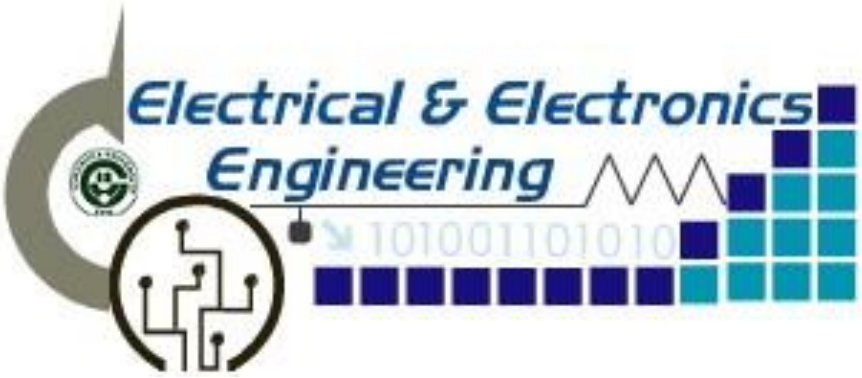

DEPARTMENT OF

ELECTRICAL AND

ELECTRONICS ENGINEERING

SUMMER PRACTICE REPORT

ÖZGÜR ŞAHİN YAŞAR
2013514067

Internship Company: ANDRITZ HYDRO

Department: HYDROPOWER PLANT

Date: 27.06.2016 – 29.07.2016

SUMMER PRACTICE REPORT

(YAZ STAJI RAPORU)

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Öğrencinin Adı-Soyadı

Starting Date : 27.06.2016
Staja Başladığı Tarih

Completion Date : 29.07.2016
Stajı Tamamladığı Tarih

Total Working Days : 20
Toplam İş Günü Sayısı

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Şirket

Department : HYDROPOWER PLANT
Bölüm

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Not: Diploma numarası olmayanlar oda sicil numaralarını da yazabilirler.

Signature **(İmza)**

Stamp **(Mühür)**

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WORK / PROJECT SUMMARY

Work Day	Date	Work / Project Description
1	27.06.2016	THE OVERVIEW OF PLANT
2	28.06.2016	HOW WORKS HEPP AND PRODUCE ELECTRİCTY
3	29.06.2016	TURBINE
4	30.06.2016	PART OF GENERATOR: “STATOR”
5	01.07.2016	PART OF GENERATOR: “ROTOR”
6	11.07.2016	COMMISSIONING TEST
7	12.07.2016	EXCITATION SYSTEM
8	13.07.2016	EMERGENCY AND QUICK SHUTDOWN SYSTEM
9	14.07.2016	VOLTAGE or POTENTIAL TRANSFORMER
10	15.07.2016	CURRENT TRANSFORMER
11	18.07.2016	CIRCUIT BREAKER
12	19.07.2016	CIRCUIT SEPERATOR

Electrical-Electronic Engineering	Name, Surname	İBRAHİM KARTAL	Signature, Stamp	

WORK / PROJECT SUMMARY

Work Day	Date	Work / Project Description
13	20.07.2016	SURGE ARRESTERS
14	21.07.2016	OVER CURRENT RELAY
15	22.07.2016	ELECTRİCAL FUSE
16	25.07.2016	SYNCHRONISATION
17	26.07.2016	STAR-DELTA CONNECTION
18	27.07.2016	SWITCHYARD
19	28.07.2016	SINGLE-LINE DIAGRAM
20	29.07.2016	SCADA SYSTEM

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PREFACE

Aim of this summer practice is that to learned how we can used our information about electrical and through this practical. I can see our department's crucial roles and which topic, situation important to us. What we can do in that points. All this mean that how we be a good engineer. I believe that this summer will be very help us to understand something in our department. Also I hope that after I graduated to the university can continuous in this company.

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Work Done	ABOUT ANDRITZ HYDRO	Date	27/06/2016

ABOUT ANDRITZ HYDRO

Company

ANDRITZ HYDRO Ltd. Şti. has been established in 1991 as 100% foreign equity Turkish Company.

Products / Local Activities

Local sourcing and contracting for
-Turbine & Generator Components (welded components)
-Electrical Balance of Plant Systems

Company

Late 2007 and beginning of 2008 the first localization concepts have been developed and implemented, mainly based on activities of local manufacturings of embedded parts like draft tubes and spiral cases for CH projects as well as for LH projects.
Beside the CH projects, in 2008, HTR (ANDRITZ Hydro Turkey) won the first LH project in the private sector, which is called Kandil cascade, others were following, (Alkumru, Boyabat, Tatar/Pembelik, Çetin, Ayvalı,Ilısu). From 1st January 2009 ELIN ELMAK became a fully consolidated "A" Daughter company of ANDRITZ Group to meet the rising local market demand, with the new registered name ANDRITZ HYDRO Ltd.Şti.

