# Summer training report

# ONGC Dehradun

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Course: B.tech in electrical engineering and

M.tech in power electronics and drives

**IIT BHUBANESWAR**

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# ACKNOWLEDGEMENT

With deep reverence and profound gratitude, I express my sincere thanks to **Mr. ANANT PRAKASH YADAV DGM(ELECTRICAL) infrastructure group** for giving me an opportunity to do training at ONGC, DEHRADUN. He provided good knowledge about the plant working and behavior and other different department being in online mode enough to complete the training report.

**Training Period: June, 15 to august 15, 2022.**

NIKHIL TYAGI

3RD YEAR

ELECTRICAL ENGINEERING

B.TECH, DUAL DEGREE

IIT BHUBANESWAR

# ABSTRACT

I was appointed to do 8-week training at this esteemed organization from 15 JUNE, 2022 to 15 AUGUST, 2022.this was a online summer training.

This report contains detail study of plant operation and substation and its central cooling system , solar plant and pump house.

These 8 weeks training was a very educational adventure for me. It was really amazing to learn about the plant and its system. This report has been made by my experience at ONGC, DHERADUN. The material in this report has been gathered from my notes, senior student reports and trainers manuals and power journals provided by training department.

# Content

# ONGC DEHRADUN


**O**il and Natural Gas Corporation Limited (ONGC) is an Indian multinational oil and gas company headquartered in Dehradun, Uttarakhand d, India. It is a Public Sector Undertaking (PSU) of the Government of India, under the administrative control of the Ministry of Petroleum and Natural Gas. It is India's largest oil and gas exploration and production company. It produces around 69% of India's crude oil (equivalent to around 30% of the country's total demand) and around 62% of its natural gas .On 31 March 2013, its market capitalization was INR 2.6 trillion (US$48.98 billion), making it India's second-largest publicly traded company. In a government survey for FY 2011–12, it was ranked as the largest profit making PSU in India. ONGC has been ranked 357th in the Fortune Global 500 list of the world's biggest corporations for the year 2012.

ONGC was founded on 14 August 1956 by Government of India, which currently holds a 68.94% equity stake. It is involved in exploring for and exploiting hydrocarbons in 26 sedimentary basins of India, and owns and operates over 11,000

kilometers of pipelines in the country. Its international subsidiary ONGC Videsh currently has projects in 17 countries. ONGC has discovered 6 of the 7 commercially producing Indian Basins, in the last 50 years, adding over 7.1 billion tonnes of In-place Oil & Gas volume of hydrocarbons in Indian basins. Against a global decline of production from matured fields, ONGC has maintained production from its brownfields like Mumbai High, with the help of aggressive investments in various IOR (Improved Oil Recovery) and EOR (Enhanced Oil Recovery) schemes.

ONGC has many matured fields with a current recovery factor of 25–33%.Its Reserve Replacement Ratio for between 2005 and 2013, has been more than one. During FY 2012–13, ONGC had to share the highest ever underrecovery of INR 494.2 million (an increase of INR 49.6 million over the previous financial year) towards the under-recoveries of Oil Marketing Companies (IOC, BPCL and HPCL). On 1 November 2017, the Union Cabinet approved ONGC for acquiring majority 51.11 % stake in HPCL (Hindustan Petroleum Corporation Limited). On Jan 30th 2018, Oil & Natural Gas Corporation acquired the entire 51.11% stake of GOI.Maharatna ONGC is the largest crude oil and natural gas Company in India, contributing around 70 per cent to Indian domestic production.

Crude oil is the raw material used by downstream companies like IOC, BPCL, and HPCL to produce petroleum products like Petrol, Diesel, Kerosene, Naphtha, and Cooking Gas-LPG. This largest natural gas company ranks 11th among global energy majors (Platts). It is the only public sector Indian company to feature in Fortune's 'Most Admired Energy Companies' list. ONGC ranks 18th in 'Oil and Gas operations' and 183rd overall in Forbes Global 2000. Acclaimed for its Corporate Governance practices, Transparency International has ranked ONGC 26th among the biggest publicly traded global giants. ONGC has a unique distinction of being a company with in-house service capabilities in all areas of Exploration and Production of oil & gas and related oilfield services. Winner of the Best Employer award, this public sector enterprise has a dedicated team of over 33,500 professionals who toil round the clock in challenging locations.ONGC's operations include conventional exploration and production, refining and progressive development of alternate energy sources like coal-bed methane and shale gas. The company's domestic operations are structured around 11 assets (predominantly oil and gas producing properties), 7 basins (exploratory properties), 2 plants (at Hazira and Uran) and services (for necessary inputs and support such as drilling, geo-physical, logging and well services).

# Substation

Substation are necessary because they are the important components of the overall electrical infrastructure that is made up of a place. They are basically electrical substations and they are responsible for ensuring the delivery of continuous electricity to the customers. They are basically designed with the help of containing high voltage equipment which includes transformers, circuit breakers, switchgear, and other associated devices.

The importance of Substations and their designs

The electricity that is available at the electricity towers are very high in voltage, if that electricity is supplied to households then it will burn up your whole system and damage your appliances hence substations are built in order to step down electricity from a high voltage transmission system to electricity with lower in order to supply it to households, industries, companies and various other places where it is needed. The distribution lines carry out the task of supplying electricity to various places.

Local electrical companies have many substations placed at various checkpoints in the country in the areas in which they provide the customers; you will see a number of substations in and around the country. The substation has a number of key components which manage the step down of the electricity from a supply of high voltage to a supply of lower voltage, these components have a high chance of getting damaged hence it is important to keep them protected while designing a substation.

Design of a substation

The design of the substations mostly contains The Transformers, Circuit Switches, Breakers, Transmitters, and the Capacitors.

- The transformers carry out the task of stepping down the high voltage electricity to lower voltage electricity which is suitable enough to send through the distribution wires.
- The flow of electricity is directed by the circuit switches
- Breakers handle the interruption of electricity when some electricity surges occur so that the system is protected from damage.

## General description of ONGC substation

Substation serves to receive, convert, and distribute electrical energy in KDMIPE campus of ONGC 33KV sub-station was commissioned in June 1985. It gets power supply from KAULAGARH POWER HOUSE through underground cables. In case of power failure, electric power is supplied from GENERATOR HOUSE (4x2000KVA) situated in service block.

The 33KV line is connected from Uttarakhand Power Corporation Limited (UPCL) in the main panel, and the necessary measurements are made. Its output(33KV) is fed from the high tension bus-bar. From the high-tension bus bar, the supply is given to four panels, which are in parallel connection through 630 A, 33KV. In the groups also the necessary measurements are made after stepping down the supply with the help of instrument transformers. Here too there are relays installed which aid in the protection of the panels.

