

United Arab Emirates University
College of Engineering

Training in Al-Ain Distribution Company

AADC



Final Report Submitted for Partial Fulfillment of the

B.Sc. Degree in Electrical Engineering

By

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Acknowledgments

In the beginning of my reports I want to say thanks for every person help me to reach to the training course or for the people who have contributed to making me qualify to take training course starting by my training advisor Dr. Mousa hussain for leading us during 16 weeks of training, guide us and even visit us in the company and ask us if we faced any problem during my training. Also, I appreciate the efforts of all the members of ALAin Distribution Company for giving us from their time and sharing with us their experience not only during the training course but their door are always open for the students. Special thanks go to Training and Graduation Projects Unit in UAE University head by Dr. Sameera and her team (Dr. Mustafa extra.....). Thanks from the depths to Hessa I will never forget her rule for being with us from one whole year not one course and follow us from the starting point to complete requested paper. Finally thanks for Members of the University who gave me the confidence to represent the university in one of the most important companies in the UAE.

Executive Summary:

The training course was 16 weeks its start in 7 of September and finish in 25 of December. In these 16 weeks I moved among two basis directorates and one division. Project Delivery Division: four weeks were spent in this division from 7/9/2014 to 30/9/2014. They are responsible about executing Power & Water projects and follow with the contractor step by step until closing of the project.

Asset directorate: the next four week in my training course were sent in the Asset directorate which was from 6/10/2014 to 30/10/2014. It is include three departments and these departments focus on the company's asset, planning for coming years, updating all the new developments in the system and record it in the company's archive.

Electricity operation and maintains directorate: I spent the last 8 weeks in this directorate which from 2/11/2014 to 25/12/2014. They are responsible about the maintenance of all equipments in the ALAin network until equipments need to be replaced so they distribute maintenance on the different departments:

Operation and Maintenance Department: I spent three weeks in this department from 2/11/2014 to 20/11/2014 which include 4 sections. Cable sections for cables maintenance and specify the fault location. OHL section is responsible for the maintenance of all the equipments that related to the OHL pole, insulators and switches. Substation maintenance section is responsible about maintenance of most of the equipments in the substations such as transformers and CB. Operation section is responsible about isolate the fault for previous sections and restores the supply to the customers at the end.

Field service department include two sections street lighting section and VIP section. This department serve a governmental property starting from palaces, hospitals extra.. I spent two weeks in this department.

Network management division: Two weeks were spent in this division, it is responsible to monitor the power network and control it remotely

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Nomenclature

AADC	Al-Ain Distribution Company	CB	Circuit Breaker
HV	High Voltage 33 KV	TDR	Time Domain Reflect meter
LV	Low Voltage 415 V	RTU	Remote Terminal Unit
OHL	Over Head Line	SCADA	Supervisory Control And Data Acquisition
PMT	Pole Mount Transformer	NOP	Normal Open Point
GMT	Ground Mount Transformer	TMT	Technical Management Team
TR	Transformer	PMT 2	Project Management Team
BB	Brick Build	CBM	Conditional Base Maintenance
PU	Package Unit	RBM	Reliability Center maintenance
TRM	Tri Ring Main Unit	CM	Corrective Maintenance
QRM	Quadratic Ring Main Unit	CC	Control Cabinet
DB	Distribution Board	ST	Service Turret
FP	Feeder Pillar	SCMS	SCADA Control Management System
VT	Voltage Transformer	AMD	Asset Management Directorate
CT	Current Transformer	LOA	Issue Letter of Award
VMS	Vertical Mounted Switch	SFT	Sanction For Test
RE	Re enforcement	NMD	Network Management Division
MHS	Master Head Switch	FOC	Fiber Optic Cable
GIS	Geographical Information System	UPS	Un Interrupted power supply

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Chapter One

Introduction:

1.1. AADC Overview

AADC Overview

AADC is a shortcut for ALAin Distribution Company and it's wholly owned by Abu Dhabi Water and Electricity Authority. AADC began its work in January 1999 according to law number 2 that issued in 1998. AADC receive its annual budget of AED Billion 1,530,000,000 through Abu Dhabi Water and Electricity Authority which are funded by executive council of Abu Dhabi Emirate which mean that AADC is a fully governmental Company. The main office of AADC in the middle of ALAin city. The main role lies in water and electricity distribution which mean that They receive the Water and Electricity from the TRANSCO which responsible for Transmission and give it to the end users "people, factories and farm ext....." within the specified limits of its geographical scope specific regions which start from North of ALAin City from "ALFaah" to South "Um ALzomol " and from west region which start from ALQazna to east region knowing that the water system along more than 3,000 kilometers and up to the power grid along the 16817 km but now more projects and development programs are establishing which mean that network become huge and keep extending. Before the water and electricity receive to customers AADC responsible for and maintenance of the water and electricity distribution network assets, meter reading, and services for the supply of water and electricity. The number of AADC employees at the end of 2012 was more than 1934 and the Company provides services to a population of the East Region of Abu Dhabi (Al Ain Region) approaching one half million people which have direct communication with the society and people not like generation and transmission companies. The company using the latest equipment and the best technology systems in order to provide the best services and the most convenient ways, as well as the establishment of a special quality system and All of this comes to earn customer satisfaction first ,to Realizing

the vision of Abu Dhabi 2021 and in solidarity with other government agencies and to be among the best companies of distribution in the middle east.

1.2. Organizational Chart of AADC :

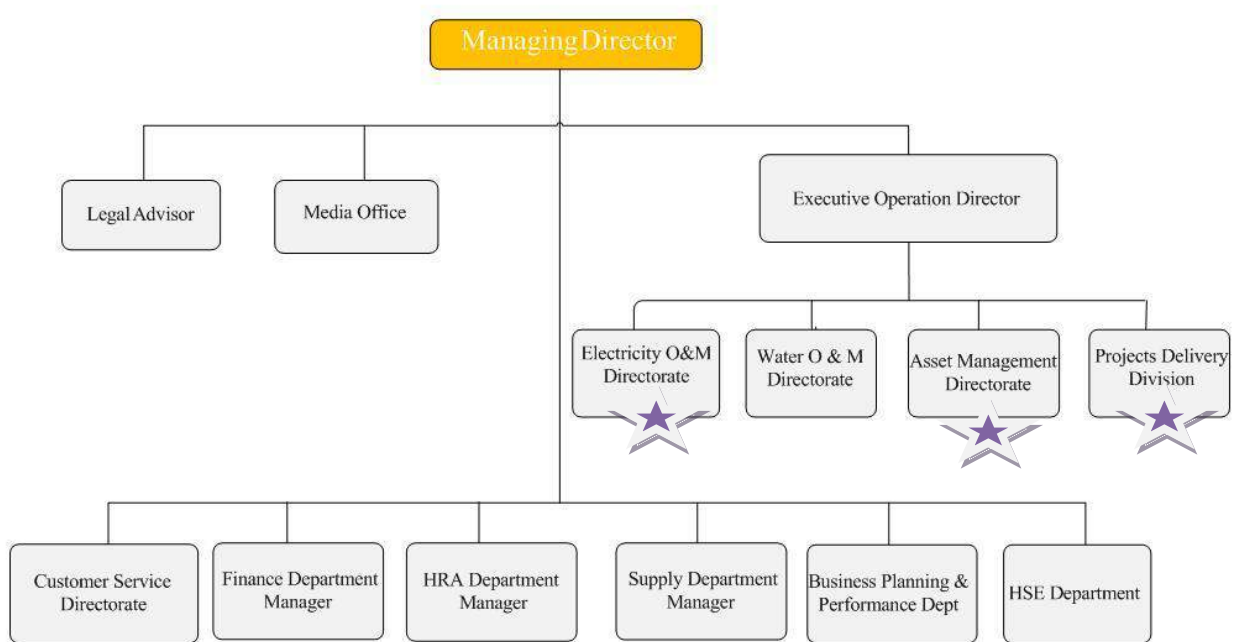


Chart 1.1 AADC Organizational chart

The AADC Organizational structure is well summarized and shown in the Chart above (Chart 1.1). The Departments and places that were assigned for the Tanning course is highlighted with stare

Chapter 2

In this Chapter I will discuss in details all directorates and divisions that I visited during my training course. All structure charts of each department will be shown in this chapter. It will include also some statistics that's indicates some problem in AADC itself. In addition to that it will explain all the information that has been acquired during my training course and it will show the difference in the student before and after training so this chapter is the most important chapter in this report.

