**ENGINEERING PROFESSIONAL CAREER EPISODE 2**

**(2.0) Introduction**

This career episode describes the engineering activity I acquired during my career path as an Engineer 1 employee of the Federal Capital Development Authority (FCDA). I worked at the construction of plot 447, Maitama District Abuja, as an Electrical Engineer overseeing the design and construction of the electrical components in district project.

**(2.1) Chronology**

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| PROJECT TITLE | Construction of Plot 447 District, Maitama Abuja |
| DATE FOR THE PROJECT | February 2009 - July 2013 |
| DURATION | 4 years |
| NAME OF ORGANISATION | Federal Capital Development Authority (FCDA) |
| LOCATION | Maitama, Abuja, FCT |
| MY ROLE | Engineer 1 |

**(2.2)** **Background**

The Federal Capital Development Authority (FCDA) is an organization mandated by the Federal Government of Nigeria to build the Federal Capital City of Abuja. The organization is working with a decree established in the year 1976. The Engineering department of the organization has been developing districts within the capital city. The department comprises of civil engineers, Electrical Engineers, and some mechanical Engineers. The electrical division oversees the design, construction, supervision of electrical infrastructure projects in districts. This includes the laying of underground cables (HV and LV) and the reticulation of electrical services to plots in the district along with streetlight and telecommunication connections in district projects. Other projects include the construction of injection substations in districts, transmission of 33KV and 11KV power lines (both underground and overhead services).

The organization takes its yearly budget from the Federal Appropriation bill. The organization has over 3,000 employees in its payroll.

**(2.3)** The main objective of the project was to service plot owners in the district by supplying electrical power to them. The initial plan for the district was for it to be a sports arena; the project changed due to the governments' concern for its proximity to other sports arena. The district was planned, designed, and plots assigned to individuals. Other motives of the project could be represented in the points below:

* To illuminate the road of 2.16km having total number of seventy-six plots in an effective manner.
* To execute the assigned project in the organization in a transparent way.
* To make the flexible electrical network to take the electrical power form the 33/11kV, 3X15MVA injection substation in Maitama district Abuja.

The contract for the provision of infrastructure was awarded, with the design done and submitted to my organization. The total number of plots was seventy-six, and the entire length of the road was 2.16KM, which had to be illuminated with streetlights.

The electrical network had to be designed to take its source from the existing 3X15MVA, 33/11KV injection substation in the Maitama district Abuja.

**(2.4)** The responsibilities which I carried out as an Engineer 1 during the project included:

* Reviewing the design that was submitted by the civil design group to ensure that the electrical design can be accommodated.
* Making corrections in the design by adding omitted parameters and avoiding cases of overbilling and under billing in the BEME (Bill of Engineering Measurement and Evaluation).
* Design and Supervising the construction of the High Voltage line to the district by way of laying 11KV underground cable from the injection substation to four package substations 500KVA 11/0.415KV and terminating them with 3X150mm XLPE 11KV armored cable.
* Design and supervise the laying of low voltage cables to the individual plots with the incorporation of distribution feeder pillars with 36 no 63A fuses and 4X95mm cable was used to connect the feeder pillars to the plots.
* I supervised the laying of underground armored cable, both High Voltage and Low voltage, by using IEEE specifications and ensuring proper quality control.
* I Designed and supervised the construction of the streetlight network by connecting the streetlight to the lighting kiosk, which is inbuilt in the package substation.
* Discuss with other electrical engineers on-site to make sure standards are maintained.
* Organize monthly site meetings with the Head Electrical Division to give a detail report of jobs done on-site.

**(2.5)** The figure below shows the complete hierarchy of the project, showing my role in blue.

**Chief Resident Engineer**

**Technical workers**

**Engineer 1**

**Head Electrical Division**

**Engineer 1/ Technical workers**

**Head Mechanical, Water&sewage**

**Technical workers**

**Senior Engineer**

**Technical workers**

**Head Roads and Pavement Division**

**Senior Engineer**

**Senior Engineer**

**Headwater and stormwater Division**

**Secretary**

**Assistant Chief Resident Engineer**

**Nature of Particular Work Area**

The project required both civil and electrical work. I had to visit the site in company of the project team to investigate the environment, size of the work area, and the topography. I examined the nature of the soil to come out with the type of cables to be used and the depth the trenches has to go before laying cables. I discovered that the area was swampy in nature which will make construction and installations difficult.

