



NORTH-WEST UNIVERSITY<sup>®</sup>  
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NOORDWES-UNIVERSITEIT  
POTCHEFSTROOM CAMPUS

## **THRIP Project Report 1**

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# 1. Introduction

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## 1.1 PROJECT BACKGROUND

Biodiesel manufacturing:

In 2013 iLive procured biodiesel technology in pursuit of its ambitions to produce 7 mill litres of biodiesel per annum from used cooking oils (UCO). The technology is to be demonstrated by manufacturing 300,000 litres of biodiesel in compliance to SANS 1935 standards. After successful completion of phase1 a ramp-up to 7million litres per annum will continue. The UCO is mainly supplied from restaurants; being collected by collection companies. By converting UCO into biodiesel iLive will compliment South African's biodiesel and renewable energy strategy, ensure SA's growing fuel demand is met by renewable and clean options, as well ensuring restaurant wastes are treated indefinably; preventing harmful secondary reuse of the wastes in the food market.

## 2. Student Activities

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During the period as from 28 April 2016 to 02 September 2016 the following activities were completed:

### WORK COVERED

#### Cables

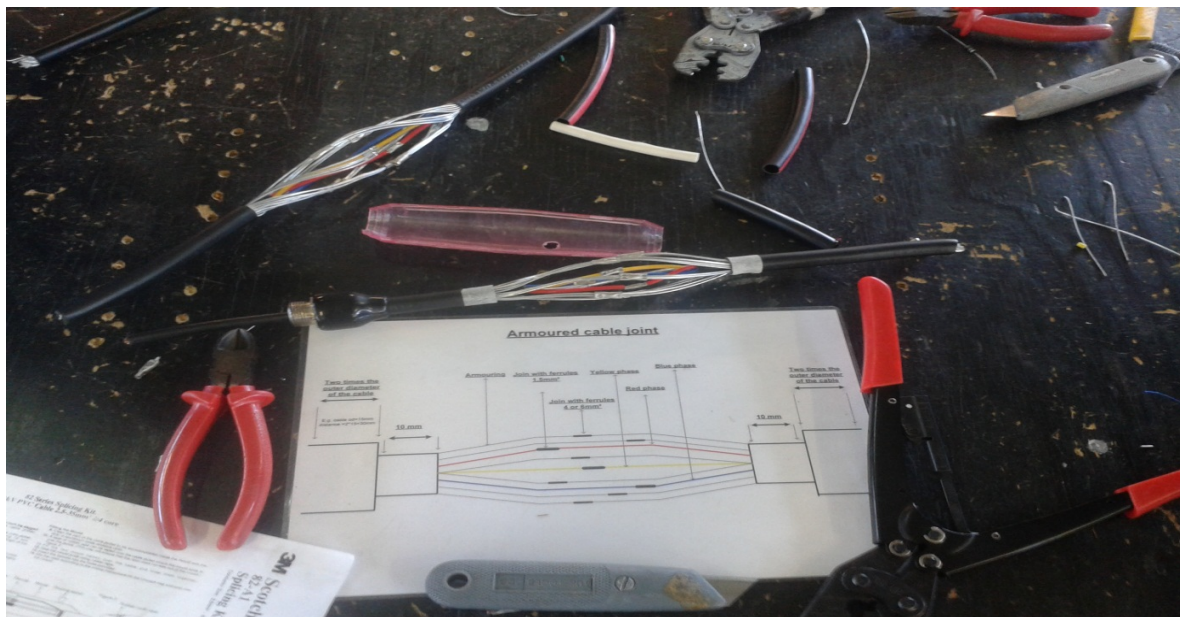


On this module I learned about different types of cables and conductors. Cable is an assembly of one or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electric power. Power cables may be installed as permanent wiring within buildings, buried in the ground, run overhead or exposed. Cables come in a variety of sizes, materials, and types, each particularly adapted to its uses. Large single insulated conductors are also sometimes called power cables in the industry. Cables consist of three major components: conductors, insulation, and protective jacket. The makeup of individual cables varies according to application.

The construction and material are determined by three main factors:

- Working voltage, determining the thickness of the insulation.
- Current-carrying capacity, determining the cross-sectional size of the conductor.
- Environmental conditions such as temperature, water, chemical or sunlight exposure, and mechanical impact.

I also learned joining cables for incase a cable need to be fixed or changed when it is damaged.



