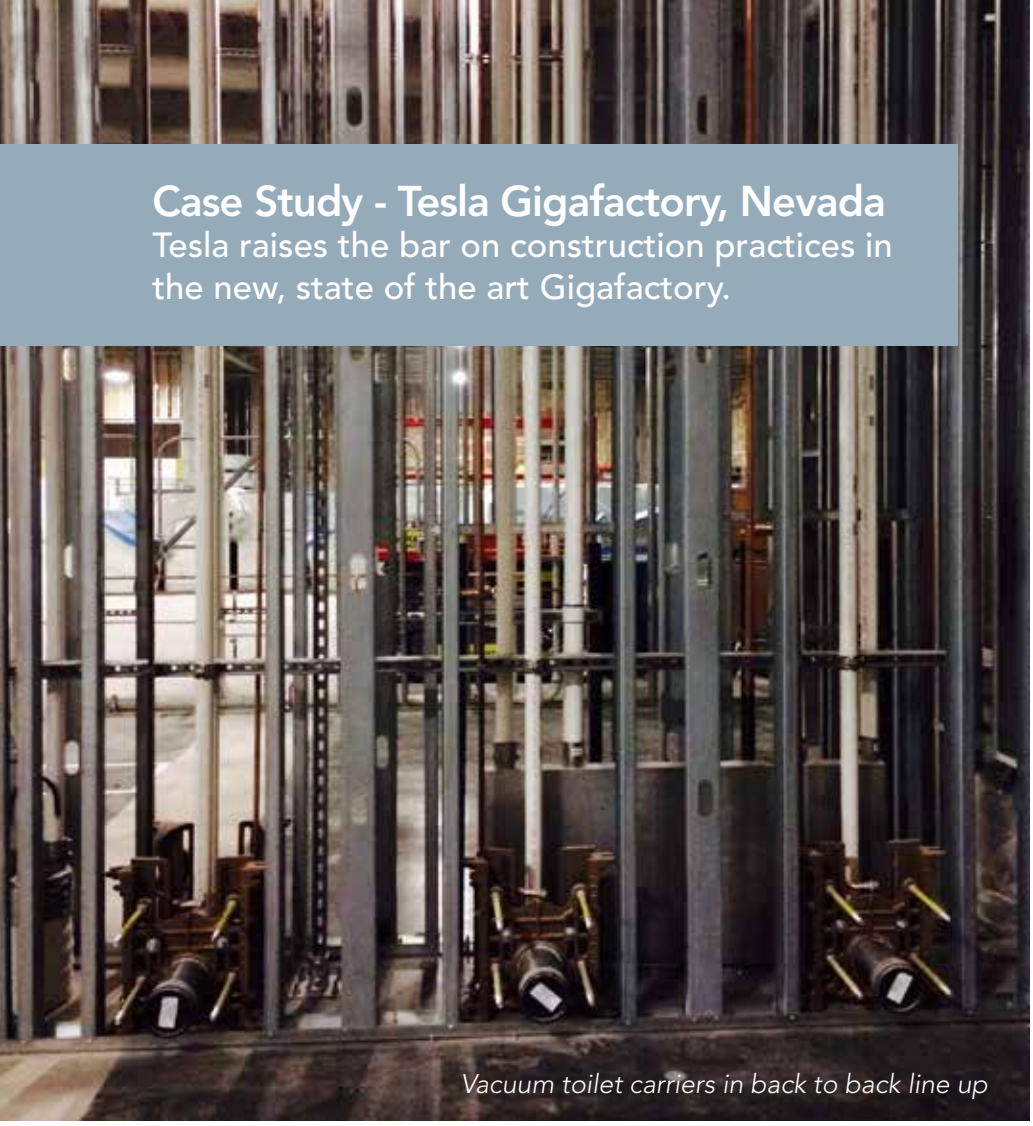
Case Study - Tesla Gigafactory, Nevada

Tesla raises the bar on construction practices in the new, state of the art Gigafactory.



Vacuum toilet carriers in back to back line up

AcornVac Inc.

VACUUM PLUMBING SYSTEMS

DESIGN ENGINEER: CH2M Hill
PROJECT ENGINEER: Aspen Engineering
MANUFACTURER'S REP: Braley-Gray

SUMMARY

Just to the east of Reno Nevada sits a newly constructed, clean manufacturing facility of enormous proportions. Within the walls of this building are miles of vacuum waste plumbing, an advanced alternative to gravity plumbing that offers Tesla unrivaled flexibility and adaptability to meet ever-changing infrastructure demands.

