Installation of Electrical System for Paso Robles Police Department

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This paper outlines the process that Peter Strykers and Jacob Studebaker went through to set up the lighting and power system for the Paso Robles Police Department gun range located off highway 46. Before our installation, the gun range had zero lighting so the officers could not use it after sunset. We allowed the officers to light the gun range with outdoor LED lights, light up both the storage units on site, and have access to multiple outlets inside and out of the storage units. The power source that the electrical system runs on comes from a Kubota generator because there is no city power that is supplied to the site. Included in our project was the installation of a 100-amp electrical panel that consisted of 3, 15-amp circuits to power the entire system. 2 of the circuits were powering the storage units on the site, and the other circuit powered the outdoor LED gun range lights. Through the guidance of our SME, Lonny Simonian, we were able to design this system. Through the guidance of David Studebaker, Jacob Studebaker’s father and career electrician, we were able to quickly problem solve while performing work at the jobsite.

Key Words: Gun Range, Police Department, Electrical System, Lighting, Power

Introduction

We reached out to multiple professors trying to find an opportunity to be part of a project-based senior project. Neither of us wanted to do a research-based project because we are both more hands on type of learners. We got involved with the Paso Robles Gun Range project through sending an email to Dan Knight, a construction management professor. Professor Dan Knight got back to Peter Strykers via email and introduced us to the idea of doing the installation of the electrical system at the gun range. Another student named Shelby Prosch, did her senior project on the schematic design of the system. So, it became our job to continue with a more detailed design and complete the physical installation. Professor Dan Knight connected us with the sheriff’s department commander, Caleb Davis, allowing us to take the first steps to solidifying our senior project proposal. The entrance to the jobsite has a padlock at the gate and there are also locks on the storage units, so we set up a meeting day with Caleb Davis on how to go about entering the site. We met Commander Davis at his office in downtown Paso then followed him to the gun range. There he showed us the lock combos and gave us
a tour of the site. We also discussed specifics like what type of lights we were to install and the location of the generator pad, electrical outlets, and electrical panel.

Jacob Studebaker completed the following tasks: mounting the electrical panel and junction boxes for outlets, switches, and lights, and also created the updated plan view of the jobsite. Peter Strykers completed the following tasks: making the concrete generator pad and cleaning out existing conduit using a shop vacuum. All other tasks were completed by both Jacob Studebaker and Peter Strykers. All these other tasks required two people and needed 4 hands to complete. When we were doing separate tasks, we still made sure that we the other person knew exactly what was going on.

**Project Funding**

The funding for this project came from the City of Paso Robles. The estimated cost we had before construction came out to be $3204.50. The actual cost at the end of construction was $3439.44. They gave us a credit card that we were allowed to use when we needed to shop at Lowes or Independent Electric. We kept all the receipts so the finance department was able to process all the charges. Our original budget was approved by Commander Davis, with an understanding that if costs were to exceed the original budget than we would be able to draw more funds for the project.

**Design Phase**

Since Shelby Prosch started the design of the system for her senior project, we had a basic idea of what needed to be done at the gun range. Her design was schematic, so there were many questions that still needed to be answered. Certain questions about the design that we had to figure out included the following: What size copper wire we were going to pull through the conduit? What size conduit were we going to lay? What kind of lights where we going to install? What type of SO chord were we going to run from the generator to the panel box? What amperage panel box with how many spaces would we need? How many circuits were we going to have? What type of outlets were we going to get? Where did underground pull boxes need to be? All these questions had to be answered by us prior to us breaking ground at the jobsite. The answers to these questions were found through working with our SME professor Lonny Simonian, and also through many back and forth emails with Commander Caleb Davis.
Pictured below is the schematic design plan view that Shelby Prosch created:
The construction part of the project was the most engaging and the most challenging. We showed up to the site early on a Friday morning and got as much done as possible until the sunset. The start of the construction process began with the creation of the concrete generator pad and the digging of the trenches where the conduit was going to be laid. To make the generator pad, which was a 4’x3’ slab, we used about 100 bags of quickrete and 2x4s with stakes to form it. This wasn’t too challenging for Peter as he has worked with concrete many times before. Once the generator pad was ready to start drying, Peter was able to help Jacob with the trenching. One thing that was extremely helpful was the fact that one of the officer’s father in laws owned a trencher which allowed us to expedite the trenching process while mitigating rental costs. We were able to complete all the trenching in one day. The next step in the process was laying the conduit and placing all the electrical pull boxes. One thing we had to be very careful of when gluing the conduit and laying it in the ground was to not let any dirt into the pipe. If this happened then pulling the wire through the conduit could have been very difficult due to added friction from the dirt.
While one person was laying and gluing conduit, the other person worked on the mounting of the main electrical panel, outlet boxes, junction boxes, light fixtures, and light switch boxes on the inside and outside of the storage units. This turned out to be more difficult than we initially thought because drilling into the thick steel of the storage unit walls was a pain. We overcame this problem by getting stronger drill bits and by being patient as we firmly pushed the drill against the storage unit wall. We used self-tapping screws to hold the boxes into place and 3/4” drill bits to make the holes for the outside outlets. We ran armored cable on the inside of the storage units to connect all the light switches, junction boxes, interior and exterior outlets, and light fixtures. We strapped the armored cable to the wall by drilling armored cable straps in the connex. We decided that each storage unit would be on its own circuit, while the outdoor LEDs for the range would be on its own circuit too. We got a total of three circuits running on the site.