From the four paralleled panels the supply is given to the step-down transformers through underground cables (at 33KV). The specifications of the transformer are 2500KVA, 33KV/433V/50Hz. The primary (HIGH TENSION) side of the transformer is DELTA connected (3phase, 3wire system) with 33KV input and secondary (LOW TENSION) side of the transformer is STAR connected with the star point grounded via neutral(3phase, 4wire system) with 433V output. An on-load Tap Changer is also connected in the H.T. side of the transformer. The necessary measurements regarding voltage, amperage, frequency, and power factor are made again by stepping down through instrument transformers on the 3000A bars connecting through fuses, earth fault relays, overcurrent relays, under voltage relays, etc. The output of the transformer is fed to four independent 3000A bars which connect it to L.T. bars. And they are independently coupled using couplers. The function of is to

connect the load on one or more bus bar to another bus bar so that all load requirements are fulfilled in case of failure of transformers. From this L. T. Bus bar, various feeders are taken out, and 3-phase supply is given to different places as and when required. A capacitor circuit is provided with each L.T. Bus bar segment to improve the power factor.

In case there is a power failure from Uttrakhand power supply electric board (UPSEB) so that transformers cannot be activated.4 diesel generators sets of capacity 2000 KVA are provided which can supply the requisite power for fulfilling the load requirements. The various measurements as regarding frequency, voltage, and amperage and power factor are made on the 6300A bus bar by stepping down the voltage and current to measurable ranges by the help of instrument transformers. System protection is provided through earth fault relays, overcurrent relays, etc. Another safety protection is by using the Reverse current relay attached to the master trip so that reverse current should not flow in the generator set which burns the armature winding in the alternator. Circuit Breaker used in sub station of ONGC is Sulfur Hexafluoride

## Components of electrical distribution

### Substation

A substation is a part of an electrical generation, transmission and distribution system Substations transform voltage from high to low, or the reverse, or perform any of several other essential functions. Between the generating station and consumer, electric power may flow through several substations at different voltage levels. Substations may be owned and operated by an electrical utility or may be held by a large industrial or commercial customer. There are different types of substation categorized on a different basis.

- **Transmission substation**

A transmission substation is one whose primary purpose is to connect various transmission lines. The simplest case is where all transmission lines have the same voltage. In such cases, the substation contains high voltage switches that allow lines to be connected or isolated for maintenance.

- **Distribution substation**

A distribution substation is one whose primary purpose is to transfer power room the transmission system to the distribution system of some area. It is uneconomical to connect electricity consumers to the leading transmission network directly (unless they use large amounts of energy).

**• Collector substation**

In distributed generation projects such as a wind farm, a collector substation may be required. It resembles a distribution substation although power flow is in the opposite direction, from many wind turbines up into the transmission grid.

**• Converter substation**

Substations may be associated with HVDC converter plants, traction current, or interconnected non-synchronous networks. These stations contain power electronic devices to change the frequency of the current, or else convert from alternating to direct current or the reverse.

**• Switching substation**

A switching substation is a substation without transformers and operating only at a single voltage level. They are used for switching the current to back-up lines or for parallelizing circuits in case of failure. Here in ONGC, we have Distribution substation.

**Circuit Breakers**

A circuit breaker is an automatically operated electrical switch designed to protect an electric circuit from damaged caused by overload or short circuit. Its primary function is to detect a fault condition and interrupt current flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume regular operation. There are different types of circuit breakers which are

**• Low-voltage circuit breaker**

Low-voltage (less than 1,000V) types are common in domestic, commercial and industrial application, and include Miniature Circuit Breaker (MCB) and Molded Case Circuit Breaker (MCCB).

**• Magnetic Circuit Breakers:**

Magnetic circuit breakers use solenoid (electromagnet)whose pulling force increases with the current.

**• Thermal Magnetic Circuit breaker:**

Thermal magnetic circuit breakers, which type are found in most of the distribution boards, incorporate both the techniques with the electromagnet

responding instantaneously to large surges in current. The thermal portion of the circuit breaker provides an "inverse time" response feature, which

trips the circuit breaker sooner for larger overcurrents.

**• Vacuum Circuit breakers:**

With rated current up to 6,300 A, and higher for generator

circuit breakers. These breakers interrupt the current by creating and extinguishing the are in a vacuum container

**• Air Circuit Breakers:**

Rated current up to 6,300A and higher for generator circuit breakers. Trip characteristics are often fully adjustable, including configurable tripthresholds and delays.

**• Sulfur Hexafluoride High Voltage Circuit Breakers:**

A sulfur hexafluoride circuit breaker uses contacts surrounded by sulfur hexafluoride gas to quench the are. They are most often used for transmission-level voltages and may be incorporated into compact gas-insulated switchgear. Here in ONGC substation The Range of SF6 Circuit Breaker is 5kA/sec. and Air Circuit Breaker is of 80kA in use.

**Isolater**

a disconnector, disconnect switch or isolator switch is used to ensure that an electrical circuit is completely de-energized for service or maintenance. Such switches are often found in electrical distribution and industrial applications, where machinery must have its source of driving power removed for adjustment or repair. Highvoltage isolation switches are used in electrical substations to allow isolation of apparatus such as circuit breakers, transformers, and transmission lines, for maintenance.

**Lightning Arrestors**

A lightning arrestor is a device used in power systems and telecommunications systems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrestor has a high-voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrestor, the current from the surge is diverted through the arrestor, in most cases to earth

**Current Transformer**

A Current Transformer (CT) is used for measurement of alternating electric currents. When the current in a circuit is too high to apply directly to measuring instruments, a current transformer produces a reduced current accurately proportional to the current the circuit, which can be conveniently connected to measuring and recording devices. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power system.

**Potential Transformer**


Voltage Transformers (VT) (also called Potential Transformers (PT)) is a parallel connected type of instrument transformer, used for metering and protection in high-voltage

**Diesel Generator Set**

In ONGC, An alternator is such a machine which produces alternating electricity. It is also known as a synchronous generator. Here at ongc self regulating brushless alternators are used. It is used in electrical power generation plant as a primary source of power. The components in brushless alternator consist of two small alternators, one called the main alternator, and the other is called the exciter. These two works together to function as one alternator.

Advantage:

They can significantly reduce heat and friction in any application. Lower operating temperature results in less wear and tear of the mechanical parts. These are also quieter while operating than standard brushed alternators.

Starting Mechanism

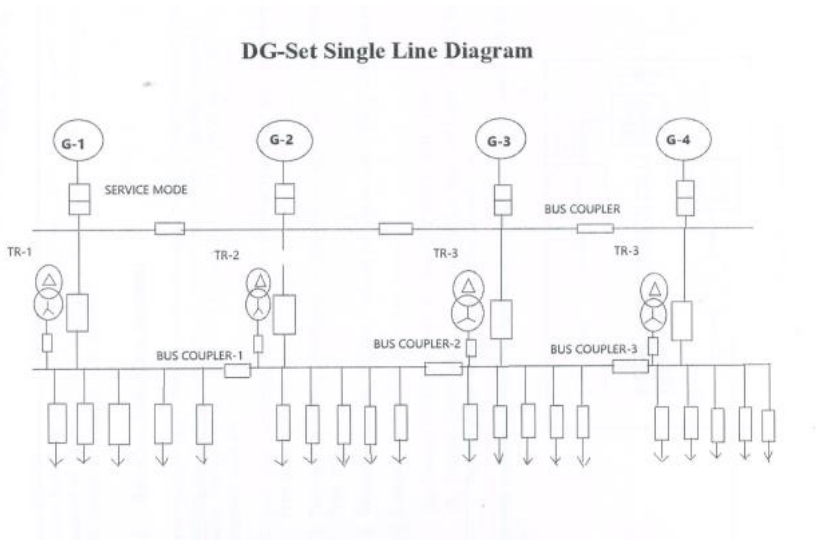
First, the air is blown into the generator until it is compressed. Subsequently, diesel fuel is injected. The combination of these processes, air compression, and subsequent injection of the fuel, will contribute to generating the heat that triggers the inflammation of the fuel. In this way, it starts combustion and causes the generator to start up. Thus, the generator begins to produce the necessary electrical energy to be distributed according to the needs of the equipment connected to it or the place that it will supply.