2.1 Projects Division

This division receives all the works from Asset directorate and transfers it from the schemes and papers to tangible building. They are responsible about Effectiveness of the all equipments in the duration of the project and also within the warranty period as specified in the contract and they keep monitoring the contractor while he works. All Engineers in Projects Division should be experts and trained well to know how to deal with Contractors and consultative. As summary objectives of this division are supervising the new assets, performing the projects according the assigned standards, and keeping updated with the warranty of the project to make any Adjustments so they work as mediator or linked point between asset and Operation & maintenance.

This Division consists of two departments and one section:

- **Power Project department**
- **Water Project department**
- **Planning & Control Section**

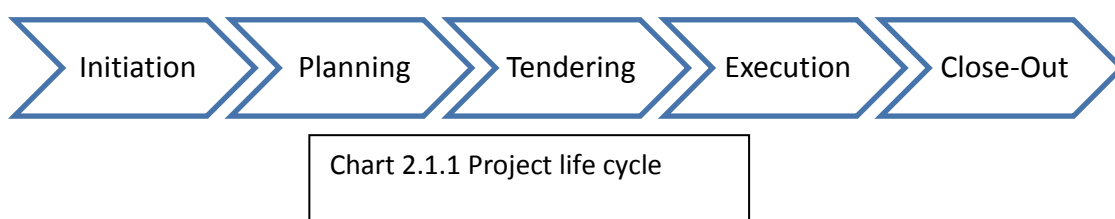
First of all we will define the Project which indicates group of activities they should give a unique output and it should done in temporary period of time while the program is couple of projects they share at the same goal. There are three factors that have a direct effect in the Project:

- Client: Owner of the Project and he is the one who financed the Project
- Consultative: Representative of the client and his presence is not necessary
- Contractor: Main job is to execute scope of work.

There are three Types of the projects in AADC. Firstly; there are projects that done by AADC and they are the client and contractor in the same time but if there is any

delay they are responsible about that. Secondly; one of the type of the projects called developer projects and that is widespread. Developer project deal with client as municipality as well as deal with governmental companies like Musanada and Tomoh and they will arrive to an agreement with AADC about the payment at the end of the project because all of the factors are governmental agency. Finally, there is a project which are suggested by any client not necessary governmental then AADC will hire one contractor form their vender list that's should follow their specification and they will let him to do the project.

Whatever was the project in the electricity or water sector it should follow approximately the same procedure from starting point until Final acceptance of the project. These procedures divided into five main stages that are shown below:



*These five stages are known as project life cycle and they known as project implementation stages and we will explain each one of them.

Types of activities done in the initiation phase are collection of business case requirement, study the project very well, what are the goal of this project and they will estimate the primary subject. Secondly, Preparation of Project Budget as a request from the owner ,Consolidation of Project Budget, Submission of the Budget Request to ADWEA ,Revision of Budget by ADWEA before the final approval then Approval from Board of ADWEA (Budget Approved) and finally Forming TMT. Thirdly, Tendering Phase which Known also as Awarding Phase. There are many activities in this phase starting by Submission to the Tender Committee, Tender Committee Award Decision, Issue Letter of Award (LOA), Successful Bidder (consultant) Acceptance of LOA, Post Award Meeting then Contract Agreement. Then project moving to a new phase which the most important phase from the perspective of the projects department called execution. As beginning they start to form PMT, Monitor , Site Hand Over, Project Payments and Finance issues, Project Risk Management and Finally they are doing all the documents that related to the project.

Finally, Closing of the project including five important steps starting by primary acceptance certificate & snag clearance, as-built drawings, material reconciliation, closeout, warranty and finally acceptance certificate. Any project should satisfy three things as shown in the figure 2.1.1. AADC adopt the projects in two areas Electricity and Water. We will discuss each department alone but still all the procedures above apply on both of them.



Fig 2.1.1 standard of any project

2.1.1 Power Project Department

This department is Responsible for the implementation of all electricity schemes concerning the development of the electricity network in ALAin city, starting from the construction of all types of stations which less than 33KV, laying cables and overhead lines, and this is known as new development as shown in figure 2.1.2.



Fig 2.1.2 New development

There is also reinforcement "RE" for the network, such as the replacement of a large number of equipments such as "Transformers, Circuit Breaker" And this requires that award contracts for the supply and installation of this equipment. In addition to that renovating an old building of the stations is also kind of reinforcement. In this department, their main responsibility start from third and fourth phase of project life cycle which was execution, but they follow up with the asset in tendering stage but they are not the leader of the team. When the first equipment installed on the ground it turn from TMT "Technical Management Team" to PMT "Project Management Team"

then they keep monitoring the project until completely finish then they close out the project so mainly in this department 3 stages of the project life cycle were done and the contents of each stages were explained and mentioned above*. Main focus of the Power Project department that the contractor should not go out of the scope of work, cost and specified time and all of these should be clear in any contract. For each project there is project engineer, site engineer. But in large or VIP projects it should be senior project engineer who supervise the project.

❖ **Project Engineer**

- Interpretation of the project documents
- Following up the progress
- Quality assurance & control
- Performance assurance & control
- Approvals (Material, Drawing...etc)

❖ **Site Engineer:**

- Ensure site works are as per the specs. (Quality, Quantity & Safety wise)
- Shop drawing review
- Reviewing the measurement sheets
- Participating in the initial & final handing over
- Inspecting material delivered to site

• **Stations Types & Construction**

All the Primary and Distribution stations were constructed by Power Project department in AADC and they follow all standards that in the contracts such as the ground of the station, quality of the cables and arrangement of the equipments inside the stations. All of that were monitored by Site engineer. In addition to that, construction of any station should do within the time stage by stage. Power Project department receive the order form Asset then they applied on the ground and they keep in contact with the contractor until warranty period finish then they handover the stations to Operation and Maintenance department.

There are three types of stations:

1. Grid Station:

Grid Station consists of: 220/33KV, 80, 90,100&140 MVA Power Transformer, 220 & 33KV Switchgears: (Double bus bar, CB, Isolator, Bus section, Bus Raiser & Bus coupler), Protection Relay, DC system & batteries, Capacitor bank, Auxiliary transformer, SCMS System, Firefighting system and but it's construction done by TRANSCO not AADC Project department . Power project department is responsible only about 33KV switch gear as shown in figure 2.1.3 which considers the linked point with TRANSCO checked by Site Engineer in AADC.



Fig 2.1.3 Grid station, 33KVswitch gear

2. Primary Station:

Primary Station consists of: 33/11KV, 20, 15,10,7.5&5 MVA Power Transformer, 33&11KV Switchgears: (single bus bar, CB, Isolator, Bus section & bus raiser), Protection Relay, DC system & Batteries, Capacitor Bank, Auxiliary Transformer, SCMS system, Firefighting System. There are two types of Primary Station. Firstly, Brick Built (BB): The numbers of Power Transformers are two. Secondly, Package Unit (PU): The number of Power Transformers is one.

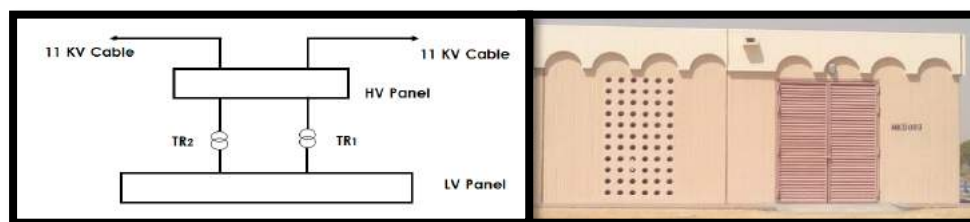


Fig 2.1.4 Brick built & its structure



Fig 2.1.5 Package Unit & its structure

3. Distribution Sub-Station:

Distribution Station steps down the voltage from 11 KV to 0.415 KV. The types of Distribution Sub-Station are shown in the following:

- ❖ Brick Built (BB): consists of electrical equipment located in a brick or concrete building that includes 600 Amp. The equipment are H.V & L.V Panel and two transformers of size 1000 KVA or 1500 KVA.
- ❖ Package Unit (PU): includes TRM, L.V Panel with fuses and transformer of size 500 KVA or 1000 KVA or 1500 KVA.
- ❖ Ground Mounted Transformer without Feeder Pillar (FP).
- ❖ Ground Mounted Transformer with FP: the FP depends on the size of transformer as follow:

- Transformer of size 500 KVA has 1 FP.
- Transformer of size 1000 KVA has 2 FPs.
- Transformer of size 1500 KVA has 3 FPs.