Electrical-Electronic	Name, Surname	İBRAHİM KARTAL	Signature, Stamp	

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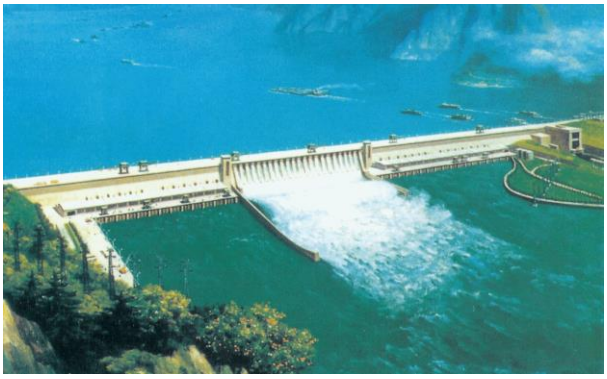
ABOUT HYDROPOWER PLANT

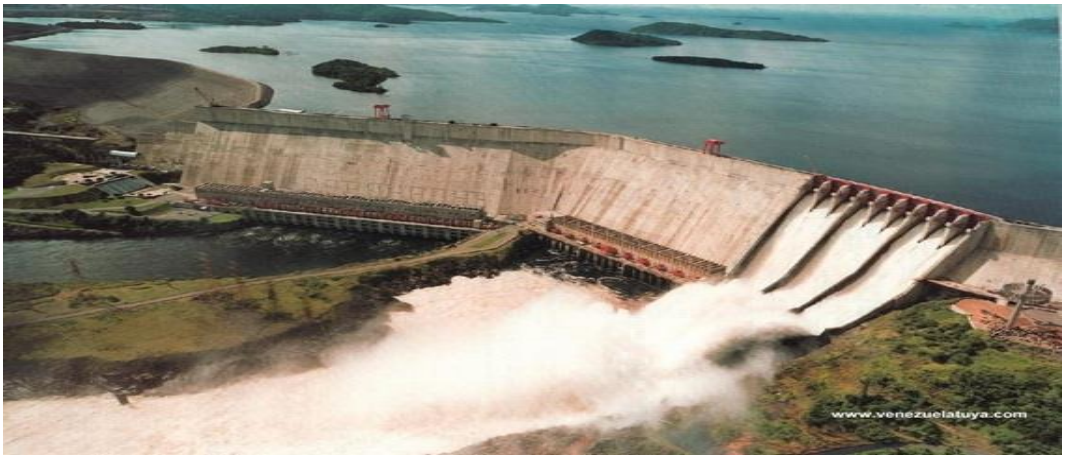
Hydroelectricity is the term referring to electricity generated by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water. In 2015 hydropower generated 16.6% of the world total electricity and 70% of all renewable electricity. There are some most famous hydroelectric power plant in the world. For example Three Gorges, China. This biggest built hydroelectric power plant produce 22,500MW. It is a conventional impoundment hydropower facility exploiting the water resource of the Yangtze River. The project is owned and operated by China Three Gorges Corporation through its subsidiary China Yangtze Power.

And also there are some another example about hydroelectric power plant in world as well as Itaipu (Brasil&Paraguar),Guri (Veneuzela),Grand Coulee(United State of America) etc.



(Figure 1,Three Gorges,China)

(Figure 2,Grand Coulee,USA)



(Figure 3, Guri,Venezuela)

Electrical-Electronic Engineering	Name, Surname	İBRAHİM KARTAL	Signature, Stamp	

1. THE OVERVİEW OF PLANT

There are some department in hydroelectric power plant like Control Room, Turbine Floor, Switchyard, Generator Floor and Communication Room etc. And of course there is a relationship between this departments. This condition make hydroelectric power plant to be complicated but if we look at the each department one by one; our job can be easy. So Andritz Hydro emply for each differant department of hydroelectric power plant as well as many company,too.

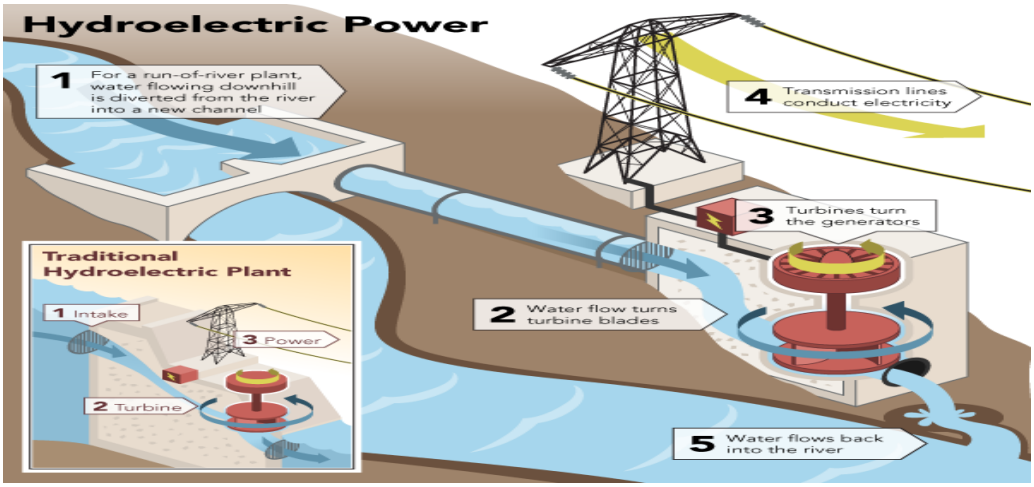
(Figure 4)