All the generators are not started subsequently, in spite the load is given slowly-slowly, so the first generator is started first then, second and so on.

**Human Machine Interface (HMI)**

Panel Human Machine Interface panels can be used for multiple generator configurations. All individual generator set operator panels communicate with the HMI panel. These panels can monitor and control up to five separate generators simultaneously and can be equipped with paralleling capabilities. Here, in ONGC the HMI panel is set in the semiauto mode so that it can be operated in both the ways manually as well as automatically also. Diesel Engine used is essentially an internal combustion engine.

Single line diagram:



# PUMP HOUSE

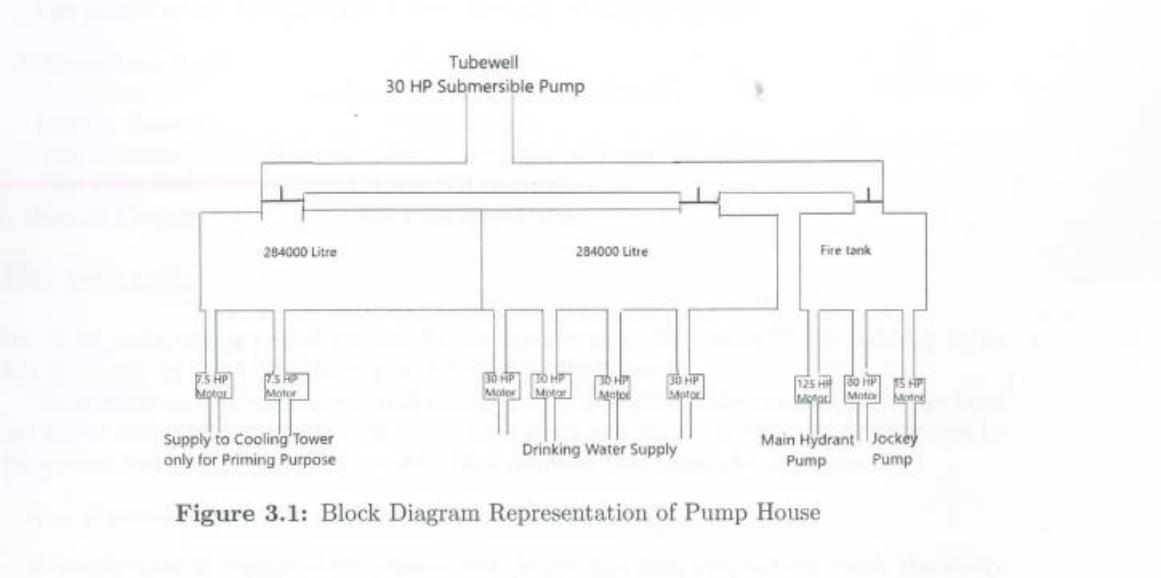



**Figure 3.1:** Block Diagram Representation of Pump House

In the kdimpe campus of ongc , there is fire extinguisher system is installed . in which three fire pump are installed in side the pump house containing the main hydrant pump of 125 hp, sprinkle system pump is of 80 hp and jockey pump is of 15 hp which keep the system always pressurise in order to avoid any misshaping due to fire caused in the industry. Inside the  kdmp campus, along with this ONGC has its own fire station which has three engine of good efficiencies  and provide a quick response to the system, the ongc fire station is operated by cisf.

Fire fighting system and equipment in the buildings

## Genreral fire fighting equipment :

Fire fighting system and equipment vary depending on the age size , use and type of building construction. A building may contain some or all of the following feature:

Fire extinguisher

Fire hose reel

Fire hydrant system

Automatic sprinkler sysems

**Fire extinguisher :**

It is the first provide attack on fire generally undertaken by the employee before the service is arrived.

**Fire hose reel:**

Fire hose reel are provided for use by occupant as the first attack fire fighting measures but may, in some instances, also used by the fire fighter.

When stowing a fire hose reel, it is important to first attach the nosel end to the hoose reel valve, then close the hoose reel valve, then open the nozel to relieve any pressure in the wound hose , then clean the nozzle. This acieve two principal objective:

A depressurised hose and hose reel seal will last.

Longer than if permanentaly pressurised. When the hose reel is next used, the operator will be forced to turn on the isolating valve, thus charging the hose reel with pressurised water supply, before able to drag the hose to the fire.

**Fire hydrant system:**

Fire hydrant system are installed in the building to help fire fighter quickly attack the fire, essentially, a hydrant system is water reticulation system used to transport water in order to limit the amount of hose that fire fighter have to lay, thus seeding up the fire fighting process.

Fire hydrant are able for the sole use of the trained firefighter(which include the fire fighting teams). Because of the high pressure available serious injury can occur if untrained person try to operate the equipment connected to such installation

# Drinking water supply system

**Pump types:**

There are generally two types of pump used for the portable water pumping application:

Vertical turbine pump, line shaft and submersible type

2- centrifugal horizontal or vertical split case pump designed for water work service.

If the pump station and intake structure are to be located within the surface or underground reservoir, vetical turbine pump ith the column extending down into the reservoir or its suction well will be logical choice. If the pump station is located at an above the ground storage facility, split case centrifugal pump will be the logical choice. Split case pump design is used for ease of maintenance of the rotating elements, which can be removed without disconnecting the suction or discharge piping. For standard waterworks design for potable systems, pump casing will be cast iron and impellers will be bronze. Base for pump and driver will be cast iron or fabricated steel. Pumps which may operate. Lubrication for horizontal pumps will be oil bath or grease. Vertical dry pit pumps will be grease lubricated. Vertical wet pit pumps will have oil or water lubrication.

**Pump drives:**

Pump drives for water supply and distribution pumps will be electric motors. Diesel or other fuels will be considered as a power source only for emergency use. The drivers will be constant speed AC motors of the squirrel-cage induction, wound rotor or synchronous type.

1. Variable speed drive: Variable-speed devices will be considered only for larger pumps and only if justified by an accurate economic analysis. There are many variable speed control systems available. Although the principle may vary, these systems consist of four basic elements: sensor, controller, programmer and variable speed driver.

2. Motor: Motors will be selected with sufficient capacity to drive the pumps under service required without exceeding 85 percent of the specified rating.

3. Valving: Valves used in pump station piping system will include: gate valves, globe and angle valves, cone valves, butterfly val(TOTAL CAPACITY-1200 T.R.)ves, ball valves, check valves, and relief valves. Globe, ball, cone, and butterfly valves will be best suited as control valves for modulating the flow to provide desired pressure or flow rate.

(a) Suction piping valve: A gate valve will be installed in the suction piping so that the pump can be isolated from the line.