Fig 2.1.6 GMT with FP

Laying cables

There is known strategy that the Engineer follows for laying of cables. Site engineer Assisted by the consultative should watch the contractor when he extend the cables step by step and observe each step how the contractor do it. They should take notes and then email it to the project engineer. The following steps will explain cables laying. Firstly, Site engineer should be sure about the place and trench path as a reference from middle of the street should be exactly the same specified number in the measurement sheet as shown in the figure 2.1.7.



Fig 2.1.7 Check the Coordination

Also, depth and the distance between the cables in the trench should be verified according cables size. If the cable was 33KV the distance between two cables in one trench should be 50 cm and if it was 11KV cable the distance should 40 cm as shown in figure 2.1.8.



Fig 2.1.8 Distance between 11KV cables



Fig 2.1.9 Cement Pieces to protect cable

Then the contractor should extend the cables in propel way not bend it this is called dressing up cables. Secondly, we should put a layer of net red sand known as du sand as thermal protection to implement the heat. Then they put cement pieces as mechanical protection for the cables as shown in figure 2.1.9. On the concrete pieces they put du sand for 15 cm. In addition to that they put warning plastic tape indicates notes on it check figure 2.1.10.

Fig 2.1.10 Warning plastic tap



For more protection they put again 15 cm of du sand. Thirdly, they connect the cables from termination and they do meger test which apply 5000 volt on the cable that show the cable can connect from point A to B. They do also high pressure test which apply 25000 v on the cables to be sure the cable can resist the high voltage. Site engineer should take the reading of Leakage current should be in Micro Ampere and take reading of resistance should be in Giga ohm. Finally, they close the trench and they put a fixed Warning cement piece on the ground that seen by people as shown in figure 2.1.11



Fig 2.1.11 Warning fixed cement piece

2.1.2 Water Project Department

This department follows the exact procedures of power project department. It's responsible of monitoring and executing a new project for development of the water network. 90% of their work is laying and extend water pipe and their work is directly related with new project of municipality because they want to ensure access of water to the new homes. Project and site engineers will have same responsibilities and tasks that they have in power department but for water. They do a high pressure



Fig 2.1.12 Water Pipe

test on the water pipe, flush and disinfect the pipe before they receive it from the contractor. Also, project engineer review layout that submit it from contractor , check all the required equipments and make sure that they are in their correct places on the map and on the ground such as Fire extinguisher and valves.

2.1.3 Planning and control Section

Main responsibility of this section starts in the planning stage from project life cycle. So they manage documents and transactions that's transfer from Asset to the power or water project department. They put and adjust some information then they award it to either power or water department but they keep in contact with the project engineer during period of the project not only in the planning stage.

Planning and Control section consists of four units:

- Power control unit
- Water control unit
- Account unit
- Clearance and Documentation unit

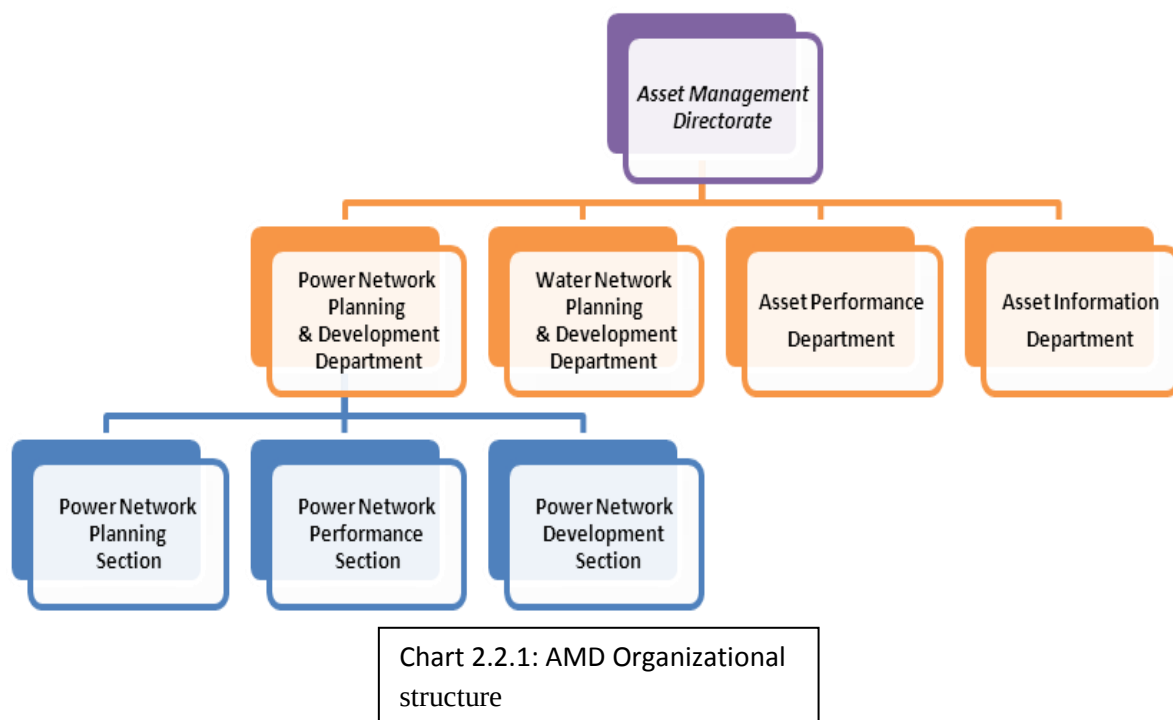
I will explain in detail the main duties of this section but I will not talk about water control unit because I did not train with them. After the project award it from Asset directorate their responsibility will start so they do not involve in starting of the project "choosing contractor, total price extra..." . first of all they form TMT "technical management team" and they choose the leader of PMT "project

management team" who should be from project department. Also, they determine the duration of the project and specify the starting date and completion date of the project. They organize meeting called "Post award meeting" which they meet with the contractor and project engineer who are responsible about this project. In addition to that, they prepare a document called "Free issue material" if the contractor will use some of the equipment from the store of AADC. They make an interview of all the staff that will work with the contractor and they review the C.V for most of them "Forman, electricians". Required from them to provide monthly report called "Monthly Progress Report" that's include scope of work, cost of the project, what are the percentage of completion and always should write the starting date of this project in the report. They should submit also final organization chart that explain this project in details and they who will agree if the contractor submit delay request based on the final organization chart and monthly reports. Moving to account unit, this unit is responsible about financial payments of the project departments either water or power. Payments divide into two types. Firstly, to the consultative of the project and this type will divide into two payments either on the design of the project or on supervise on the site of the project. Secondly, payments to the contractor and will be either for supply or installation of the equipments (60%, 40%) based on the fast delivery while the civil work will have direct payments not like equipments. Finally, Clearance and Documentation unit is responsible of help power & water control units to do their charts, statistics and form of any official documents and reports.

2.2 Assets directorate

Assets directorate we conclude from the name that it is responsible for managing the company's assets and we mean by management that managing all the administrative work of the assets including other departments work such as supplying equipments, direct contact with the customers so its reflect the company's business. Also, this directorate represents the company in the meeting with TRANSCO most of the time. The main goal of the Asset directorate is to ensure supply of the power to the client in the best way and that's done by improving all the company's assets which is why the provision of electricity which serve the customers at the end. In addition to that, Asset directorate who is the one who divide ALA in city into four regions west that's start from ALyahar to ALKazna, North "from ALFoaa to ALFaqa", south to um alzomol

and center of the city. Asset directorate manage all the asset in ALAin that belong to 33KV and less so it's responsible about 19 grid stations but not all of the equipment only switch gear, 150 primary stations and around 15000 distribution stations including all the equipments in these huge number of stations. Structure of Asset directorate is shown below:



2.2.1 Power Network Planning & Development Department.

Because of the huge network in ALAin city and it's grow by huge different every year so they divide this department in three separate sections and each section will take certain responsibilities and focus on them.