(Figure 5)

(Figure 6)

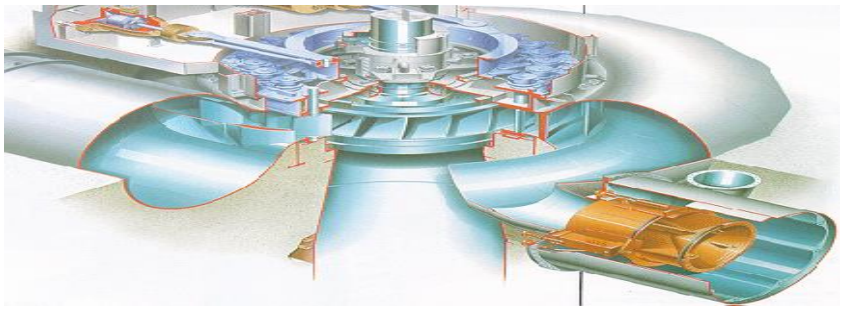
2.HOW WORKS HEPP AND PRODUCE ELECTRİCTY

I learned the main idea of the how hydroelectric power plant works. Hydropower is using water to power machinery or make electricity. Water constantly moves through a vast global cycle, evaporating from lakes and oceans, forming clouds, precipitating as rain or snow, then flowing back down to the ocean. The energy of this water cycle, which is driven by the sun, can be tapped to produce electricity or for mechanical tasks like grinding grain. Hydropower uses water that is not reduced or used up in the process. Because the water cycle is an endless, constantly recharging system, hydropower is considered a renewable energy.



(Figure 7)

When flowing water is captured and turned into electricity, it is called hydroelectric power or hydropower. There are several types of hydroelectric facilities; they are all powered by the kinetic energy of flowing water as it moves downstream. Turbines and generators convert the energy into electricity, which is then fed into the electrical grid to be used in homes, businesses, and by industry.

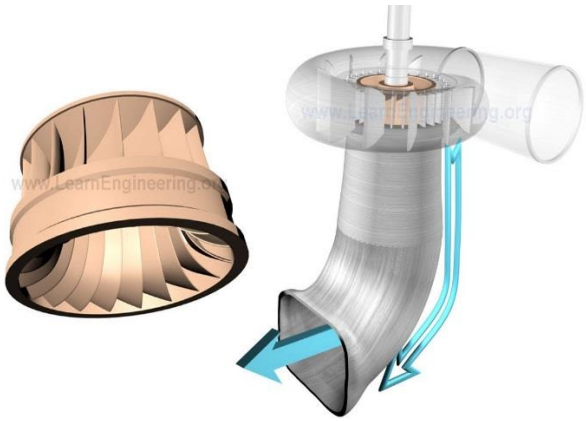


(Figure 8)

3.TURBINE

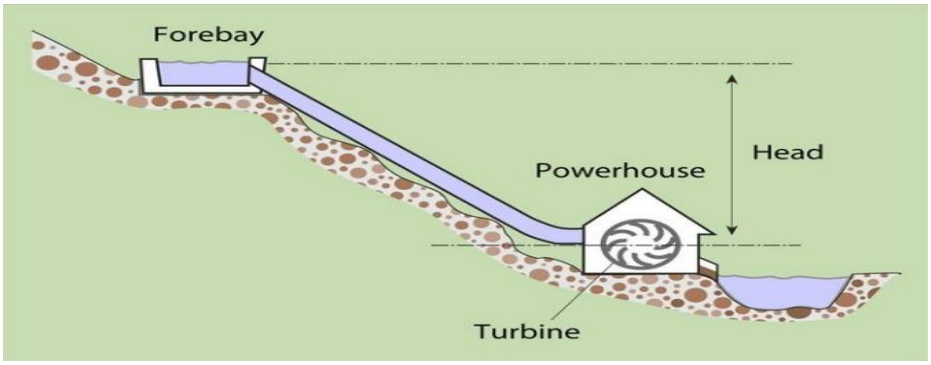
As we before talked about, “turbine” is the part of the hydroelectric power plant.