I also learned about cable testing which is done to ensure that a cable is in good condition before installation and after installation to eliminate electrical faults due to cable poor insulation, incorrect crimping, incorrect connection, tear and wear.

**The test that should be done on cables:**



- Continuity test to verify that a cable is not broken and to ensure correct cable connection using a single line diagram.
- Insulation resistance test to verify that insulation of the cable is in good condition by not making electrical conduct with other cables or earth. There is an acceptance value of insulation resistance measured; it should be 1.1MΩ or more.
- Inspect exposed sections of the cable for physical damage.
- Verify tightness of connections by using calibrated tools (spanners and screwdrivers).
- Check for loose cable trays and tiers to ensure that their always in good condition.

**Copper Earth wire**



## Earth

### Importance of Earthing in Electrical system

I have learned that Earthing or grounding means to connect any electrical appliance, machine or equipment at zero potential of general mass of earth with wire connected with the earth electrode buried in the earth at the moistened place.

Earthing is as important as the fuses in the wiring circuits in the case of short circuit over loads, the heavy current flows through the wires and fittings, which melts the fuse wire and stops the flow of current in the circuits, thus save the whole circuit from being damaged.

Similarly, when any live or phase wire touches the metal part of the fitting, appliance, machine or equipment, the current passes through the earth wire, if the appliance, equipment or machine are connected with proper earth connection, blows the fuse at once and saves the operator from getting shock. Thus to avoid these dangers, all metal parts of the fitting, appliances, equipment, machines are earthed.

## PROTECTION SYSTEMS

A protection system is a branch of electrical engineering that deals with the protection of electrical systems from faults through the isolation of faulted parts from the rest of the electrical network. The objective of a power protection is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation.

### Requirements of Electrical Protection

- **Speed:** for power system stability, reduction of damage & outage time, and to prevent development of other faults.
- **Selectivity:** determination of fault point & tripping only the nearest CB (faulted zone)

- **Sensitivity:** capability to reliably operate under actual conditions that produce least operating tendency
- **Reliability:** trip at all times when required – dependability; not to trip falsely – security
- **Simplicity:** use the minimum protective equipment necessary to achieve the protection objectives.
- **Economy:** about 5% the cost of equipment to be protected

Faults may occur due to:

- Insulation failure
- Incorrect operation of circuit breakers
- Short and open circuits

Protection systems comprise five components:

- VT to step down high voltages.
- CT to step down high current.
- Circuit breakers to open/close the system based on relays auto closer commands.
- Batteries to provide power in case of power disconnection in the system.
- Fuses which are capable of both sensing and disconnecting faults.

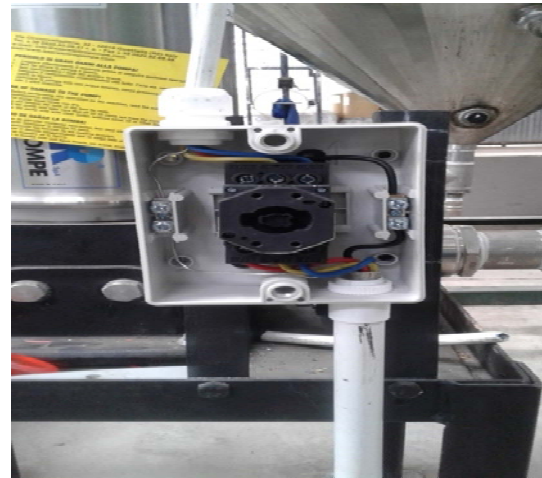
## SWITCHGEARS

I gained knowledge on switchgears which is a combination of electrical disconnect switches, fuses, circuit breakers and relays used to control, protect and isolate electrical equipment. The power station consists of many switchgear rooms for different units and their equipment. The type of switchgear that I was exposed to is vacuum switchgears which consist of circuit breakers with vacuum interrupters because they have minimal arcing characteristics.

### Three-phase isolators

They serve as the local emergency stop/start switches in the plant.