**Personal Engineering Activity**

**(2.6)** In this project, the High Voltage (HV) design that was earlier proposed was faulty because the directions shown in the plan did not conform to electrical design specifications. The HV line was proposed to be on the same route as other services like the water pipes and the sewage lines; also the 11kV lines were running on both sides of the road. The proposed design omitted the road crossing which was essential during maintenance

In resolving these issues, I teamed up with the Head Electrical Engineer by:

* Designing the 11KV line to be on a route different from other service lines. We did this to avoid problems like hazards that might arise when water and sewer lines are being serviced. This could cause explosions or electrical hazards.
* Designing all HV lines to be on the same route to avoid electromagnetic flux that arises when they were on opposite sides of the road

**(2.7)** During the project design, knowing the area was swampy in nature, the type of cables and equipment had to be taken into cognizance. For the HV cable, I recommended that the screened S.l type 3 core armored cable should be used, because it minimizes the possibility of core to core breakdown. I suggested using the S.1 type three core armored cable to the associated members as it was easy to lay in the underground as it could be bent easily due to prevention of the total lead sheath, capable of withstanding the moisture of the soil and of minimizing the total degradation as well as it was capable of carrying the higher capacity current as compared to the stranded cables. Secondly, the bending of cable became easy due to elimination of overall lead sheath. It brought the degradation of the cable minimal due to the excessive moisture of the soil. For the Low Voltage (LV) cables, I recommended utilizing the MC Cable type with PVC in the low voltage cables as it contained corrosion resistant jacket, high tensile strength, flexible, easy to joint and was a good conductor of electricity.

To facilitate the voltage of required level, I picked the suitable transformer of appropriate ratings. For the transformer and feeder supply, I assisted in taking metals equipment as they were less susceptible to the corrosion as well as longer life span. To facilitate the electrical charge from one place to another, I recommended utilizing the copper wire as it had high conductivity and low resistivity and positive temperature coefficient. To decrease the value of the earth resistance in the swampy area, I assisted to follow the water table of that area.

**(2.8)** During the design, I discovered the power allocated for the district from the injection substation was not enough to compare to the district load demand. I had a meeting with the operators at the injection substation, and they asked me to come out with proof that can substantiate my request for higher allocation. I had to calculate the load demand analysis of individual plot owners to conform to the already designed load requirement for the district. I determined the power transmitted from substation to the distribution feeder. I compared the total power available from the substation to the distribution feeder to find whether load demand was met or not and to avoid the load shedding in the districts and to facilitate the essential power to the consumers. I calculated the amount of power required for the district by classifying the plots into four parts such as low density, medium-density, high density and street lighting. I evaluated the total demands of those consumers by using the maintenance factor, utilization factors, reduction factors etc. I prepared the block diagram of the power system network from the injection substation to the house through distribution substation and form feeder pillars. I assumed the reduction factor in power from the distribution substation to the feeder pillar was 0.8, and that form feeder pillar to house as 0.7 as the utilized cable and devices were not fully transformed the electric charge with elapse of time and undergoes certain wastages in the form of heat.

The plots were divided into three house types based on their land use.

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| --- | --- |
| **LAND USE** | **TOTAL LOAD REQUIREMENT** |
| Low density | 17.076KW |
| Medium-density | 7.86KW |
| High density | 5.62KW |
| street lighting | 543.09KW |

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**FEEDER PILLARS**

**11/0.415KV DISTRIBUTION S/S**

**INJECTION S/S**

REDUCTION FACTOR 0.8 REDUCTION FACTOR 0.7

*Fig: Block diagram of supply from substation to house*

*Table: Calculation*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Description** | **No. of Plots** | **No. of Dwelling Unit/Plot** | **Power for One Dwelling Unit/Plot** | **Total Required Power for a Plot** | **Reduction Factor for Transformer load & Feeder Pillar** | **Power Demand(KW)** | **Rated KVA** | **Required No. of 500KVA Transformer**(*on 80% loading*) |
| Low density | 36 | 1 | 17.07 | 614.52 | 0.56 | 344.13 | 403.2 | 1 |
| medium density | 16 | 4 | 7.86 | 503.04 | 0.56 | 281.702 | 169.02 | 1 |
| High density | 24 | 6 | 5.62 | 809.28 | 0.56 | 453.196 | 347.44 | 1 |

After proper calculation, the total load demand was determined, and the ratings of the package substation were known. I made sure the appropriate reduction factors were implemented.

From the calculation, the streetlight got a package substation, which made the total number of package substation units to be 4 with a plan for spare or future expansion. The FCDA specifications stipulate a 500KVA transformer as a standard for district infrastructure projects.

With this calculation, the operators were convinced that the area needed more allocation of power, which made them increase the rating of the switchgear at the injection substation. I submitted the calculated parameters to the operators of the injection substation and thoroughly explained the power demand by the consumers and recommend them to increase the ratings of the power devices and switchgear utilized in the injection substation to ensure the reliability of the power system networks. I created situation to avoid underutilization and overvaluation issues. I suggested utilizing 11/0.415kV 500kVA for package substations with 3X150mm XLPE armored cable in the HV lines.

**(2.9)** I designed the 11kV network to be a ring-type distribution .which made all the 500KVA package substation linked together using the Ring Main Unit (RMU). With the RMU, stability was brought to the network, and the RMU also acted as protection for the HV network. I employed thirty-six numbers of feeder pillars to distribute the powers as well as sixty-three-ampere fuses along with 4\*95mm cables. This electrical engineering knowledge I gained from electrical engineering design and installation training

**(2.10)** To get the suitable sizes of the LV cables to avoid overloading of LV line, I considered some parameters; for example, I applied my electrical engineering knowledge in getting load demands and making sure cables that can carry the loads are procured.