A water turbine is a rotary machine that converts to kinetic energy to potential energy of water into mechanical work. The turbines uses water to rotating turbine blades and this factor influence generator to turn. The most important thing for turbine rotating is the “flow rate” and “head”. This two important factor determine after some mathematical calculation. And also there are some fundamental hydro turbine for most available position of plant. That are called “Kaplan”, “Pelton” and “Francis”. Andritz Hydro uses generally Francis Turbine.



(Figure 9)

(Figure 10)



(Figure 11)

4.PART OF GENERATOR: “STATOR”

Stator is the fixed part and the portion of the alternating voltage obtained of the generator. The stator is made from thin sheets metal. Rotor creates a rotating magnetic field in the stator according to Lenz's rule. This rotating magnetic field induces a voltage in different phases in the stator winding. Induced voltage in the stator is transmitted as the three phase. The stationary part -the stator- consists of two main parts, the core and the armature winding. The stator core comprises many tons of low loss magnetic steel sheets.

(Figure 12)

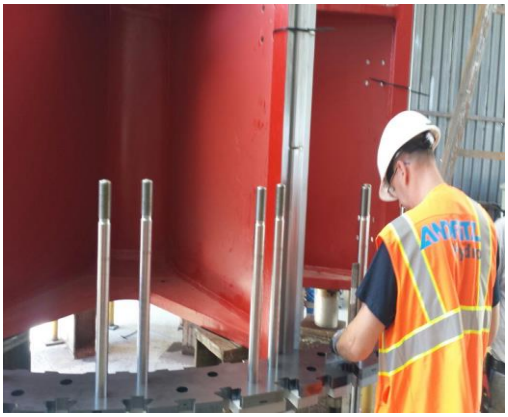
There are many copper stator bars. The winding is formed by connecting the stator bars to make a balanced three-phase lap type winding. The generator produces a current, which passes from the generator via conductors (bars) and a circuit breaker to the generator transformer.

(Figure 13)

5.PART OF GENERATOR: “ROTOR”

Rotor is the rotating part of the generator. The rotor is made from conductor windings and coils. The rotor is not magnet itself. Direct current is supplied to the rotor windings through coal, so rotor behaves magnet and it has magnetic pole. Andritz Hydro uses thin sheets metal as well as another big company and insulated this sheets metal part by part at construction site. Because of the diameter of the rotor and weight of it so large. And also moving this big built can some negative effect like economical factor etc.

(Figure 14)



(Figure 15)

(Figure 16)

6.COMMISSIONING TEST

İn this case of my internship I learned that commissioning test and why we need this tests.

Commissioning tests are the test of the pre-active of the devices and we need that to be not something wrong in devices. In this case we will look for the commissioning test Rotor Spider. And so that we will analyses the “Dry Tests” and “Wet Tests” of the Rotor Spider.

Dry Tests;

- Resistance Measurement
- Insulation Resistance
- High voltage test

Wet Tests;

- Vibrations
- Bearing Heat Run
- Verification of over speed protection
- Short circuit saturation characteristics
- Open circuit saturation characteristics
- Voltage symmetry
- Phase sequence
- Voltage wave form
- Shaft voltage
- Load rejection

(Figure 17)

7.EXCITATION SYSTEM

I learned some information about the excitation system of generator.

Excitation systems have a powerful impact on generator dynamic performance and availability, it ensures quality of generator voltage and reactive power, i.e. quality of delivered energy to consumers. Following types are common:

- Brushless excitation systems, with rotating exciter machines and Automatic Voltage Regulator (AVR), or
- Static excitation systems (SES), feeding rotor directly from thyristor bridges via brushes.

(Figure 18)

Main functions of excitation system are to provide variable DC current with short time overload capability, controlling terminal voltage with suitable accuracy, ensure stable operation with network and/or other machines, contribution to transient stability subsequent to a fault, communicate with the power plant control system and to keep machine within permissible operating range.

8.EMERGENCY AND QUICK SHUTDOWN SYSTEM

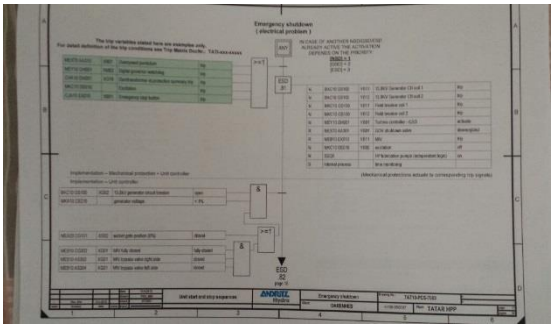
In this case, I learned part the excitation system that emergency and quick shutdown system and how generally these shutdown systems work and which part of condition these systems can be activated.

