

Invisible Giants Powering The Subway: New York's Abandoned Substations

Our modern world is full of abstraction. We all take the train, or drive on the highway, but rarely are we considering how the subway car draws power, or who paves and guides the highway. There are so many gears turning behind closed doors to keep our delicately balanced system running. Very often those invisible gears are born from fantastic industrial might and powered by underappreciated laborers.

Few places represent this abstraction as well as New York City. When the subway and the convenience stores are open all night, the densely populated metropolis is transformed into a 24-hour free-for-all for the nearly eight-and-a-half million people who call it home. Over four million of those people take the city's vast subway system every single day. Whether it's to get to work, to grab a slice, or visit a friend, public transit is in many ways the heart of the city.

But what keeps this heart pumping? What's been powering the trains for well over a hundred years? Hidden behind vast, yet unassuming facades, hundreds of thousands of pounds of machinery and hundreds of machinists operated New York's substations for decades and brought the subway to life. **I'm your host and you're watching 'It's History'.**

To simplify a complex matter, there are two important types of electric current, alternating current (or AC) and direct current (or DC). These two make up the vast majority of electrical systems, and they have different usages. Power stations, especially in the late 1800s, were only producing DC as that is what was used in light and other electronics.

The low voltage of DC power generation meant that lightbulbs plugged in just 5,000 feet from the power station were dim and faded compared to those closer to the station. It was prohibitively expensive for companies to build the dozens of power stations in the density required to give the city proper coverage. The substations were a solution to that problem.

Instead of trying to transmit DC power over long distances, AC was well suited for the task. But DC was still how things like electric motors or lights were powered, so instead of an extreme density of power stations throughout the city, the electric companies built substations to convert the AC power that can travel long distances into the localized DC power.

New York's transit system was cutting-edge: the very first elevated rail in the city didn't run on electricity at all, but rather was a steam locomotive. New York isn't the cleanest city, and at the turn of the century the non-stop steam engine operation from the railways was choking the city with fumes.

In 1888, Richmond, Virginia successfully installed an electric powered streetcar. This eliminated the noise, fumes, and cinders of the steam locomotives, but also provided a simpler, more efficient system of getting around. Instead of a single engine dragging an entire train, each car on an electrified rail is individually powered, allowing the train to start and stop much quicker. It was easier, cheaper, faster and cleaner than the steam locomotive. After the unmitigated success of Richmond's system, New York began to follow suit and electrified their rail system between 1898 and 1903.

Two unintended consequences of the switch to electric rail were that due to the limited supply of available electricity, the rail company would be required to build their own power stations and substations throughout the city, and that after eliminating the smoke and fumes, trains could now feasibly be run entirely through underground tunnels without choking it's occupants. Thus, New York's subway was born.

For each new line built during the rapid expansion of the rail system in the first half of the twentieth century, many substations had to be constructed in concert. Each of the 78 substations constructed were generally manned by two men, a maintainer and a helper. They

were responsible for adjusting the number of converters operating at a time, in order to keep up with demand. In the dead of night, only one converter might be online, but during the morning commute, an entire substation might be pumping.

The two men also had to keep the converters physically synced with the alternating current coming from the power stations. They would watch a synchroscope and manually adjust the synchronicity by hand. If the current wasn't synced, the power coming into the substations would deliver a powerful electric shock to the whole system, sometimes even causing the 60-ton converters to physically jolt from their foundations.

The converters worked on an oil circuit breaker due to the high voltages creating dangerous conditions. Arcs would form between contacts, which had to be doused with oil quickly or they risked causing explosions. The oil circuit breakers could approach 19 thousand volts, enough to kill a person instantaneously.

The job was dangerous, and few men served in the substations without picking up at least one gruesome tale of someone meeting their electrocuted fate. Safety regulations were relatively lax, so the workers would, for example, test whether equipment was energized by tapping it with a wooden stick with a metal tip. If it sparked and hissed, it wasn't dead.

New York is dense, there isn't a lot of spare room laying around to build dozens of substations. The buildings were accordingly built to disguise themselves in the environment. Standing tall, they could often only be distinguished from the surrounding neighborhood by their tall windows and lack of signage. One substation even went as far as to fake a commercial facade, putting out consumer appliances in the front window as if they were in the business of dishwashers and not powering the subway.

Every machine inside the station had a twin so that even if there was an electrical or mechanical failure, there would be little disruption to service. The beauty of the interiors was not a concern during construction, but as electric current was often flowing in high voltages, there was a need to properly insulate tools and systems. Wooden handles and marble paneling served as excellent insulators, and also gave substation systems a very unique and charming look, as well as protecting workers from unintended shock.

The anonymity of a substation lends it an air of mystique and drama that most industrial equipment doesn't possess. Any building could be a substation, chugging electricity and powering your world right under your nose. There were numerous different substations types, often varying in architectural style. Some rail lines even hired famed architectural firms in order to build their substations. It could be a tall and proud Beaux-Arts beauty, or a rugged modern box. We didn't have to build them beautiful, but we did. The substations slipped into the streets of New York City and pumped her heart for decades. Millions of New Yorkers rode the transit system while it was powered by them without even knowing they existed.

Decline and abandonment

Of course, technology changes, and the manually operated rotary converters that were typical of a substation began to be replaced by miniaturized mercury arc rectifiers. While lacking in the romantic appeal and industrial beauty department, mercury arc rectifiers are essentially maintenance-free and can be operated entirely remotely. The technology advanced, and new "substations" weren't grand halls dedicated to man's dominion over electricity but rather underground closets or windowless boxes. Sleek, convenient and modern, but something was lost.

The conversion was a slow process, New York Edison announced the switch in 1928, but it wasn't until 1978 that the company retired its last substation. By this time New York's subway was no longer a jewel in the cap of America's industrialization, but rather a vast under-funded headache. The substations had also been built to last, prepared for indefinite service; they required less upkeep even at their advanced age. Repair crews would cannibalize old equipment and decommissioned substations to keep them operational.

While some mercury arc rectifier stations were being built as early as 1932, it wasn't until 1959 that the transit system dedicated itself to a full conversion. The Transit Authority sold its power stations to the Con Edison company, and the terms of that sale bound Con Edison to deliver power to the substations until 1999. This would give the Transit Authority time to complete a full conversion and eliminate the old substations from their system.

The last manually operated substation was Substation 42 on 57th Street in Manhattan. Once powering almost all of Broadway and Lexington Avenue, by 1999 Substation 42 was a dinosaur. She was only ever powered up at peak hours to provide a little extra power. At the end of 1999, Con Edison discontinued service to these stations, and New York's once cutting-edge substation system never saw the twenty-first century.

The buildings weren't all torn-down though. Construction is expensive, and these buildings were made to last with thick walls and solid foundations. Many of the substations were transformed after their retirement. New York kept the soul of the substation alive by repurposing its structure for new ends. Movie theaters, auto repair shops, warehouses, office buildings, and more sitting where 60 ton oil circuit breakers and rotary converters once sat.

Strangely enough, the buildings that once served as the lifeblood of America's largest city continue to serve to this day, in one way or another. Like the vibrant taxi industry being reduced

to a gig economy of apps and anonymous amateurs in consumer cars, the city is growing more abstract. The invisible and abstract labor behind our everyday lives is harder to see than ever, but it's vital to understand how deliveries get to your doorstep, or food to your table, or even electricity to your subway car. Understanding the power and precarity of industry and technology is the first step to advancing it. And for now, take a closer look at your neighborhood, you might be surprised by what you find right under your nose. **For more of "It's History", don't forget to subscribe and check out our daily stories – this is ... signing off.**