(b) Discharge piping valve: A check valve and a gate or butterfly valve will be installed in the discharge piping with the check valve between the pump and the gate valve. The check valve will protect the pump from excessive back pressure and prevent liquid from running backwards through the pump in case of power failure. The gate valve will be used to isolate the pump and check valve for maintenance purposes.

(c) Air release and vacuum relief: Air release and vacuum relief valves will be used on discharge piping for vertical turbine pumps.

Piping layout 1. Suction piping:

Proper design of suction piping is important to minimize pressure losses and allow sufficient flow into the pump.

2. Discharge piping:

If the discharge pipe is short, the diameter of the pipe will be the same as the pump discharge nozzle. If the discharge pipe is long, the diameter will be increased by one or two sizes depending on length.

3. Meter runs:

At meter locations the required straight approach and downstream length of straight pipe must be considered. It is good practice to allow straight runs of 10 and 5 pipe diameters for upstream (approach) and downstream of meters in the piping layout. This will accommodate any type of meter.

**Controls**

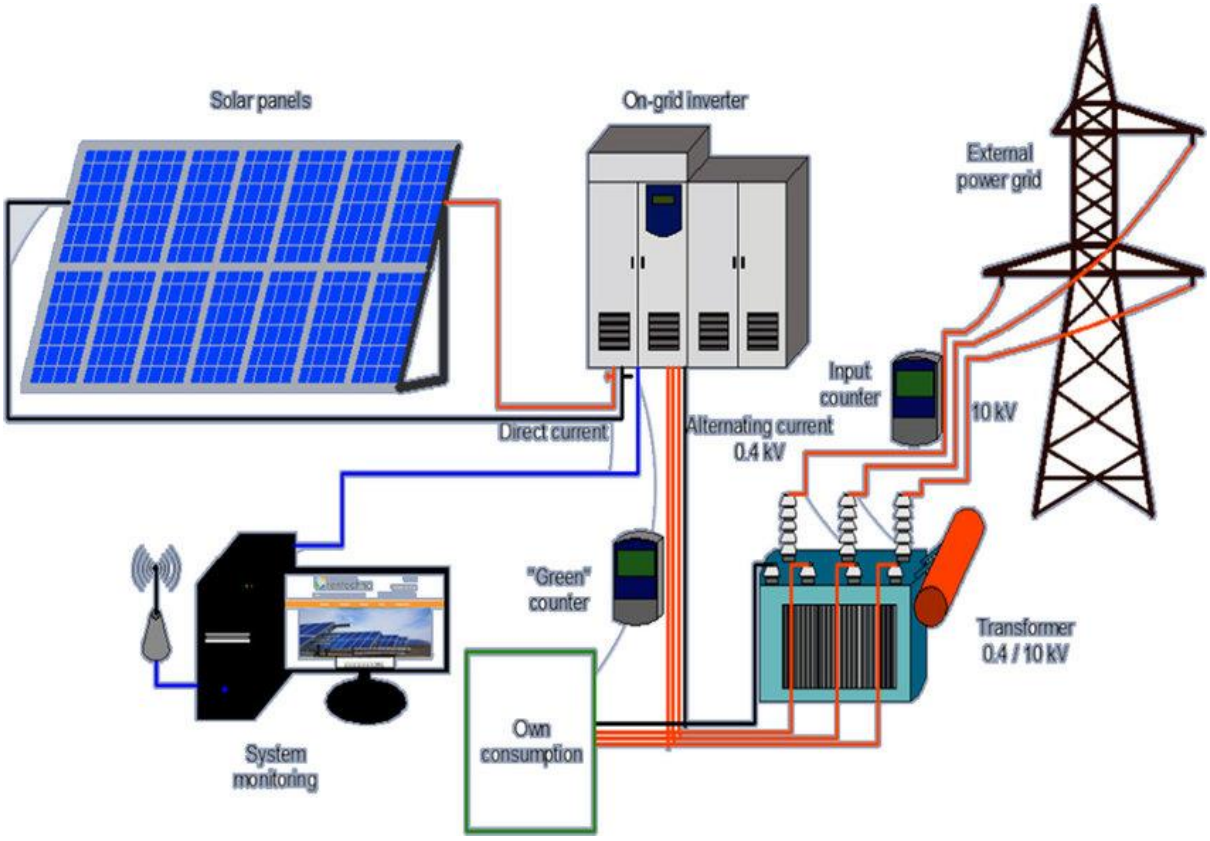
Pump controls will have the capability to provide the desired flow rates, pressures and liquid levels; to provide protection from pump and piping system damage; and to serve as a tool to find system problems which may need operational adjustment, repair or maintenance. Control systems consist of the following:

• Sensing and measuring elements (primary device).

• Comparison and relaying element (controller).

• Final control element (as a valve) to produce the required change including an actuator to move the control element.

# Solar power plant




Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), indirectly using concentrated solar power, or a combination. Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect.

Solar power is arguably the cleanest, most reliable form of renewable energy available, and it can be used in several forms to help power your home or business. Solar-powered photovoltaic (PV) panels convert the sun rays into electricity. This electricity can then be used to supply renewable energy to your home or business.

A photovoltaic cell, commonly called a solar cell or PV, is a technology used to convert solar energy directly into electricity. A photovoltaic cell is usually made from silicon alloys.
Particles of solar energy, known as photons, strike the surface of a photovoltaic cell between two semiconductors.

These semiconductors exhibit a property known as the photoelectric effect, which causes them to absorb the photons and release electrons. The electrons are captured in the form of an electric current - in other words, electricity.

**How does solar system work?**

A photon is a basic unit that makes up all light,it is a bundle of electromagnetic energy, When a photon strike a solar cell,they loosen electrons from their atoms. If we attach a conductor to a cell's negative and positive sides, we have an electrical circuit. When electron flow through the circuit,they generate electricity.

Solar panel-Solar cell-Solar array Solar panels(Solar modules)consist of many solar cells. When there are many panels wired up together, we have an solar array.

The amount of electricity a solar panel produces depend on following factors . Its size

The efficiency of the solar cell within that panel • How much sunlight hits the solar panel.

4.1.1 Advantage and disadvantage of using Solar Energy Advantage:

• Solar power is pollution free and causes no greenhouse gases to be emitted after

installation. • Reduced dependence on foreign oil and fossil fuels. • Virtually no maintenance as solar panels last over 30 years Creates jobs by employing

solar panel manufacturers, solar installers, etc. and in turn helps the economy, • Excess power can be sold back to the power company if grid intertied.

Cell:

Semiconductor device that converts sunlight into direct current (DC) electricity. Module:

PV modules consist of PV cell circuits sealed in an environmentally protective laminate and are the fundamental building block of PV systems. Panel:PV panels include one or more PV modules assembled as a pre-wired, field installable unit.

Array:

A PV array is the complete power-generating unit, consisting of any number of PV modules and panels.