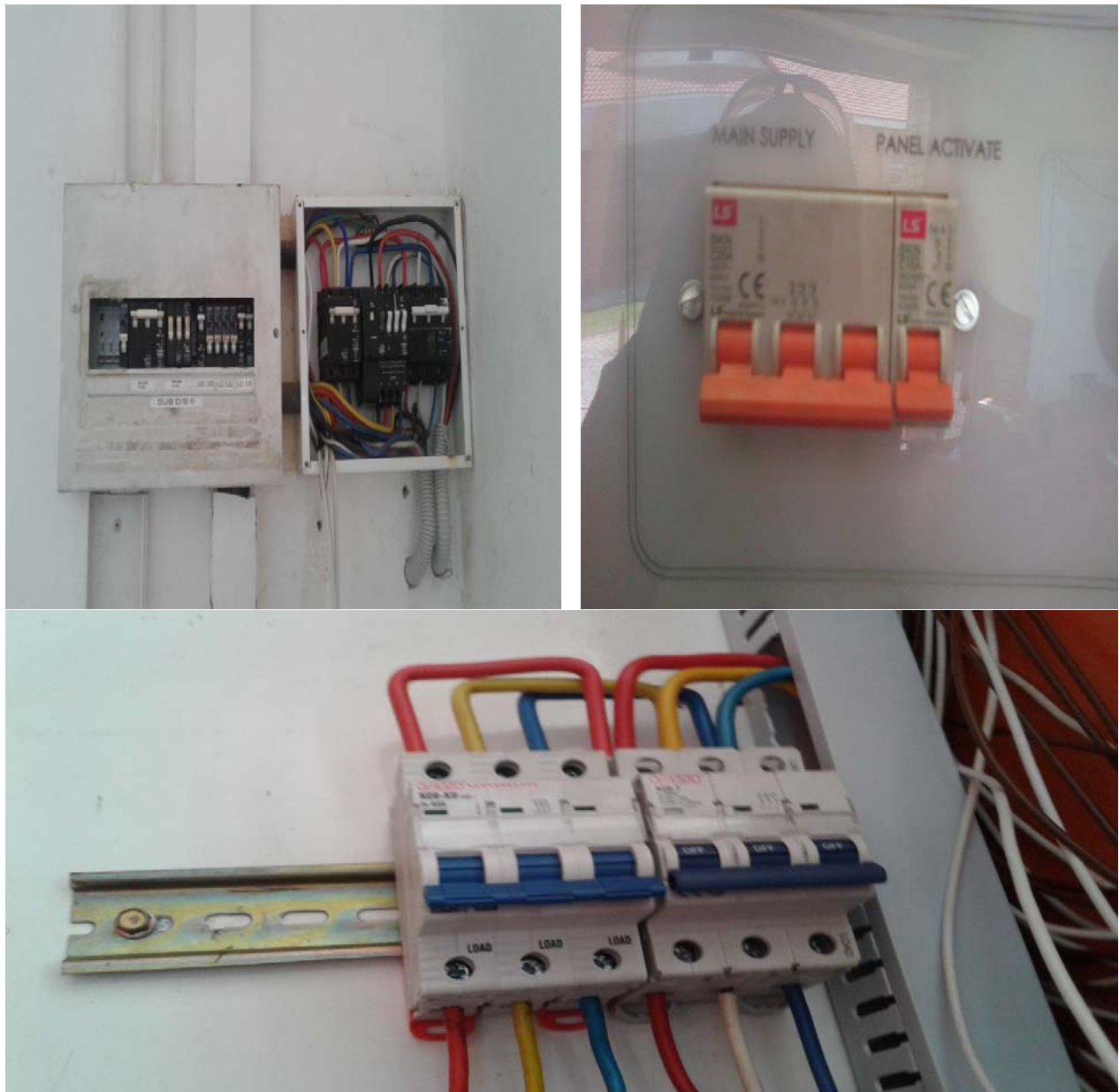




## **CIRCUIT BREAKERS (CB)**

I gained knowledge on circuit breaker (CB) test which was done to ensure that the circuit breakers are in good condition all the time as some CB take long time without operating. These circuit breakers are for medium voltage 6.6kv and they are installed in the power station switchgear rooms. They are used for motors, transformers, pumps and fans. The general function of the circuit breaker is to close and open the circuit to be able to remove faults and connect/disconnect objects and parts of electricity network. The circuit breaker is a part of the protection of the main components in the network.





