FLUOR

King Fahd University of Petroleum & Minerals

Flour Arabia Limited (FAL)

Summer Training Report

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1. Introduction

The college of science engineering gives a chance to their students to spend 8 weeks in industrial companies. This training gives the student the opportunity to see what they have studied and how to deal with the practical live. My training program was in the period from Saturday,3 July 2010 to Wednesday , 25 August 2008 at Flour Arabia Limited (FAL) in AL-Khober.

2. Fluor Arabia Limited (FAL)

Fluor Corporation is one of the world's largest publicly owned engineering, procurement, construction and maintenance services companies. Clients rely on Fluor to deliver world-class solutions that optimize their assets, improve their competitive position and increase their long-term success. It is ranked No.1 in the "Engineering, Construction" category of America's largest corporation. Also, it is ranked as No.1 on ENR (Engineering News-Record) magazine's lists of top 100 Contractors by new contracts and top 100 Design-Build Firms.

Fluor Arabia limited (FAL) has been a constructive force in Saudi Arabia since 1947 and has played a major role in supporting the development of Saudi Arabia. FAL has two primary objectives, first, to provide world class EPC services to their clients and second, to maintain world class engineering center electronically linked to other Fluor offices and capable of providing cost effective quality engineering services.

A total of 26 nationalities are in FAL's workforce. Most of workforce is well acquainted in Saudi Aramco standards and procedures and the requirements of the Royal Commission in Jubail and Yanbu, and the Saudi Electricity Authority (SEC).

3. Electrical Orientation

Electrical today is involved in every stage of a project from initiation to completion. It deals with engineering, design, selection and application of power systems, equipment, control and protection for the electrical distribution network. It involves the understanding of principles for power generation, distribution, control and protection. Electrical consist of detailed Electrical engineering activities including construction engineering, support, and startup assistance. The Electrical function can be divided into two functions; **Electrical Engineering and Electrical Design**.

3.1 Basic Responsibilities of Electrical Engineering and Design

Electrical Engineering is the application of power, power distribution, and power control concepts to plant operation. It deals with the engineering, design, selection and application of electrical equipment hardware for the powering of plant processes and units. Electrical Engineering performs power studies, defines systems and specifies major electrical equipment.

On the other hand, The **Electrical Design** group's function is to convert the engineering data into construction deliverables. It also specifies the non-engineered items known as 'Electrical bulks'. These include cables, cable trays, junction boxes and all other items required to complete the Electrical systems.

3.2 Design Development

3.2.1 Electrical Engineering

Electrical Engineering is responsible for the following project activities:

- Develop overall Power Distribution philosophy.
- Develop power studies.
- Develop Single Lines.
- Prepare equipment specifications and data sheets.
- Size, select and specify electrical equipment.
- Procure electrical items and equipment.
- Prepare HV/MV/LV systems specification.
- Develop Substation layout.
- Assist in commissioning, checkout and start up.

3.2.2 Electrical Design

Electrical Design is responsible for the following project activities:

- Prepare standard installation details.
- Prepare wiring diagrams.
- Prepare cable schedules.
- Prepare schematic diagrams.
- Prepare 3D model.
- Prepare electrical equipment location and all plan drawings.
- Prepare single line diagrams.
- Perform heat tracing calculations and prepare drawings (if in Electrical scope).
- Prepare lighting / small power and grounding plans.
- Perform tray fill, lighting and grounding calculations.
- Develop heat tracing zone drawings.

Basic design of Electrical systems:

We have many different electrical systems in every application such as **lighting system**, **grounding system and cable trays system**. They are important since they provide safety and facility in maintenance. Let's have a trip in these three systems.

4. Lighting System

Before talking about designing lighting systems, let us go through the types of lighting and their applications and specifications.

4.1 Types of Lighting

4.1.1 HID (High Intensity Discharge)

There are four types under this one and they are summarized in this table:

Type of HID	High Pressure Sodium (HPS)	Low Pressure Sodium (LPS)	Metal Halide (MH)	Mercury Vapor(MV)
Lamp watts	35-1000	35-1000	100 to 1500 watt	40-10000
How!!	passing an electric current through sodium vapor	Passing an electric current through sodium vapor	passing an electric current through an arc tube containing various metal halides	passing through mercury vapour
Efficiency (lumen/watt range)	80-140	137-183	70 – 125	30-63 Least
Color Rendition	Poor	Poor	Good	Good
Life Time(Hours)	24000	24000	20000	24000

Table 1: Types of HID

4.1.2 Fluorescent

This kind of lighting has several characteristics as following:

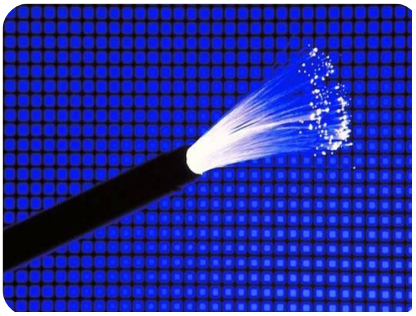
- Lamp wattages generally less than 80 watts.
- Produce light by ionizing mercury inside of a glass tube causing phosphors on the inside of the tube to glow.
- Efficiencies of 30-100 lumens / watt.
- Color of light produced varies, cool white is standard in industrial applications.
- Lamp life – depends on type of lamp, F32/T8 lamp is about 20,000 hours.
- Very high sensitivity to temperature variations! High temperatures cause the ballast to fail prematurely and low temperatures will not allow lamps to ignite.

4.1.3 Incandescent

- Lamp wattages 25 to 1000 watts.
- Produces light by electrically heating a wire filament to incandescence.
- Efficiencies of 10-23 lumens / watt.
- Color of light is white (except for colored styles).
- Many styles and shapes of envelope.
- Starting is immediate, light output is immune to temperature variations.
- Lamp life – approximately 1000 hours for industrial lamps.
- Normal Lamps are subject to poor performance in high vibration areas.

4.1.4 Fiber Optic

- Limited applications for clean rooms and areas not easily accessible.
- Utilizes a remote mounted, common lamp source and transmit a beam of light down fiber optic cable to a lens.
- Maintenance is minimal on remote fixtures.



4.2 Designing

To design a lighting system, we have to consider the human needs and the environmental requirements.

4.2.1 Human Needs

- Types of tasks being performed.
- Glare effect.
- Color quality of lighting system.
- Type of equipment being used.
- Age of occupants.

4.2.2 Environmental Requirements

Physical arrangement of lighting fixtures:

How will the fixtures be supported (i.e. pendant, ceiling, wall…)**?**

Are there any obstructions in the way of the proposed fixtures locations**?**

Are you trying to match existing fixture arrangements**?**

How the proposed mounting heights exceed your fixture's capabilities**?**

Shadows:

Is the equipment in the area restricting distribution of the fixtures**?**

Is the surrounding equipment dark or dirty**?**

Is the floor made of grating**?**

Will the day-to-day operations restrict lighting distribution**?**

Amount of vibration of equipment:

Is the equipment surrounding the area subject to periods of high vibration**?**

Is the environment subject to periods of severe upheaval as in an offshore rig**?**

Is the vibration vertical or horizontal**?**

Corrosion Protection of Equipment:

What is the corrosive element present**?**

Is the fixture you are proposing suitable for this environment**?**

Is the corrosive agent gas, liquid or dust**?**

Ambient Temperature Requirements:

What are the temperature variations of the environment**?**

Are they present due to equipment being operated periodically**?**

If the ambient temperature is elevated above normal, is it being done by the Sun, by equipment surrounding the area, or both**?**

Is it required that fixtures stay energized 24 hours a day**?**

All the above questions shall be answered and considered when we want to design a light system.

5. Grounding System

A connection made with a conductor, whether intentional or accidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent, which serves in place of the earth. For mankind nature has provided “EARTH” as the single largest grounding conductor.

5.1 Grounding Systems Serve Four Main Functions

- Equipment or Safety Grounding.
- System Grounding.
- Lightning Protection System Grounding.
- Static Discharge Grounding.

5.2 Design Consideration

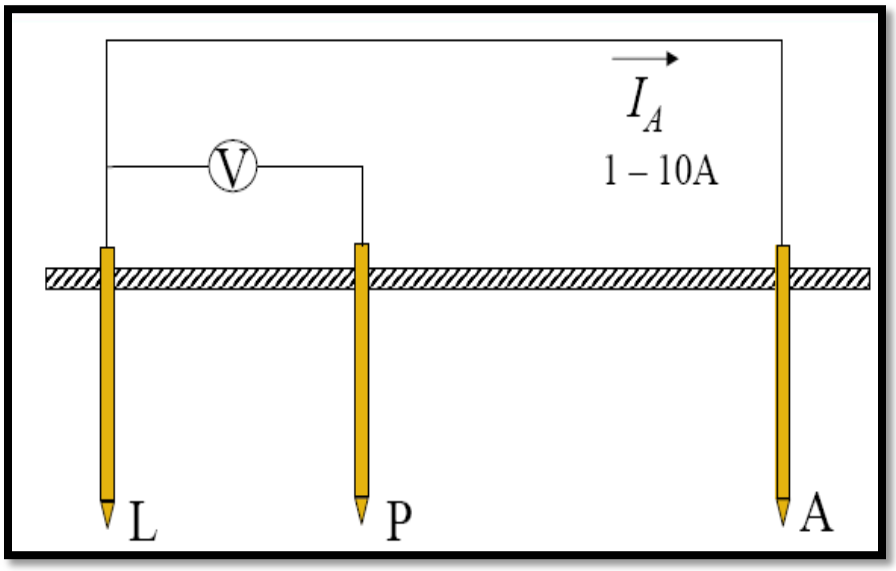
In the event of a fault or other transient phenomena (Lightning or switching transients) the ground grid must:

- Ensure personnel safety.
- Protect equipment against damage.
- Grid must be able to withstand the maximum ground current without damage.
- Limit the ground potential rise between two points to a safe value.

Figure 1: Ground Grid

5.3 Measurement of Ground Resistance

Current I_A is passed through auxiliary probe A. Voltage between L and P is measured. R is then calculated based on IA and VLP. Finally, several ground resistance measurements are taken and the results are averaged.



5.4 Grounding Electrodes

Grounding electrodes shall consist of:

A) Manufactured grounding electrodes.

- Consists of 2 rod electrodes or more bonded together and spaced typically 3m apart.
- Plate electrode.

B) Field assembled grounding electrodes.

- Min 6m bare copper conductor buried or encased on concrete

C) In-situ grounding electrodes.

- Copper water pipe.

Soil Description	Group Symbol*	Average Resistivity (Ω·cm)	Resistance of 5/8 in (16 mm) x 10 ft (3 m) Rod (Ω)
Well graded gravel, gravel-sand mixtures, little or no fines	G W	60 000–100 000	180–300
Poorly graded gravels, gravel-sand mixtures, little or not fines	GP	100 000–250 000	300–750
Clayey gravel, poorly graded gravel, sand-clay mixtures	GC	20 000–40 000	60–120
Silty sands, poorly graded sand-silts mixtures	SM	10 000–50 000	30–150
Clayey sands, poorly graded sand-clay mixtures	SC	5000–20 000	15–60
Silty or clayey fine sands with slight plasticity	ML	3000–8000	9–24
Fine sandy or silty soils, elastic silts	MH	8000–30 000	24–90
Gravelly clays, sandy clays, silty clays, lean clays	CL	2500–6000†	17–18†
Inorganic Clays of high plasticity	CH	1000–5500†	3–16†

Table 2: Resistively of Soils and Resistance of single Rods

5.5 Ground Rod Formulas

- Contact resistance of one ground rod.

  $$R = (\rho / 2\pi L) \times Ln \{(4L/ a) -1\}$$

  ρ = Soil resistivity in Ω-cm

  L = rod length in cm

  a = rod diameter in cm

- Contact resistance of multiple ground rods.

  $$R_n = R_n \times 2 - e^{-0.17}(n - 1)$$

  n = number of ground rods

- Ground Rod Separation.

  D = 2.2 X L

Design Problem:

Let us consider a substation with following equipments and we want to design a ground system for it.

1. **Modular Substation incorporating:**
   - 5 kV Switchgear and Motor Control Centers(MCCs).
   - 600 V Switchgear and MCCs
   - UPS power distribution system
   - DCS Control System
2. **Grounding system consists of:**
   - Power Distribution System Ground
   - 5kV Low resistance ground system sized at 200A
   - 600V High resistance ground system sized at 5A
3. **Equipment Ground.**
4. **Instrumentation ground.**
5. **Lightning surge arrestor ground**