The elements to be controlled in hydro power stations are intake gates, main inlet valve, turbine, governor, the lubrication system, the excitation of the generator, main circuit breakers. Each of these elements has a particular function in the overall operation. The intake gate and main inlet valve render the plant inoperative and conserve water during shutdown period of the plant.

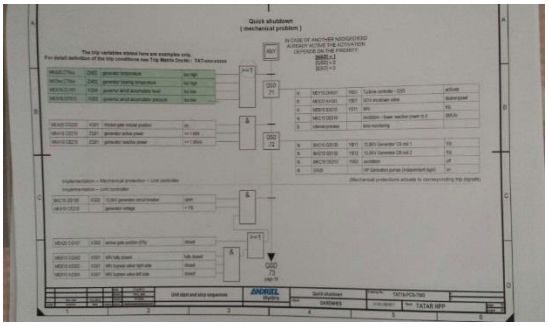
1) Emergency shutdown is activated at electrical problem of system.
2) Quick shutdown is activated at mechanical problem o system.

If ;

- Over speed pendulum
- Digital governor watchdog
- Gen/Transformer el.protection summary
- Excitation
- Emergency stop button is “TRIP”
  Then “Emergency Shutdown System”
  will be work automatically.



(Figure 19)



(Figure 20)

If ;

- Generator temperature is too HIGH
- Generator is to HIGH
- Governor air/oil accumulator level too LOW
- Governor air/oil accumulator pressure too LOW
  Then “Quick Shutdown System”
  Will be work automatically.

9.VOLTAGE or POTENTIAL TRANSFORMER

This part of internship I learned definition of the voltage transformer and why we need to use it.

Voltage Transformer or Potential Transformer used in electrical power system for stepping down the system voltage to a safe value which can be fed to low ratings meters and relays. A voltage transformer theory or potential transformer theory is just like a theory of general purpose step down transformer. Primary of this transformer is connected across the phase and ground. Just like the transformer used for stepping down purpose, potential transformer i.e. Potential Transformer has lower turns winding at its secondary. The system voltage is applied across the terminals of primary winding of that transformer, and then proportionate secondary voltage appears across the secondary terminals of the Potential Transformer.

(Figure 21)

The secondary voltage of the PT is generally 110 V. In an ideal potential transformer or voltage transformer, when rated burden gets connected across the secondary; the ratio of primary and secondary voltages of transformer is equal to the turn ratio and furthermore, the two terminal voltages are in precise phase opposite to each other. But in actual transformer, there must be an error in the voltage ratio as well as in the phase angle between primary and secondary voltages. The errors in potential transformer or voltage transformer can be best explained by phasor diagram, and this is the main part of potential transformer theory**.**

10.CURRENT TRANSFORMER

In this part, I got some information about current transformer. Current transformers are used for protection, measurement and control in high-voltage electrical substations and the electrical grid. Current transformer circuits are connected in series.

The primary windings of current transformers are thick and less wound, while secondary windings are fine-wire and very wounds. Secondary circuits of current transformers work in case of a short circuit. Secondary terminal of the current transformer must be grounding.

The power performance of a current transformer depends on the transformation ratio and on the cross-section of the iron core.

Current transform reduces the flowing current in circuit desired ratio so that, this current feeds tools connected to the secondary terminals and isolates them from the high voltage.

(Figure 22)

11.CIRCUIT BREAKER

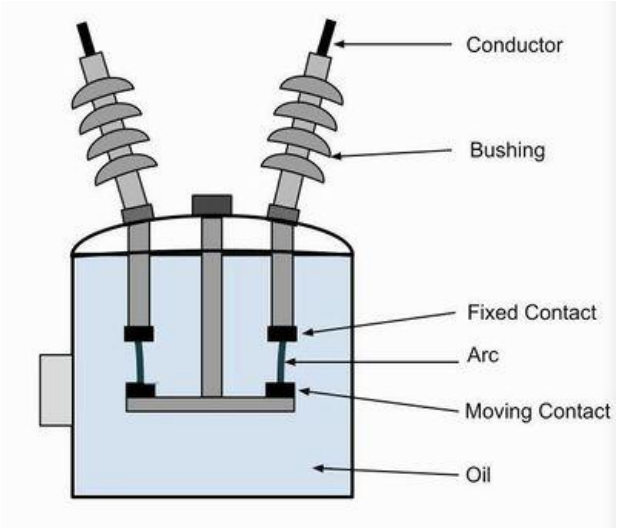
Circuit breakers are critical to the safe operation of an electrical grid.

Switching operation in high-voltage and high-current grid cannot be performed with simple structure switch. Because, arcs which are called sparks are produced during the switching operation under load. These arcs can damage contacts in a short time, in addition it can cause big bang. Hence these arcs are isolated by SF6 (sulfur hexafluoride) gas in a closed system. So, Load breakers are devices used for opening and closing circuits under load.