### CB OPERATION

When a fault is detected by a protective relay and a trip impulse is sent to the CB's operating mechanism, the CB has to function as specified and interrupt the current as soon as possible or severe damage may occur. Proper functionality of a breaker is reliant on a number of individual components that has to be calibrated and tested at regular intervals. Circuit breakers perform three main tasks: When closed, they must carry the current as effectively as possible. When open, they must insulate the contacts from one another as effectively as possible. In the event of a malfunction, they must interrupt the fault current as quickly and reliably as possible, thereby protecting all subsequent equipment.

### **Circuit breaker test conducted**

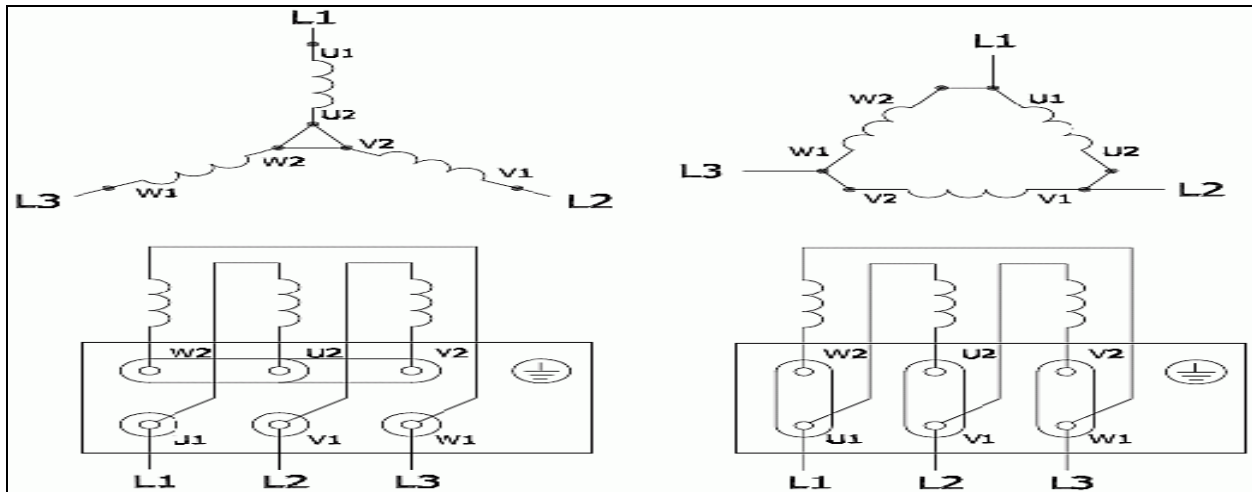
- Visually inspect breaker for any visible missing or damaged components prior to incoming testing
- Performing incoming operational testing to include:
  - Manual and electrical functional operation tests
  - Check minimum and maximum coil operating voltages
  - Check for proper operation of electrical and mechanical safety interlocks
  - Check for operation of indicating devices, including all visual indicators and operational counter
  - Check for proper operation of racking device and check interlocks
- Perform insulation resistance testing. All testing will be performed at 2500 or 5000 dc voltage (depending on voltage class of breaker) using a megger. Individual tests on primary current carrying components is performed to include phase to phase, phase to ground, and testing of each pole piece, with the main contacts open. Minimum acceptance value is 1000 MΩ or greater. Insulation resistance checks of secondary (control) circuits, to ground, are also conducted.
- Perform circuit breaker opening and closing tests at normal operating control voltage.
- Perform main contact resistance checks. Maximum acceptable readings will depend on the breaker manufacturer and model.
- Test for proper operation of applicable circuit breaker trip features.
- Perform circuit breaker speed test to ensure that the breaker operate within the correct time range.

### **MOTORS (AC and DC)**

An electric motor is an electric machine that converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. An AC motor is driven by AC current and a DC motor is driven by DC current. Motors in the power station they are used as pumps for water and oil, fans for moving hot or cold air as it is required and driving machines in the plant like conveyor belts. I also gained knowledge on how to practically connect a motor in star or delta.

Star connection

delta connection



Star Connection



Delta Connection



During the time I was learning I was opening different motors in order to understand the connection of every motor from different manufacturers. When connecting a motor its name plate needs to be taken into consideration as it has all the guidelines on how to do the connections. I also learned about installation and commissioning which helped me to understand how to replace motors in the plant as some motors were to be replaced due to failure or increase of load to be driven by the motor.

### **ELECTRICAL FAULT FINDING**

During this course “electrical fault finding” I learned skills of fault finding on different electric control panels. I learned to Interpret, diagnose and trace faults using the

prescribed fault finding techniques on electrical circuits including contactors, relays, timers, limit switches, and overloads.



