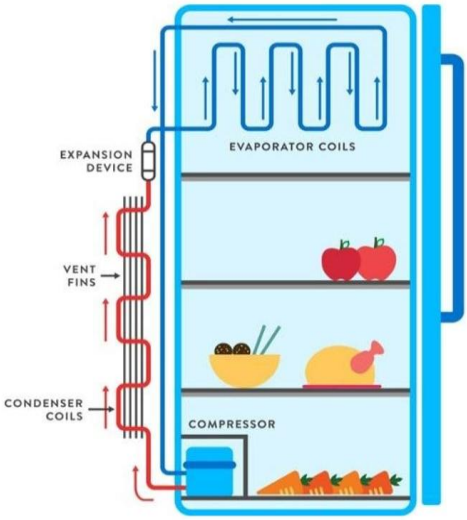
Electrical/Electronic Equipment Servicing Level III
Based on October, 2023, Curriculum

Version II





Module Title: Refrigerator Maintain and Repairing

Module Code: EIS EEES3 M07 1023

Nominal duration: 75 Hours

Prepared by: Ministry of Lobar and Skill

Ocb, 2023

Addis Ababa, Ethiopia

Table of Contents

Acknowledgement 4
Acronyms 5
Introduction to the Module ..... - 1 -
Unit one: Overview of refrigeration unit maintenance /repair ..... - 2 -
1.1. Basic concept of refrigerator system and units ..... - 3 -
1.1.2. Principle and operation of refrigerator ..... - 4 -
1.1.3. The working of refrigeration system ..... - 4 -
1.1.4.The principle of refrigeration ..... - 5 -
1.1.5. Basic of refrigerator cycle ..... - 5 -
1.1.6. The Refrigeration Cycle – Components: ..... - 6 -
1.1.7.The Refrigeration Cycle – Flow Direction: ..... - 6 -
1.1.8. The Refrigeration Cycle – Transfer of Heat: ..... - 7 -
1.1.9. The Refrigeration Cycle – Pressures ..... - 8 -
1.1.10. The Refrigeration Cycle – Refrigerant State: ..... - 9 -
1.1.11. The Refrigeration Cycle – Complete: ..... - 9 -
1.2.Parts and components of refrigerator system with function ..... - 10 -
1.2.1. The refrigerator components and their working ..... - 10 -
1.2.2. Thermostat ..... - 13 -
1.2.3. Refrigerant types ..... - 16 -
Self-check-1 22
Unit Two: Diagnose faults 23
2.1. Reading and interpreting circuit diagram 24
2.2. Assemble and disassemble of components and parts 30
2.2.1.Inside Parts of a Refrigerator 30

2.2.2.Outside Parts of a Refrigerator.....31
Unit Three: Repairing Refrigeration..... 31
2.3. Identifying defect faults.....33
Unit Four: Testing repaired product 43
2.4. Testing functionality and replace component.....44
Operation sheet 2.1.....53
Operation sheet 2.2 54
Operation sheet 2.3 56
Operation sheet 2.4 58
Lap Test 61
Unit Five: Complete work and report activities..... 62
Reference 74

Acknowledgement

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronyms

AC	Alternating current
DC	Direct current
KV	Kilo Volt
OHS	Occupational health and safety
LAP	Learning Assistance Program
LED	light emitting diode
PCB	printed circuit board
ESD	Electro-Static Discharge

DMM	Digital Multi-Meter

Introduction to the Module

In Electrical/electronic equipment servicing filed; the: Install ,maintaining/repairing air conditioning systems project helps to require Install ,maintaining/repairing air conditioning systems includes constructing, diagnosing faults, dismantling, re-assembling, testing and preparing report. This module is designed to meet the industry requirement under the Electrical/electronic equipment servicing occupational standard, particularly for the unit of competency: Install maintaining/repairing air conditioning systems

Module units

- Overview of refrigeration unit maintenance /repair
- Diagnose faults
- Maintain/repair refrigeration unit
- Test repaired product
- Complete work and report activities

Learning objectives of the Module

At the end of this session, the students will able to:

- Prepare to maintain/repair refrigeration unit
- Diagnose faults
- Maintain/repair refrigeration unit
- Test repaired product
- Complete work and report activities

Module Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets

6. Do the “LAP test

Unit one: Overview of refrigeration unit maintenance /repair

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Basic Concept Of Refrigerator System And Units
- Identifying And Implementing WHS/OHS
- Identifying Tools, Equipment And Testing Devices
- Selecting Components, Piping, Accessories, Controls

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Basic concept of refrigerator system and units
- Identify and implementing WHS/OHS
- Identify tools, equipment and testing devices
- Select components, piping, accessories, controls

1.1. Basic concept of refrigerator system and units

A. What is a Refrigerator?

As per the dictionary, a refrigerator

- It is kitchen equipment used by us to preserve our food at a cold temperature.
- It uses electricity to run.

B. What is the function of the refrigerator?

Before we talk about the Working Principle of the Refrigerator, we will discuss the function of a refrigerator.

- The fundamental reason behind keeping a fridge is that it keeps your food cool.
- The cold temperature helps to keep the food fresh for a long time.
- Refrigeration slows down the activity of bacteria present in the food so that the bacteria take time to spoil the food.

For example, if we leave milk outside the fridge at room temperature for 2-3 hours, it gets spoiled. Keeping it in the fridge will reduce the temperature of the milk, and it stays fresh for more than a week. So, the refrigerator working principle is: the cold temperature of the milk decreases the bacteria's activity.

How does a refrigerator work?

There are three steps to how the fridge works-

1. When food items are kept in the fridge, the cool refrigerant is passed.
2. The heat from the food items is absorbed by the refrigerant.
3. The heat absorbed by the refrigerant gets transferred to the relatively cooler surroundings outside.



Figure 1.1: Single door refrigerator -Interior

1.1.2. Principle and operation of refrigerator

The working principle of refrigerator is a simple one-

- It removes heat from one region and deposits to another region.
- If one passes a low-temperature liquid close to a liquid substance that one wants to cool, heat from those objects gets transferred to the liquid. In that process, it evaporates and takes away the heat.

1.1.3. **The working of refrigeration system**

- The refrigerant circulates inside the fridge by changing the state of liquid to gas. This process is called evaporation. It cools the surrounding area and produces the desired effect. You can understand this by doing a simple experiment. Put a few drops of alcohol on your skin. You will feel a chilling sensation as it evaporates. This is the basic principle that gives proper food storage.
- To keep the fridge working, the refrigerant's pressure is reduced through an outlet called a capillary tube. The pressure needs to be reduced to start the evaporation and change the refrigerant from liquid to gas. Example-The same thing happens with your body/hair spray. The contents inside the bottle are the pressure or liquid. The outlet is the capillary tube, and the open space is the evaporator. It turns from liquid state to gas when we release the liquid/pressure into the lower pressure open space.

- The gas refrigerant needs to be back to the liquid state. For that, the compressor compresses the gas to a higher pressure and temperature. A similar effect is felt with the bike pump. You can understand that the heat increases while you pump and compress the air.
- The gas gets heated up and is under high pressure. This needs to be cooled down in the condenser. This is present on the back of the refrigerator so that the air can cool the contents.
- The condenser cools off the gas inside and thus changes back into the liquid.
- This changed liquid refrigerant goes back to the refrigerator evaporator, and then the same cycle starts over once again. This keeps the refrigerator working.

This is the mechanism of refrigerator. The process seems to be complicated, but it's based on principles of science, making it possible.

1.1.4.The principle of refrigeration

As now we know about the working principle of refrigerator, let us talk about the refrigerator principle. It uses the principles of

- Pressure
- Condensation
- Evaporation of a fluid in a closed circuit to remove heat and reduce the temperature inside it.

1.1.5. Basic of refrigerator cycle

The Refrigeration Cycle – **Transfer of Heat**:

Shows the transfer of heat energy. Heat is absorbed by the evaporator and rejected by the condenser. The heat removed from the air flowing over the evaporator makes it colder. The evaporator fan then blows this colder air back in to the space being cooled.

- Compressor
- Condenser

- Evaporator
- Capillary tube(restriction)

1.1.6. The Refrigeration Cycle – Components:

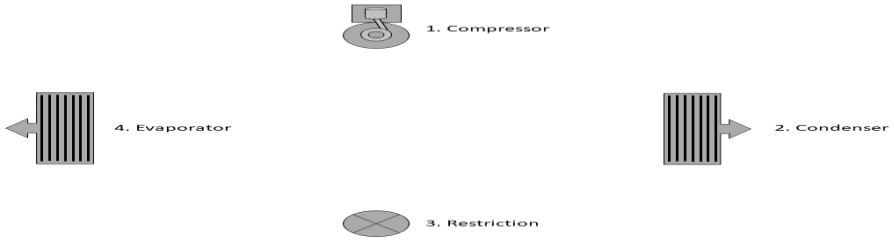


Figure 1.2:Refrigeration Cycle

1.1.7.The Refrigeration Cycle – Flow Direction:

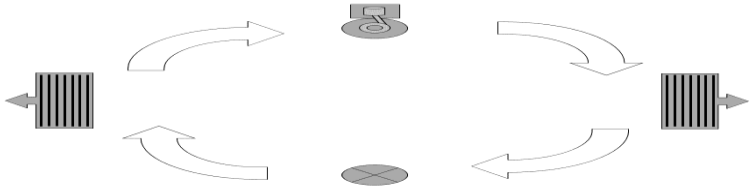


Figure 1.3: Shows the direction of flow of the refrigerant– Starting at the Compressor in a clockwise direction

1.1.8. The Refrigeration Cycle – Transfer of Heat:

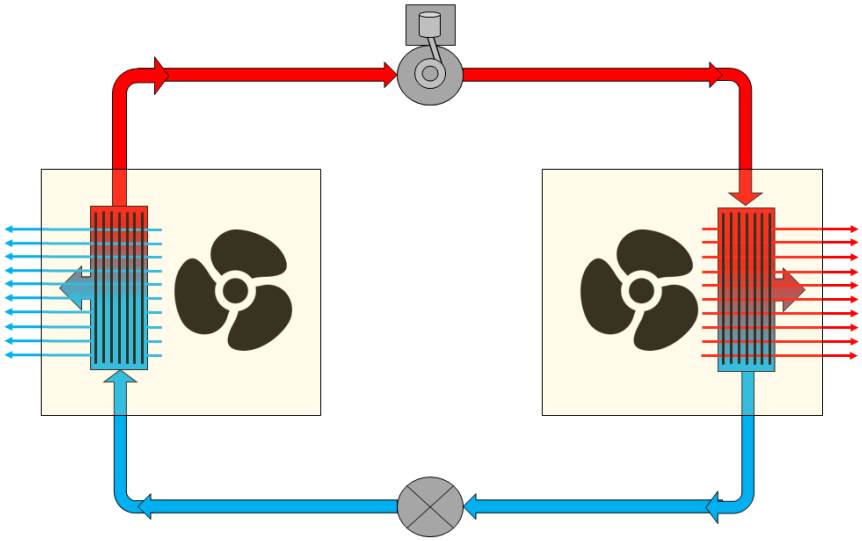


Figure 1.4: Shows the transfer of heat energy

Heat is absorbed by the evaporator and rejected by the condenser. The heat removed from the air flowing over the evaporator makes it colder. The evaporator fan then blows this colder air back in to the space being cooled. The heat removed is then rejected by the condenser which is outside of the space being cooled, and usually physically outside in the open air. The fan blows ambient air over the hot condensing coils. This cools and condenses the refrigerant but heats up the air blown over the condenser. That's why when you stand in front of a condenser it's usually blowing hot air at you.

1.1.9. The Refrigeration Cycle – Pressures

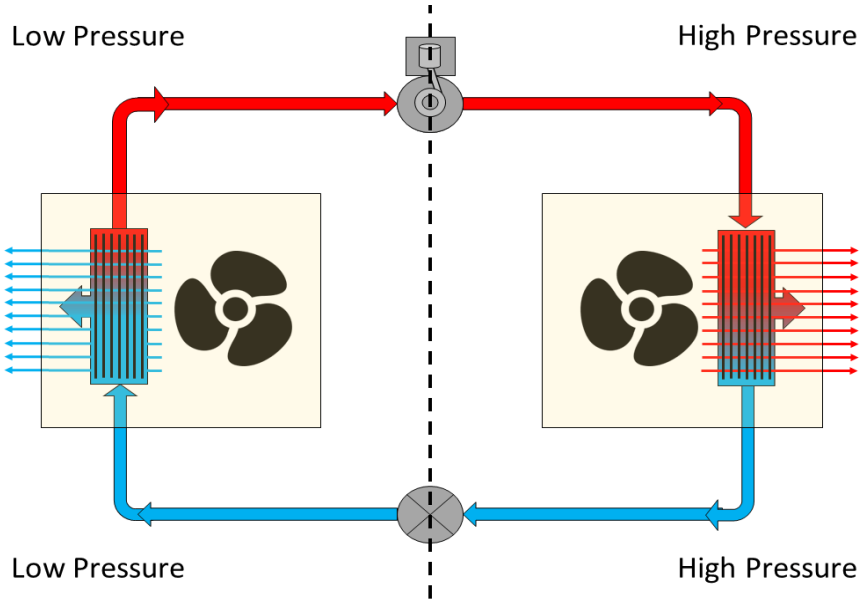


Figure 1.5: Refrigeration Cycle – Pressures

By dividing the system vertically as above, we can see that at all points to the left of the line – the refrigerant is at low pressure, and at all points to the right of the line – the refrigerant is at high pressure.

1.1.10. The Refrigeration Cycle – Refrigerant State:

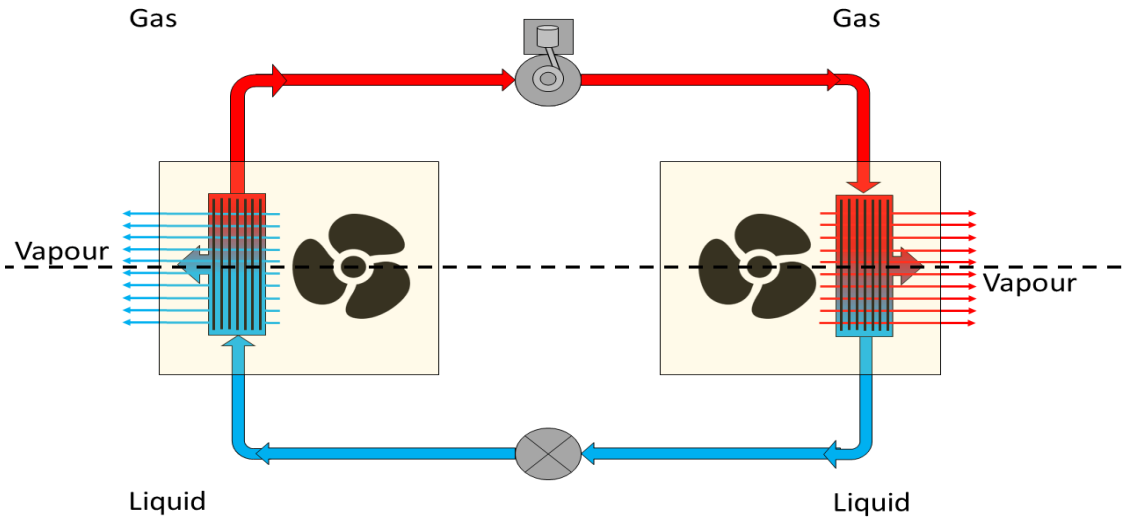


Figure 1.6: Refrigeration Cycle – Refrigerant State

By dividing the system horizontally as above, we can see that at all points above the line – the refrigerant is a gas, and at all points below the line – the refrigerant is a liquid. In the middle of both the condenser & evaporator, where the change of state of the refrigerant happens, the refrigerant is present in both liquid & gaseous states, and is referred to as a vapour.