(a) Photovoltaic Cell:

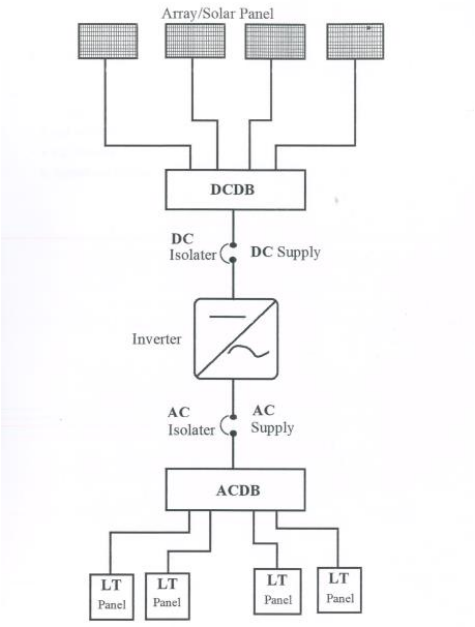
A single PV cell is a thin semiconductor wafer made of two layers generally made of highly purified silicon (PV cells can be made of many different semiconductors but crystalline silicon is the most widely used). The layers have been doped with boron on one side and phosphorous on the other side, producing surplus of electrons on one side and a deficit of electrons on the other side. When the wafer is bombarded by sunlight, photons in the sunlight knock off some of excess electrons, this makes a voltage difference between the two sides

excess electrons try to move to the deficit side. In silicon this voltage is 0.5 volt

Metallic contacts are made to both sides of the semiconductor. With an external circuit attached to the contacts, the electrons can get back to where they came from and a current flows through the circuit. This PV cell has no storage capacity, it simply acts as an electron pump.

The amount of current is determined by the number of electrons that the solar photons knock off. Bigger cells, more efficient cells, or cells exposed to more

intense sunlight will deliver more electrons




Solar Single Line Diagram

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(b) Photovoltaic Module:

A PV module consists of many PV cells wired in parallel to increase current and in series to produce a higher voltage. 36 cell modules are the industry standard for large power production.

The module is encapsulated with tempered glass (or some other transparent material) on the front surface, and with a protective and waterproof material on the back surface. The edges are sealed for weatherproofing, and there is often an aluminum frame holding everything together in a mountable unit. In the back of the module there is a junction box, or wire leads, providing electrical connections. There are currently four commercial production technologies for PV Modules:

Single Crystalline:

This is the oldest and more expensive production technique, but it's also the most efficient sunlight conversion technology available. Module efficiency averages about 10% to 12%.

Polycrystalline or Multicrystalline:

This has a slightly lower conversion efficiency compared to single crystalline but manufacturing costs are also lower. Module efficiency averages about 10% to 11%.

In KDMIPE Campus we have Polycrystalline PV module used, whoes colour is Dark Blue(On the Basis of Colour also the type can be judged.) Amorphous or Thin Film: Silicon material is vaporized and deposited on glass or stainless steel. The cost is lower than any other method. Module efficiency averages 5% to 7%.

(c) Photovoltaic Panels:

PV panels include one or more PV modules assembled as a pre-wired, fieldinstallable unit. The modular design of PV panels allows systems to grow as needs change. Modules of different manufacture can be intermixed without any problem, as long as all the modules have rated voltage output within 1.0 volt difference.

(d) Photovoltaic Array:

A PV Array consists of a number of individual PV modules or panels that have been wired together in a series and/or parallel to deliver the voltage and amperage a particular system requires. An array can be as small as a single pair of modules, or large enough to cover acres. 12 volt module is the industry standard for battery charging. Systems processing up to about 2000 watt-hours should be fine at 12 volts. Systems processing 2000 - 7000 watt-hours will function better at 24 volt. Systems running more than 7000 watt-hours should probably be running at 48 volts.

2. Solar Inverter:

A solar inverter or PV inverter, is a type of electrical converter which converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network.

(a) Stand-alone inverters, used in isolated systems where the inverter draws its DC

energy from batteries charged by photovoltaic arrays. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source, when available. Normally these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection.

(b) Grid-tie inverters, which match phase with a utility-supplied sine wave. Grid

tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons. They do not provide backup power during utility outages.

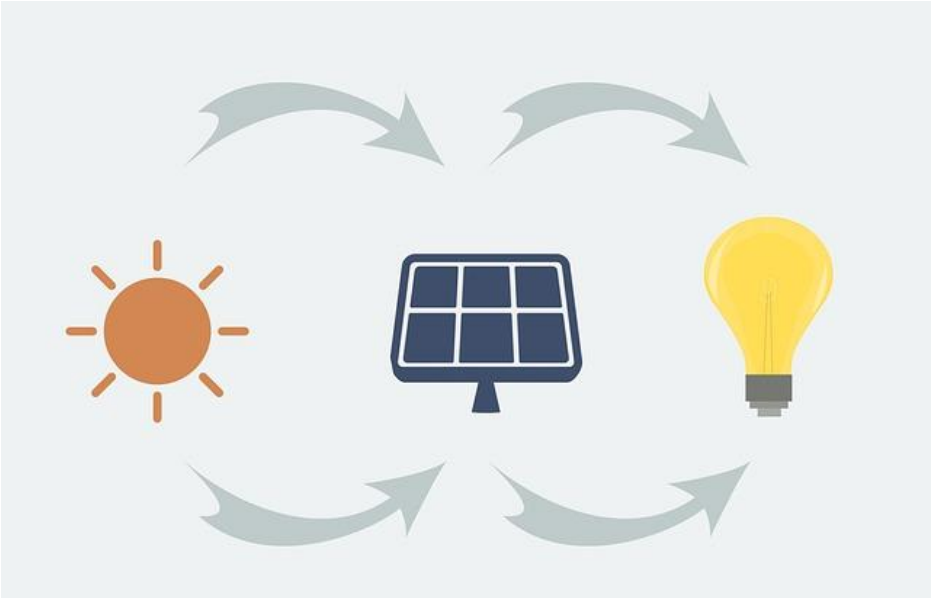
(c) Battery backup inverters, are special inverters which are designed to draw en

ergy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid. These inverters are capable of supplying AC energy to selected loads during a utility outage, and are required to have anti-islanding protection.

How does a solar inverter work?

A solar inverter works by taking in the variable direct current, or 'DC' output, from your solar panels and transforming it into alternating 120V/240V current, or 'AC' output. The appliances in your home run on AC, not DC, which is why the solar inverter must change the DC output that is collected by your solar panels.

To be a little more technical, the sun shines down on your solar panels (or photovoltaic (PV) cells), which are made of semiconductor layers of crystalline silicon or gallium arsenide. These layers are a combo of both positive and negative layers, which are connected by a junction. When the sun shines, the semiconductor layers absorb the light and send the energy to the PV cell. This energy runs around and bumps electrons lose, and they move between the positive and negative layers, producing an electric current known as direct current (DC). Once this energy is produced, it is either stored in a battery for later use or sent directly to an inverter (this depends on the type of system you have).



When the energy gets sent to the inverter, it is in DC format but your home requires AC. The inverter grabs the energy and runs it through a transformer, which then spits out an AC output. The inverter, in essence, 'tricks' the transformer into thinking that the DC is actually AC, by forcing it to act in a way like AC – the inverter runs the DC through two or more transistors that turn on and off super fast and feed two varying sides of the transformer.

Types of solar inverters

Now you know what a solar inverter is and how it works, it's time to look at the different types of inverters. There are 5 different kinds of solar inverters, all with varying benefits :

- **Battery Inverters**

A battery inverter is the best option if you are needing to retrospectively fit a battery into your solar system, or are wanting to keep your battery separate from your solar panels and run through a different inverter. A battery inverter converts your battery power into 230V AC and feeds it into your switchboard (instead of grid power) wherever possible.