**I also learned about the steps to follow when doing fault finding:**

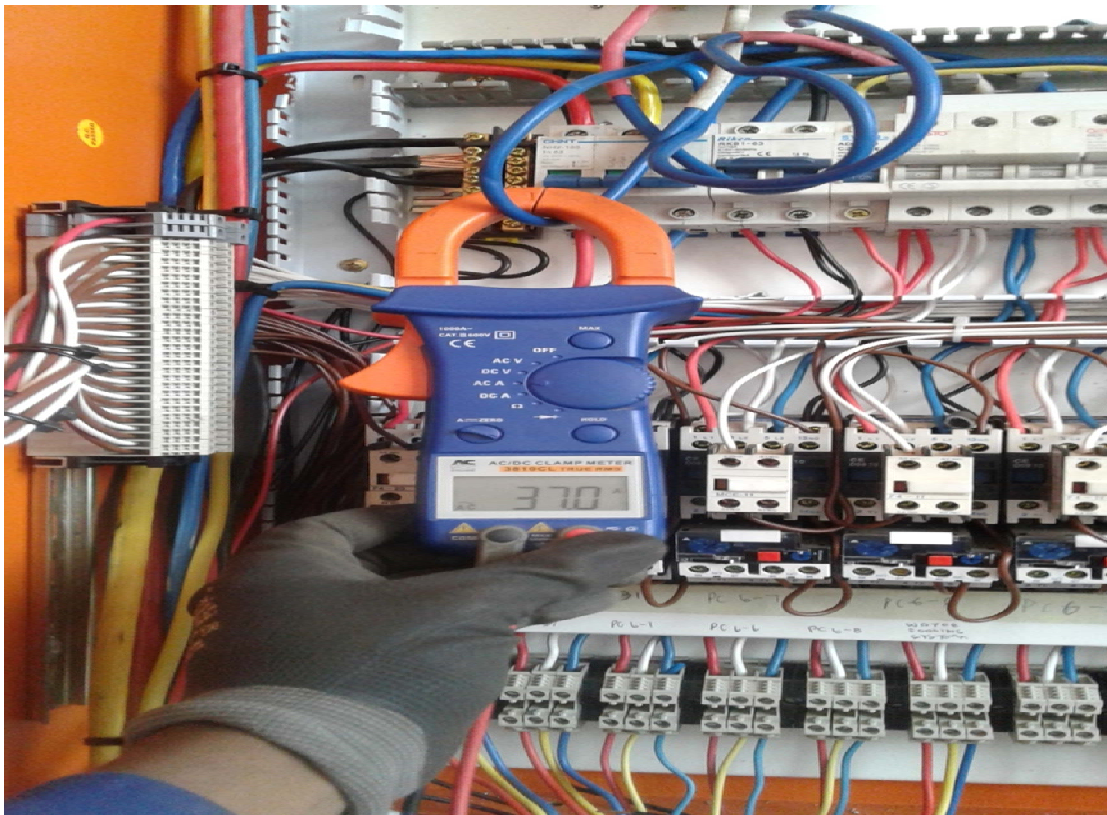
- Before you begin to troubleshoot any piece of equipment, you must be familiar with your organization's safety rules and procedures for working on electrical equipment. These rules and procedures govern the methods you can use to troubleshoot electrical equipment (including your lockout/tagout procedures, testing procedures).
- When observing malfunctioning equipment, look for visual signs of mechanical damage such as indications of impact, chafed wires and loose components. Look for signs of overheating, especially on wiring, relay coils.
- At this stage that you apply logic and reasoning to your observations to determine the problem area of the malfunctioning equipment.



- Once the problem area have been defined, it is necessary to identify all the possible causes of the malfunction. This typically involves every component in the problem area. It is necessary to list (actually write down) every fault which could cause the problem.
- Once you have determined the most probable cause, you must either prove it to be the problem or rule it out. An important rule when taking meter readings is to predict what the meter will read before taking the reading. Use the circuit schematic to determine what the meter will read if the circuit is operating normally. If the reading is anything other than your predicted value, you know that this part of the circuit is being affected by the fault.
- Then the fault can be solved by replacing damaged components or by replacing damaged connecting wires.