○ 2.2.1.1 Power Network Planning Section

This section is responsible about 33KV net work. Firstly, they do a plan every year for next five years at least and they keep updating this plan monthly in case there is a sudden case happen of development projects. They are a linked point with transmission company "TRANSCO" and they keep informing Transco every year about their plan for next five years to let TRANSCO prepare if there is huge different in coming years. They focus on their plan about projects that related to 33KV which mean building new primary stations and that need huge amount of money not like

distribution stations that's why they plan for next 5 years to specify the budget. When they predict how much the total load will increase next year's they keep in their mind the total capacity of each primary and they follow rule (N-1) which mean there are three transformers and one of them has a fault then the rest two can take the whole load without any problem. In addition to that, when they design for their prediction they design with ring system with previous stations not radial system which defined as if there is a fault and the whole primary station come out of the network the load under it can be feed it from other primary. Finally, this section has a meeting every couple of months with other governmental agencies if they have new coming projects.

○ **2.2.1.2 Power Network Performance Section**

This section will have similar responsibilities of planning section but with 11Kv and less and they do not have a plan for long time because they deal with distribution stations and with much lower cost. This section is concerned to receive a request called "Supply Arrangement Request" for electricity supply to the customers. They study the request that's come from customer service directorate if the load 300KW and more only. They see if they can feed the customers from closest distribution station then to feeder panel then to requested house but if they cannot they start to suggest on the customer to have a transformer in his house. They divide the load into two types AC load and other loads such as lights, fans and extra. Also, they calculate the load in KW and they calculate the current by following equation

$P = \sqrt{3} * V_{pp} * I * \cos\theta$. After that they can find out the cable size by dividing current on a factor of 1.74 and decide cable size.

○ **2.2.1.3 Power Network Development Section**

The responsibility of this section shared between planning section and project department. Their work start at the beginning of project life cycle which we mean from the second stage which they receive a request from planning section and they start to put scope of work and specification of the project as a first step. Secondly; they enter the third stage "tendering". In the beginning of this stage they start to review a vender list of the factories and they approve the list. In addition to that they approve bender list which the list that shows all the contractors that apply to take this project and also they who approve the list. Thirdly, they start to do their evaluation for

the contractors which divide into two types: Technical evaluation which supervised by this section and they approve the contractors who get 70% and above. Other type is commercial evaluation which about the price and this happens outside this section. Also, they give approval on the price that specified by contractor in the middle of the project if he wants extra money. If the contractor wants to change in the bell of quantity he should communicate with development section only. Finally, they record all the projects that are finish and done form project department in the company's archives.

2.2.2 Asset Performance Department

This department divides into two sections; water section and power section. I was trained in the power section only but both of them they follow the same procedures which focusing on the Assets of the company and study them. Assets divide into two types Non Moving Materials and Moving Materials and both of them invested by the company. In the performance departments they concern about Non Moving materials only such as power network and its equipments. There is some information and features of the assets itself placed by performance department such as an "identification number" this number should be unique for every equipment as shown in figure 2.2.1.



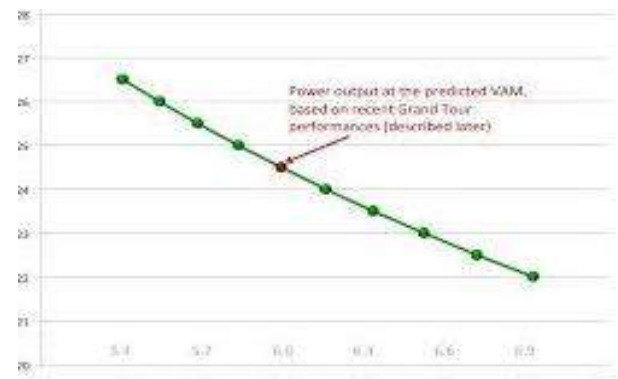
Figure 2.2.1 serial number of Transformer

Every asset should have an Introductory Certificate that's explaining when the asset was supplied and installed. Also, performance department study the asset if have a value or just supplied and do not used. Most important thing that, they should specify each location for each asset that related to AADC and records it in the system. In addition to that the department monitors the whole network and doing monthly reports

on the network to see the performance of the company based on number of shutdowns in every year. Department works on the analysis and converts information to charts so they can calculate the number of interruption and see which region have more interruption. They look also to the reasons that cause the interruption especially for over head line if its storm, fire or weak protection. This department is concerned about inventory of materials in the store every year as shown in the figure 2.2.2 and they classify wanted equipments to each department. One of the most important tasks in the department is studying the life time cycle for most of the assets by analyzing graph and they used some specific equation to know the performance of this asset like for transformer: $Performance = \frac{40\text{ years}-used\ Age}{40} * 100$ and they analyze the graphs to know life time cycle as shown in a sample graph below:



Figure 2.2.2 Stored Materials



Graph 2.2.1

Also, when there is any FAT "Factory acceptance test" to buy any equipment Engineer from this department should to be there and attend the test and accept the equipments. They do the test on 10% of the quantity that will buy. Check Appendix A

2.2.3 Asset Information Department

Asset information department include two sections:

- ❖ Asset information section
- ❖ Asset Data management section

In the Data management section all the staff and engineers work on a maximo program. They Store and archive the data on system & reviewing the layout. The

order of the steps, Data management section should finish their work before asset information section because information section they need the data stored in the system so they can work and see the latest update. Moving to the second section "asset information section" which includes two units:

- GIS water
- GIS electricity

In the asset information section old maps which designed before year 2000 were editing on the GIS system "Geographical information system". Main job is to keep updating and entre new network specially cables and water pipes. In the GIS system there are all the shapes and symbols that represent "primary stations, TRM, transformers Extra... in GIS so they can also build all of the stations and edit them in GIS.

2.3 Electricity Operation & Maintenance Directorate

This directorate mainly deals with AADC equipments for long time after the warranty period from project department. They are the responsible of the maintenance for all the equipments until its need to be replaced. Every department or section is responsible about certain device. We stayed around 8 weeks in this directorate. Organizational Structure of Electricity Operation & Maintenance Directorate is shown below:

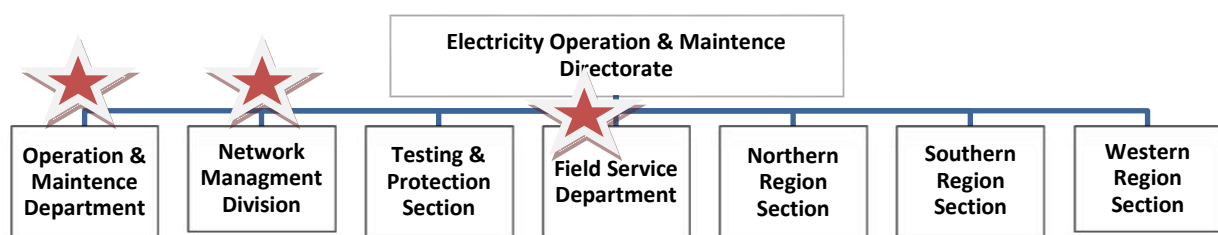


Chart 2.3.1 Organizational Structure of Electricity Operation & Maintenance Directorate

2.3.1 Operation and Maintenance Department

The responsibility of this department is to maintain most of the equipments such as all the stations, cables and OHL. Also, they responsible about the operating and shutdown any stations when there is fault happen and they isolate from termination.

O&M department is divided into five sections:

- Cable Section.
- OHL Section.
- Substation Maintenance Section.
- Operation Section.
- Maintenance Planning Section

2.3.1.1 Cable Section

This section is very important because most of the network in ALAin is cables so its need very well maintenance, expert engineers, labors for digging and modern equipments to find the fault quickly because its underground around one meter. Their responsibilities start when there is a fault happen to 33, 11 KV, and LV .Operation section will send a request to them to specify the fault location approximately by GIS as shown in figure 2.3.1 so the operation section can isolate the damage cables for them from two termination side from the substations. Cable section asks operation section about SFT "sanction for test" as shown in figure 2.3.2 which mean this cable is safe to work on it. They do this process in either situation fault happen or identification which they consider the main responsibilities of cable sections.



