this little narrow rocky gorge, came on out in here, and eventually hooked up with the Sacramento River down in the town of Sacramento.

He bought land from the Leidesdorff holding in here, the land grant. He got the water rights to the river coming through, and he let the contract for his dam and canal. The rock was so very hard that it was too expensive for him. By that time he'd actually become a State Senator, and he learned that the prison board was looking for an alternate site to San Quentin. It was overcrowded in those days. So he said “I'll give you 450 acres of land for your prison if you'll give me 60,000 convict days of labor for six years." So he traded a worthless pile of rock, which wouldn't grow anything, for the labor to finish his dam and canal within the prison grounds.

Now this is the outline of the old Represa Prison. Right in here. It's still in use today. The new side is over on this side over in here. But this is all the prison grounds. In those days of course you had to become a prisoner and then you had to build your own prison, obviously, so you could get prison labor at the site. That took about 20 years. Well, in the 1850s and '60s when he started this project, all they knew about was direct current power, and that is site specific--you had to have the waterwheel, the generator with all the dynamo in those days, right at the same location, which is what he planned to do for his sawmill.

Well, 20 years later Nikola Tesla and the Westinghouse Brothers on the East Coast at Niagara Falls were learning about alternating current because they wanted to send power to Buffalo, New York. The idea then was to be able to transform the power through transformers that were just being developed--the alternating current philosophy that was being understood and put into practice. The General Electric people wanted to get their oar in the water, if you will. So they came out and talked with the sons of Livermore to power up Sacramento, 23 miles away. This had really never been done probably anywhere in the world, at that time in the 1890s.

You can see the striped suiters and the derby hats--the prisoners--working on the inlet structure in the dam, which is this dam here. It's about 120 feet across. The canal is about 50 feet wide. It's about 12 feet deep, and it runs down along the east side of the North Fork of the American River at this point. The canal stays high, and the river drops away. So by the time it got down to the millpond, it was about a hundred feet difference in elevation between there and the water of the American River, which is approximately where we are here. Well that was perfect so that they could continue the canal down, have that differential in head to be able to drive the turbines that we'll see in the other room when we get around to that side.

There was a railroad that ran up. Do you remember Johnny Cash in the "Folsom Prison Blues"? He sang about the "lonesome wail of the train whistle." Well, that was the train right here that took the prisoners up the river. You got sent up the river to get to Folsom Prison. You also got sent up the Hudson River to Sing Sing. We'll let them use that on the East Coast, we'll use our story out here on the West Coast, because you actually did get sent up the river to get to Folsom Prison.

And then of course the prisoners would make little ones out of big ones and send them back down the railroad to this location where it was put in place--the foundation of this building and the dam you'll see in the other room. There even was a fish ladder around the old dam, which was a little surprising to me that they bothered with that in those days, but they took care of their fish--that's why we have salmon in the river today I'm sure.

We will see in a moment, we'll go up above and we'll see, the forebay. That is the pool that is at the end of the canal. It looks like this today. Back in 1895 it looked like this over in here with water in it. At the end there are the four gates that would allow the water to go into the penstocks, again which we will see in a moment. The output of these generators is 800 volts of alternating current. The transformers, and you have to have a transformer to be able to send power any distance so we send them at high voltage, those transformers, we'll see down at the other end a little later, increased the voltage up to 11,500 volts.

The power plant was 3,000 kilowatts. Now, kilowatts are pocket change compared to what we talk about today--we're into megawatts. But the 3,000 kilowatts did the job on the first day. I want to talk about that a little bit because we're talking about an energy crisis today where supply is not keeping up with demand. Same thing happened on day two back in 1895 when all of the people wanted this wonderful new technology of energy to possibly go into their homes and illuminate their homes. So we've been chasing supply and demand ever since. Today is no different than anything we had way back.

As I say, this 3,000 kilowatt plant was about 2% of the output of Folsom Dam alone today. And there is Shasta's, and Orville's, and there's nuclear power, and there's green power and there's all kinds of other power that we use. So this was a very small plant, but it was all they needed in those days. Now, PG&E took over and bought the Livermore family out in 1905. Livermores ran it for the first 10 years. In 1905 to 1952 PG&E ran this power plant in the grid of Northern California, supplying power to these environs around here.

This is the McCormick turbine--we'll see that in the other room. This is the hydro side of the plant. And we'll also see that we need motion. We have to have movement to be able to generate alternating current. So this provides the movement. It's similar to the pinwheel that you blow on, and when it turns by air power, if you could hook it up to something, you could generate. We have that down in Altamont Pass--the windmills going in. There's many windmills, but that's a good example. Windmills are the kinds of things that can generate electricity. Well, in this case it's water power turning instead of air power, but it's the same idea.