- **Central Inverters**

A central inverter is *huge* and is what is used for systems which require hundreds of kilowatts (or even sometimes megawatts) of volume. They aren't for residential use and resemble a large metal cabinet, with each 'cabinet' being able to handle around 500kW of power. They are generally used commercially for large-scale installations, or for utility-scale solar farms.

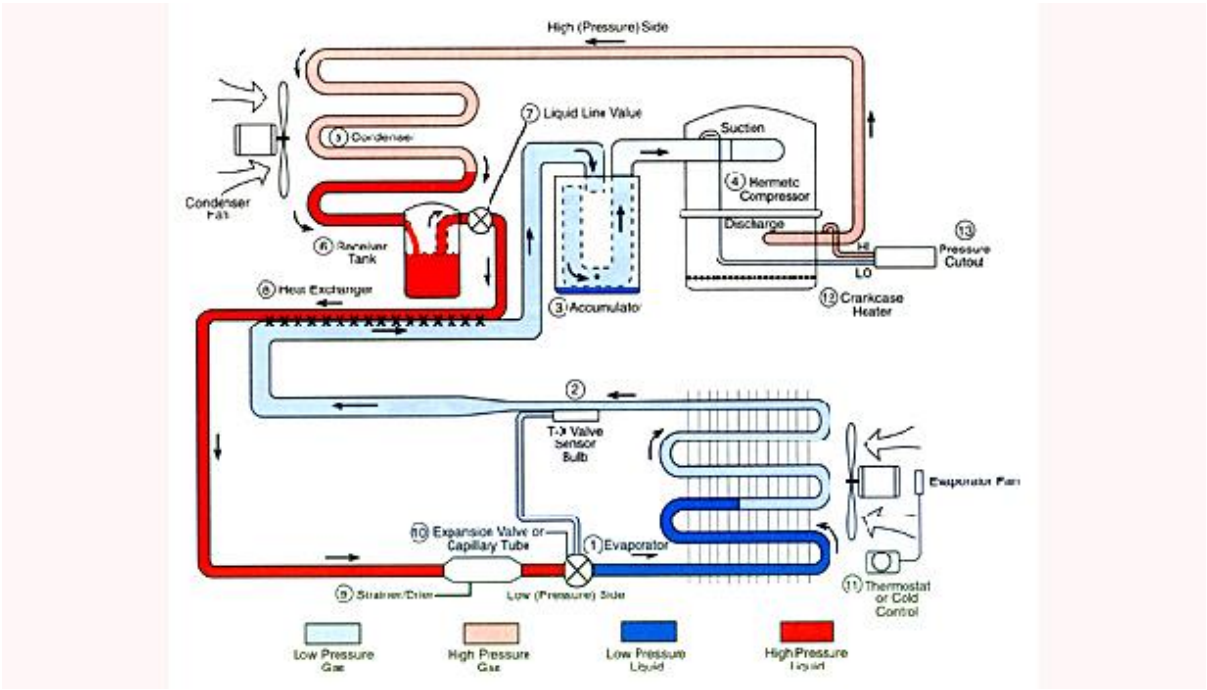
- **Hybrid Inverters**

Hybrid inverters, otherwise known as 'multi-mode inverters', are pretty uncommon in Australia and allow you to connect batteries to your solar system. It engages with the connected batteries through 'DC coupling' (when both the solar and batteries use one inverter and the DC from the solar panels charges the batteries via a DC charger) and its electronics organise the charging and discharging of the battery.

- **Microinverters**

As their name suggests, microinverters are super small (the size of a book!) and the ratio of solar panels to microinverters is 1:1. The benefit of a microinverter, among others, is that they optimise each solar panel individually, which offers more energy (especially in shady conditions).

# Central AC plant




In the central air conditioning systems there is a plant room where large compressor, condenser, thermostatic expansion valve and the evaporator are kept in the large plant room. They perform all the functions as usual similar to a typical refrigeration system. However, all these parts are larger in size and have higher capacities. The compressor is of open reciprocating type with multiple cylinders and is cooled by the water just like the automobile engine. The compressor and the condenser are of shell and tube type. While in the small air conditioning system capillary is used as the expansion valve, in the central air conditioning systems thermostatic expansion valve is used.

The chilled is passed via the ducts to all the rooms, halls and other spaces that are to be air conditioned. Thus in all the rooms there is only the duct passing the chilled air and there are no individual cooling coils, and other parts of the refrigeration system in the rooms. What is we get in each room is the completely silent and highly effective air conditions system in the room.

Further, the amount of chilled air that is needed in the room can be controlled by the openings depending on the total heat load inside the room.

The central air conditioning systems are highly sophisticated applications of the air conditioning systems and many a times they tend to be complicated. It is due to this reason that there are very few companies in the world that specialize in these systems. In the modern era of computerization a number of additional electronic utilities have been added to the central conditioning systems.

**Air-Conditioning System**

An air-conditioning system is a means of cooling/ heating, dehumidification/humidification, filtration and its distribution to the various conditioned spaces, maintaining indoor air quality, energy efficiency, and other resources. Various types of air-conditioning systems commonly used are:

1. Unit type equipment, which may be a window type room air-conditioner or a split type air-conditioner.

2. Packaged type units, which may be fully self contained (factory assembled), or split type units.

3. Variable refrigerant volume/Variable refrigerant flow (VRV/VRF) system

4. Central plants, which are of two types

(a) Central DX-Plants with Air Handling Units (AHUS) etc.

(b) Central chilled water plants with AHUS, Fan Coil Units, Chilled Beams, Embedded chilled water pipes in slabs & walls, etc.

**Window Type A.C.**

The window air conditioner is sometimes referred to as a room air conditioner as well. It is the purest form of an air conditioning system and is mounted on windows or walls. The evaporator side is located facing the room for cooling of the space and the condenser side outdoor for heat rejection.

Applications 1. Window for fixing the AC is available or necessary opening in wall is provided for

the purpose. 2. Sound level of up to 50 dB inside the room is acceptable 3. These types of A.C.s are efficient & easy to maintain as compared to split A.C.

Split Type A.C.

A split type air conditioner consists of an outdoor unit and an indoor unit. The outdoor unit is installed on or near the exterior wall of the room that you wish to cool. This unit houses the compressor, condenser coil, and the expansion coil or capillary tubing. The sleek-looking indoor unit contains the cooling coil, a long blower, and an air filter.

Applications

1. Where window for installation of Window Type AC (WTAC) is not available, split type AC are planned.

2. Almost Silent (low db level) operation of A.C. is important, considering VIP rooms,conference rooms, etc.

**VRV/VRF System**

In a generalizing definition, Variable refrigerant flow (VRF) can be explained as a multiple Split Air-conditioning system using the principle of control of flow/quantity of refrigerant through the Indoor Unit to control the cooling/ heating effect. VRF system uses a refrigerant as the cooling and heating medium. This refrigerant is compressed and liquefied by a single outdoor condensing unit (ODU) and is circulated within the building through copper refrigerant pipes to multiple fan-coil units (FCUS) called the IDUS (Indoor Units).