1.1.11. The Refrigeration Cycle – Complete:

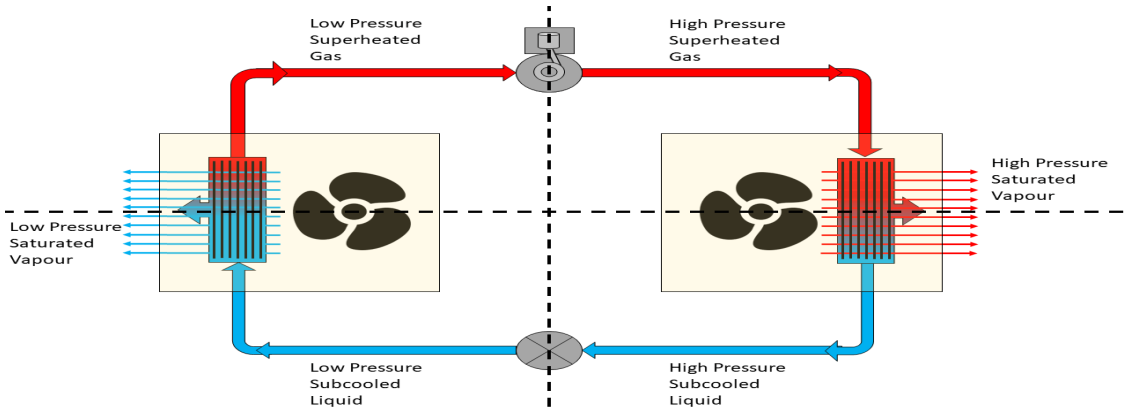


Figure 1.7: Refrigeration Cycle – Complete

In this final diagram of the refrigeration cycle we have introduced 3 new terms: Superheated, Saturated & sub cooled.

- **SUPERHEAT** – Is an amount of heat added to refrigerant vapour beyond its boiling point. This ensures the refrigerant is in a gas state with no liquid present.
- **SATURATED** – Is when the refrigerant is a vapour with both liquid & gas present.
- **SUBCOOLING** – Is an amount of heat removed from the refrigerant below its condensing point. This ensures the refrigerant is in a liquid state with no gas present.

So, looking back at our completed refrigeration cycle diagram (fig 1.6), let's describe the process in full:

- The refrigerant enters the compressor as a low pressure superheated gas.
- The compressor compresses the gas, changing it to a high pressure superheated gas.
- Inside the condenser the gas begins to cool and change state in to a vapour. Additional cooling inside the condenser causes the refrigerant vapour to condense in to a high pressure subcooled liquid.
- As the high pressure liquid refrigerant passes through the metering device it enters a low pressure environment, causing it to flash off in to a vapour – remember our nozzle on an aerosol spray can example from above?
- The refrigerant vapour enters the evaporator where it absorbs heat from the space being cooled, causing the refrigerant to boil. As it continues through the evaporator coil the vapour is superheated turning the refrigerant to gas before it enters the compressor and starts the cycle over again.

1.2.Parts and components of refrigerator system with function

1.2.1. The refrigerator components and their working

- ❖ Maintains a low temperature to reduce the growth of harmful bacteria.
- ❖ Transfers the inside heat to the outer environment.

Here we can see the 4 basic and additional components in a fridge.

These are :-

- Compressor
- Condenser
- Evaporator
- Capillary tube
- Compressor



Figure 1.8:Compressor

- It is the heart of the fridge.
- The compressor circulates the refrigerant throughout the system.
- It consists of a motor that sucks in the refrigerant from the evaporator and compresses to make a hot and high-pressure gas.
- It can compress and convert low-temperature to high-temperatures.
- Condenser

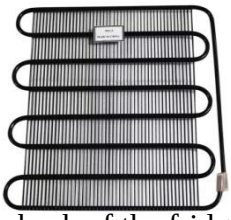


Figure 1.9:Condenser

  - It sits in the back of the fridge.
  - It sits in the back of the fridge.
  - It extracts heat from the refrigerant.
  - It cools down the refrigerant and changes the matter. That means it changes gas back into liquid. This is the refrigerator cooling system.
  - -12 degree to -1degree C should be the range of temperature of condensation.
  - The vapor cools down to become liquid refrigerant.

- Evaporator

- The evaporator in the refrigerator is located inside a fridge and makes the items in the refrigerator cold.
- It removes the unwanted heat from the food items through liquid refrigerant.
- The pressure of the liquid refrigerant must be low.
- Two factors determine the low pressure- first, heat gets absorbed from the product to the liquid refrigerant and the second one is the removal of air pressure by the compressor.
- Through evaporation, the refrigerant turns liquid into a gas and cools down the area. Hence, it produces the appropriate environment for storing and preserving food.



Figure 1.10: fine type



Figure 1.11:plate type

- Capillary tube

It is an expansion device and a thin piece of tubing.

Through the capillary tube, the liquid refrigerant is routed and sprayed into the low-pressure environment of the evaporator.



Figure 1.12: thermostatic metering device

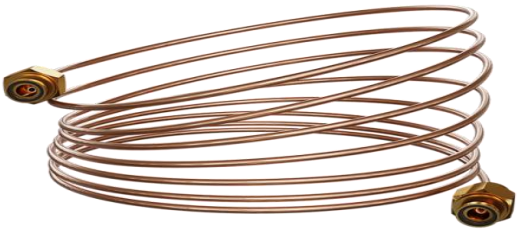


Figure1.13: capillary tube metering device.

1.2.2. Thermostat



- It controls the cooling process in the fridge by monitoring the temperature and switching the compressor on and off.

Figure 1.14: thermostat

- **overload protector**

- electrical device that we use for compressor protection,
- when the compressor temperature is high from his range the compressor overload cuts off the electric supply from the compressor motor that's why we called him thermal overload.



Figure 1.15: over load relay

- **Start relays**

Start relays belong to the switch category. They use electromagnetic and electromechanical principles to close or open contacts to drive or control related circuits.



Figure 1.16: starting relay

- **mechanical defrost timer**

The most common control is a mechanical defrost timer which is a motorized device that opens and closes several electrical contacts. Each contact can be thought of as a simple light switch but instead of a light, one connects the defrost heater circuit, another connects the cooling system. When one of these is switched on, the other is switched off.



Figure 1.17:defrost timer

- **Defrost heater**
- Defrost heater is used to prevent the icing formation in the Refrigerator and is controlled by a Thermostat. During the defrost cycle, the defrost heater melts frost from the evaporator fins.

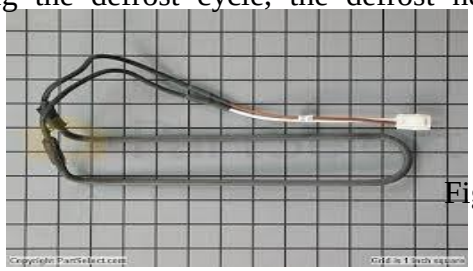


Figure 1.18:heater

- **Defrosting Thermostat**

The defrost thermostat differs from the refrigerator thermostat, which is the temperature gauge used to regulate the cooling system of the refrigerator. This device works to measure internal temperatures and prevents the refrigerator from becoming too hot or too cold.

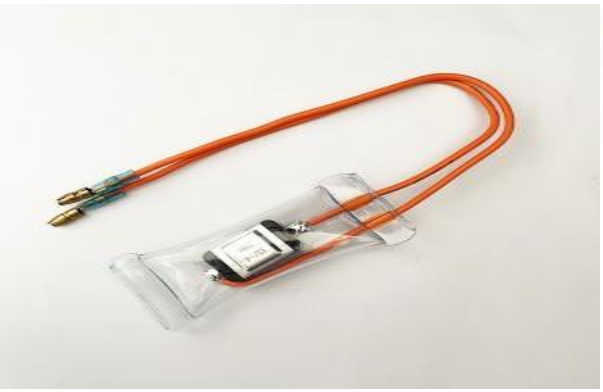




Figure 1.19:bimetal & Figure 1.20:thermo fuse

- **Evaporator fan**
- The evaporator is the part that releases cold air while removing any heat inside the freezer compartment.
- Its purpose is to blow cold air into the freezer compartment.

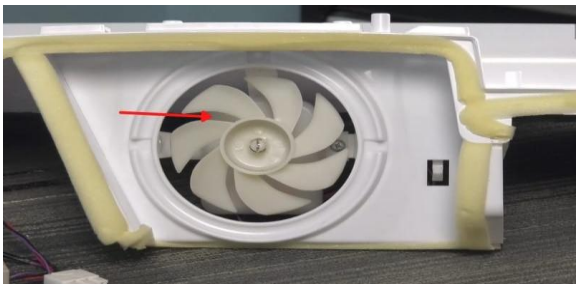
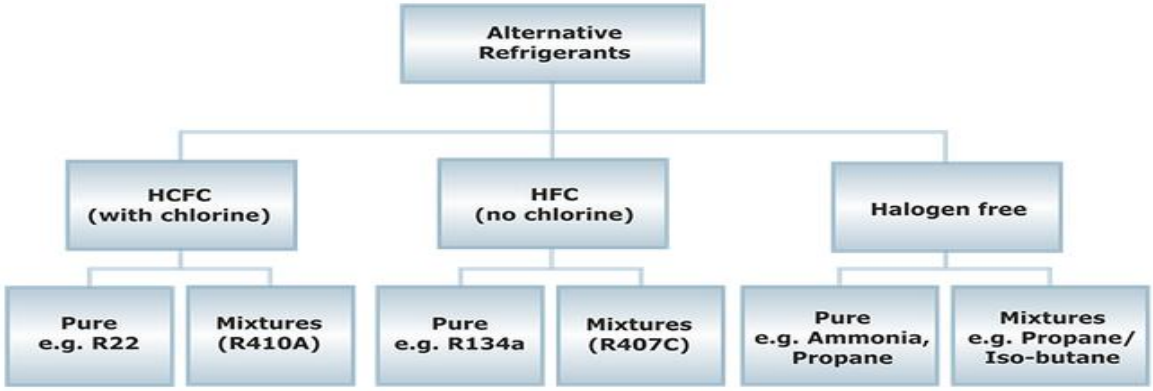


Figure 1.21: Fan

1.2.3. Refrigerant types

Refrigerants are divided into groups according to their chemical composition.



- **CFC = ChloroFluoro Carbons**

they have been banned since the beginning of the 90's because of their negative environmental impacts.

Examples of CFCs are R11, R12 and R115. On the contrary, the illegal market for this type of refrigerants flourishes worldwide.

- **HCFC = HydroChloroFluoroCarbons**
  - The slow phase-out of CFCs shows it is a costly process.
  - The availability of HCFCs, which were officially indicated as temporary (until 2030) substitutes for CFCs.

    Examples include R22, R123 and R124

- **HFC = HydroFluoroCarbons**

- The hydrofluorocarbons are refrigerants that contain no chlorine and are not harmful to the ozone layer (ODP = 0,

  The most common HFC refrigerants available

Refrigerant	Series
R32	Methane series
R125	Ethane series
R134a	Ethane series
R245ca R245fa	Propane series
R404A	Zeotropic mixture (44% R125, 52% R143a, 4% R134a)
R407C	Zeotropic mixture (23% R32,25% R125, 52% R134a)
R410A	Zeotropic mixture (50% R32, 50% R125)
R507A	Azeotropic Mixture (50% R125, 50% R143a)
R508B	Azeotropic mixture (46% R23, 54% R116a)

❖ **FC = Fluoro Carbons**

Fluorocarbons contain no chlorine and are not harmful to the ozone layer. However, they are extremely stable, and they have a high GWP.

R218 is an example of a fluorocarbon, and FCs are also present in the mixtures R403 and R408.

❖ **HC = HydroCarbons**

- A very limited solution to the environmental problems.
- They are harmless to the ozone layer (ODP = 0) and have hardly any direct green house effect (GWP<5), but they are
- Highly flammable.
- The use of HCs in household refrigerators with refrigerant charges up to 150 g.

Examples, R600a,R290.

❖ **NH_3 = Ammonia**

- Ammonia, R717, is an attractive refrigerant alternative.
- This is a highly toxic and corrosive

❖ **CO_2 = Carbon Dioxide**

- R744, carbon dioxide, has several attractive characteristics:

  - Non-flammable.
  - Does not cause ozone depletion.
  - Very low toxicity available in large quantities, and low cost.
  - A low efficiency and a high operating pressure (approximately 10 times higher than R134a).

1.3 Identifying And Implementing WHS/OHS

When identifying and implementing workplace health and safety (WHS)/occupational health and safety (OHS) procedures for refrigerator maintenance, consider the following steps:

Conduct a Risk Assessment: Assess the potential hazards associated with refrigerator maintenance, such as electrical risks, chemical exposure, or physical injuries. Identify the specific risks and prioritize them based on severity. This assessment will help you determine the necessary safety measures.

Develop Safe Work Procedures: Based on the identified risks, develop safe work procedures for refrigerator maintenance. These procedures should outline step-by-step instructions on how to safely inspect, clean, and maintain the refrigerators. Include guidelines on personal protective equipment (PPE) usage, handling of hazardous substances, and electrical safety precautions.

Provide Training: Ensure that all employees involved in refrigerator maintenance receive appropriate training. Train them on the safe work procedures, potential hazards, emergency

procedures, and proper use of PPE. Training should be provided both to new employees and as refresher courses for existing employees.

Implement Control Measures: Implement control measures to mitigate identified risks. For example:

a. Electrical Safety: Ensure that only authorized and trained personnel work on electrical components. Use lockout/tagout procedures to isolate power sources before maintenance work. Regularly inspect and maintain electrical connections.

b. Chemical Safety: Use appropriate chemicals for cleaning and maintenance, and store them securely. Provide necessary training on safe handling, storage, and disposal of chemicals. Follow Material Safety Data Sheets (MSDS) for each chemical.

c**. Manual Handling:** Implement safe manual handling practices when moving heavy components or lifting objects. Provide mechanical aids or equipment to minimize the risk of injuries.

d. Ergonomics: Ensure that workstations are ergonomically designed to reduce strain and musculoskeletal injuries. Provide adequate lighting and ventilation in the maintenance area.

Personal Protective Equipment (PPE): Identify the required PPE for refrigerator maintenance, such as gloves, safety glasses, hearing protection, or respiratory protection. Provide appropriate PPE to employees and ensure its proper use and maintenance.

Regular Inspections: Conduct regular inspections of refrigerators to identify any potential issues or hazards. Inspect electrical connections, seals, and cooling systems. Maintain a log of inspections and any corrective actions taken.