Circuit breakers for large currents or high voltages are usually arranged with protective relay pilot devices to sense a fault condition and to operate cutting mechanism.

The circuit breaker should be opened in a controlled manner in case of fault before separator opened. When the circuit will closed, firstly separator had to be closed.

(Figure 23)



(Figure 24)

12.CIRCUIT SEPERATOR

Separators used in high voltage are used to isolate from voltage in the system. It has no opening and closing properties the circuit. It can't be opened or closed under load. Otherwise, the separator and the person making operation will be damaged.

Separators are on the current flow path of circuit breaker, they are located front and back of breaker. When maintenance and repair of circuit breaker will be performed, separators are opened after breaker is opened. When the system is energized, before separators are closed, then the circuit breaker is closed and the system is energized.

There are three types separator in this plant

- Line separators
- Bar separators
- Ground separator

Line separators are used on electric transmission line outputs

Bar separators are used between breaker and bar

Ground separator are placed at the ends of the input or output to power lines

(Figure 25)

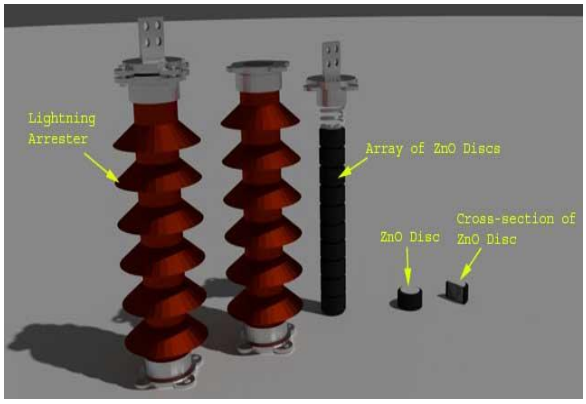
(Figure 26)

13.SURGE ARRESTERS

I got some information about surge arresters. One of the protection elements in high-voltage plants are surge arrester.

Surge arrester is used to protect against to damage may occur on devices depends on the system and failures. It prevents excessive voltage that caused by circuit breaker trip maneuvers, line faults, such as lightning in high-voltage plants. Surge arresters transmit high-current pulses into ground and, so plant is not interrupted.

Surge arrester works as a safety valve. Overvoltage waves are transferred to earth. Surge arrester is insulating state in normal operating condition. But, when a very large current passed through, it behaves minimum resistance to transmit current as soon as possible.



(Figure 27)


(Figure 28)

14.OVER CURRENT RELAY

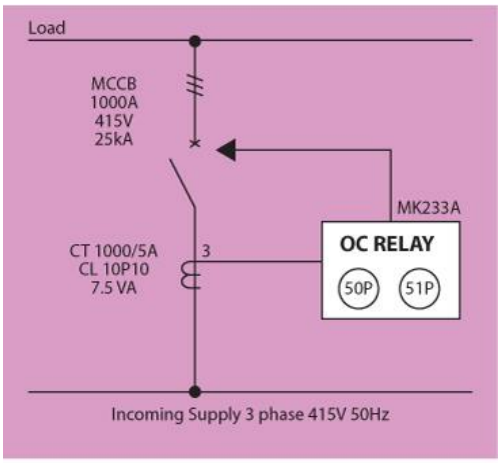
In this part of my internship, we talked about over current relay. If a failure occurs in the system, the current values can reach much higher level of nominal value. These values get too high is directly reflected the system.

Various protection elements are used to prevent affecting the networks and electrical equipment from failures occurring in the system. One of these elements is also circuit breakers. To use the breaker need to relay.

The relay that sends opening and closing signals to the circuit breaker is called over current relay.it operates circuit breaker.

In other words, over current relay is a type of protective relay which operates when the load current exceeds a preset value.

(Figure 29)



50P : Phase instantaneous overcurrent relay
51P : Phase instantaneous overcurrent relay
OC : Overcurrent relay

(Figure 30)

15.ELECTRİCAL FUSE

My another part of internship topic is the Electrical Fuse.

The fuse is an electronic device, which is used to protect circuits from over current, overload and make sure the protection of the circuit. There are many types of fuses available in the market, but function of all these fuses is same.

Fuse consists of a low resistance metallic wire enclosed in a non combustible material. Whenever a short circuit, over current or mismatched load connection occurs, then the thin wire inside the fuse melts because of the heat generated by the heavy current flowing through it. Therefore, it disconnects the power supply from the connected system. In normal operation of the circuit, fuse wire is just a very low resistance component and does not affect the normal operation of the system connected to the power supply.

Andritz Hydro works with Schneider Electric for Electric Fuse.