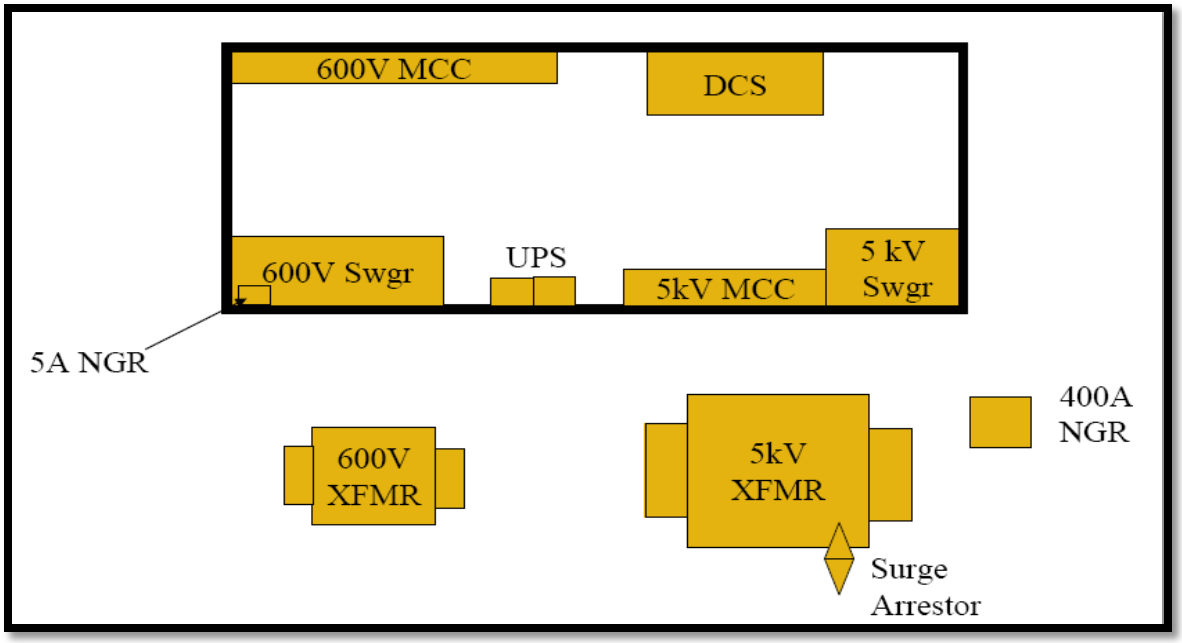


Figure 2: Substation Layout

600V NGR (Neutral Ground Resistance):

- 1500kVA Transformer.
- Estimate max 1.5 amps charging current.
- Rule Of Thumb for NGR sizing is 3 X Charging current.
- NGR resistor sized at 5A.
- Using a ground rod with 300 cm long and 1.6 diameter. In addition, if we place the ground grid in a clay soil, then the resistivity is **6500**.

  So, using the equations we got:

  R = 3.44 X 5.62 = 19.37 ~ 20Ω per ground rod
- Ground Rod Separation:

  D = 2.2 X L

  D= 2.2 X 300 cm = 6.6 m

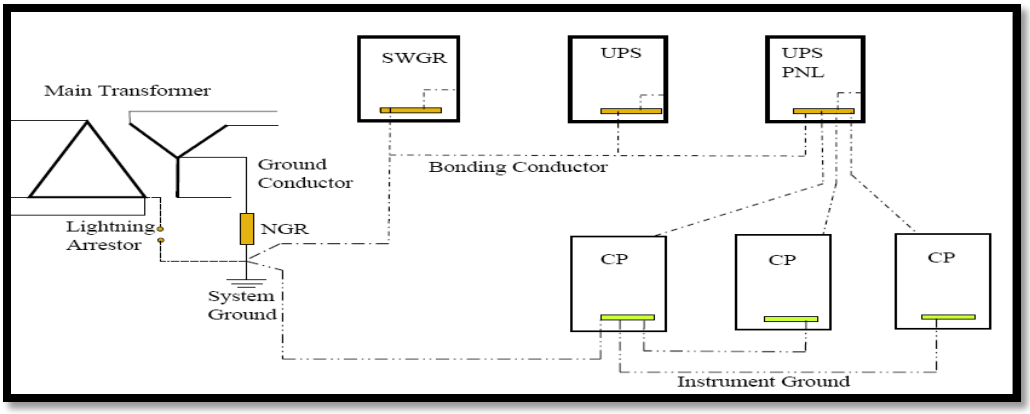


Figure 3: Distribution Substation Ground Scheme

The final ground grid system will be like this:

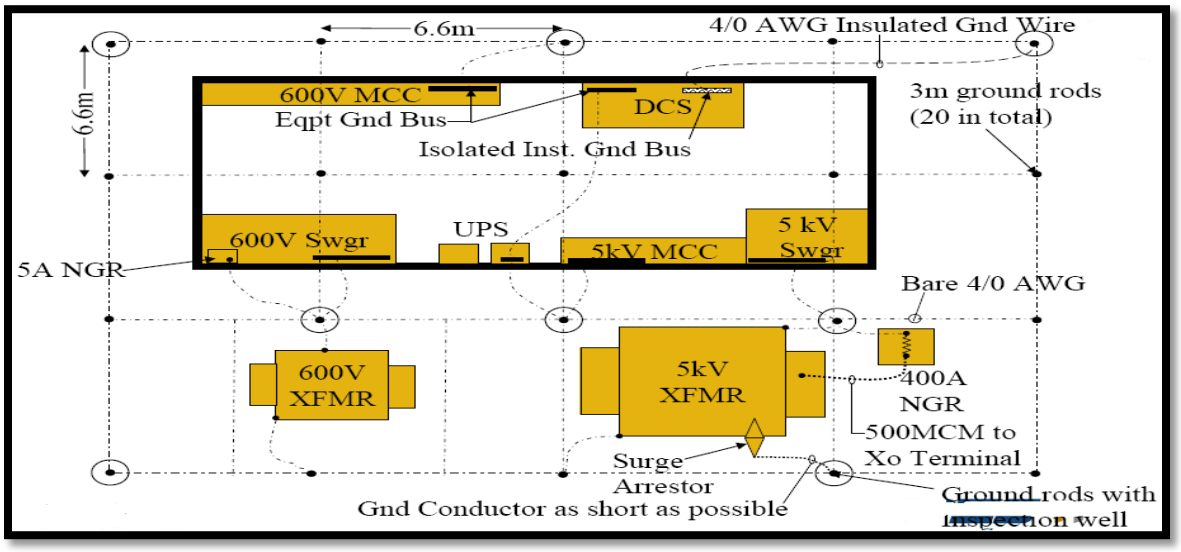


Figure 4: Final design for the Substation

6. Cable Tray

In the electrical wiring of buildings, a cable tray system is used to support insulated electric cables used for power distribution and communication. A cable tray system is "a unit or assembly of units or sections and associated fittings forming a rigid structural system used to securely fasten or support cables and raceways.

6.1 Types of Cable Trays

There are many types of cable trays depending on the applications and the distance used.

- ***Ladder Cable Tray:***

It provides Solid side rail protection and system strength with smooth radius fittings and a wide selection of materials and finishes. Ladder Cable Tray is generally used in applications with intermediate to long support spans, 12 feet to 30 feet.

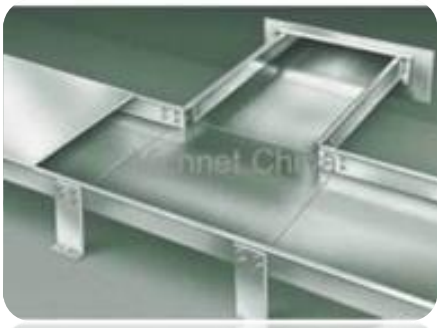
- ***Solid Bottom Cable Tray:***

It provides Non-ventilated continuous support for delicate cables with added cable protection available in metallic and fiberglass. Solid Bottom cable tray is generally used for minimal heat generating electrical or telecommunication applications with short to intermediate support spans of 5 feet to 12 feet.

- ***Trough Cable Tray:***

It provides Moderate ventilation with added cable support frequency and with the bottom configuration providing cable support every 4 inches. It is available in metal and nonmetallic materials. Trough cable tray is generally used for applications with short to intermediate support spans of 5 feet to 12 feet.

- ***Channel Cable Tray:***

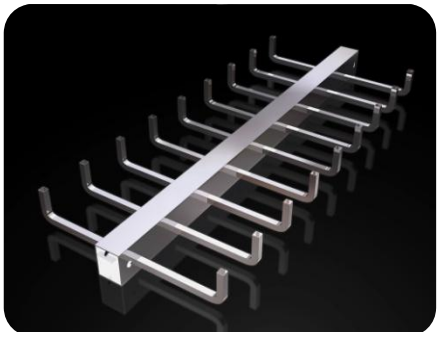


It provides an economical support for cable drops and branch cable runs from the backbone cable tray system. Channel cable tray is used for installations with limited numbers of tray cable when a conduit is undesirable. Support frequency with short to medium support spans of 5 to 10 feet.

- ***Wire Mesh Cable Tray:***

It provides A job site, field adaptable support system primarily for low voltage, telecommunication and fiber optic cables. These systems are typically steel wire mesh, zinc plated. Wire Mesh tray is generally used for telecommunication and fiber optic applications and are installed on short support spans, 4 to 8 feet.

- ***Single Rail Cable Tray:***



These aluminum systems are the fastest systems to install and provide the maximum freedom for cable to enter and exit the system. Single Rail Cable Tray is generally used for low voltage and power cables installations where maximum cable freedom, side fill, and speed to install are factors.

6.2 Advantages of Cable Trays

Cable trays have many advantages such as

- Safety Features.
- Dependability.
- Space Savings.
- Cost Savings.
- Design Cost Savings.
- Material Cost Savings.
- Installation Cost & Time Savings.
- Maintenance Savings.