1.5 Tools, Equipment And Testing Devices

❖ **Pinch Off Pliers / Self-locking Pliers**




❖ **Piercing Pliers / Valve**




❖ **Male & Female /Quick Coupler**






❖ **Tube Cutter**



❖ **Debarring tool**



❖ **Capillary Tube Cutter**




❖ **Tube Bender**

(lever type) **(spring type)**




❖ **Flaring**



❖ **Wire stripper**




❖ **Ratchet wrench / Service valve wrench**



❖ **Igniter**



❖ **Digital Thermometer with puncture probe**



❖ **Quick Test Board**



❖ **Digital Clamp Meter (Multi function)**



Self-check-1	Written Tests

Test-I: Choose the best answer

1. In a refrigeration system, the expansion device is connected between the
   A. Compressor and condenser
   B. Condenser and receiver
   C. Receiver and evaporator
   D. Evaporator and compressor
2. During a refrigeration cycle, heat is rejected by the refrigerant in a.....
   A. Condenser
   B. Compressor
   C. Evaporator
   D. Expansion valve
3. In a refrigeration system, the highest temperature of refrigerant occurs
   A. between compressor and condenser
   B. before expansion valve
   C. in evaporator
   D. between condenser and evaporator
4. Freon R12 is a compound consisting of atoms of
   A. carbon, fluorine and chlorine
   B. carbon, hydrogen, fluorine and chlorine
   C. carbon, hydrogen and oxygen
   D. carbon, hydrogen and fluorine
5. . In a refrigerator, evaporator is located
   A. adjacent to compressor
   B. inside the refrigerator cabinet
   C. behind the refrigerator cabinet
   D. on the bottom of refrigerator cabinet

Unit Two: Diagnose faults

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Reading and interpreting drawings of circuit arrangements and component locations
- Observing pre-testing procedure
- Carrying out fault diagnosis
- Conducting assemble and disassemble of components and parts
- Identifying Components that require routine maintenance
- Explaining and Identified defect faults

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Reading and interpreting drawings of circuit arrangements and component locations
- Observing pre-testing procedure
- Carrying out fault diagnosis
- Conducting assemble and disassemble of components and parts
- Identifying Components that require routine maintenance
- Explaining and Identified defect faults

2.1. Reading and interpreting circuit diagram

we are going to see the **Refrigerator Wiring Diagram**. We will discuss the wiring diagram of the Refrigerator with Switch and MCB.

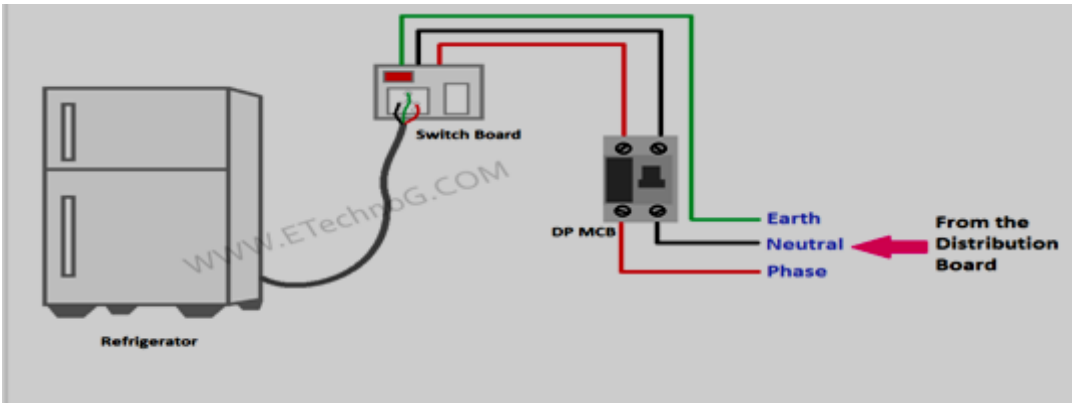


Figure 22.1: Refrigerator with Switch and MCB

As you see in the above figure, the power lines come from the distribution board and goe to the Double Pole MCB. The output of the MCB is connected to the switchboard. The power lines of the refrigerator are connected to the switchboard five pin socket. Actually, the refrigerator has the plug which is to be connected to the socket but to understand the connection, the plug is not used here

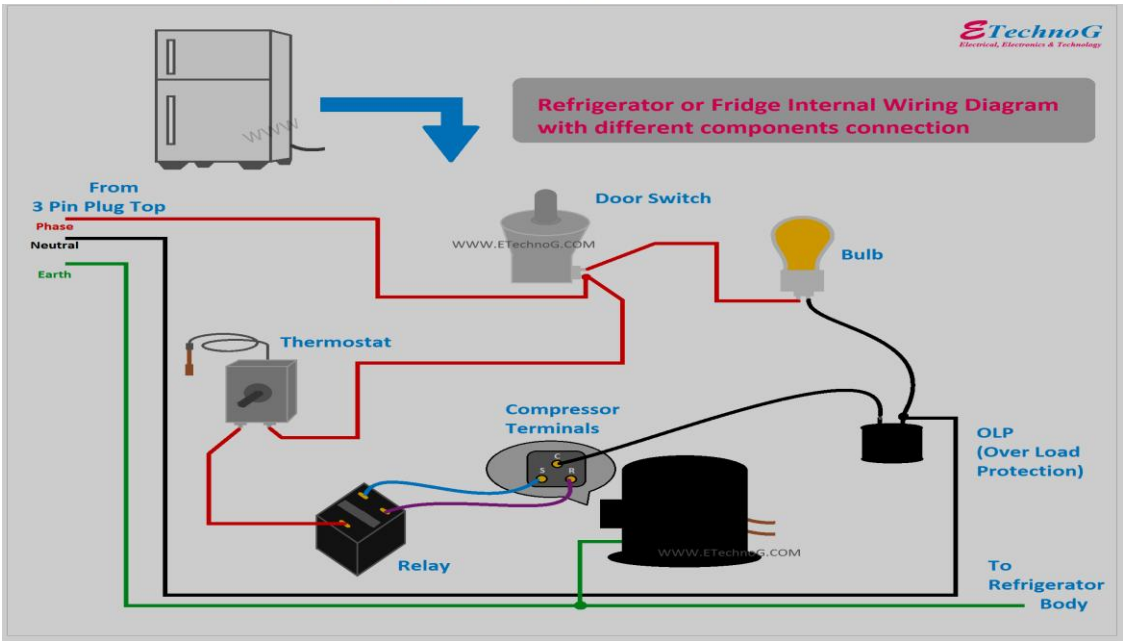


Figure 2.2: Refrigerator Wiring Diagram

Here, you can see the main internal wiring diagram of refrigerator.

- Compressor
- Relay
- OLP or Overload Protector
- Door Switch
- Thermostat
- Bulb

A. Compressor

A compressor is the main part of the refrigerator. It has a total of three terminals as shown in the above wiring diagram - Common(C), Start(S), and Run(R). The common terminal is to be connected to the neutral through an OLP and the Start and Run terminals are to be connected to the relay.

B. Relay

Here, the relay has a total of three terminals the input terminal is to be connected to the thermostat from where it will be got the phase supply and the other two terminals are to be connected to the compressor start and run terminals.

- **OLP or Overload Protector**

It is a safety device. When any fault happens with the compressor it will disconnect the power supply. Generally, it is connected in series with the neutral supply and the compressor common terminal.

- **Door Switch**

It is connected in series with the lamp. It helps to turn on or turn off the light during the closing and opening of the refrigerator door. When we open the door it allows the supply to the lamp and the lamp will glow, and when we close the door it disconnects the power supply and the lamp or bulb will turn off.

- **Thermostat**

The thermostat is the device or sensor that monitors the temperature inside the refrigerator and according to the temperature, it turns off and turns on the compressor.

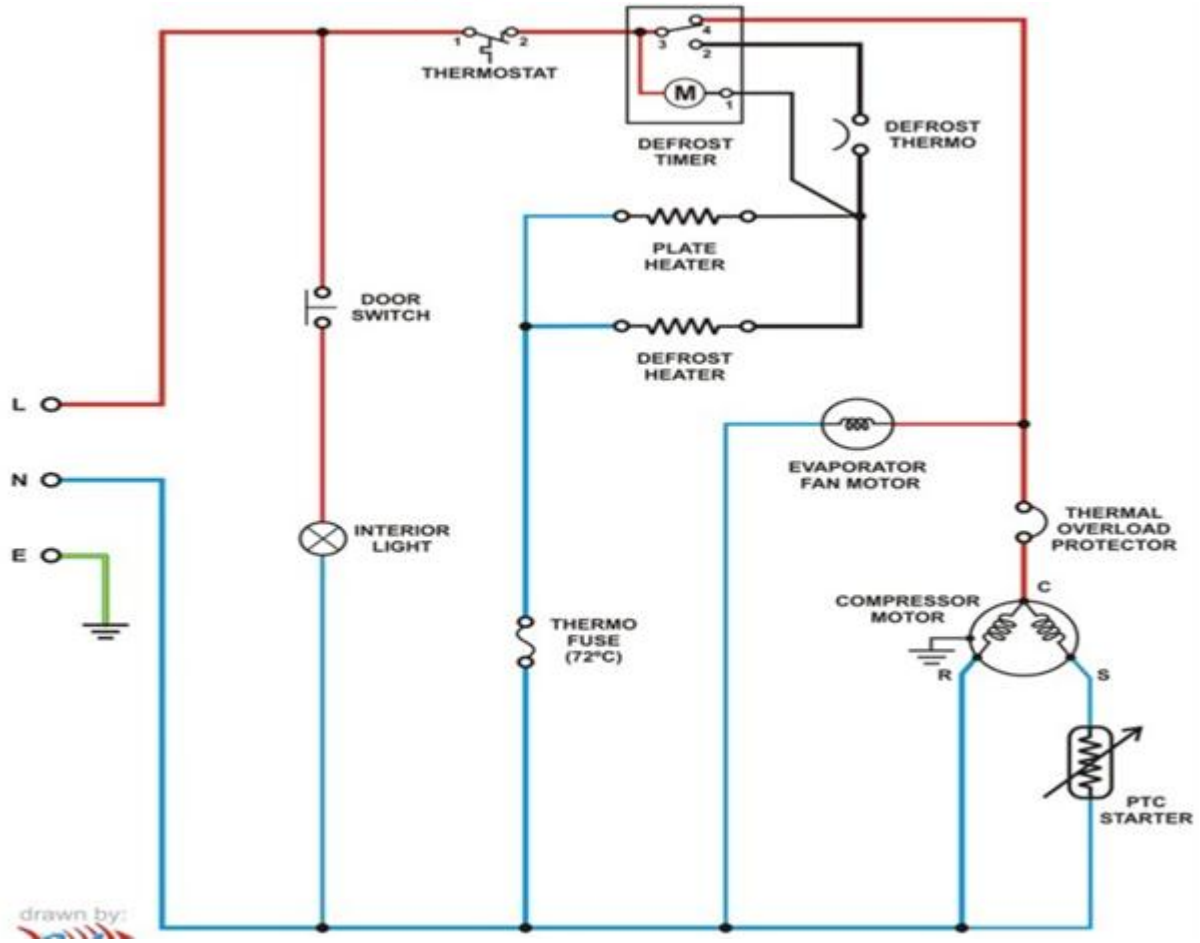


Figure 23: Domestic Refrigerator Wiring type-1

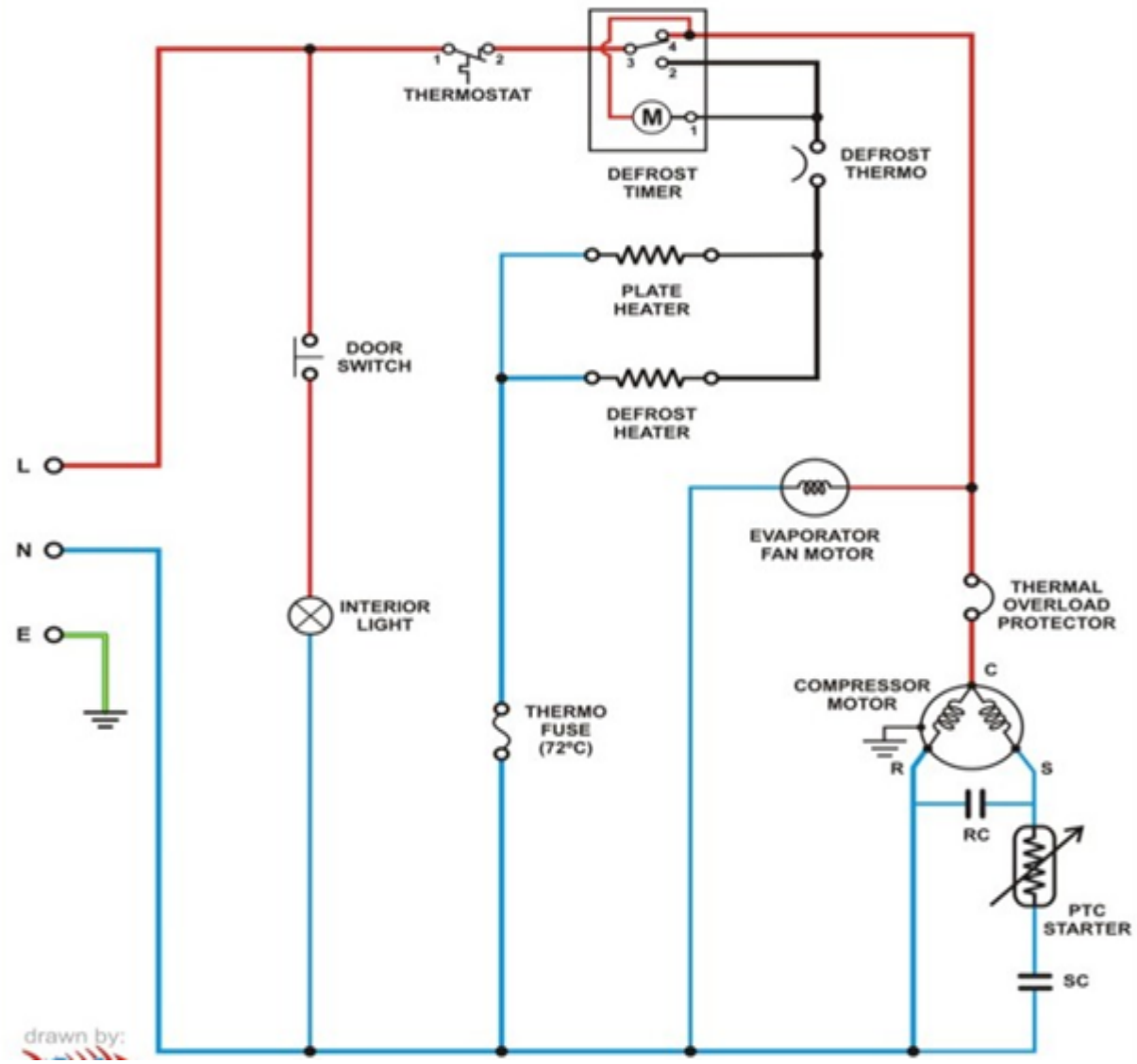


Figure 2.5: Domestic Refrigerator Wiring type-2

2.1 Observing pre-testing procedure

1. **Check the power supply:** Start by ensuring that the refrigerator is properly connected to a power source. Check if the power cord is securely plugged into an outlet and if there are no visible signs of damage. If the refrigerator has a built-in power switch, make sure it is turned on.