This is the original marble control panel--Tennessee marble. They used it because it was slabable, drillable, available, and it was inert to electricity. Later on we'll see it; it's right there. And what that tells us is that everything we see in here is 107 years old. All of it came around the Horn of South America because, as I told you before, everything like this was built on the East Coast and it had to get here some way. The transcontinental railroad was way too small to carry anything like this through its tunnels and over its bridges. So therefore it had to go that way, and the Panama Canal didn't come in until 1915. So everything came in that manner.

Above us, above the roof here, is a loft. And we'll see that as we are outside the building. It's a room up above, where originally there were air-cooled transformers. Those of course burned up in the first Sacramento summer. They replaced them by the water-cooled transformers down at the other end of the room.

There also was a switching that went on up in there to send the power wherever it was needed. And they used, in those days, knife switches. Well, when you pull a knife switch apart, you get a big ball of fire. They wanted that up there, not down where the people were working. So that's why the loft and the equipment was up there.

In 1952 as the new dam, the new Folsom Dam, was put in place right behind the old dam, they blew up the old dam to get it out of the way. It was making a hump in the river and that was taken out. So that is one of the reasons why, of course, we can't get water to this power plant.

We can't crank it up and help us with our supply problem. This piece of the dam is still there. It can be seen from the bike trail over on the other side. It's in prison grounds so you can't get to it.

Now this here, and we'll see this later on, is the fifth powerhouse. And it was put in and it's called the lower powerhouse. It is down below down here, and it was put in in 1897 to try to increase the supply.

I would like to now take us up to the forebay and follow the water as it comes down through, and how then it generates the electricity. Now, the dam we talked about was up about 2½ miles up the American River. And the canal came down from it by the sawmill, which actually did get in place. It ran from about 1896 to 1901, and it folded and was never very practical.

But the canal kept on coming. It came down on the other side of the road there. It made a right turn and came through, and as it went down in through here, the forebay, which is what we call this facility here, was 100 feet wide where the canal was only 50, so what it did in effect was make a stilling basin. And it would drop the sand and the gravel and the sticks and all that kind of thing before it went through those gates that you see right down there. There's four of them that led into the penstocks, which we will see in a moment on the other side. You can see that there's a wall down the center so that they could close down one side, clean the gravel out, keep the other side of the powerhouse running.

You can see the hydraulic lift mechanisms up in there. They were all hydraulic gates that were lifted by a pump station, which is down below on the other side of the wall there. On both sides there were overflow canals, and that took the excess water that wasn't needed to go through the penstocks to drive the turbines so that he could keep his pool height constant. There is 55 feet of driving head of water that ran the turbines at this location here. Now that's very, very small--probably it's 250 feet up at the new Folsom Dam, maybe a thousand feet at Hoover Dam. That kind of height. But this is a low head facility that ran very well until 1952 when it went down.

Those that you're looking at now are transformers that were put in right after World War I in 1919. Again in an attempt to try and keep up with supply to match the demand. Those are 125,000-volt transformers. Actually, the practical limits--you really can't build them much bigger than that. And they're similar to the ones that we use today.

The building that you're looking at, of course, is the generator room, and it is a used brick building. The bricks came from the roundhouse and the locomotive sheds of the Sacramento Valley Railroad--the 26 miles of rail that was east of the Mississippi in those days. That rail was surveyed by Theodore Judah, and the town of Folsom was surveyed by Theodore Judah. The thought was that possibly the transcontinental railroad, this was going to be the beginning of it, and that the line might go up through the American River canyon rather than the way it did eventually when the Big Four took Judah through Roseville and up over Donner. So when that happened, they didn't need all of the buildings that they had--the locomotive sheds, the roundhouse, and all of that. The buildings had been put together with limestone, and that was easily taken apart. The bricks were all cleaned up by this company, brought up in here, and put into this building with Portland cement, which is what we use today.

This and the prison were one of the first uses of Portland cement. So that's why the building looks as sound as it is today. There's not a crack in it--it's been looked at by the seismic people. The two major earthquakes in the San Francisco area the ‘06 and the ’89 Loma Prieta--not a crack in the building. And brick buildings don't do well anywhere. We’re not in earthquake country up in here, but that building is just as sound as the day it was put up 107 years ago.

This is stacked rocks. It’s made as a retaining wall. No grout; it’s about 25 feet thick at the bottom and about 10 feet at the top. It's just stacked rocks to make a retaining wall to hold that pump plant that is up in there that provides the hydraulic pressure to raise and lower the gates that we just saw up in the forebay. That’s in that building there, and there’s an oil reservoir.

What we’re seeing here is the dam wall, the counter forces that are supporting it out in front. The white stains that you see on the wall is the natural method of sealing the cracks on a dam by utilizing the groundwater carrying natural calcium. When the calcium comes out and hits the air it becomes calcium carbonate, which then seals the cracks of the dam. That's what we're seeing in all of the staining that’s along the walls in here, similar to stalactites in a cave. They’re out in the open hanging down and actually form a cone. These in here are just runs of calcium down the wall that seal it up.