### Load test

I have learned to do a load test, to check that the supply power is sufficient to the project of Bio-Diesel.



### **Installation and Commissioning of equipment**

I gained knowledge on cable installation when installing motors, lights and relays because some of these equipment I had to install power supply cables and also to do connections during installation. I learned how to do cable joining, crimping, cable gland, using cable trays and cable tiers. I also learned about application of different types of cables which helped me to understand that an individual should know the rated voltage, size and type of a cable needed to be used for a specific job.

The construction and material are determined by three main factors:

- Working voltage, determining the thickness of the insulation.
- Current-carrying capacity, determining the cross-sectional size of the conductor.
- Environmental conditions such as temperature, water, chemical or sunlight exposure and mechanical impact.

### **Installation of Panels and Circuit Diagrams**



I have learned to build up three-phase panels, starting from the main protection of the panel, to the individual protection of each component/ machine. This includes the installation of circuit breakers, contactors, overload relays and connectors. I have used the power circuit to complete this installation.

I have also learned to build up a control circuit of the panel, this includes the

installation of emergency stop, start/stop buttons and light indicators of each component.



### **Main Panels of the Bio-diesel Project**



### **Installation of Flash evaporators and three phase heating element**





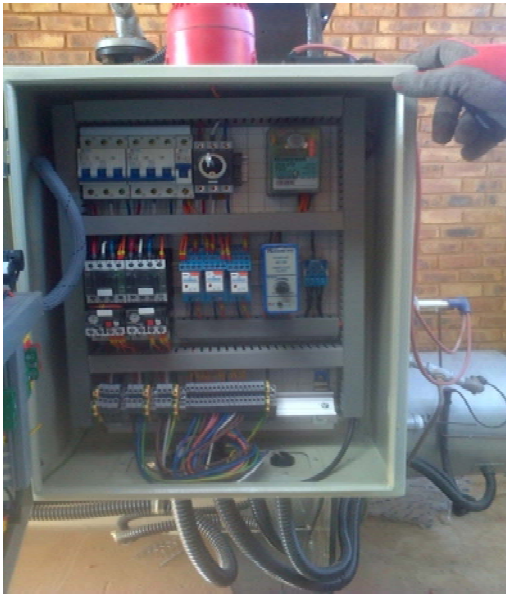
The Flash evaporators are used to separate oil and water. They use three-phase motors to speed up the separation of waste cooking oil and water through the filters.



The three-phase heating element is used to heat waste cooking oil in the Flash evaporators, in the process of separation of waste cooking oil and water.

### **Installation of Boiler and the cooling Tower**





I have learned to connect a three-phase Boiler, the boiler boils water and the water changes in phase to super-heated steam, then the steam is used to warm up methanol and waste cooking oil to 60 degrees Celsius, then the wet steam goes to the Cooling Tower to change the phase of steam into water, then back to the boiler again.

The cooling Tower it uses motors as fans to cool the wet steam to liquid state. The motors are connected in three-phase system.



## Installation of Generator



I have learned to connect a three-phase diesel generator as a backup system. The system is designed to power loads during extended outages, it is reliable as it uses fuel to produce electricity.

The generator is connected in automatic form, when the power cuts out, the generator automatically starts up within 30 seconds, it then supplies power to the system. The supply voltage is 400Volts, and the supply current is 90Amps.



## **2.1 RESEARCH ACTIVITIES**

- The Research was done on the UPS system of the Generator (Uninterrupted power supply of the Generator) which is an electrical apparatus that provides emergency power to a load when the input power source fails or is disconnected. The UPS uses the power stored in the backup batteries to supply the load. In the plant the UPS is used to protect protection systems, telecommunication equipment and all the equipment that should be kept running even when main supply has failed. I was also doing fault finding on the UPS and chargers for in case of failure due to some components failing, loose connections, overheating. I was also exposed on doing inspections to make sure that the UPS with batteries and battery chargers are in good condition to make sure that whenever they are required they will operate normal without errors. The UPS is a combination of the rectifiers, inverters, chargers and batteries.

## **3. Conclusion**

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- The work I covered was very helpful as I managed to cover all the work and experience that was required in order for me to be competent. I learned more about everything on Protection systems which helped me to get experience on switchgears, circuit breakers, instruments and protective relays. I covered the experience that an electrical engineering student should know in order to qualify to work in the industry without causing damage to equipments or injuries to other employees.