AcornVac was the chosen solution because the vacuum system

- Cuts cost by eliminating the need to dig large sump pits.
- Provides options, often where the design most needs freedom from constraints.
- Allows for future changes without disruption to the manufacturing process.

BACKGROUND INFO

By 2018, Tesla plans to ramp production to 500 thousand electric vehicles annually, accelerating the transition to sustainable energy and permanently altering the trajectory of the auto industry. The problem was, all the lithium ion battery manufacturers in the world could not produce the quantities of batteries required to fulfill the anticipated demand. Tesla turned its vision toward supplying the solution itself and the Gigafactory project was born.

"The flexibility of [AcornVac's system] means you can design without the owner knowing where they want things to go because you can change it pretty easily. As long as you know the total number of fixtures, you can start designing from there."

Quincy Collins, project manager, Aspen Engineering

Bathroom wall framing with overhead drainage

Elon Musk, CEO of Tesla Motors, wasn't interested in building just another factory. During a publicity event at the newly opened facility, Musk was heard saying, "[A factory] deserves more innovation and more engineering skill than the product itself."

The factory was designed using physics' first principles to optimize density, meaning that instead of accepting what's been done before as the prescriptive approach, the team boiled every decision down to its basic elements, asking what's true and reasoning out new solutions from there.

Tesla CTO, JB Straubel credits their engineering teams with modeling the factory to fit with minimum wasted space based upon this first principles approach. This philosophical outlook helped lead the engineers to discover a unique approach to drainage that challenges the commonly accepted wisdom of today. A system, produced and supported by a company called AcornVac, introduced a revolutionary new way of moving drainage into the overhead ceiling space by utilizing vacuum on a closed piping network.

CHALLENGES

Challenge #1
Floor cutting and trenching for gravity drainage was too costly, too time consuming, and too constraining.

Challenge #2
The square footage in the Gigafactory is big enough that it could house one hundred 747s. At 6 million square feet, the challenges with moving waste in a traditional gravity system were immense.

Challenge #3
Design to achieve maximum density and no wasted space was ongoing, so the location of bathrooms, eye wash stations, sinks, and other equipment or fixtures requiring drainage was continually changing.

Challenge #4
Tesla had an accelerated schedule, including a requirement to obtain a Temporary Certificate of Occupancy by the third quarter of 2015.

THE CONVENTIONAL APPROACH

Gravity plumbing was the obvious choice during the early phases of design. However, the design engineers quickly realized that the below-ground plumbing would have reached depths of more than 30 feet below grade to maintain slope. Pumping equipment would need to be located throughout the building to lift waste and move it. This also meant floor cuts, trenching, considerable trench export, lift stations, backfill, compaction, and resealing. Once done, the drainage would be in fixed locations, constraining the designers or, worse yet, leading to relocation work. The obstacles seemed cost prohibitive and work intensive.

Sink drainage - vertical risers in wall

THE ACORNVAC SOLUTION

In the fall of 2014, a manufacturers' representative called Braley-Gray got involved. Braley-Gray represents a full array of plumbing, piping, and industrial products, including the AcornVac vacuum plumbing system. Braley-Gray began discussing the project with CH2M Hill engineers who were working on the concept design for the Gigafactory. CH2M Hill shared about the challenges ahead on the Gigafactory project and Braley-Gray confidently suggested they consider AcornVac's vacuum plumbing solution.

The AcornVac solution would eliminate the cutting and trenching. Because the drainage went into an overhead, closed-network pipe, drainage could be picked up wherever it was required, lending dramatically to the ever-changing design needs. And it could travel the distances required to handle the size of the building. Just as the CH2M Hill engineers had begun to resign themselves to the constraints of gravity, this new plumbing system gave them all new options that would eventually have a wide ranging, positive impact throughout the project. It would change everything.

By January 2015, the contractor and engineering team were convinced of the benefits of vacuum plumbing. They then turned to the Tesla team.

Tesla and its team did not have any first-hand experience with a sanitary vacuum waste system in a land-based application. However, the features and benefits the system promised compelled them to learn more. Tesla, with its unique, first principles approach, has never been a stranger when trying new things where others might not.

During the summer of 2015, after Tesla's representatives had conducted a cost analysis of the vacuum system, it was clear that vacuum plumbing

AcornVac, introduced a revolutionary new way of moving drainage into the overhead ceiling space by utilizing vacuum on a closed piping network.