2. **Inspect the temperature settings:** Verify that the temperature settings are appropriate for both the refrigerator and freezer compartments. The ideal temperature for a refrigerator is between 35-38°F (1-3°C), while the freezer should be set at 0°F (-18°C). Use a thermometer to measure the actual temperatures inside each compartment.

3. **Examine the door seals:** Inspect the door seals or gaskets for any signs of wear, cracks, or gaps. Damaged seals can lead to air leakage, causing the refrigerator to work harder and consume more energy. To test the effectiveness of the seals, close a dollar bill or a piece of paper in the door and try pulling it out. If it slides out easily, it may be time to replace the seals.

4. **Clean the condenser coils:** The condenser coils are responsible for dissipating heat from the refrigerator. Over time, these coils can accumulate dust and debris, hindering their efficiency. Locate the coils (usually at the back or underneath the appliance) and use a vacuum cleaner or a brush to remove any dirt buildup. Cleaning them regularly improves cooling performance and reduces energy consumption.

5. **Inspect the fan and motor:** Check the fan located near the condenser coils to ensure it is clean and functioning properly. The fan helps circulate air over the coils, aiding in heat dissipation. Additionally, listen for any unusual noises coming from the motor, as this could indicate a problem that needs attention.

6. **Test the defrost system:** If your refrigerator has a defrost system, it is important to ensure it is working correctly. Frost buildup inside the freezer compartment can hinder proper cooling and airflow. Manually initiate a defrost cycle (consult the appliance's manual for instructions) and observe if the defrost heater turns on and melts any accumulated frost.

7. **Check the water dispenser and ice maker (if applicable):** If your refrigerator has a water dispenser or ice maker, inspect their functionality. Ensure that water flows smoothly through the dispenser without any leaks or blockages. Test the ice maker by filling it with water and allowing

it to produce ice cubes. If there are any issues, refer to the appliance's manual for troubleshooting steps.

8. **Monitor temperature consistency:** After conducting all the pre-testing procedures, monitor the refrigerator's temperature over a period of time to ensure it remains within the desired range. Use a thermometer to periodically check both compartments and make adjustments if necessary.

2.3. Assemble and disassemble of components and parts

A refrigerator is a thermally insulated box that helps to transfer inside heat to the outside environment to maintain the inside temperature below room temperature. It is the assembly of various parts. Each part of the refrigerator has its function. we will see refrigerator anatomy, components, names & functions.



Figure 24 : Inside Parts of a Refrigerator

2.2.1.Inside Parts of a Refrigerator

- Compressor
- Condenser
- Expansion Valve
- Evaporator

2.2.2.Outside Parts of a Refrigerator

- Freezer Compartment
- Meat Compartment
- Storages
- Thermostat Control
- Shelf
- Crisper
- Doors
- Magnetic Gasket

Unit Three: Repairing Refrigeration

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Using personal protective equipment
- Following Electro-static discharge (ESD) protection procedure
- Soldering and replaced defective parts/components
- Refrigerator units
- Techniques of Maintain/repair refrigeration unit

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Use personal protective equipment
- Follow Electro-static discharge (ESD) protection procedure
- Soldering and replacing defective parts/components
- Refrigerator units
- Techniques of Maintenance /repair refrigeration unit

2.1Use personal protective equipment

When it comes to refrigerator maintenance, personal protective equipment (PPE) may not be necessary for routine tasks. However, if you're planning to perform any maintenance or repair work that involves potentially hazardous materials or situations, it's always a good idea to prioritize safety and consider using appropriate PPE. Here are some general guidelines:

1. **Gloves**: Wear gloves when handling any chemicals or cleaning agents that could irritate or harm your skin. This includes substances like solvents, detergents, or refrigerator coil cleaners.

2. **Eye protection:** If you're working with chemicals or using tools that may produce debris or particles, consider wearing safety glasses or goggles to protect your eyes from potential splashes or impacts.

3. **Respiratory protection:** For routine refrigerator maintenance, respiratory protection is generally not required. However, if you're working in a confined space or dealing with strong chemical fumes, it's crucial to use appropriate respiratory protection, such as a mask or respirator, to safeguard your lungs.

2.2 Follow Electro-static discharge (ESD) protection procedure

When performing maintenance on a refrigerator or any electronic device, it's important to take precautions to avoid damaging sensitive components due to electro-static discharge. Here are some general guidelines to follow:

1. **Grounding:** Ensure that you are properly grounded before handling any electronic components. This can be done by using an ESD wrist strap that is connected to a grounding point or by working on an ESD mat that is properly grounded.

2. **ESD-safe work area:** Set up your work area on an ESD mat or an ESD-safe surface. These surfaces are designed to dissipate static charges and prevent them from building up.

3. **ESD-safe tools:** Use ESD-safe tools and equipment when working on the refrigerator. These tools are typically made of materials that do not generate or hold static charges.

4. **Proper clothing:** Avoid wearing clothing made of static-prone materials such as wool or synthetic fabrics. Instead, wear clothing made of cotton or other materials that are less likely to generate static charges.

5. **Avoidance of high-static environments:** Keep the work area free from materials or conditions that can generate static charges, such as carpets, plastic bags, or dry air. If possible, work in an environment with controlled humidity.

6. **Handling components**: When handling electronic components, avoid touching the sensitive parts, such as pins or connectors. Instead, hold them by their edges or use appropriate tools like anti-static tweezers.

7. **Packaging:** When not working on the refrigerator, store sensitive components in anti-static bags or containers to prevent electro-static discharge.

2.3. Identifying defect faults

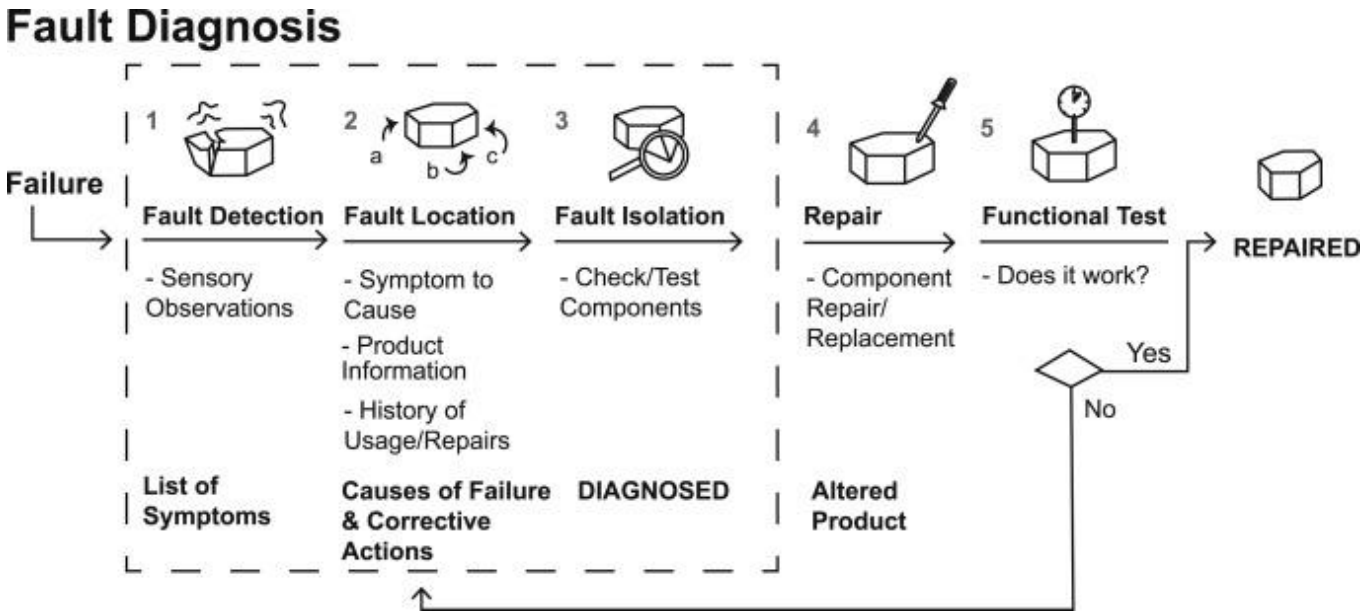
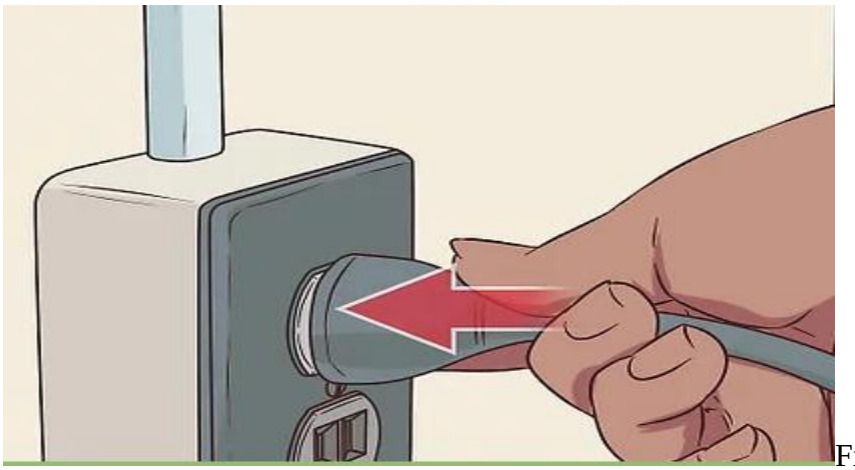


Figure 25.6:diagnosis follow

- Diagnosing a Dead Refrigerator

Check that the power cord is plugged in all the way. Pull out the refrigerator if needed and press the plug firmly into the outlet.Check your appliance's electrical cord for damage. Any exposed wire, kinks or cuts in the cord might make the appliance malfunction.


Fig2.7

Remove an extension cord if you were using one between the refrigerator's main cord and the outlet. The extension cord may be damaged or faulty. Plug the refrigerator directly into the outlet. If this solves the problem, replace the faulty extension cord.

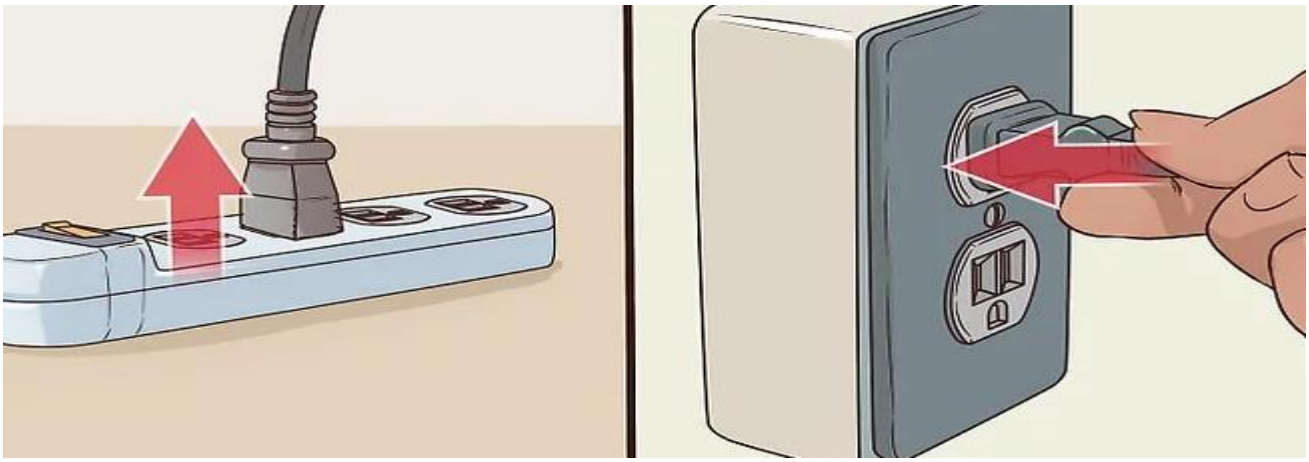
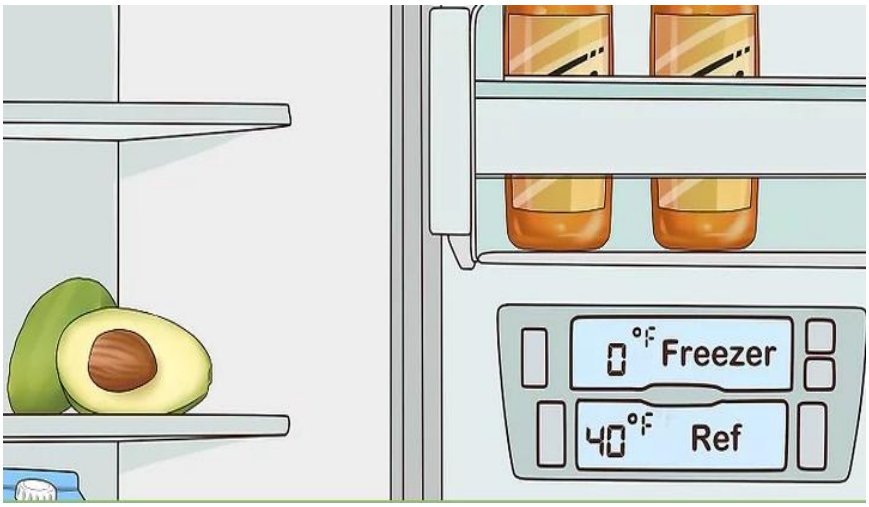


Fig 2.8

- **Try another appliance in close proximity to the refrigerator.** Plug the other appliance into the same outlet that your refrigerator was plugged into. If that appliance also does not work, check your fuse or circuit breaker box. You might have a blown fuse or tripped breaker.
- **Try plugging the refrigerator into a different outlet.** If this solves the problem, then the problem is with the outlet. Check the current and voltage of the outlet with a multimeter and voltage tester.

- **Try leaving it unplugged for a while, then plugging it back in.** This may reset the circuit board (like rebooting a computer or a cell phone). By leaving it unplugged, you allow capacitors to lose any charge they may be holding.
  - Diagnosing if Only the Light Works
  - **Check your temperature gauge inside the appliance.** If the dial was bumped, it could have made it too warm for the refrigerator to turn on. It's important to check both the refrigerator and the freezer temperature settings, because the refrigerator gets its cold from the freezer. A problem with the freezer setting will affect the refrigerator as well.
- It should be set between 37 and 40º F (3-4ºC) for the refrigerator and between 0-5ºF (-15 to -18ºC) for the freezer.



  - **Make sure there's proper airflow around the appliance.** Check the space between the walls and the appliance. There should be a 3-inch (76.2 mm) gap around the sides of the appliance and at least a 1-inch (25.4 mm) gap at the top. This provides airflow needed for the machine to function.