Figure 2.3.1 GIS System

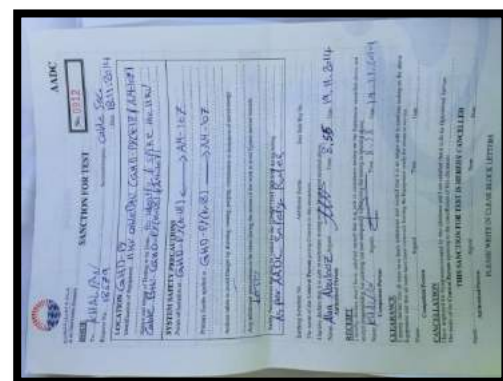


Figure 2.3.2 SFT request

First of all I will explain what are the procedures and steps that follow when the fault happen. They start by doing burn process which help to found which one of the phase is damage. When the engineer start to do burning in the test van for each phase, the damage phase will



Figure 2.3.3 Burn process

show increasing in the leakage current and it will show small value of volt as shown in the figure 2.3.3 above.

Second step is called TDR "Time Domain Rectometer" which show the distance of the fault from your place by meters on a screen and also will show you which one of the phase having the fault as shown in 2.3.4. The most important step when the fault happen is search which means that it will specify the location of the fault exactly by sending a pulse every period of time specified by engineer then he will wear the dig headphone which help him to hear the voice of digging and that voice represents the leakage current when it try to escape as shown in figure 2.3.5. The last step called HPT "high pressure test" and this step done only when the voice not clear especially in HV 33 KV because it's underground too much.



Figure 2.3.4 TDR screen



Figure 2.3.5 Person with a dig headphone



Figure 2.3.6 fault of the cable

Type of fault:

- Join fault
- Manufacture fault "If it's in warranty period they will contact with factory or the contractor who supply them".
- Damage fault which may happen because of one contractor damage it when he want to dig so need to inform the legal affairs then the police.
- Termination fault

Second job of the cable section called identification. When the contractor wants to build a new substation and he want to take a node from specific cable so he will ask the cable



Figure 2.3.7 more than one cable in trench

section to identify to him the cable if there is more than one cable in the trench as shown in figure 2.3.7.

Cable section will follow certain steps to identify the cable:

- Ask the operation section to isolate from termination and sign sanction for test paper
 - Fix a sender on the wanted cable in one of the terminals only by putting a red mark in the device on one phase of the cable and black & green to the ground as shown in figure 2.3.8.
 - Other terminal in the second substation should be connected to the earth by operation section.
- a) Engineer takes the receiver device with him to the site and he put it on the many cables. The signal will be strongest on the wanted cable as shown in figure 2.3.9 and it will indicate two colors red and green. If the receiver in the same direction of the grounded termination the signal will be green otherwise will be red .We can double check by using device called locator and its shows the signal without the direction in figure 2.3.10.



Figure 2.3.8 Sender device



Figure 2.3.9 Receiver device

Identification was done and now the contractor wants to cut the cable to take a node for his connection but that done by cable section only by using spick gun or hydrogen gun in figure 2.3.11 that fix it on the wanted cable then engineer will pull the bullet by long thread then the contractor can cut the cable very well and make his connection.



Figure 2.3.10 Locator device



Figure 2.3.11 Spick gun

Main components of the cable:

- 1- Conductor "which made of copper"
- 2- Semi-conductor " prevent the electrons of current escape"
- 3- Insulating material "made from XPLE" cross linked polyethylene
- 4- Steel strips as "inner jacket"
- 5- Stranded wires
- 6- PVC "Outer Shell made from (Poly-Vinyl-Chloride) Sheath", but before PVC there is armor for mechanical protection which between 5 and 6.

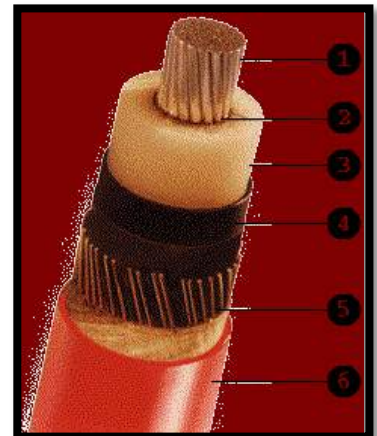


Figure 2.3.12 cable's component

Cables are classified according to specific criteria as follows:

Voltage level	Classification
400 KV, 220 KV, 33 KV	High voltage cable
11 KV to 1000v	Medium voltage cable
Less than 1000	Low voltage cable

Table 2.3.1

- **Current ratings:** Cross section area of cables differs with current value directly proportional.

- **Insulation Type:** Three types of cables are used according to the insulation material: (XLPE and PVC).
- **Number of cores:** A run of cable may consist of 1, 2, 3, 4, or 5 cores.
- **Conductor type:** The type of conductor used in cables could be Copper or Aluminum.

2.3.1.2 OHL Section

This section is responsible of the 33/11KV OHL network in Al Ain city so it's feed too many distribution stations that's why they specify a special section for it because it consider a second most important source of distribution in the network and as a first transmission way because of the small amount of losses. In AADC they use copper of aluminum conductor and the cross section of the conductor are: 35, 70, 95, 120, and 150 mm². There are around 6000 KM of OHL in ALAin city especially in the external regions that why this section consists of two units:

- Inspection and monitoring unit
- Maintenance unit

Inspection and monitoring unit is responsible about scan over ALAin city especially after the storm they keep patrolling, observe if there are any problems and if they found any problem they reported quickly to maintenance unit but some time there is temporary fault so they will solve it. When maintenance unit receive call or report from inspection unit, they will contact with operation section to isolate the line for them from both terminals of the line, grounded to the earth around 7 m from each side as a safety for them and ask for SFT then they will do their maintenance on the damage equipment or the pole itself.

OHL Components: Check Appendix B

1- OHL switches:

The main aim of OHL switches is delivering energy safety, efficiency and reliability.

- VMS: vertical mountain switch

When we have OHL and there and there is any interruption such as street ans we want to complete we use VMS

- VMSE: vertical mountain switch with fuse will have the same purpose but with fuse

- Master Head switch (MHS)

From its name master that mean its control the whole line from pole to pole or it give you a choice to open the line from middle

2- Auto-re-closer (CT)

Is a circuit breaker prepared with a mechanism that can automatically close the breaker after it has been opened due to a transient fault. It will make several pre-programmed attempts to re-energize the line. If the transient fault has cleared, the auto-re-closer's circuit breaker will remain closed and normal operation of the power line will resume. If the fault is a permanent fault, the auto-recloser will exhaust its pre-programmed attempts to re-energize the line and remain tripped off until manually instructions.

3- Sectionalize (VT)

It operates when a line is "dead" because of the operation of an auto-re-closer or breaker along the line. Sectionalizes serve to isolate a section of line while allowing the remainder of the circuit to remain energized.

4- PMT

it is step-down TR. The PMT should have some specification such as TR power 200 KVA

5- A Lighting Arrestor/ Surge Arrestor

Lighting Arrestor is located in the top of the pole. It used to protect the cable and PMT. It consists of insulation (porcelain), bracket and fault indicator.

6- Pin for 11KV or Post insulator for 33KV

It's made from porcelain or polymer which used as a protection to the pole itself from the fire.

7- Kicking blocks.

When they start to construct Hpole in new project or replace one of them they use blocks to fix the pole very well under the ground.

8- Earth Fault Indicator (EFI)

Is designed to indicate the short circuit fault and identify fault location. It accurate fault indication enables the operator to identify the fault sections easily and isolate them in time.