7. Automation

Software programs are very important tools in Electrical field since they give accurate results causing less time and less cost.

There are many programs but during summer training, I learnt three designing programs used for electrical design such as MicroStaion, PDS-Electrical raceway and Luxicon.

- **MicroStation:**

  It is a CAD software product for 2- and 3-dimensional design and drafting**.** It is important since it Provides accurate materials lists for every item included in the design.

Example

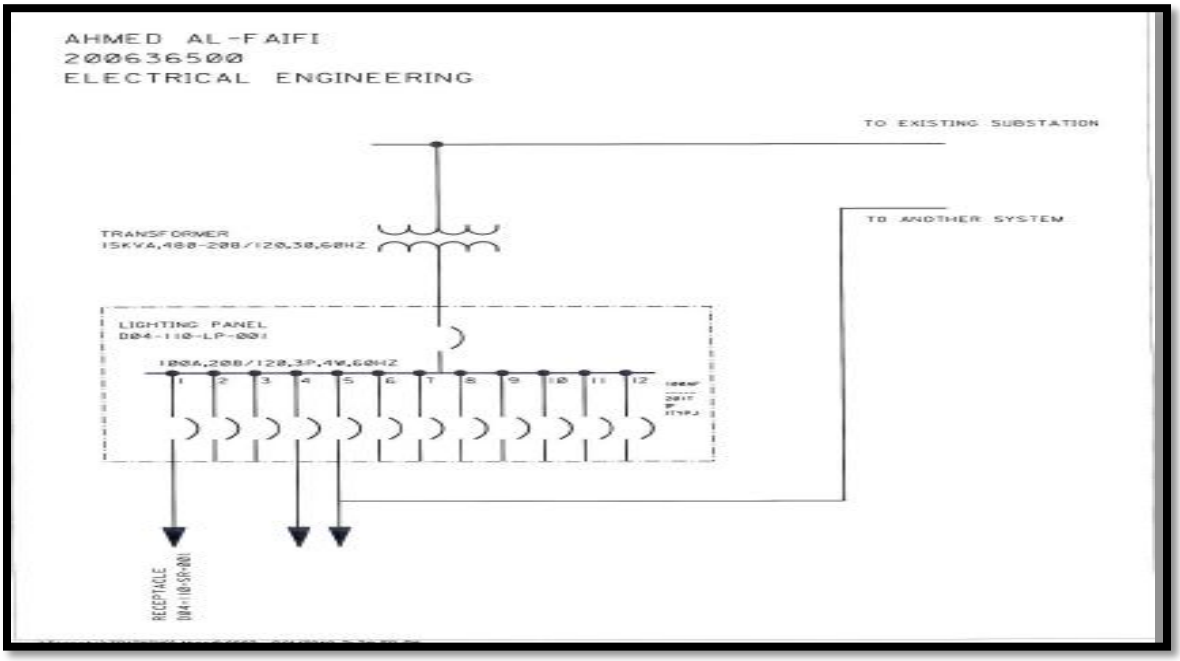


Figure 5: Design using MicroStation

This design is about several breakers connected through a transformer to the existing Substation. Then, the breakers are connected to other systems.

- **PDS-Electrical raceway:**

It is a big program used in many fields such as electrical, civil, piping and control. In electrical, this program is used to design cable trays and cable trenching as shown in the figure.