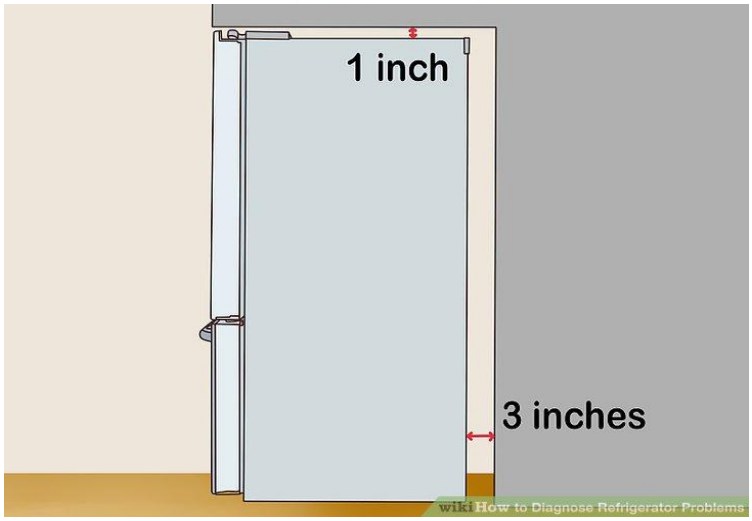


Fig 2.9

- **Clean the condenser coils with a vacuum or brush.** This part helps dissipate heat that could make the appliance act funny. This cleaning should be done with the appliance turned off. You should clean rear-mounted coils once a year, and floor coils twice a year.



Fig 2.10

- **Test for overheating and continuity.** Unplug the refrigerator for 2 hours and then plug it back in. If it starts running "normally" again, the compressor is overheating and it should be checked by a repair technician. Use a multimeter to test each component for continuity. These include the
    - Temperature control.

- the evaporator fan
- the defrost timer
- the overload protector
- Compressor motor.

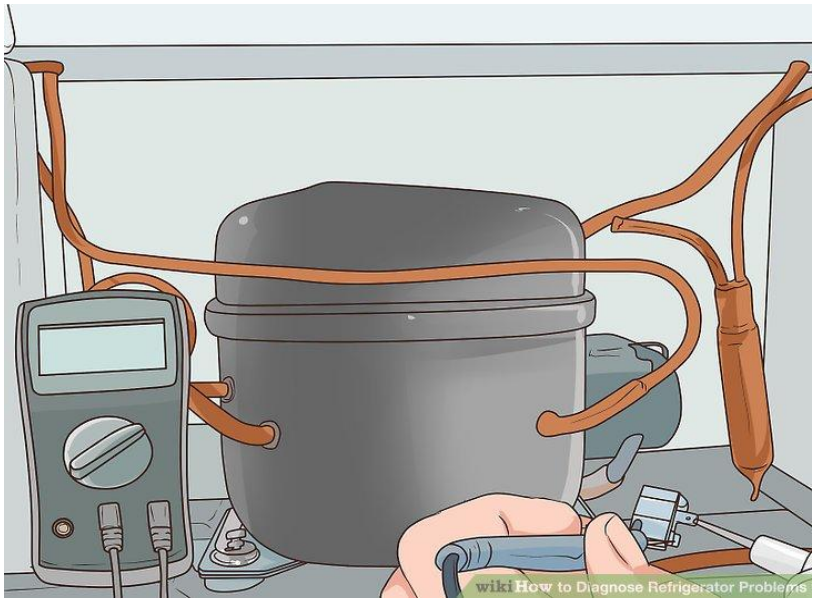


Fig 2.11

- You may have to consult your owner's manual for the locations of the components. If a part does not have continuity, it is faulty and will need to be replaced.

  - Investigating a Refrigerator That Isn't Cold Enough
  - **Check your temperature gauge inside the appliance.** The dial could have been bumped, raising the refrigerator's temperature. It's important to check both the refrigerator and the freezer temperature settings, because the refrigerator gets its cold from the freezer. A problem with the freezer setting will affect the refrigerator as well.
    - It should be set between 37 and 40º F (3-4ºC) for the refrigerator and between 0-5ºF (-15 to -18ºC) for the freezer.

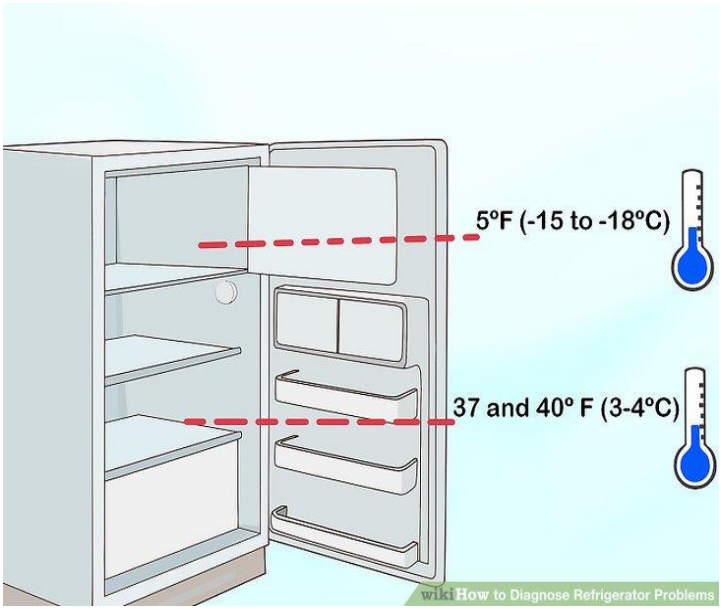


Fig 2.12

- **Inspect the vents.** Check the vents between the freezer and refrigerator and the drain tube for debris and ice. Remove debris if needed. This obstruction could be your problem.

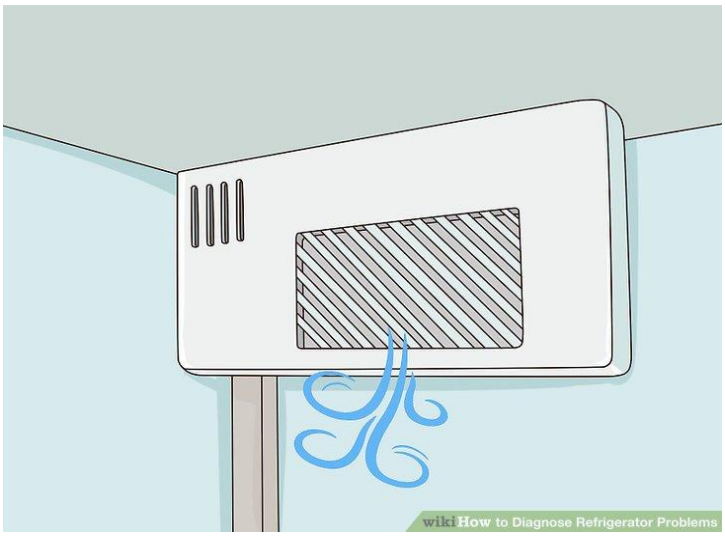


Fig 2.13

- **test your door seals.** Place a piece of paper between the seals and the appliance. Close the door and pull out the paper. You should feel tension if the seals are functioning properly.

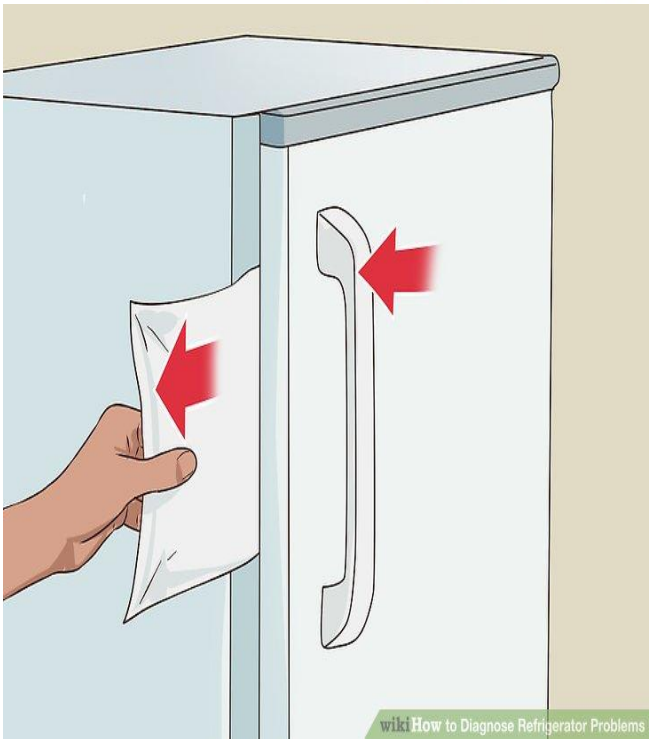


Fig 2.14

- Repeat the process all around the seals of the appliance. If there's no tension at any spot, the seals are starting to fail. You should also check for cracks and rigidity that could be causing a failing door seal.
- **Test the refrigerator components.** Use a multimeter to test the continuity of the appliances various components. These include the door switches, the defrost heater and timer, and the evaporator fan. If any of these parts fail, they could be your problem.

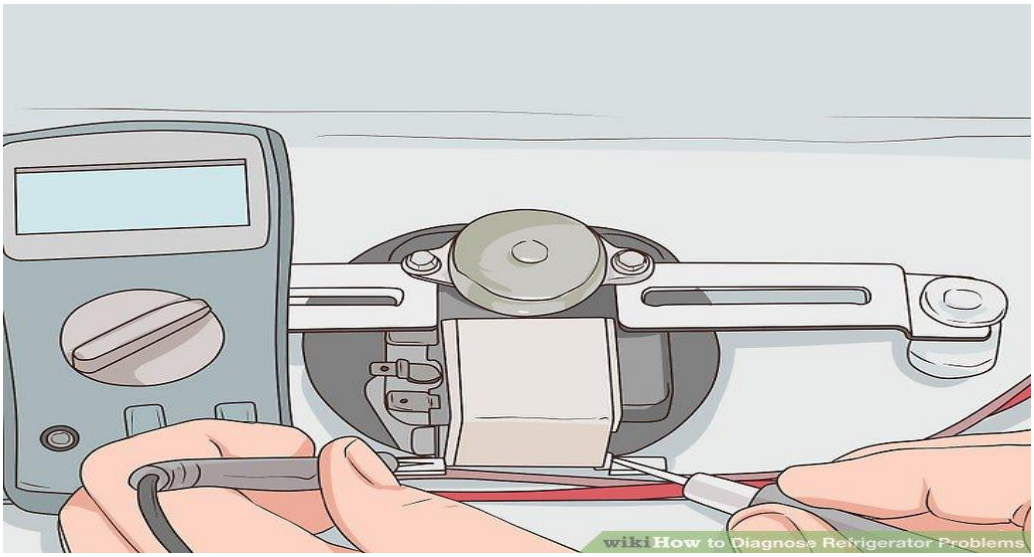


Fig 2.15

- **Diagnosing a Refrigerator That Keeps Running**

- **Wait a day to see if the problem solves itself.** Several factors could cause your refrigerator to temporarily run continuously. If you live in a humid environment, just loaded the refrigerator, or recently adjusted its temperature, it might take a while for the refrigerator to cool completely. It could take 24 hours or possibly more for it to cool.

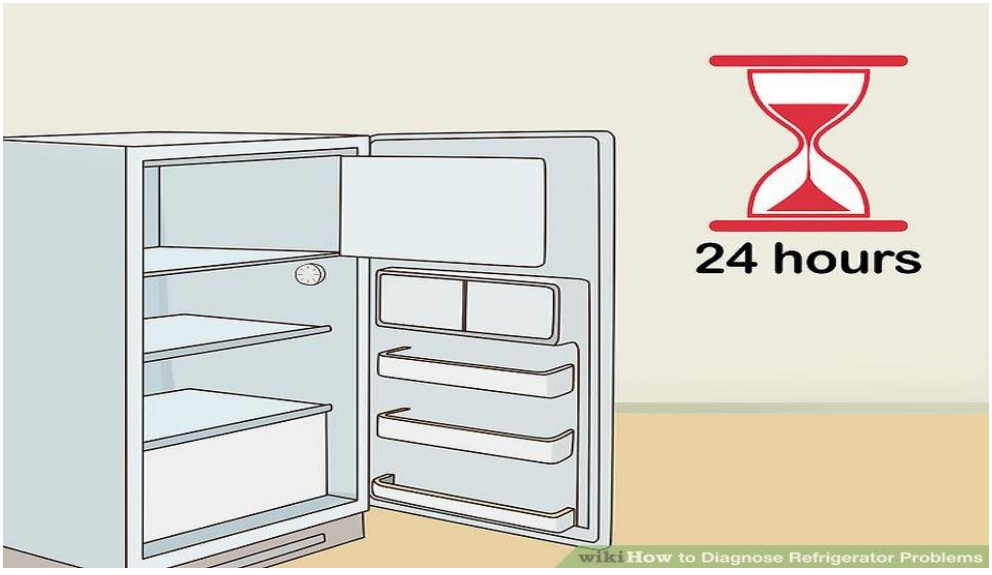


Fig 2.16

- **Defrost the freezer in case there's too much ice built up and clean your condenser coils.** If there is a build of debris on your condenser coils, they won't be able to efficiently dissipate heat, and the refrigerator will have to constantly cool. If the defroster is faulty, then the evaporator coils will frost over, and the refrigerator will work harder to keep cool.

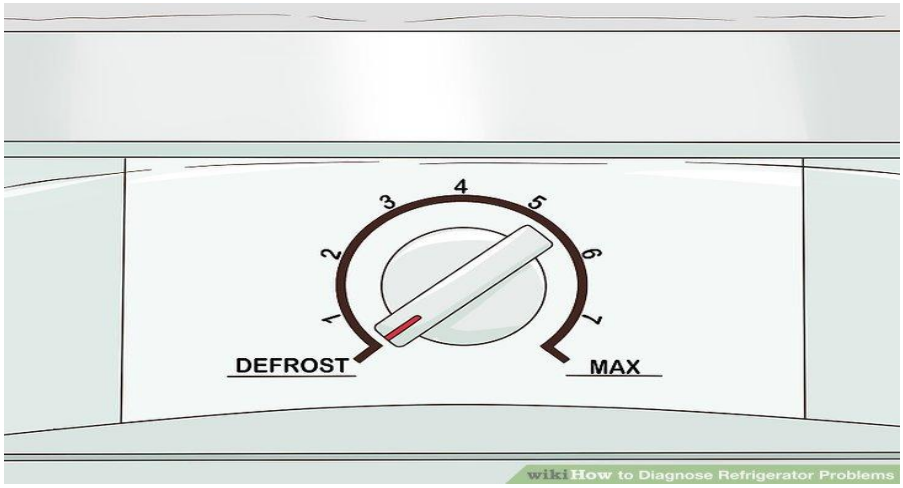


Fig 2.17

- **Test the door seal.** The door of your refrigerator has a seal that prevents cool air from leaking out. If the seal is faulty, your refrigerator will have to constantly cool itself. Use a piece of paper to check for breaks in the seal. Close the door on the piece of paper and pull it out. There should be resistance when pulling the paper out, and if there isn't, a faulty door seal may be your problem. Repeat the test along the whole seal



Fig 2.18

- **Clean the condenser coils with a vacuum or brush.** This part helps dissipate heat, and if it's too dirty, the refrigerator will have to work harder to stay cool.