2.3.1.3 Operation Section

This section is the busiest section in O&M department because its serve all other sections when they want to do their work. Main responsibility of this section is to isolate the fault equipment and restore the supply to the customer so they isolate the fault and feed the customers from other substations according to ring system. They identify the fault by a device called earth fault indicator which appear on the door of the stations. When the light on in the device that's mean the fault happens after this substation. Operation section is responsible for all shut down, energize, isolate fault in the network. The main challenge for the operation section is to return back the load as soon as possible in emergency time. This section consist of two Units: planned shutdown and UN planned "emergency" unit.

- Planned shutdown: planned before such as operate new substation for project or contractor want to do join in the cables or fix something in the station.
- Emergency unit: fault happen in the network "cables, OHL or equipments in the stations" because of fire or storm.

Both of the units follow the same procedures:

- Isolation the fault from both side
- Apply earth from both side
- Put danger signs. Check figure 2.3.13
- Put a lock on the isolated place. Check figure 2.3.14



Fig 2.3.13 warning signs



Fig 2.3.14 Lock

- Give safe document which include three types
 - ❖ PTW "permit to work". If it was on the earth the other section's engineers or labors cannot remove the earth off.
 - ❖ SFT "sanction for test". He can remove the earth but with permission from operation section.
 - ❖ LAB "Limit access permit". He can enter the station but without doing anything or just to check simple equipment.

2.3.1.4 Substation Maintenance Section

This section is responsible about 80% of the equipments in the substation. This section divides their work into Corrective Maintenance "CM", Condition Base Maintenance (CBM) and Reliability Center Maintenance. Corrective maintenance mean emergency that's mean fault happen in of the equipments that related to this section. Condition Base Maintenance is a group contains engineer, assistant engineer and technicians to do inspections on substations and check the following:

- Circuit Breaker (oil , vacuum and SF6)
- Transformer with whole the equipments (tap changer, body of the transformer, its oil and extra...) as shown in the figure 2.3.15
- Silicajel which define as small grains absorb humidity from the body of the transformer it's have two color white or blue, the white when its damage or need replacement change to brown while blue change to pink color.
- Check the whole buttons of LV and HV panels, if some of them need replacement.

If they found something danger they reported to the corrective maintenance as soon as possible but filling oil, refresh circuit breaker and clean the transformer from their specialty as shown in figure 2.3.16.



Fig 2.3.15 Filling the Transformer



Fig 2.3.16 Fill CB

Reliability center maintenance "RCM" collects the information from CM and CBM then they analyze it, study it and finally they put commandments to the section to change the company that supply this type of equipments according to increase number of defects.

These section deals with same equipments that do same purpose but each company manufacture it in different way. I will identify related equipments to this section

Type of cooling for the transformer:

- ONAN "oil natural air natural"
- ONAF "oil natural air forced"
- OFAF "oil forced air forced"

Difference between isolator and circuit breaker

- Isolator: when we want to close it or open it , we should do that with the load is off because it does not have a media to extinguish the spark.
- Circuit breaker: we can open it or close it even with the load is connected

Difference between bus coupler, bus section and bus riser **check Appendix C.**

- Bus coupler: connect between two bus bars
- Bus section: connect between two separate piece of bus bar it self
- Bus Riser: complete the connection so if the first load connected on bus bar 1 then I will use bus riser to connect load 2 on bus bar 2.

2.3.1.5 Maintenance Planning Section

Planning section is developing and scheduling all maintenance activities for respective sections. All scheduled activities are done after coordinating with Network Operation Department. In addition to that they organize between all the sections in O&M department if one of the sections needs to do any shutdown what are the effect on other sections.

2.3.2 Field Service Department

This department serves governmental agencies and ministries such as hospitals, palaces, street lights and any other governmental services. They have all the equipments that O&M department has except OHL section so they can manage their work alone but also sometimes provide help to other departments to supply the electricity to the customers in emergency time. This department includes two sections:

- Street light section
- VIP section

2.3.2.1 Street light section

Street light Section responsible about all the streetlight columns in ALAin city and its external regions. Street light Section consists of two Units Patrolling & Emergency Unit "accidents of cars, check the damage and Maintenance Unit. Patrolling unit receives reports from DMS and then they transfer it to maintenance unit. There are two types of light used in AADC (high pressure sodium & metal halite) and their brightness {150w, 200w, 600w, 700w, 1000w, 2000w}

- For Neighborhoods 150 w were used.
- For highways 1000 & 2000 w were used

They have an indication for each color such as :

- ww for purely white
- yy for yellow
- yw between the two color

During my visit to Swehan with engineer, I knew the steps of how the connection is done:

- Photo cell is programmed at certain time to give an order but there is time difference in the winter and summer so time difference its programmed by engineer
- Photo cell give an order to the Solar cell then it's give order to the magnetic contactor to open which give an order to the MCCB "main control circuit breaker"
- One control cabinet it has 8 circuits and every circuit can feed street with long of 30 or 40 meter.



Fig 2.3.17 Control Cabinet



Fig 2.3.18 1000w light

2.3.2.2 VIP Section

The main job of this section is to secure the supply for sensitive places such as palaces, hospitals and military bases. So they should put in their consideration many ways to secure supply even after the generators crash. These places have fixed generators in the substations but sometimes they used mobile generators which mean is movable generators for emergency case. VIP section consists of four units:

- Operation Unit
- ALRawda palace Unit
- Maintenance Unit
- Workshop Unit



Fig 2.3.19 Diesel Generator

Operation unit is responsible about isolate the fault when it's happen and restores the supply from the generators. They responsible about inspection and test the generators

if its response when fault happen of not. Also, they operate mobile generators "movable generators" when it's emergency happen.

ALRawda palace unit has all the powers which in three other units have which mean that they have a maintenance team, operation team and mobile generators. They do inspection and test for the generators every three months because it's a very important place.

Maintenance unit which is receive the request from operation unit when they record any strange thing or damage equipments or the generators do not response in normal way. Maintenance unit is responsible about all the palaces, hospitals except ALrawda palace because they have their own team. Maintenance unit divide the fault into three types Mechanical, Electrical and Control & Instrument so they send particular team.

Workshop unit is very important unit because as I said this section consider a separate section from AADC they have most of the equipments and they do not depend on the other sections so they need a workshop to do some test on the mobile generators to fix them, on Relays and how its response when there is fault happen and on the other equipments.

Type of the generators and how its work:

- **Manual generators**

- ❖ Engineer should be sure that there is no supply for electricity from other source
- ❖ Convert MTS "Manual Transfer Switch" button from main to off and then put it on the generator mode.
- ❖ Fix frequency and the volt manually and then turn on the generator manually

- **Semi Automatic**

Sensing voltage relay will sense if there is any change in voltage or frequency and it will activate automatically by sending a signal to LMS "load management system" to trip all outgoing feeders in the substations and then give order to CB of the generators to close then the generators will start. After that Voltage and frequency will be stable after few minute. Generators will feed bus bar and return the outgoing feeders one by

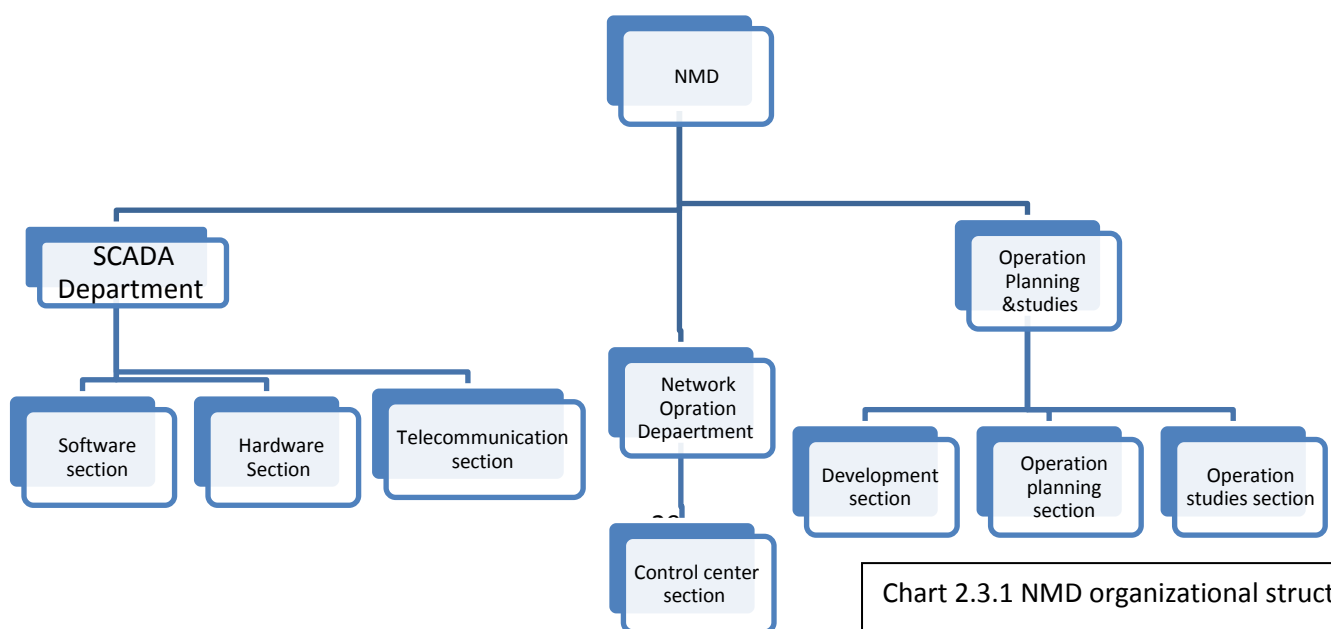
one according to popularity. When the main incomer back to supply, the engineer should switch the MTS to the main supply side then the generators will shut down after 5 minutes.