Back to back toilet installation

Bathroom drywall finish with carriers for toilets

should be a foundational part of the project. There were cost savings of hundreds of thousands of dollars. The vacuum approach would allow the project to move on a far more aggressive schedule. And the ability to rearrange plumbing infrastructure whenever needed meant that the project designers were no longer beholden to the dictates of the plumbing when considering the optimal layout.

Their decision to go with AcornVac's system was bolstered by the confidence and expertise demonstrated by Tom Files, Principal at Braley-Gray, and Tom Zinn, Engineering Director at AcornVac, who consistently maintained support, training, and response throughout the project.

By late summer of 2015, purchase orders were signed and AcornVac began shipping that fall.

TRANSITION

During the spring of 2015, CH2M Hill had completed their assignment, having functioned as the design engineers, and had begun to transition the project over to Aspen Engineering, the project engineer.

Aspen did not have experience with vacuum plumbing systems. However, "[AcornVac] stayed involved through the whole process," said Quincy Collins, project manager.

Collins felt that any delays associated with getting personnel up to speed on the vacuum system were worth the investment.

"In our case, this is still the best choice. The standard system is quite inconvenient to use out there. Because it's such a huge building, they would have had to dig large sump pits, gravity drained everything to those, and then pumped it back out," said Collins.

In addition, Collins said the limited overhead space and slope required for such a massive building made the vacuum system a much better option.

VERSATILITY

In a perfect world, the contractor and engineers are given plans that include the exact location of every fixture, but nobody lives in that perfect world.

Construction was well underway, and the locations of bathrooms, floor drains, emergency shower stations, and the locations requiring drainage were still in a state of flux.

Tesla wasn't just building one of the world's largest, clean manufacturing facilities, it was reinventing the manufacturing process. That commitment meant that plans constantly changed, and changes had to be incorporated on the fly.

Collins spoke confidently, "The flexibility of [AcornVac's system] means you can design without the owner knowing where they want things to go because you can change it pretty easily. As long as you know the total number of fixtures, you can start designing from there."

TEMPORARY CERTIFICATE OF OCCUPANCY

Tesla was looking to obtain a Temporary Certificate of Occupancy (TCO) before the end of 2015, just months after the decision to go with the AcornVac vacuum plumbing system. They had a need to move employees into the building and to do that, they needed a working plumbing system--a system that could accommodate up to 400 people.

Braley-Gray learned of the need and presented Tesla with the option to rent a fully functioning temporary vacuum center that could handle those 400 employees while the larger, permanent center was being built.

Tesla agreed to the proposal, giving its employees fully functional bathrooms with flush toilets instead of the chemical toilet alternative. The TCO was obtained, and the temporary system was in place from late 2015 until the permanent vacuum center was switched on in July of 2016.

COMPLETION

The AcornVac vacuum plumbing system conforms to Elon Musk's vision of manufacturing. It proved to be reliable and easily modifiable. It afforded the design engineers the option to achieve ideal, minimized wasted space. And it challenged the status quo, causing engineers to ask "why?" about gravity drainage systems.

The AcornVac system was commissioned at the end of July 2016, just in time for the grand opening celebration held on July 29, 2016. Tesla invited somewhere around 3,000 people into the new factory, including current car owners and those with cars on order. The system that had given them the solution to an impossible problem, allowed them to change plumbing on the fly, and will give the facility continued adaptability as needs change into the future, functioned perfectly.

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SHORT PANEL

WHEN TO CONSIDER VACUUM PLUMBING

Files says the ideal time to weigh the benefits of vacuum plumbing with new construction is at the site development point—when the civil engineer and/or architect is laying out the design. AcornVac's environmentally friendly system reduces potable water consumption for toilets by as much as 68% and reduces sewage waste discharge with a half-gallon toilet flush.

"That's the greatest opportunity afforded to the owner because of the significant SDC savings based on the impact the building will have on water or sewer infrastructure," said Files. "Often, the owner has already engaged or contracted the civil engineer to begin working on their site planning, but they are going under the pretense it will be gravity, not vacuum."

Alternatively, when rehabbing an office building or any facility with any significant degree of plumbing fixtures, you can very effectively retrofit a vacuum system into the building and do so without disrupting the structural aspect of the building.

That is because you have the option to route your plumbing through existing floor penetrations or into areas that access a common shaft. You are not bound by the physical limitations of gravity where the pipe has to maintain a continuous slope.

CHEMICAL TOILET SAVINGS

Tom Files, estimates a savings of over $100,000 worth of chemical toilet servicing due to the installation of the temporary vacuum center.

"We gave them full functioning, flushing toilets in the building with the temporary center. They could use their sinks and everything else in there for pennies on the dollar for what they would have spent," said Files.