(Figure 31)

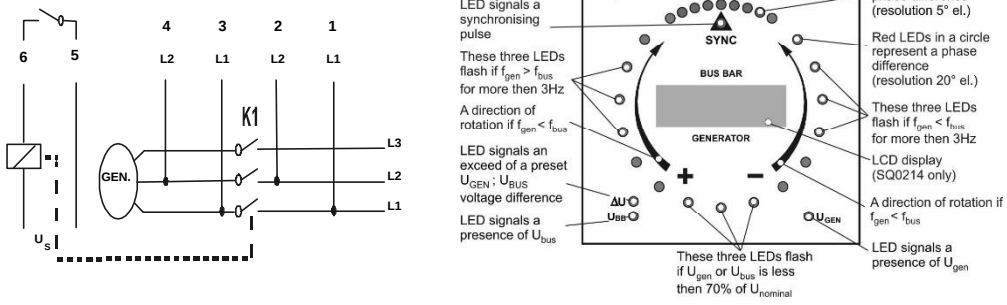
(Figure 32)

(Figure 33)

16.SYNCHRONISATION

In an alternating current electric power system, synchronization is the process of matching the speed and frequency of a generator or other source to a running network. An AC generator cannot deliver power to an electrical grid unless it is running at the same frequency as the network. If two segments of a grid are disconnected, they cannot exchange AC power again until they are brought back into exact synchronization.

A direct current (DC) generator can be connected to a power network by adjusting its open-circuit terminal voltage to match the network voltage, by either adjusting its speed or its field excitation. The exact engine speed is not critical. However, an AC generator must match both the amplitude and the timing of the network voltage, which requires both speed and excitation to be systematically controlled for synchronization. This extra complexity was one of the arguments against AC operation during the War of Currents in the 1880s. In modern grids, synchronization of generators is carried out by automatic systems.



(Figure 34)

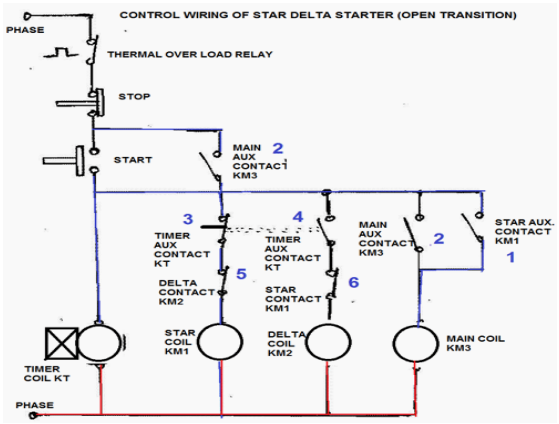
17.STAR-DELTA CONNECTION

They are two different kind of connections as far as three phase system is concerned.

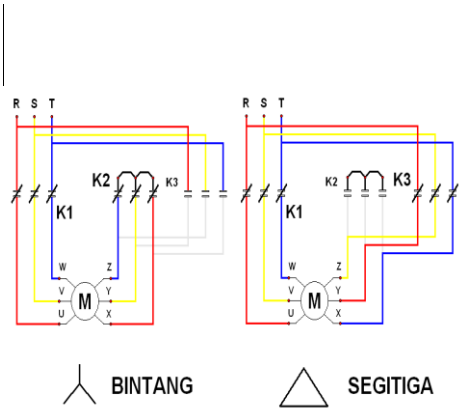
In STAR connection, the starting or finishing ends (Similar ends) of three phases(coils) are connected together to form the neutral point. A common wire is taken out from the neutral point which is called Neutral.There is no such connection in Delta network.

The Line voltage is root three times the phase voltage. That means the insulation requirement for each phase is low as compared to delta connection where line voltage is same as phase voltage.Hence the no. of turns in any phase in star connection of the conductors is also less than no of turns of conductors in any phase of delta connection.

Star Connection is prefferable in transmission system as the voltage insulation required is less. Delta connection is used in Distribution system.



(Figure 35)



(Figure 36)

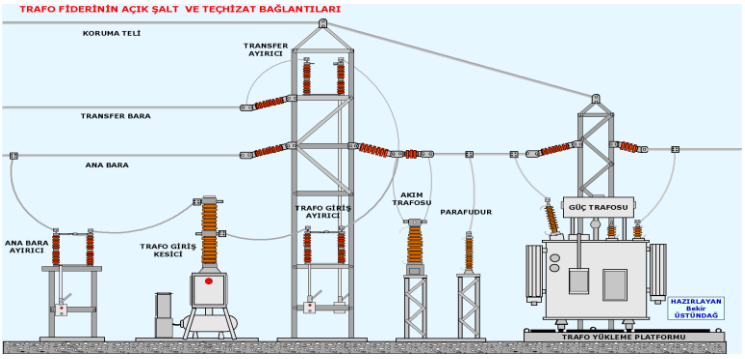
18.SWITCHYARD

Switchyard is place that contains high-voltage unit that connect between interconnected networks with power plant. Switchyard includes circuit breakers, separators, bars, transformers. Switchyard units are placed in open area due to the magnitude of the voltage.