- **Full Automatic generators**

It will follow same procedures of semi automatic generators but it has a switch called ATS "Automatic Transfer Switch" that's mean no need for switching the MTS manually when the main incomer back to supply the substation because it will transfer the load automatically by ATS. There is a system called Full Automatic with back synchronizing. The customers will not feel the shutdown when the main incomer back to the service because the generators and main supply they will share the load until main incomer take all of it. there is an interruption of electricity happen when the generator start to work and that can be a void it by UPS system which define as a storage of the DC then its converted to AC by device called inverter but it works for specific time only. Reasons of providing these two systems patients in the hospitals who cannot breathing without electrical equipments even for seconds or when the doctors make an operation.

2.3.3 Network Management Division

This Division with all departments is responsible about monitoring the network and detect if there is anything that is unusual in the net work which include all the primary and distribution substations. They monitor load, frequency, transformer and every single equipment in the network so they distribute their work among many departments. The structure of this division is shown below:



2.3.3.1 SCADA Department

SCADA stand for supervisory control And Data Acquisition

2.3.3.1.1 Hardware Section

Hardware section is responsible of transducers (analog input for RTU) , command relays (digital output for RTU) and status relays (digital input for RTU) and RTU itself .



Fig 2.3.20 RTU

RTU will collect all the information from these devices which they define as follow:

Transducer: analog input device locate it always after CT and VT. Its purpose to step down voltage and current because of the electronic devices that cannot read large values.

Command relay: two relays to switch on / off the circuit breaker.

Status relays: contain of all relays "earth fault, over current and over voltage to check values of power, voltage and current.

2.3.3.1.2 Telecommunication Section

Telecommunication section is responsible to transfer the information send by RTU in substation to software section. They responsible about the media that carry information to the software section. There are two types of media that they can send the information through it either wireless or cables. Wireless either by WLAN or GPRS "Etisalat" and that commonly used in AADC because it can send for long distance while cables will be costly for long distance. Cables divide into copper or Fiber Optic cable "FOC" as shown in figure 2.3.21



Fig 2.3.21 FOC

2.3.3.1.3 Software Section

Software section is responsible of receiving signals from RTU then they analyze it and convert them to information that can be understandable and readable. After that, they send this information to control section and it will appear to them on the screen so they follow the following procedures:

- Front End which mean that the beginning of receiving information from RTU
- Data Processing include three types :
 - o Dual processing : both processor will work together
 - o Hot standby: output get it from one processor and the other is just stand by. They will communicate together if the first one not working
 - o Cold Standby: they are not in contact if the first one not working the standby will start update and work after 5 minutes

2.3.3.2 Operation Planning & Studies Department

Operation Planning and study department consists of three sections:

1- Development section

The responsibilities of development section are focusing on the projects, its documents and help project engineer during the period of project especially in the warranty period. Also, they involve in technical evaluation with TMT "Technical management team".

2- Operation planning section

Operation planning section will study and review the requests of shutdown electricity in ALA in city with its external regions and they give the approval to contractor or O&M to shutdown electricity to specified place only in addition to that they arrange that all shutdowns should not happen at the same time. They calculate the full load before they transfer the load on the other substations.

3- Operation studies section is responsible for :

- Load management by shifting the load.
- Security of supply
- Observe increasing or decreasing in the voltage and reset it if there is changing.
- they the one who close NOP when there is any fault

2.3.3.3 Network Operation Department

Which include only one section called Control Center Section. This section is the most important section in the NMD because it shows the entire network in ALA in city in the huge screen as shown in figure 2.3.22. Also, it shows the peak load of whole city, frequency and every reading for all substations in ALA especially primary stations. There are two main screens one of them to the center of ALA in city and the other one for external regions.

Control Center Section divides their work into two units:

- Planned "for maintenance purpose or operate new project to the network"
- UN planned "which mean emergency or fault happen to the system"

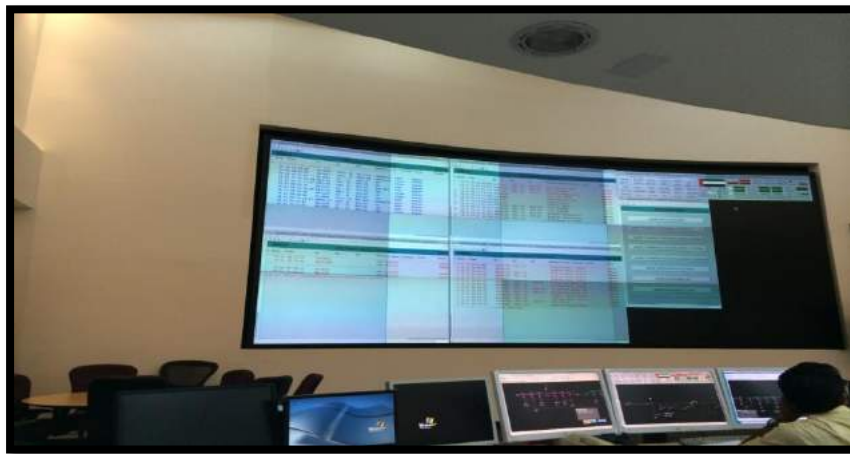


Fig 2.3.22 Control Center Screen

In both unit , any section want to make a shutdown even if its emergency, the section should submit a work request to the HV operation section in O&M department then it will move to operation planning section to review it and finally to the control room. Control engineer will review the request last time and then he will isolate for him.

Chapter Three: Proposal for a Graduation Project

At the beginning of year 2015 which exactly from 1/1/2015 there will be an increase in the price of electricity after the ADWEA has an approval from executive board. Increasing in the Electricity price for the local will be if his consumption reaches 400 KW and above per month there will be more charge about 5 cents for every one KW while for the residents they will pay production rate for every 1 KW if they reach up to 200KW per month. Most of the people they do not know how much they will consume per a month or if they reach 400 KW to reduce their consumption especially old men and women.

We know that there is already a counter outside in every house that checked by AADC engineers. This defined as electricity meter or energy meter, is a device that measures the amount of electrical energy consumed by homes.

I propose a device that gives an alert to the owner that warning him that he will exceed the limit soon. Simply this device like a sensor should be fixed in the main DP of the house "counter". Then it should program to sense at a certain consumption rate according to the customers for example for the locals at 350KW so when the energy meter reaches up to 350KW the sensor will sense this number and direct send a text message to the mobile of the owner "reduce your consumption".

There are other valid equipments that can be added to increase the performance of reduce the consumption such as putting a monitor in the house itself same as monitor in the DMS building of AADC. This monitor do the same purpose of the screen in the DMS which show the consumption rate of this house and customer put this screen in the living room when the consumption rate reach 350KW the color that show the number "load" change to red in the screen. Also, in this screen may have an indication about which room has the most consumption so the customers can reduce the rate before he exceeds the limit.