1. For the LV cable connection from the compact transformer to the feeder pillar, I came out with the calculation. I considered highest possible numbers of plots on single feeder pillar as five and power on each slot as 17.08kW to avoid the overloading on the LV lines, as overloading on the LV lines decreased the life expectancy of utilized cables. I evaluated the total power required by the feeder pillar as 85.4KW and current required as 118.81A through utilization of the derived formula. I considered the coincidence as well as group factors and evaluated the current and found Is as 157.99A. In the design, I implemented the cable of size 4\*95mm2 of PVC/SWA/PVC to carry the calculated current without undergoing short circuit faults, insulation breakdown, to withstand the voltage drop.
2. For the LV cable connection from the feeder pillar to plots, I consulted the Nigeria Electricity Supply and Installation Standards Regulations (NESIS), where 4x 50mm2 was recommended.

**(2.11)** Executing the project was not that easy because of the swampy nature of the area. Laying underground cables became a task that needs a lot of Electrical Engineering knowledge. To avoid problems of cable malfunctioning after the execution of the project, I have to come up with cable protections. For the HV cables I directed an excavation of 1200mm, trenches were two 11kV cables has to be laid together, a minimum distance of 300mm was maintained between the cables. The HV cable routes were indicated at surface level with cable markers at suitable intervals, particularly where the cable changes direction stating the voltage level. For the LV cables, I directed an excavation of 900mm. All of them (both the HV and LV cables) in bed of sifted soil or sand with concrete slabs for the HV cables to prevent mechanical damage of the cables. In trenches where the HV and LV cables had to be laid together because of limitation of road corridor, the trench had a width of 300mm and a depth of 1200mm for the HV cable and 600mm for the LV cable.

For road crossings, I made sure they were all ducted following the IEC 61084: 1-2 standard.

**(2.12)** While inspecting the cable trenching process, I found that lots of cables were to be joint. I realized that improper joining of the cable may lead to the higher voltage drop and malfunctioning of the cables and have to do unplanned maintenance. To avoid the malfunctioning of the cables and to minimize the voltage drop and to enhance the performance of the designed cables, I consulted with the cable manufacturers to join the cables in the proper way. I recommended to facilitate the barrel type copper compressor lugs and crimps to prevent the moisture ingress. I suggested layman to implement the cable of different color code, and each type of cables was covered with the heat shrink tubing along with the adhesive sealant. By doing so, possible errors were eliminated.

**(2.13)** While inspecting the feeder pillars, I analyzed that installed pillars might execute corrosion due to direct contact with the soil. So the life expectancy of the pillar and the equipment that came in direct contact with the soil might decrease. For increasing the life expectancy of the pillar, problems related to the project had to be solved in an effective manner. I conducted series of discussion with the engineers of civil department to mix the proper concrete and beams for installation purpose. I realized that by designing the base of 8ft\*9ft for the package substation and by facilitating 7ft distance for the termination purpose by utilization of the copper lugs, problems of corrosion could decline. Then, effective plinth design was executed by employing the 7ft dimension among which the plinth 3ft above the soil. I recommended to make the several boxes of the fibre to avoid corrosion, and all terminations of the copper lugs were done effectively.

**(2.14)** In this project, I made sure the BEME (Bill of Engineering Measurement and Evaluation) was followed to detail. I avoided any case of overvaluation and issues of underutilization. And when there was any case I had to make a change, I usually bring it up during monthly site meetings for approval

**(2.15)** I made sure proper electrical earthing materials were used by making sure all-metal casing were earthed using the Protective Multiple Earthing System (PME). PME system is where the neutral conductor is connected to the general mass of the earth at several locations. I made sure that the reading of the earth resistance test did not exceed 2 ohms

**(2.16)** During the project, I had weekly meetings with the Head Electrical, and this meeting enabled us to keep abreast of all that had happened in the previous week. We also had monthly meetings with the Chief Resident Engineer, which is where the chief resident Engineer got operational briefings for the electrical division of the project. Hence the incorporation of the electrical job to the project in general.

**(2.17)** while working on the project, I did some social activities. I arranged meetings with the residents of the district. This helped me understand the challenges they faced with the quality of power supply to their homes.

**(2.18)** By the end of the project, I was able to achieve the set goals for my organization. The project was a complete success. We put to use the four package substations, and the streetlights illuminated the roads flawlessly at night.

**(2.19) Summary**

The project was outstanding, and I used my skills as an electrical engineer to achieve the set goals and also gained knowledge and experience from my boss. Though the project got delayed due to budget limitations, the quality of electrical work was excellent, and the individual plot owners were satisfied with the quality of the electrical supply received.