Applications These systems are basically extensions of split type A.C's and are much less efficient as compared to central A.C. plant hence should not be provided except in following cases

1. In the existing building, requiring central AC but the space for providing AC plant,

height of ceiling for ducting, water supply for chilled water based AC plant, is not available.

2. It is not possible to provide central A.C. plant and run the chilled water lines up to

cool the rooms with fan coil units to cool the rooms.

Such system is normally provided where high diversity in demand is available i.e. small Guest houses, small hotels, small offices, Art Galleries, etc.

**Packaged Type A.C.**

A Heating Ventilation AC (HVAC) designer will suggest this type of air conditioner if you want to cool more than two rooms or a larger space at your home or office. There are two possible arrangements with the package unit. In the first one, all the components, namely the compressor, condenser (which can be air cooled or water cooled), expansion valve and evaporator are housed in a single box. The high capacity blower throws the cooled air, and it flows through the ducts laid through various rooms. In the second arrangement, the compressor and condenser are housed in one casing. The compressed gas passes through individual units, comprised of the expansion valve and cooling coil, located in various rooms.

Application:

These are best suited for air conditioning of areas up to about 450 sqm about 30 TR A/C load) located adjacent to each other beyond this central plant is generally more economical.

These are usually available in 5 TR, 7.5 TR, 10 TR, 15 TR, and 20 TR capacities. The components are housed in a vertical cabinet. These units can be used singly or in multiples of two, three units.

Central Plants

The central air conditioning plants or the systems are used when large buildings, hotels, theaters, airports, shopping malls, etc. are to be air-conditioned completely. The window and split air conditioners are used for single rooms or small office spaces. If the whole building is to be cooled, it is not economically viable to put a window or split air conditioner in every room. Further, these small units cannot satisfactorily cool the large halls, auditoriums, receptions areas etc.

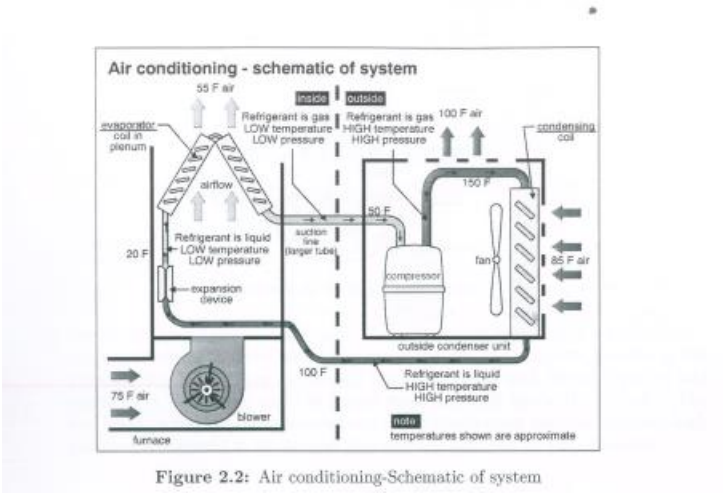



Figure 2.2: Air conditioning-Schematic of system

## Central A.C. Plant

For capacities larger than 100 TR, it is generally economical to go in for central plants.

System Components

1. Refrigeration unit (Central plant) comprising of compressor, condenser, expansion valve, evaporator & interconnecting refrigerant piping.

2. Hot water generators.

3. Cooling Towers.

4. Condenser water pumps

5. Chilled/Hot water pumps

6. Air handling units (AHUS) comprising of supply air blower, cooling coil and heating coil, humidification system (wherever specified), & filters (the room in which AHU is installed is called weather maker room).

7. Air distribution system comprising of ducting, variable air volume (VAV) valves, fire control dampers, grilles & diffusers. Depending upon the application and design requirements, which the air-conditioning system must meet, some of above components shall have to be arranged in certain sequence to condition the air.

**Basic Components of the Central A.C. Plants**

1. Compressor: It compresses the refrigerant. It causes the refrigerant to circulate in the system. The refrigerant is pushed from the compressor to the condenser at high temperature and pressure to the discharge tube during the discharge process. There are four basic types of compressors in use

(a) Reciprocating compressor: These compressors have an arrangement of cylinder which is quite similar to the engine of an automobile. The piston has a back-and-forth motion which first compresses the gas and then discharges

(b) Rotary compressor:

A typical rotary air compressor consists of a pair of rotors of a special design having very little clearance between each other. These rotors rotate in opposite directions and the air is passed through them to emerge at a higher pressure than before.

(c) Screw or Gear Type Compressor:

The screw compressor uses a pair of helical rotors where it traps and compresses the gas as the rotors revolve in the cylinder. In HVAC, they are usually used in systems with 20 ton capacity and above. The male rotor and the female rotor are built inside the cylinder. The low pressure refrigerant enters one end of the compressor and the resultant high pressure refrigerant is discharged into the opposite end to the condenser.

(d) Centrifugal Type Compressor:

Centrifugal compressor is usually used in large capacity refrigerating system. In this compressor, the vapor is moved in a circular motion known as centrifugal force. An impeller which is a disk with radial blades spins rapidly inside this housing causing the gas to gain velocity.

Condenser:

Here the gas temperature is reduced. In the condenser, the sensible and latent heat of the gaseous refrigerant is removed and is liquefied. From the condenser, the liquefied refrigerant is fed into the chiller through an expansion valve, which expands it and reduces its temperature. Now the water circulation in the chiller takes up the temperature of the liquefied gas and becomes cool. The water is fed to A.H.U. By small tubes. The A.H.U. Sucks air from one side. The water whose temperature is raised is again fed to the chiller, and the cycle goes on. A thermostat is installed which trips off the machine when the temperature

falls below 42 F. Condensers are divided into two parts: (a) Air Cooled Condenser:- In these condenser heat is passed on to the surroundings

through air.

(b) Water Cooled Condenser:- In these condenser heat is passed to the surrounding through water.

3. Chiller: It is a device used for absorbing heat into the refrigeration system. The

chiller is placed in the area of the system to be cooled. The heat is absorbed because

of the vaporization of the refrigerant fluid inside the evaporation tubes. 4. Air-Handling Unit:-

These are the last part of the A/C plant. Many AHU depends

upon the area to be cooled. These are installed in various floors of a multi-story building, and a floor may have two or three AHU through pipes. The water is circulated inside the AHU in small copper tubes of small diameter. The AHU sucks air of surroundings, which is at a higher temperature from one side. This air comes in contact with the cool water circulating in the thin copper tubes. It exchanges heat with, making the temperature of the water rise and its temperature lower When the air is cooled to the required temperature, it is fed to the various rooms and places through an air duct from one side of an AHU. If the air contains too much of the dust particles, then instead of room air, fresh air is used. A thermostat is used to maintain the desired temperature. When the temperature reaches the desired value, the cool water is not allowed to enter the cooling coils. When the temperature increases beyond the desired value, it again allows the water to pass through it. In winters, when the ambient temperature is high, AHU is used to the air being fed to the rooms. For this purpose, the entire plant is closed, and only the AHU is operated. These AHU suck air, which is at the low temperature, and the

air is passed through heaters before being fed to the air duct. 5. Refrigerant: To obtain a transfer of heat from the inside of a cabinet to the outside

or to refrigerate, heat carrier must be used. Fluids, which may be changed easily from a gas to liquid or vice-versa, are used as a medium because such a change is accompanied by a change in heat content. The most popular refrigerant is Freon-11, Freon-12, and Freon-22. Nowadays a refrigerant named Mefron-11,

Mefron-22 are used. Here in ONGC Mefron-22 is frequently used. Basic Requirements of Refrigerant:

• It should be non-explosive. . It should be non-poisonous and non-corrosive. • It should be a stable gas.