Energy loses are important for energy transmission and loses are reduced minimum level. To do that transformers are used.

Electricity is adjusted to required transmission by increasing or reducing via transformers in the switchyard.

Maneuver is performed by using circuit breakers and separators in case of failure, so the transmission continuity is provided.

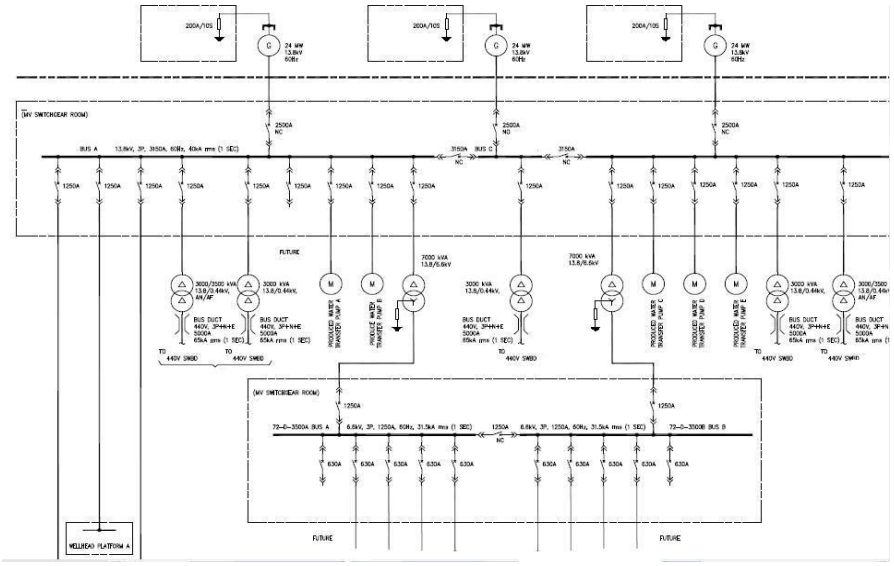


(Figure 37)

19.SINGLE-LINE DIAGRAM

The single-line diagram is the blueprint for electrical system analysis. It is the first step in preparing a critical response plan, allowing you to become thoroughly familiar with the electrical distribution system layout and design in your facility.

Whether you have a new or existing facility, the single-line diagram is the vital roadmap for all future testing, service and maintenance activities. As such, the single-line diagram is like a balance sheet for your facility and provides a snapshot of your facility at a moment in time. It needs to change as your facility changes to ensure that your systems are adequately protected.



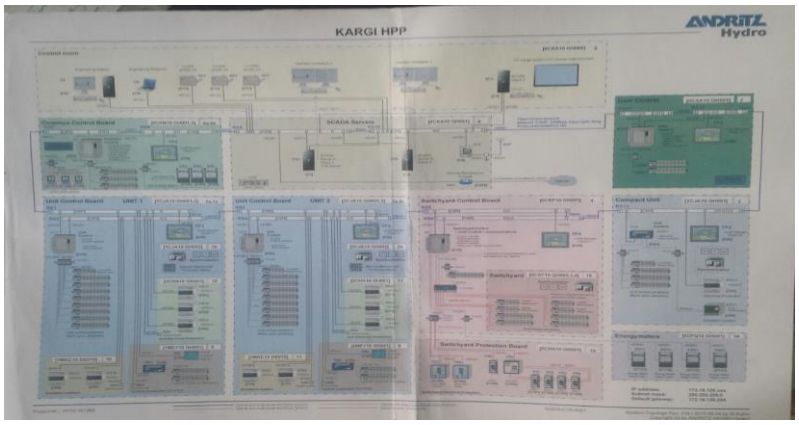
(Figure 38)

20.SCADA SYSTEM

In the last part of my internship, I got information about SCADA SYSTEM.

SCADA is a system that controls and collects data all plant.it is most useful and important system for communication for plant. SCADA system that is used in hydropower plant satisfies the technical requirements such as;

- Water level control
- Sending the instantaneous data of generated energy to TEİAŞ
- Auto / Manual - Local / Remote control functions
- Viewed and control of the turbine and governor
- The synchronization of the generator
- Control Temperature of the turbine
- Speed information
- Turbine governor start / stop control
- Excitation system operation and fault information
- Viewed Protective relays and energy analyzer
- Turbine oil level information, oil pressure information



(Figure 39)

CONCLUSION

During my internship, I have learnt various things that I hadn't heard before.
I had the opportunity to learn new knowledge to meet new people during 20 training days.I saw how the working life of an engineer is, and how it should be communication to employees in plant, it was a good experience for me.

Furthermore, I found opportunity to use theoretical knowledge that I learn in school in practice in this internship.

Finally, my internship was very instructive and useful. I have realize how the working life is as a candidate engineer.

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7-) MEGEP kitapları