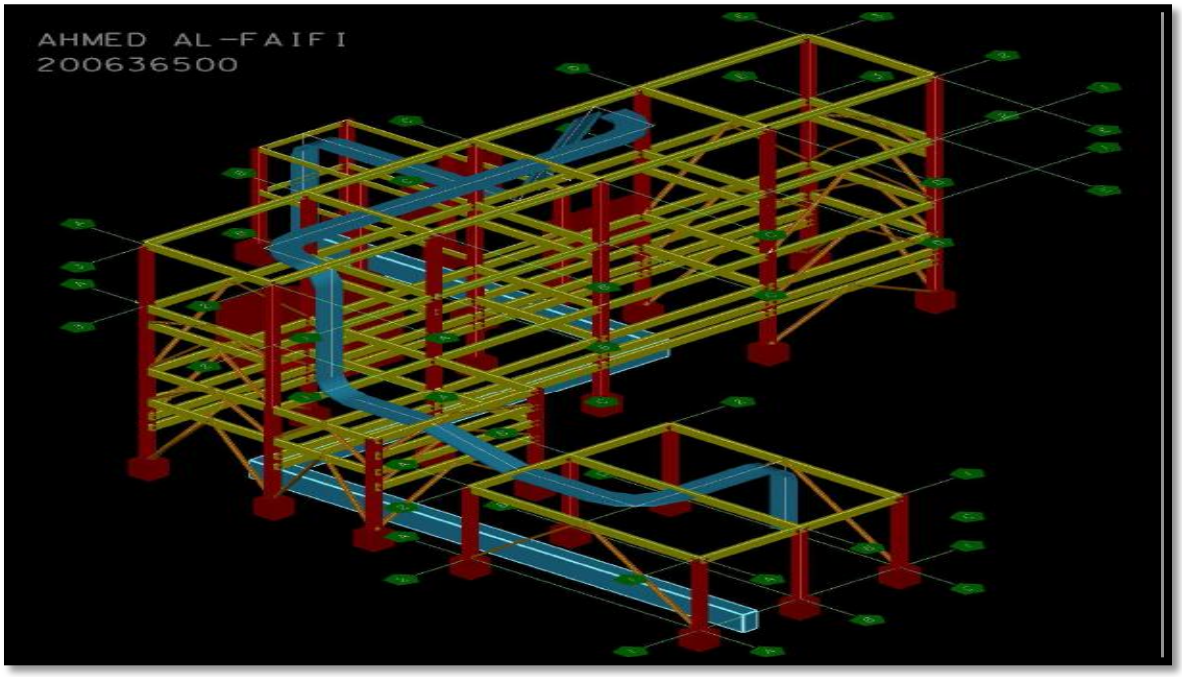


Figure 6: Cable trays and trenching

- **Luxicon:**

This program is very important for lighting calculations for areas in which we want to design a lighting system.

Problem Solved by Luxicon:

If we have an area and we want to design a lighting system to cover all the area by sufficient light.

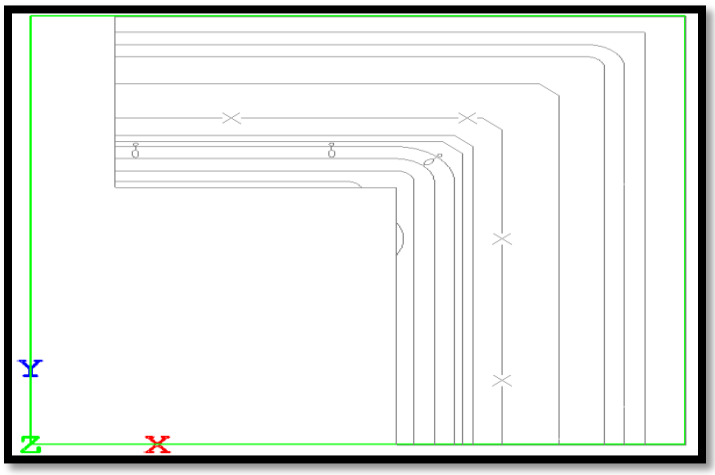


Figure 7: Part of a big area

If we place a light as shown and we use the program to see how the light is distributed over the area.