This cleaning should be done with the appliance turned off. You should clean rear-mounted coils once a year, and floor coils twice a year.

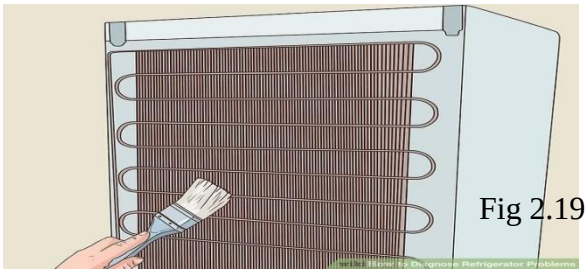


Fig 2.19

- **Test the continuity of the refrigerator's various components.** This will require using a multimeter on several of the refrigerator's components. These components include: the condenser fan, the overload protector, and the compressor relay and motor. A fault in any one of these components can cause the refrigerator to cycle improperly.

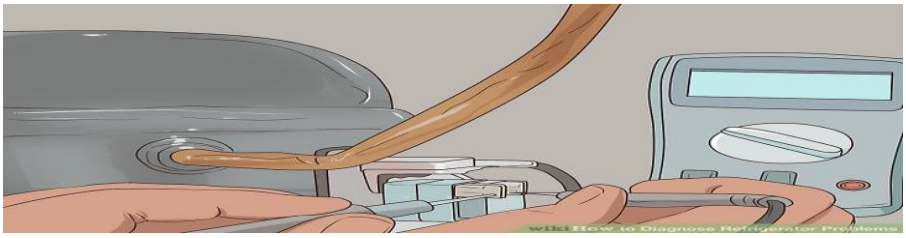


Fig 2.20

- **Test the outlet voltage.** Use a multimeter to test the outlet voltage of the outlet that the refrigerator is plugged into. Do this only with the proper tools and safety measures. The voltage should test between 180 and 220 volts.

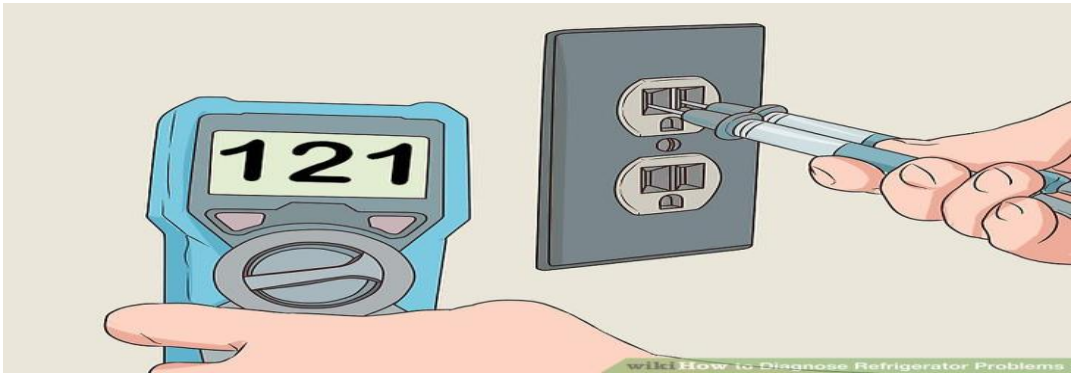


Fig2.21

Unit Four: Testing repaired product

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Testing functionality of repaired part/components
- Final testing and reassembled units

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Test functionality of repaired part/components
- Test and reassembled units

2.4. Testing functionality and replace component,

1. Replacing the thermostat.
2. Replacing electrical equipment.
3. Replacing the compressor.
4. Tube brazing
5. Good Prac1tice in Refrigeration

1. **Replacing the thermostat**.

Before replacing the compressor it is a good idea to check the thermostat. A simple test can be made by short-circuiting the thermostat so the compressor gets power directly. If the compressor can operate like this then the thermostat must be replaced.

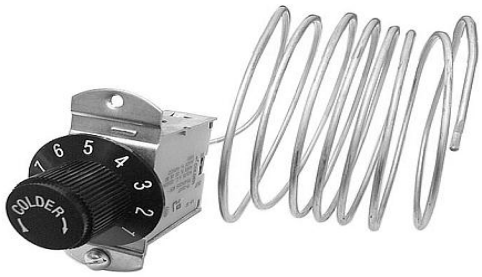


Fig 2.22 Thermostat

2. **Replacing electrical equipment**

The cause of faults may also be found in the electrical equipment of the compressor, where it is possible to replace the **starting relay/PTC starting device**, **motor protector**, **or starting or run capacitor.**

A damaged **starting capacitor** may be caused by the thermostat differential setting being too low, since the starting capacitor must be maximum cut in 10 times/hour. If a fault is found on the winding protector built into many hermetic compressors, the entire compressor must be replaced.

3. **Replacing the compressor**

If the failure is a defective compressor, the technician must pay attention to selecting a compressor with the correct characteristics for the appliance.

If it is a question of changing from one compressor to another, it can be difficult to select the correct compressor, and therefore different parameters have to be considered. Compressor voltage and frequency must correspond to voltage and frequency on location. Then the application area must be considered (low, medium, or high evaporating temperatures).

The cooling capacity must correspond to the one of the previous compressor, but if the capacity is unknown, a comparison of the compressor displacements will be applicable. It would be appropriate to select a compressor slightly larger than the defective one.

For a capillary tube system with pressure equalization during idle periods, a LST compressor (low starting torque) can be used, and for a system with expansion valve or no pressure equalization a HST compressor (high starting torque) is to be chosen. Of course a HST compressor may also be used in a capillary tube system

Finally the compressor cooling conditions must also be considered. If the system has an oil cooling setup, a compressor with an oil cooler must be selected.

When performing service work, a compressor with an oil cooler instead of a compressor without oil cooler can be used without any problems, since the spiral can be completely ignored when it is not required.

4.Tube Brazing

Creation of the correct brazing fit is important. Recommended brazing gaps for brazing joints.

If the connection tube is made of steel a solder without phosphor and with a melting point below 740 °C must be used

	Material	Material
Silver brazing solder	Copper tubes	Steel tubes
Easy-flo	0.05 - 0.15 mm	0.04 - 0.15 mm
Argo-flo	0.05 - 0.25 mm	0.04 - 0.2 mm
Sil-fos	0.04 - 0.2 mm	Not suitable

The connectors of most Secop compressors are copper plated steel tubes welded into the compressor housing. The welded connections cannot be damaged by overheating during brazing

It is possible to drift the 6.2 mm connectors to 6.5 mm, which fits a ¼" (6.35 mm) tube, but it is not recommended to drift the connectors more than 0.3 mm. During drifting a backstop is necessary to prevent the connector from breaking off. See Fig.

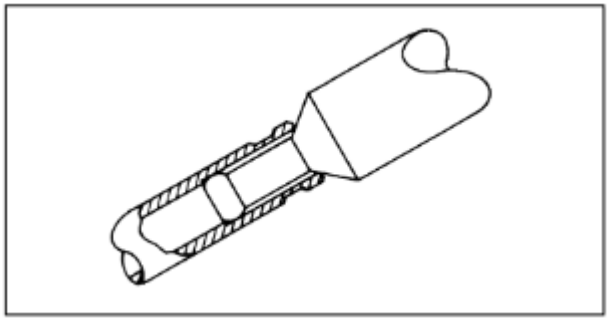


Fig2.23Drifting of connector

Instead of drifting the connectors a reducing pipe as shown in Fig. below can be used.

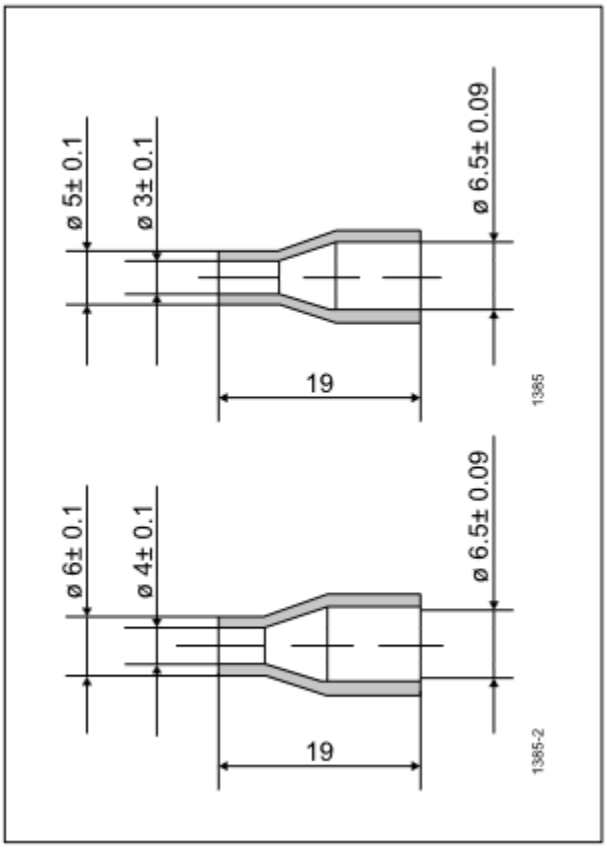


Fig2.24 Reducing pipe

To achieve a sufficiently high torch flame temperature, it is recommended to use both acetylene and oxygen or propane and oxygen since bottled gas, for example, provides a temperature that is too low.

Brazing steel connectors is slightly different from brazing of copper connectors.

Below you will find guidelines for brazing steel connectors:

During heating, the temperature must be kept as close to the solder melting point as possible. Overheating will cause damage to the tube surface, which reduces the chances for a good joint.

Use the soft heat in the torch flame when the joint is heated.

Distribute the flame in a way that at least 90% of the heat is concentrated around the connector and approx.

10% around the connection tube.

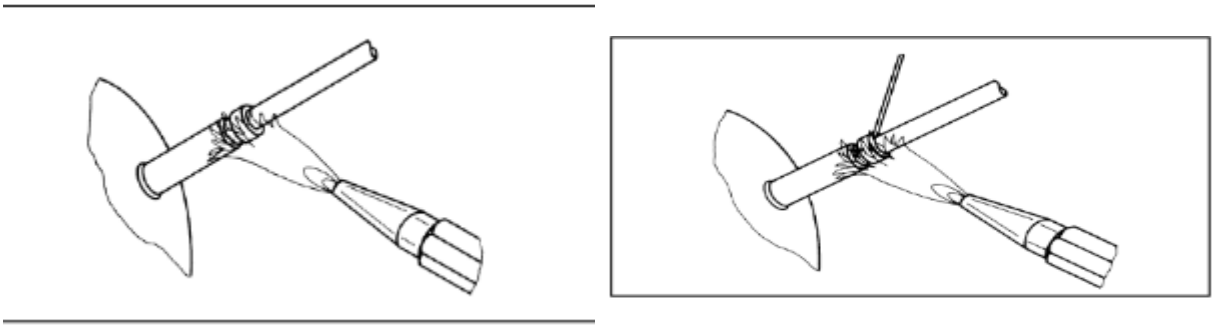


Fig 2.25 Continue heating the joint with a soft flame and add solder.

5.Good Prac1tice in Refrigeration

- Recovery of Refrigerant
- Pressure Leak Testing
- Evacuation & Vacuum holding
- Charging Refrigerant
  - **Recovery of Refrigerant**
    - Recover these are ODP & GWP gases
    - Use piercing pliers or piercing valve
    - Use Recovery machine & a recovery cylinder.

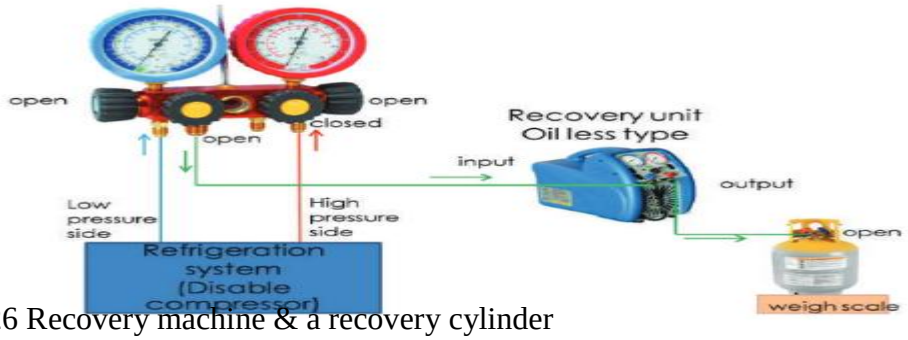


Fig 2.26 Recovery machine & a recovery cylinder

❖ **Pressure Leak Testing**

This leak test provides information on the overall leak tightness of the refrigerated system.

Only dry Nitrogen must be introduced into the refrigerated system.

Transferring the dry Nitrogen gas from both, the high and low pressure side up to a system pressure of a maximum of 10 bar.

NEVER USE OXYGEN (e.g. shop-air) FOR PRESSURIZING A REFRIGERATION SYSTEM.

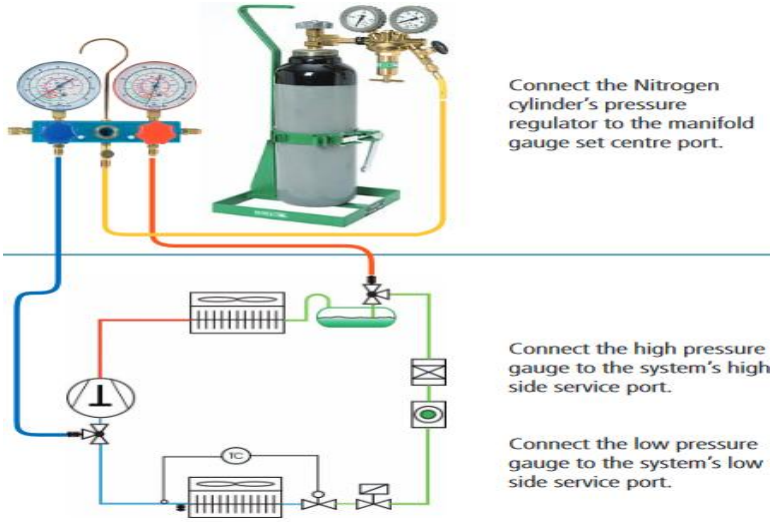


Fig 2.27 **Pressure Leak Testing**

- pressurize the refrigeration system up to a maximum of 10 bar dry Nitrogen.
- Close the pressure regulator and hold the pressure in the system.
- Observe the pressure at gauges. If leaks exist, pressure will drop. Some leaks are audible and can be identified by the sound of discharging gas.
- Check all connections, flares and joints with soap water solution. Identify leaks by bubbles

formed by discharging Nitrogen.

- Repair leaks.
- If necessary repeat leak test.



Fig 2.28**Example of a leaky connection (see bubbles)**

❖ **Evacuation & Vacuum holding**

- To remove non-condensable gases (e.g. air) & moisture
- Deep vacuum important due to hygroscopic nature of polyol ester oil
- Two stage rotary vacuum pump - capable of developing blank off pressure of 20-50 microns, minimum capacity 2cfm
- Micron gauge capable of reading pressures in microns or other scales

Step1. Connect the vacuum pump to the manifold gauge set to the centre port.