Chapter Four: Conclusions & Recommendations

In the end, Training course was very useful to us. It was a link between 4 years of study and experimental work in the field. AADC is among the best place for electric engineers to take the training course with them because their job is to distribute water and electricity to the customers so trainee will see all the steps of electricity's distribution and they will have an idea about transmission & Generation. During 16 weeks of training with them, I moved among two directorates and one division started by Project Delivery Division, Asset Management directorate and Electricity operation and maintains directorate. During the training gained a lot of experience and skills such as what are the basic procedures to do any kind of projects, How to manage the asset and plan for the future in the asset directorate and field experience, see most of the electrical equipments that I never see before, identify the job of each one and how they monitor the whole network of ALA in from one place all of that was taken in electricity operation and maintains directorate and its departments. Finally it was the most enjoyable and helpful course.

❖ Recommendation:

- For AADC
 - I trained around 4 weeks in Asset directorate and from my opinion this period of time is too much because most of their work as management work so if they reduce it to one or two week
 - Send an Email to each department & directorate to inform them about trainees because when we move from directorate to another they ask for official letter or emails from hr.
 - Add to the training schedule Customer service directorate because it's too important for trainees to deal direct with customers.
- For UAEU
 - Change submission of the report from Iwill to black bored because Iwill site shutdown every couple of days.
 - Increase number of meeting in the course that is before training course

References

- ❖ <http://www.aadc.ae/en/pages/AboutAADC.aspx>
- ❖ www.wikipedia.com
- ❖ <http://emiratestransformer.com/>
- ❖ <http://www.ducab.com/>
- ❖ [Some information from the reports that given by AADC engineers](#)

Appendix A (Transformer's Factory)

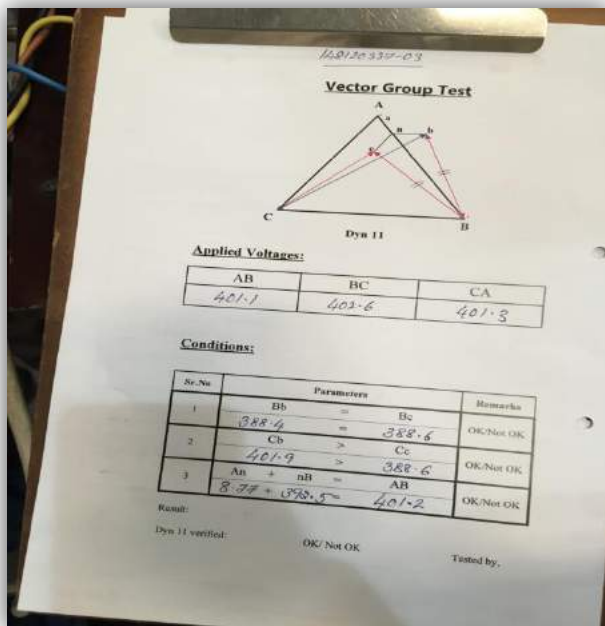


Fig A.1 record measurements



Fig A.2 opens TR from inside

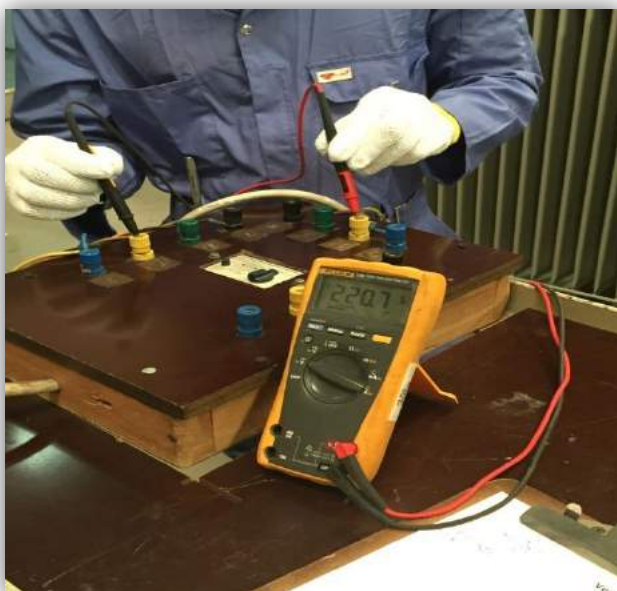


Fig A.3 measure HV phase with LV phase



Fig A.4 manufacture of TR

Appendix B (OHL Components)



Fig B.1 PMT



Fig B.2 Pin insulator



Fig B.3 Master Head switch



Fig B.4 Auto-Recloser

Appendix C (substations equipments)

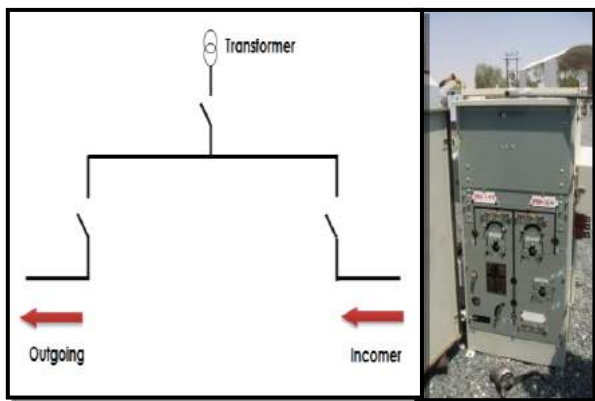


Fig C.1 TRM

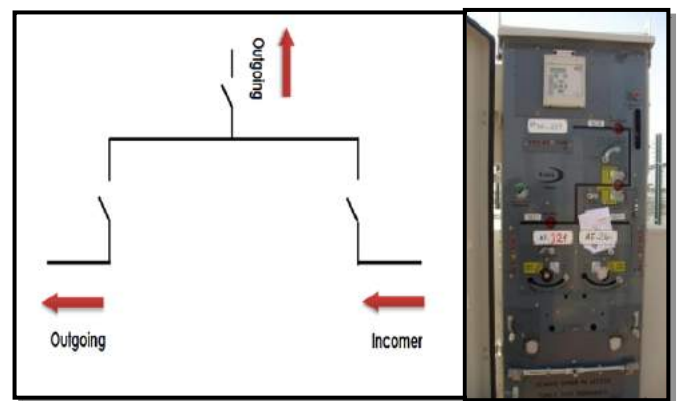


Fig C.1 RMU Feeder Type



Fig C.3 Bus Riser



Fig C.4 Bus coupler

Appendix D

United Arab Emirates University

College of Engineering - Industrial Training Unit

Industrially Suggested Senior Project

Student Name: Hamad Mohammed Ali ALSaadi

Student ID: 201010114

Department: Electrical Engineering

Semester & Year: Fall 2014

Company/Organization: AADC

Industrial Supervisor: Dr. Mousa Hussain

Project Description: At the beginning of year 2015 which exactly from 1/1/2015 there will be an increase in the price of electricity after the ADWEA has an approval from executive board. Increasing in the Electricity price for the local will be if his consumption reaches 400 KW and above per month there will be more charge about 5 cents for every one KW while for the residents they will pay production rate for every 1 KW if they reach up to 200KW per month. Most of the people they do not know how much they will consume per a month or if they reach 400 KW to reduce their consumption especially old men and women.

We know that there is already a counter outside in every house that checked by AADC engineers. This defined as electricity meter or energy meter, is a device that measures the amount of electrical energy consumed by homes.

I propose a device that gives an alert to the owner that warning him that he will exceed the limit soon. Simply this device like a sensor should be fixed in the main DP of the house "counter". Then it should program to sense at a certain consumption rate according to the customers for example for the locals at 350KW so when the energy meter reaches up to 350KW the sensor will sense this number and direct send a text message to the mobile of the owner "reduce your consumption".

There are other valid equipments that can be added to increase the performance of reduce the consumption such as putting a monitor in the house itself same as monitor in the DMS building of AADC. This monitor do the same purpose of the screen in the DMS which show the consumption rate of this house and customer put this screen in the living room when the consumption rate reach 350KW the color that show the number "load" change to red in the screen. Also, in this screen may have an indication about which room has the most consumption so the customers can reduce the rate before he exceeds the limit.