• It should be easy to lubricate parts moving in its presence. • It should be easy to detect and locate. • It should be non-inflammable. • It should have a small relative displacement to obtain a certain refrigeration

effect.

2.3 Different Features of Air Conditioning 1. Comfortable Temperatures • Office-Club-Large Reception

: 76 2 F(24.4C) • Residential Hotel Rooms

: 75 2 F(23.9C) • Shops-Market-Cinema

: 742 F(23.3C) • Computer Room-laboratories

: 72 + 2 F(22.2C) 2. Humidity: Humidity control also adds to comfort. It is the amount of moisture present in air(room). Desired level of humidity for: • Human comfort

: 55+ 5% RH • computer and Electronic eq.

: 50+ 5% RH • Pharmaceutical

: 45 + 5% RH 3. Noise: Noise is measured in a scale convenient for every day use. Noise level are

reported in decibels(DB). A normal man works best at 40-50DB. At sound levels around 90DB, his work accuracy and output are imparted and he is more likely to have an accident. If his exposure to levels exceed 85DB for 8 hrs. every day his hearing will probably be permanently damaged. Recommended and acceptable noise levels: Private offices: 40-45 DB Libraries: 40-45 DB Hospitals: 35-40 DB

We can curtail noise in a room/hall 10 db by using heavy curtains carpets and furniture.

**Controls in Central A.C.**

Equipment Safety Control

1. Compressor

• High discharge pressure (HP) safety (cut out) to stop the compressor auto

matically, in case discharge pressure exceeds a pre-set safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual

resetting shall be provided for this safety. • Low suction pressure (LP) safety (cut-out) to stop the compressor automat

ically, in case suction pressure falls below a pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in and cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigeration plant.

• Oil pressure (O.P) safety (cut-outs) to stop the compressor, in case lubricating

oil pressure falls below a safe set value. A time delay mechanism shall also be provided, so as to permit running of the compressor upto a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set

value within that time, or otherwise shut-down the compressor 2. Condenser: The safety control for a condenser shall comprise a safety pressure relief

valve on the shell. This shall operate to relieve the pressure at the set point without prior leakage. For small condensers, a fusible plug may be provided to melt at a

predetermined temperature. 3. Chiller: An antifreeze shall be provided with water chiller, set at a few degrees

above the freezing point. This shall operate, when the temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.

4. Refrigeration Plant

• Compressor motor over current cut-out.

• Condenser water flow switch.

• Chilled water flow switch.

• Condenser air flow switch in the condenser fan discharge (in case of air-cooled

condensers).

Refrigerant Flow Controls

A refrigeration plant shall be provided with controls, necessary for starting, stopping and modulating the flow of refrigerant in the plant so as to satisfy the load requirements.

**Thermostatic/Electronic Type Expansion Valve**

Thermostatic/Electronic type expansion valve shall be provided in DX type refrigeration plant to modulate the flow rate of liquid refrigerant entering the evaporator in response to the extent of superheat of refrigerant gas leaving the evaporator, so that only a metered flow is ensured matching the load.

**Thermostats Air conditioning**

thermostats have bimetals (older thermostat) or thermistor (new thermostat). These bimetals or thermistor sense the air current returning to the return ducts or the surrounding air. The basic operation principle of air conditioning thermostat is it relies on random air current that passing thought it to determine the room temperature. It uses room temperature to compare with the set point temperature. Thermostat used in Central AC plant in Service Block had Setting Range of 8-15°C

**General Description of Central Air-Conditioning Plant of K.D.M.I.P.E Campus of ONGC**

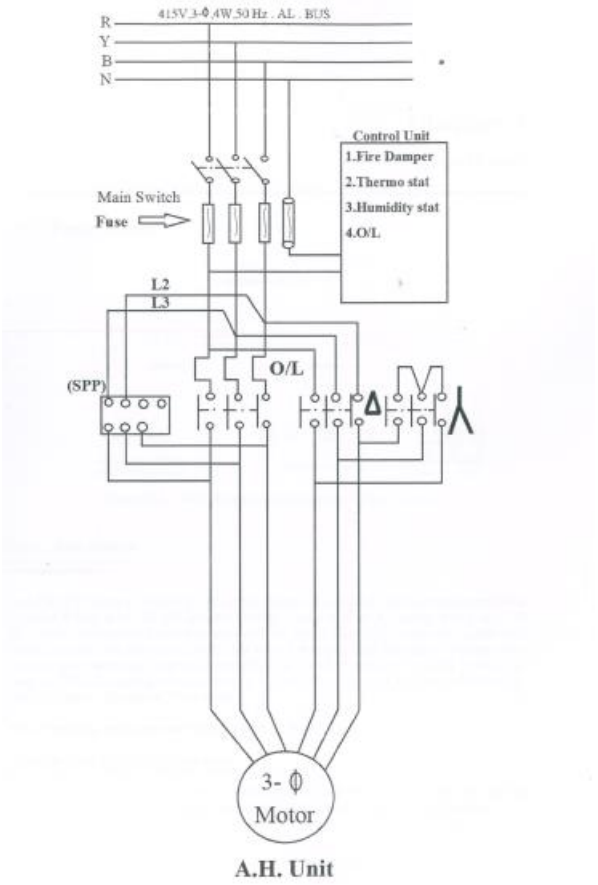
Central air-conditioning system has been installed at KDMIPE, Dehradun to cater to equipment and human comfort needs of various areas. The system consists of water

chilling units feeding Air Handling Units located near specific areas to be air-conditioned. In these AHU Rooms, a mixture of fresh air and returned air is cooled and circulated in conditioned areas to achieve the objective. Basically, there are four central A/C plants as per the details below:

. 4x120 TR AMN Ghosh Auditorium plant.

. 4x60 TR IBM plant.

. 10x120 TR Service Block CAC plant. In Addition to the huge capacity Central A.C. plant. There are more than 600 Split and Window A.C. are in operation in K.D.M.I.P.E campus of ONGC, which are being maintained inhouse by ONGC officers team.



A.H. Unit

**Conclusion :**

By doing so internship, I got to know about the different working systems of the plant, substation and its component, fire system, its motor, pressure pump and solar plant, its converter and power electronic base system and its working. The ac plant, its type, compressors, single line diagram.

Based on the internship, I got to know about the working environment and coordination in between the personnel to make the process of the plant very smooth and hazel-free with minimum damage in case of emergency. It has a very good backup system and relay management in order to avoid any damage. Its regular check-up plan and maintenance make the working and quality of the

product in the market perfect. this experience made me amazed to see how a perfect system is working in so synchronized manner to make everything fit.

Thank you.

NIKHIL TYAGI

IIT Bhubaneswar