Once the setting up of all the boxes inside and out of the storage units was complete, it was time to wire up the outlets, switches, and lights. This is where we connected the wire from the armored cable to the outlets, switches, and lights. Something we had to make sure of was to not have to much lead wire coming from the armored cable or else we wouldn’t have been able to stuff the outlet/switch into the corresponding box. We also had to make sure that our wire nuts were secured tight enough so our splice wouldn’t come undone.

After all the conduit was laid, and the storage units were wired up, it was time to pull wire throughout the whole jobsite. To do this we bought a 150’ fish tape and 8 spool wire caddy from Independent Electric. Pulling the wire through the conduit was rather difficult in some runs because of the number of 90 degree turns we had to go through. The more 90 degree turns there is in a run, the harder it is to pull the wire due to friction. As for pulling the wire up the iron poles for the outdoor LED range lights, we needed to get ahold of a scissor lift. The officers provided us with one and had it delivered to the site. Once all the wire was pulled, we spliced at all the pull boxes in the ground and at the bottom of the light poles.

The next step was to install the lights at the top of the poles. The back two lights at the gun range mounted very easily as they slipped right over the 3inch diameter poles. The front four lights closer to the targets didn’t mount as easily, so we ended up using hose clamps to fasten them to the top of the poles.

**Electrical Panel**

The electrical panel was the final step in our construction process. This is where we connected our 12/4 SO chord to the panel. We ran the chord from the generator to the panel and then attached our 2 hot wires (red and black) to the two busbars and our ground and neutral (green and white). We then added our 15 amp circuit breakers to 3 of the 6 available spaces in the panel. Each breaker had a black hot wire coming from it going towards its corresponding circuit. We also had to wire each circuit’s neutral and ground into the panel.
Below is an image of our wired-up panel.

First Trial

Once the panel box was all buttoned up and wired, it was time for the two of us to face the moment of truth that we have been waiting for. It was time to start the generator and turn on the circuit breakers. We plugged in our SO chord, switched the generator on, and crossed our fingers. When we walked inside the first storage unit we saw that first light was on, but the second was not. So, we knew that there was some sort of connection error within the circuit following the first light fixture. This was an
easy fix because after pulling apart the second light fixture, we noticed that there was a splice that had come undone. There was a wrong sized wire nut being used. The wire nut was too large, so the copper splice was able to come undone. We got the right sized wire nut, re-spliced, and then put the fixture back together again. This fixed our issue and we were able to get the first storage unit completely lit up. As for the second storage unit, both lights wouldn’t turn on, but we discovered that the first outlet in the circuit did have power. We figured out that the second outlet in the circuit must’ve had an issue. Again, this was an easy fix which just took a rewiring of the faulty outlet, and we got the whole circuit working in the second storage unit. For the outdoor lights, the front four LED lights where all turned on, but for some reason the back two wouldn’t fire up. We couldn’t find a messed-up splice and were very confused for a long time. Eventually we figured out the issue. The back two lights came with a photocell. This is a sensor that can detect light and will prevent the fixture from turning on if it does. To overcome this issue, we simply taped the photocell with black duct tape so it would always assume that it is dark. Once we did this, we got both back lights to turn on. After resolving all these issues, we had a fully functioning electrical system set up at the Paso Robles Police Department Gun Range.

Lessons Learned

While working on this project, Jacob and Peter ran into some issues. They knew this was inevitable and that they would have to resolve these issues as they worked. One of the first things they struggled with was drilling holes into the connex so that they could mount junction boxes and outlets. They ended up using a uni-bit to drill the holes and inserted a ¾” rigid nipple that fit through the junction boxes and outlets. When it came to mounting the panel board, Jacob and Peter had to work around the depth of the corrugated metal walls. They bought 8 inch bolts that went through the panel board all the way to the back of the connex wall. Another lesson they learned was that existing construction from previous projects is not always done properly. For instance, one of the preexisting conduits that ran beneath the concrete paths was not long enough. The conduit was about 8 inches from the edge of the concrete, which made it impossible for them to use that conduit run for their electrical raceway. Another lesson learned came from using the trencher. When they were doing the trenching with the ditch witch, they ran into a layer of asphalt that was about 12 inches under the ground surface between the two connexes. When the trencher would tear through the asphalt, large chunks of asphalt would get stuck in the machine and bind it up. It took about an hour before Jacob and Peter realized that they needed to reverse the machine to unbind the chunks of asphalt. Another lesson learned regarded sequencing of subcontractors on a project. In order to mount the lights, a welder needed to come out to weld holes on the top and bottom of each. Unfortunately, Jacob and Peter had already pulled the wire through the poles when the welder came out to weld. This led to the wires melting together from the heat of the welds.

Photos
Armored Cable, Junction Box, Outlet Box, and Switch Box Installed

Splicing at Junction Box

Installing Outlet
Pulling Wire

Splicing Wire at Bottom of Light Pole

Outdoor LED light Install

Outdoor LED light Installed
Wiring Up the Panel

Completed Panel Board

SO chord plugged into Generator

Compacting Trench

Storage Unit Lit Up

Securing Armored Cable
View of Lights on at Night from Behind the Targets

View of Lights on at Night from Right side of Gun Range
View of Lights on at Night from Left side of Gun Range

View of Lights on at Night from Behind Gun Range