The dam wall is about 10 feet thick. It goes below our level here about 20 feet down to bedrock. It's probably a hundred feet long, and maybe 35-40 feet high. All the rock that you see, cut by hand by the prisoners and sent down on the little railroad we talked about before to be put in place by the local artisans into the dam wall. Now, they didn't have pneumatic tools in those days, so what they would do is they would drill a line of holes in the rock, drive redwood pegs into those holes, drop the whole thing into water. and as the redwood would expand, it would crack the rock. Now that's the way they did it in the pyramid days, but they told us up at the prison that's how they cracked the rock down here. In some of the pictures you can see some of the lines, the vertical holes in those rocks, where the split line was. It took them actually about three years of prison labor to crack the rock and send it down here. This actually looks very much like what the prison looks like. Very blocky and craggy like this. The stone masonry is similar to what the prison looks like.

This is a little of the theory of alternating current. We have a magnet here, a circular magnet--North Pole out here and let's say the South Pole is in here. We know that there is a force in that magnet because it can pick up paper clips and tacks and that kind of thing. We don't know why a magnet works today, we just accept the fact that there is a force. And a law of physics says that if you can harness force, you can do work, and so what we would like to do is be able to do something with that force that’s in that magnet. Now I can prove that there’s a force in there by taking iron filings, and I put the iron filings over the magnet. They were random in there before, and now you can see that there is the outline of the force field laid out by the little iron filings in here. We need to be able to harness that; we can't harness it in there.

So they learned that if they took a coil of wire--and that's the same kind of molecules that are in the iron filings are in the copper wire--if we took that copper wire, put it in the form of a coil, hooked it up to a voltmeter, and if I passed the coil through the field of the magnet, you can see I'm getting alternate charges of voltage, plus to minus, as I cut the field. I'm not touching the magnet, I'm just passing the coil through the magnetic field. Now if I don't move it, I don't get anything. I'm in the field but I'm not moving. I have to have movement. Outside the field obviously I don't get anything. I have to pass through the field of the magnet with the coil.

Now we go up to the real world up here. In your house you have say 220 volts/110 volts--this is 800 volts. Also in your house, the power that is in there, the amperage, is like a 200 amp circuit, 100 amp circuit. Your air conditioner probably runs on 50 amps, hair dryer maybe on 30. The light works on about 30 amps. If you take the wires of a light and pop them together, you'll get a pretty good spark.

Well what happened in 1952 is that when this plant was going to go down, maintenance got a little sloppy, and the area ionized in here--the 800 volts, instead of going down through the brushes and out the wire and over to the transformer, it went straight to ground. And what you've got here is the original meltdown. All of this is fried. These are solid copper. The whole thing melted due to the amperage and the voltage going straight to ground.

Now what they learned was that it didn't make any difference what passed what. The coil can pass the field or the field can pass the coil. Just movement one by the other. So they learned "Let's take the magnets and put them down on the armature. Turn the field. We'll take the coils, hardwire them onto the frame, take them right straight out. We don't have to take that high amperage through the very critical brush system." That's one of the big changes that was made.

The other big change is that the axels are vertical; the armatures are turning horizontally. Those two changes are probably the only major changes that have ever been made since 1895 in the generation concept or configuration.

Now this is the control panel. And this is where the operator worked on an eight-hour shift. These are the outgoing switches here. It would take the power from the transformers, send them up into the attic, up into the loft, and switch them wherever they needed to be sent.

These here now are the controls for the various generators throughout the building here. You had to be able to turn them on and turn them off. Originally there was a knife switch in here. It was removed and this behind-the-wall switch was put in. I think you can imagine a knife switch pulling 800 volts by hand was probably pretty dangerous.

This is the phone booth, which is the way the operator could contact with the outside. There's a switchboard back there in the back, the old crank phone over in here. They even had double glass walls so that they could hear something over the noise of the powerhouse.

Here's what the sound was like in the powerhouse.

[Very loud sound of machinery running]

We're now at the lower powerhouse. This is the fifth generator. And it is different in design from the ones we saw in the upper powerhouse, indicating that they had finally understood that you could turn the field and hardwire the coils to the frame, which is what we have here. It's a different design. It came in here probably right after the turn of the century when PG&E came in. It's a GE generator but it's field wound--the armature turns the magnetic field. Not like the ones that were up there.

Well this ends our tour of the Folsom Historic Powerhouse State Park. We're glad you came and witnessed this piece of technology that brought so much to the people of the world--alternating current that could be sent a distance, where the dam could be located in its location with the need somewhere else.

And of course that's a way of life today. We don't depend on direct current nearly as much as we used to, which was very cumbersome and not very useful to the public at large. So alternating current was understood and put into use, and it made a great change in our way of life and our quality of life. So thank you for coming, and I hope you'll come back again and enjoy our powerhouse in the future.

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