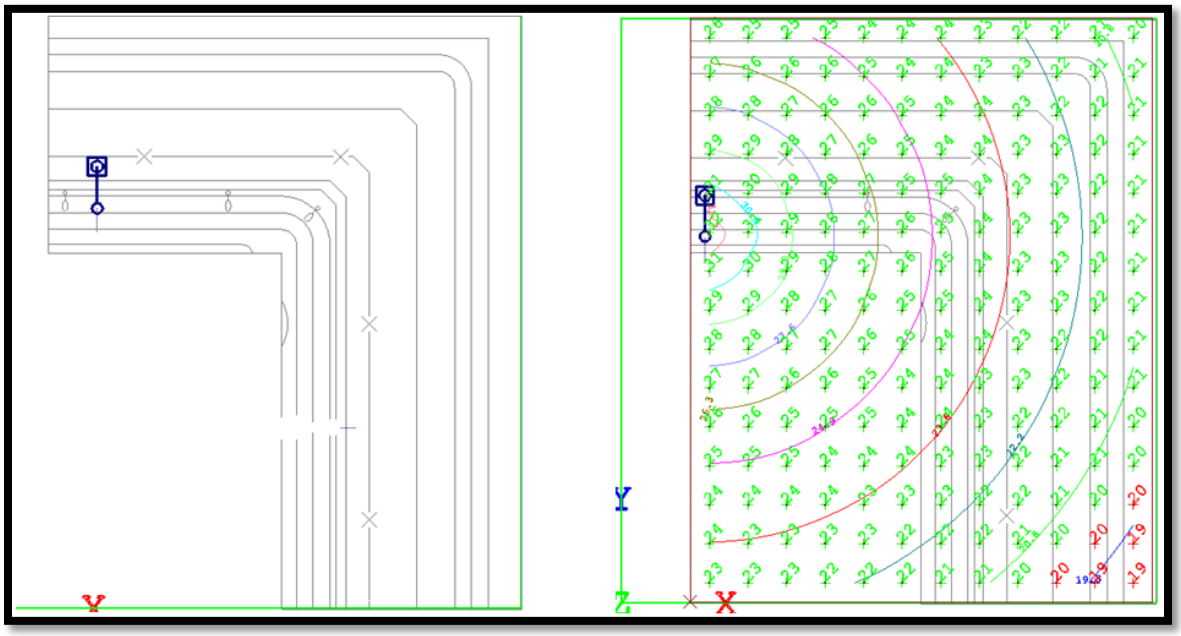


Figure 8: The Area before calculating and after

As we can see, the area is almost cover by light but small area is not. The reason is that the light is not powerful enough to cover all of it. The red color means there is no sufficient light in that area.

To recover this problem, we add another fixture as shown in the figure:

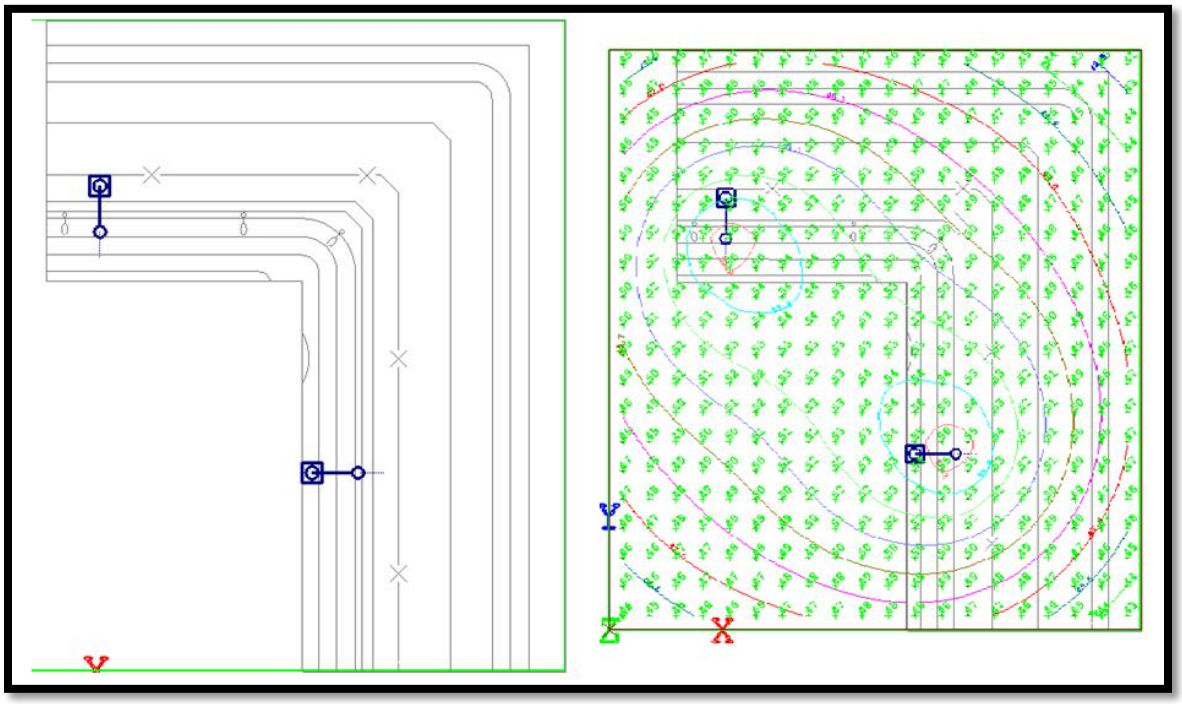


Figure 9: The area after solving the problem

It is important to choose a proper place for fixtures to cover most of areas by light.

8. Conclusion

Working with Fluor Arabia Limited (FAL) as a summer training was a very nice experience. I learnt a lot about designing basic systems in electrical and how the importance of electrical power tools, hardware and software, in any project. I also practiced what I learnt in the university and applied it on field. Working with Electrical department enhanced my major understanding .In addition, I gained a good experience in term of self confidence, real life working situation, interactions among people in the same field and working with others with different professional background. I had an interest in understanding basic engineering work and practicing what has been learnt in the class. Also, the training was an opportunity for me to increase my human relation both socially and professionally.

ATTACHMENTS