Step2. Connect the vacuum gauge to the service port at the evaporator's outlet service port

Step3. Run the vacuum pump and read the vacuum indicated at the vacuum gauge.

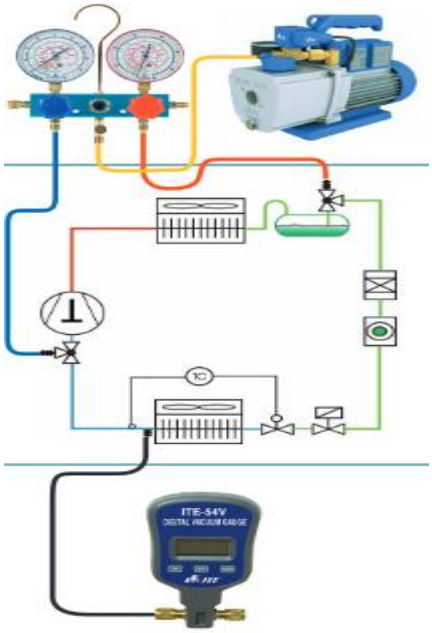


Fig 2.29 Vacuum holding

Charging

The compressor must never be operated without refrigerant or under vacuum. A damage of the compressor would result.

If the filling capacity of the plant is known, liquid charging of the refrigerant into the high side of the system can be carried out with the plant at rest, against vacuum, using a charging cylinder or scales.

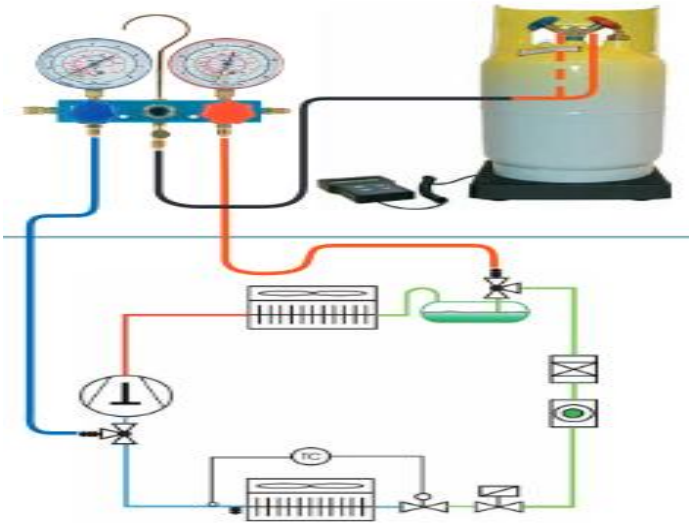


Fig 2.30 Refrigerator charging

Self-check questions

I. Multiple-choice

1. Charging a refrigeration system refers to ____.
   A. removing refrigerant from a system
   B. adding refrigerant to a system
   C. cleaning the refrigerant
   D. vaporizing the refrigerant
2. Brazing is the process used for joining
   A. two ferrous materials
   B. two non-ferrous materials
   C. two non-metals
   D. one ferrous and one non-ferrous material
3. What is the purpose of using a refrigerant compressor?
   A. Raise the temperature of refrigerant
   B. Reduce the temperature of refrigerant
   C. Reduce the pressure of refrigerant
   D. Expand the refrigerant

Operation sheet 2.1

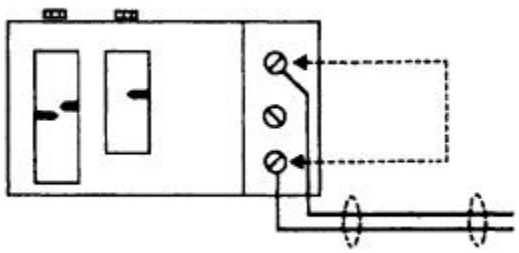
Operation sheet title: - Test **Supply and control switch**

Purpose: - To practice and demonstrate the knowledge and skill to test supply and control switch of refrigerator part

Instruction: - Use the given select tools and equipment accurately done sure the skill **to**testsupply and control switchof refrigerator partthatoperates properly. For this operation you have given 2 Hour and you are expected to provide the answer on the given steps.

- **Tools and requirements**
  - ✓ Refrigerator
  - ✓ Digital multi-meter
  - ✓ pliers
  - ✓ wire stripper
  - ✓ screwdriver Philips and flat
- **Step to follow procedures**

1. Check the electrical supply at the power point, the fuse and the fuse rating.
2. Ensure that the control switch is set to the on position, and check the electrical supply to the control. If there is supply to the input side of the control, bridge out the control contacts with a jumper wire or join the two control wires together; this will effectively take the control out of circuit (Figure below)
3. If the compressor fails to start, check the supply voltage at the compressor terminals or at the relay terminal board.



Operation sheet 2.2

Operation sheet title: -**Test and replace Start Relay and compressor.**

Purpose:-To practice and demonstrate the knowledge and skill To Test Start Relay and compressor.

Instruction: - Utilize the tools and components provided. Within 2hours, test the compressor and starting relay and locate any problematic components.

- **Tools and equipment needed**
  - ✓ Refrigerator compressor
  - ✓ Starting relay
  - ✓ Capacitor
  - ✓ PTC thermistor
  - ✓ Digital multi-meter
  - ✓ pliers
  - ✓ wire stripper
  - ✓ screwdriver Philips and flat
- **Procedures to do the task**

1. Disconnect the refrigerator
2. Remove the connectors of the relay
3. Identify the model of the start relay
4. Do the test with a multi-meter
   - **Starting relay test(electro mechanical)**

1. With the relay in any position, check if there is continuity between terminals 1 and 2 of the relay. If there is not, change the relay.

2. With the relay in the vertical position, coil of the relay upwards, check if there is continuity between terminals 1 and 3 of the relay. If there is not, change the relay and repeat step 1.

- **Starting relay test(PTC)**

1. With the aid of an ohmmeter, measure the ohmic resistance between terminals 2 and 3. At ambient temperature, the values should be near those presented in the list below:
   - Relay PTC– Relay PTC 8EA 1B1X – 2.8 to 5.2 Ω;
   - Relay PTC 7M4R7XXX / 8M4R7XXX / 8EA14CX– 3.8 to 5.6 Ω;
   - Relay PTC 8EA4BX / 8EA3BX / 8EA21CX – 3.5 to 6.5 Ω; –
   - Relay PTC 8EA5BX – 14 to 26 Ω;

Relay PTC 7M220XXX / 8M220XXX / 8EA17CX – 17.6 to 26.4 Ω.

Step 3: With the relay in the vertical position, coil downwards, check if there is continuity between terminals 1 and 3. If there is, change the relay



Testing the Compressor step

1. Put the probes of a multimeter on the left and right prongs of the compressor.
2. Measure the resistance between the leftmost and the third prong.
3. Find the measurement from the rightmost and third prongs.
4. Add the lowest 2 readings to see if they’re within 0.5 Ω of the largest reading.

Take the smallest 2 resistance readings from the compressor and add them together to find the total. Compare the sum of the 2 readings to the highest resistance measurement you took to see how close they are. If the sum of the 2 readings is within 0.5 Ω of the highest reading you took, then the compressor is okay. If the readings are higher or lower than the threshold, then you need to call someone to repair or replace the compressor for you.

Operation sheet 2.3

Operation sheet title: - **brazing copper tube.**

Purpose: - To brazing copper tube.

Instruction: - Use the given equipment's and material apply copper brazing technique within 3hrs.

- **Tools and requirements**
  - ✓ Brazing Torch
  - ✓ Brazing Goggles
  - ✓ Brazing Flux
  - ✓ Brazing Rod
  - ✓ Hand Gloves
  - ✓ Hacksaw
  - ✓ Copper pipe bender
  - ✓ Brush for Coil cleaning
  - ✓ Tube Cutter
  - ✓ O2 &DA Cylinders
- **Procedures to do the task**

1. clean all the pipe surfaces as well as the inside of the joint fittings thoroughly with a wire brush or abrasive pad.
2. Sand down the outside tip of the pipes with an abrasive material of your choice.

3. If your copper pipe is phosphorus, apply the flux with a flux brush to the end of the pipe.
4. Apply the pipe to the socket of the fitting. And now it's time to heat the pipe in accordance with manufacturer guidelines.
5. Heat the fitting's hub after the pipe has been heated while keeping the flame moving at all times.
6. The rod can be used to determine if the pipe is hot enough by touching the edges. The edge won't budge if the temperature isn't hot enough. The temperature is reached only when it melts. A red pipe is another sign that indicates that the pipe has reached the required temperature.
7. Once the pipes are fully heated, with the flame still concentrated on the pipe, you can begin smoothing the rod over the edges of the pipe, ensuring there are no gaps between the pipe and the fittings.
8. Once your joint has been properly brazed, allow it to cool naturally. Applying a wet rag too soon might compromise the joint.
9. Remove any excess debris or grease from the pipe surface with a wire brush or cloth once the joint has cooled down.
10. Make sure your joint is free of holes, voids, and gaps by inspecting it all around. Use a mirror if you're working in an awkward position.



Operation sheet 2.4

Operation sheet title: **-charging of refrigerant gas.**

Purpose: - To charging of refrigerant gas.

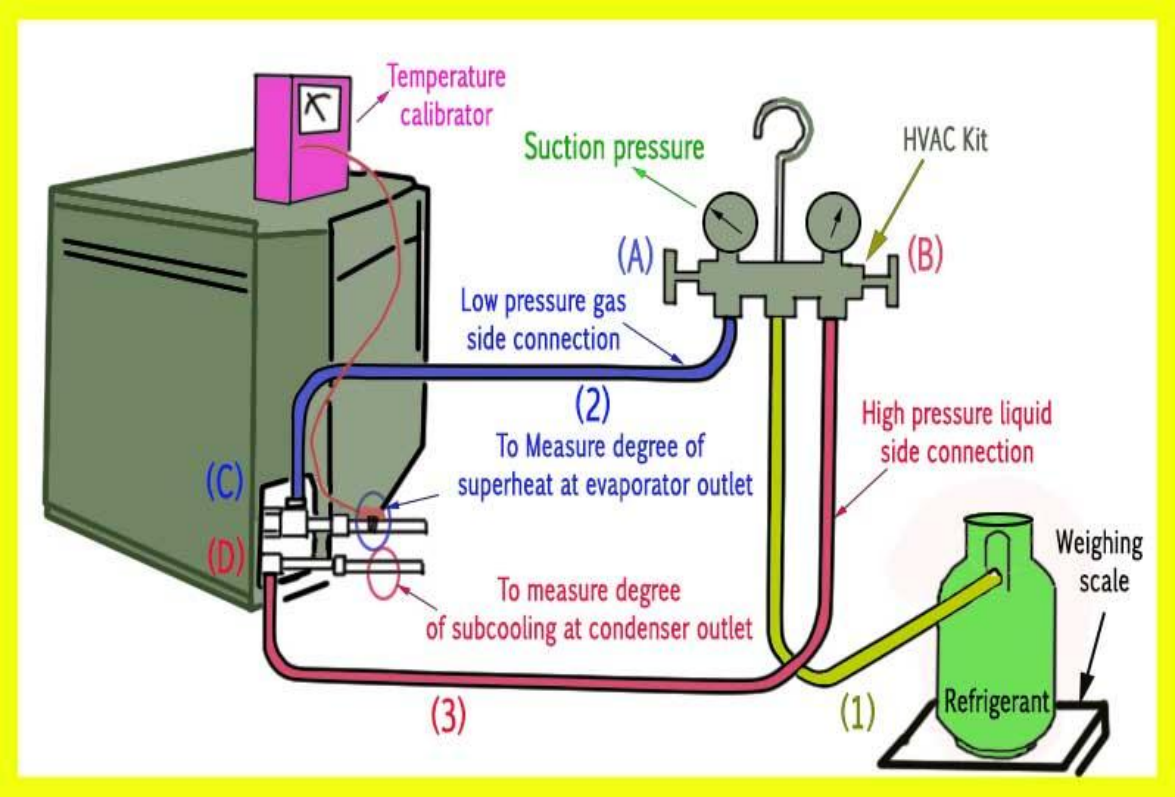
Instruction: To apply refrigerant, recover, evacuate, vacuum, and replace gas, use the provided tools and materials. 5 hours to do

- **Tools and requirements**
  - ✓ Recover machine
  - ✓ Vacuum pump
  - ✓ Gauge manifold
  - ✓ Nitrogen Cylinders
  - ✓ Refrigerant
  - ✓ Refrigerator
  - ✓ Recovery cylinder
- **Procedures to do the task**

1. Connect hose 2 and 3 connection to C and D, respectively.
2. Both the gauges must be zeroed.
3. Evacuate the system into a recovery bottle by connecting the vacuum pump to charging hose 1, open both valves A and valve B till the evacuation process is complete (vacuum gauge reading showing 500 microns as final reading).

4. Stop the vacuum pump after the system has evacuated, close the charging hose (1) valve going to the recovery bottle, check the pressure drop in the gauge for around 20 min to know if there is any leakage in the system.
5. Disconnect the charging hose 1 from the vacuum pump and connect it to the blue connection of the charging cylinder for a **gas charge**.
6. Open valve A, slightly open the connection at C and purge the whole hose line from 1 to 2 by crack opening the gas valve of the refrigerant charging bottle; try not to avoid any excess leak directly into the environment.
7. Same way, purge the high-pressure liquid side hoses from 1 to 3 to remove any air/moisture inside the hose.
8. Now tight both the low and high-pressure side hose at position C & D, respectively as shown in the image.
9. Start charging the gas refrigerant from the refrigerant bottle to the low-pressure side of the system at connection C by opening valve A and the refrigerant valve of the charging bottle until the vacuum comes to zero.
10. Now start the compressor as the suction pressure goes above zero.

11. After about 30 – 40 seconds of charging, close valve A and check the suction gauge pressure for a rise in pressure.
12. Keep monitoring the degree of superheat by the temperature calibrator to ensure the liquid is not entering into compressor suction also; we can calculate how much charge present in the system by the pressure chart.
13. If the superheat temperature is high, then it means the system is running low in refrigerant, whereas a lower superheat temperature than the desired reading means the system is overcharged.
14. Repeat the procedure 10 to 11 until the suction pressure reaches 60 psi (as per maker). This avoids the risk of overcharging of the system also keeps measuring the refrigerant by the weighing scale.
15. Once the refrigerant has charged, close the refrigerant valve, valve A and B and disconnect all the hoses, and secure everything.


Temperature calibrator
Suction pressure
HVAC Kit
(A)
(B)
Low pressure gas side connection
(2)
To Measure degree of superheat at evaporator outlet
High pressure liquid side connection
(C)
(D)
Weighing scale
To measure degree of subcooling at condenser outlet
Refrigerant
(3)
(1)

Lap Test

Instructions: Given the necessary templates, tools, materials, and equipment you are required to use to perform recovery, evacuation, vacuuming, and gas charging, you have to complete this task within 5 hours.

Task – 1: Tube brazing

Task –2: Refrigerant recovery.

Task - 3: Evacuate the system

Task - 4: Vacuum the system

Task - 5: Recharge the refrigerant

Unit Five: Complete work and report activities

This learning unit is developed to provide the trainees the necessary information regarding the following content coverage and topics:

- Cleaning worksite and equipment
- Recording refrigerant usage
- Complying service completion procedures and documentations
- Disposing waste materials

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Clean worksite and equipment
- Record refrigerant usage
- Comply service completion procedures and documentations
- Dispose waste materials

5

5.1 Clean worksite and equipment.

To clean a worksite and equipment for refrigerator maintenance, follow these steps:

- **Gather necessary supplies:** You will need cleaning materials such as gloves, safety goggles, a face mask, cleaning cloths, mild detergent, warm water, a bucket, and a vacuum cleaner.

- **Clear the worksite:** Remove any items around the refrigerator that could obstruct your access or get damaged during the cleaning process. This includes nearby furniture, appliances, or any other objects.

- **Disconnect the refrigerator:** Unplug the refrigerator from the power source to ensure your safety during the cleaning process.

- **Empty the refrigerator:** Remove all the food items, shelves, and drawers from the refrigerator. Dispose of any expired or spoiled food. Place the removable parts in a sink or tub filled with warm, soapy water for cleaning.

- **Dust and vacuum:** Use a vacuum cleaner with a brush attachment or a microfiber cloth to remove dust and debris from the exterior of the refrigerator, including the coils, vents, and grills. Be gentle to avoid damaging any parts.

- **Clean the interior:** Prepare a mixture of mild detergent and warm water in a bucket. Dip a clean cloth or sponge into the soapy water and wipe down the interior surfaces of the refrigerator, including the walls, shelves, and drawers. Pay special attention to any spills or stains. Rinse the cloth or sponge frequently and change the water as needed.

- **Clean the removable parts:** Scrub the shelves, drawers, and other removable parts that were placed in the soapy water. Rinse them thoroughly with clean water and allow them to air dry.

- **Clean the door seals:** Use a cloth dampened with soapy water to clean the door seals or gaskets. Ensure that they are free from dirt and debris, as they play a crucial role in maintaining the refrigerator's efficiency.

- **Dry and reassemble:** After cleaning, use a dry cloth to wipe down the interior surfaces of the refrigerator, as well as the removable parts. Make sure everything is completely dry before reassembling the refrigerator.

- **Reconnect and power on:** Once the cleaning is complete and everything is dry, plug the refrigerator back into the power source and turn it on. Allow it to cool down to the desired temperature before returning the food items.

5.1 Record refrigerant usage .

To record refrigerant usage effectively, follow these steps:

- **Gather necessary tools and materials**: You will need a logbook or a digital spreadsheet, a pen or a computer, and a refrigerant usage chart or table.

- **Identify the refrigerant type:** Determine the specific type of refrigerant being used. It is essential to know the exact type since different refrigerants have varying environmental impacts and require specific handling procedures.

- **Monitor initial and final quantities:** Before starting any refrigerant-related work, record the initial quantity of refrigerant in the system or container. This information can usually be found on the equipment nameplate or refrigerant container. Similarly, note the final quantity after the work is complete.

- **Document work details:** Record relevant information about the work performed, such as the date, location, equipment identification, and the reason for refrigerant usage (e.g., maintenance, repair, or charging).

- **Measure and record refrigerant quantities:** Use an approved refrigerant scale or measuring device to determine the amount of refrigerant added or removed from the system. Ensure accurate measurements and record them in the logbook or spreadsheet.

- **Verify recovery and disposal activities:** If the refrigerant is being recovered from the system, document the amount recovered. Note the method of recovery (e.g., reclaiming, recycling, or destruction) and any relevant details about the recovery equipment used.

- **Calculate net refrigerant usage:** Calculate the net refrigerant usage by subtracting the final quantity from the initial quantity. This figure represents the amount of refrigerant added or removed during the work.

- **Note any leaks or losses:** If there were any refrigerant leaks or losses during the process, document them separately. Include details such as the location and cause of the leak and the quantity of refrigerant lost.

- **Ensure compliance with regulations:** Familiarize yourself with local regulations and requirements regarding refrigerant usage and recordkeeping. Adhere to any specific guidelines provided by regulatory bodies or environmental agencies.

- **Maintain records and retain documentation:** Keep the records of refrigerant usage in a secure and organized manner. Retain the logbooks, spreadsheets, and supporting documentation for a specified period, as required by regulations or company policies.

5.2 Comply service completion procedures and documentations.

The specific procedures and documentations may vary depending on the nature of the service or project. However, there are some common elements that are typically included in service completion procedures and documentations. These elements may include:

1. Final Inspection: Before declaring a service or project as complete, a final inspection is often conducted to ensure that all requirements have been met. This may involve checking the quality of work, verifying that all components are functioning properly, and confirming that all necessary tests have been performed.

2. Client Acceptance: Once the final inspection is completed, the client or customer is usually asked to formally accept the service or project. This acceptance may be documented through a signed acceptance form or agreement.

3. Documentation of Deliverables: It is important to document all deliverables provided as part of the service or project. This may include physical items, such as equipment or materials, as well as intangible deliverables like reports or software applications. The documentation should clearly outline what has been delivered and any associated warranties or guarantees.

4. Finalization of Contracts: If there were any contracts or agreements in place for the service or project, they need to be finalized upon completion. This may involve closing out any outstanding financial transactions, settling any disputes, and ensuring that all contractual obligations have been fulfilled.

5. Handover of Documentation: All relevant documentation related to the service or project should be handed over to the client or customer upon completion. This may include technical specifications, user manuals, maintenance guides, and any other documentation that may be required for future reference or support.

6. Final Payment and Invoicing: Once the service or project is completed, any outstanding payments should be settled. This may involve issuing a final invoice to the client or customer

and ensuring that all financial transactions are properly recorded.

7. Archiving and Storage: It is important to archive and store all relevant documents and records related to the service or project. This ensures that they can be easily accessed in the future if needed for reference, audits, or legal purposes.

In summary, **s**ervice completion procedures and documentations encompass a range of activities aimed at finalizing a service or project and documenting its completion. These procedures ensure that all requirements have been met, all deliverables have been provided, and all necessary information has been recorded for future reference.

5.3 Dispose waste materials.

When it comes to disposing of waste materials from refrigerator maintenance, it's important to follow proper guidelines to ensure safety and environmental responsibility. Here's a step-by-step guide on how to handle waste materials from refrigerator maintenance:

Step 1: Unplug the Refrigerator

The first step in the refrigerator disposal process is to unplug the appliance from the power source. This is a crucial safety measure to avoid any electrical hazards during the disposal process. Follow these simple steps to safely unplug your refrigerator:

Step 2: Remove All Food and Items

In order to prepare your refrigerator for disposal, it’s crucial to remove all food and items from its interior. This not only prevents any unpleasant odors or leaks but also ensures that no perishable items are wasted. Follow these steps to effectively empty your refrigerator:

Step 3: Clean the Refrigerator

Now that your refrigerator is empty, it's time to give it a thorough cleaning. This step is important not only for hygiene purposes but also to ensure that the appliance is in good condition for disposal. Follow these steps to effectively clean your refrigerator:

Step 4: Find a Recycling or Disposal Option

When it comes to the disposal of a refrigerator, it's important to choose an environmentally responsible option. While throwing it in the trash may seem like the easiest solution, it can harm the environment due to the hazardous materials present in refrigerators, such as refrigerants and foam insulation. Follow these steps to find a recycling or disposal option for your refrigerator:

Step 5: Prepare the Refrigerator for Disposal

Before you can dispose of your refrigerator, it's important to properly prepare it to ensure safety during transportation and handling. Follow these steps to prepare your refrigerator for disposal:

Step 6: Arrange for Pickup or Delivery

Once you have prepared your refrigerator for disposal, the next step is to arrange for its pickup or delivery to the designated recycling or disposal location. The method you choose will depend on the available options in your area and the requirements of the recycling center or waste management facility. Follow these steps to arrange for pickup or delivery:

Step 7: Properly Dispose of Refrigerant

As you prepare to dispose of your refrigerator, it is important to address the proper disposal of the refrigerant inside the appliance. Refrigerants, such as chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs), can be harmful to the environment if released improperly. Follow these steps to ensure the proper disposal of the refrigerant:

Step 8: Dispose of the Refrigerator

After you have completed all the necessary preparations and arrangements, it's time to finally dispose of your refrigerator. Follow these steps to ensure a proper and responsible disposal:

Conclusion

Disposing of a refrigerator may seem like a daunting task, but by following the steps outlined in this guide, you can ensure a smooth and responsible process. From unplugging the refrigerator to arranging for its pickup or delivery, each step plays a crucial role in ensuring a safe and environmentally friendly disposal.

5.4 Disposing waste materials.

Household Waste Disposal

There are many items that consumers have doubt about when it comes to proper disposal. Some may be discarded as regular garbage and others require special treatment. Below is a list of some of the most common items that require special treatment.

Appliances

Items that fall under the classification of appliances include refrigerators, freezers, ranges, water heaters, air conditioners, humidifiers, and other similar domestic and commercial large appliances. These items, also referred to as white goods, that have not had their components removed were banned from landfills on July 1, 1994. These components are mercury switches, chlorofluorocarbon (CFC) refrigerant gas (Freon), and polychlorinated biphenyls (PCBs).

The only landfills permitted to receive appliances are those that:;

- Remove the white goods components prior to sending to a landfill; and
- Have an Illinois EPA approved operating plan and permit for white goods disposal.

Rather than placing the appliance in a landfill after its components are removed, you can arrange to have the appliance hauled to a scrap yard where the metal can be reclaimed.

Batteries

Lead acid motor vehicle batteries were banned from landfills on September 1,1990.

- Exchange old motor vehicle batteries for new when purchasing a battery.
- Sell used motor vehicle batteries to a salvage yard or recycling center.

Information about **recycling rechargeable batteries** is also available.

Construction Debris

Landfills accept both clean and general construction and demolition debris. It is illegal to open dump either clean or general construction or demolition debris.

Clean construction or demolition debris, also known as "clean fill", is defined as uncontaminated broken concrete without protruding metal bars, bricks, rock, stone, reclaimed asphalt pavement, or dirt or sand generated from construction or demolition activities. Clean construction and demolition debris can be recycled, buried below grade provided it is outside of a groundwater well setback zone, or disposed of in a landfill. If the material is recycled, make sure the recycler is a bona fide recycler; otherwise, the generator, hauler and property owner where the material is placed may be subject to substantial penalties. If buried below grade outside of a groundwater well setback zone, the construction and demolition debris must be covered with sufficient uncontaminated soil to support vegetation within 30 days of the completion of the burial. Broken concrete without protruding metal bars may be used for erosion control.

General construction or demolition debris is defined as non-hazardous, uncontaminated materials resulting from the construction, remodeling, repair, and demolition of utilities, structures, and roads, limited to the following:

- soil
- wall coverings
- reclaimed asphalt pavement
- rock

- plaster
- glass
- non-hazardous painted wood
- drywall
- plastics
- non-hazardous treated wood
- plumbing fixtures
- electrical wiring
- non-hazardous coated wood
- non-asbestos insulation
- bricks
- wood products
- roofing shingles
- concrete
- general roof coverings

If recycling general **construction or demolition debris**, make sure the material is taken only to a recycling facility in compliance with the Environmental Protection Act and regulations; otherwise, the generator, hauler, and property owner where the material is placed may be subject to substantial penalties.

If you choose to dispose of construction or demolition debris in a landfill make sure the cost of proper disposal is specified in the contractor's bid. As a precaution, get receipts from your contractor.

For more information about construction and demolition debris disposal management, contact the Illinois EPA's Permit Section at 217-524-3300 or your **Illinois EPA Regional Field office**.

Electronic Equipment

The law establishes a statewide system for recycling and/or reusing the items listed on the **electronic waste recycling** page discarded from residences by requiring electronic manufacturers to participate in the management of discarded and unwanted electronic products.

Fluorescent Lamps

Improper disposal of used fluorescent and high density discharge lamps damages the environment. When broken, these lamps release mercury and other metals that damage the environment. Used fluorescent and HID lamps may be classified as hazardous waste due to their mercury content and are thus regulated under the Resource Conservation and Recovery Act (RCRA). They should be **managed** properly to ensure safe usage. There are **recyclers** that will take your used lamps.

Landscape Waste

Landscape waste has been banned from landfills since July l, 1990. There are many landscape waste disposal options:

- Leave grass clippings and leaves on the lawn as a nutrient.
- Mulch grass clippings, leaves, and wood chips for lawn and garden application.
- Take landscape waste to a permitted compost facility.
- Participate in community landscape waste collections.
- Construct an on-site, well maintained, household compost bin. Use the compost as a soil amendment.

Mercury Containing Products

In order to protect health and the environment, safe and proper storage of mercury is vital! Mercury-containing products have no alternative disposal options and must be saved for a household hazardous waste collection. View more details on **disposal of mercury**, or what citizens **need to know** about mercury.

Motor Oil

The release of used motor oil can have adverse effects on the environment. Just one gallon of used oil can make a million gallons of fresh water undrinkable. When used oil is poured down the drain and enters a sewage treatment plant, a very small concentration of oil can foul the treatment processes. A film of oil on a water surface prevents oxygen from entering the water and blocks sunlight. This makes it difficult for plants to grow, thus reducing the animal and plant life in a body of water. Water, air and soil are all connected, and oil can make its way to these media.

Self cheek 5.1

Test I: for the following questions write ‘true’ if the statement is correct and ‘false’ if the statement is incorrect.

1_____ It is safe to dispose of old refrigerators by throwing them in the regular trash.

2_____ Recycling is the preferred method for disposing of old refrigerators.

3_____Refrigerator maintenance should be performed at least once a year to ensure optimal performance.

4_____ Emptying and cleaning the refrigerator regularly helps prevent the growth of mold and bacteria.

Reference

1. Shan K. Wang second edition:- handbook of air conditioning and refrigeration
2. http://www.danfoss.com/BusinessAreas/RefrigerationAndAirConditioning.
3. Modern Refrigeration and Air Conditioning 18th Edition

The trainers who Develop these Learning modules							
No	**Name**	**Qualification**	**Educational background**	**Region**	**College**	**Mobile number**	**E-mail**
1.	Tesfahun Ayalew Denidine	MSc	Electronics and comm Eng.	BGRS	Assosa poly TVET	**012132308/09212121**	tesfugps4545@gmail.com
2.	Shimeles Dejen Mekonenn	BSC	Electrical Comm Techn	Ahama	W/Sein PTC.	**0910838814**	shimelesdejen@gmail.com
3.	Petros Gelana Megersa	BSC	Electrical comm.T	Oromia	Ambo poly TVET	**0921183975**	petrosgelana6@gimal.com
4.	Mezgebu Alemseged	BSC	Electrical & comm.T	A.A	G/M/B/ Poly TVET	**0943933255**	----------
5.	Zekarias Sisay G/egziabher	MSc	Electrical & Power Eng.	Harari	Harari poly TEVET Co	**0703747163 /o913344201**	szekarias07@gmail.com