

Refrigeration Systems

Student Resource Package No: NR 6 OF NR 6/18/19/20/45/46

Nominal Student Hours: 72 Hours.

Delivery: Competence in this training program can be achieved through either a formal education setting or in the workplace environment.

Recognition of Prior Learning: The student/candidate may be granted recognition of prior learning if the evidence presented is authentic and valid which covers the content as laid out in this package.

Package Purpose: This package provides the student with the underpinning knowledge to identify various types, of domestic refrigeration and commercial refrigeration systems together with their operational characteristics.

Suggested Resources: Australian Refrigeration and Air Conditioning Vol 1&2.

Various Manufacturers Service and Installation Manuals.

Assessment Strategy: The assessment of this package is holistic in nature and requires the demonstration of the knowledge and skills identified in the student package content summary. To be successful in this package the student must show evidence of achievement in accordance with the package

Competence: This package should be supported by workplace exposure to the various applications under the guidance of a licensed mentor.

Assessment:

Grade Code: 72

GRADE	CLASS MARK (%)
DISTINCTION	>=83
CREDIT	>=70
PASS	>=50

Assessment Events:

1.	Theory Test	Domestic Refrigeration	30%
2.	Theory Test	Coolrooms / Freezer Rooms Merchandising Cabinets	40%
3.	Theory Test	Beverage Dispensing Equipment	<u>30%</u>
		Total Marks:	100%

Theory Tests: Short answer Questions / electrical drawings
This assessment covers the contents of this student resource package.

Content Summary:

Domestic Refrigeration: _____ 3

Coolrooms & Freezer Room, Merchandising Cabinets, Beverage Dispensing Equipment, Beverage Cooler (Temprite) systems and associated equipment: Glycol Systems, Ice Making Machines, Postmix Refrigeration systems (Refer to Stage 3 Student Resource Package 18,19,20,45,46 Notes)

Domestic Refrigeration

Section No: 1



Purpose: the purpose of this section is to provide you with the underpinning knowledge and skills to identify the various type's domestic refrigerators / freezers and their individual operational characteristics.

Preamble:

The majority of Australian homes have domestic refrigeration in the form of refrigerators and freezers that require 240 volts for their operation. It should be recognised that 240 volts can be deadly in the true sense of the word. It should be noted that domestic refrigeration appliances are referred to as white goods.

Types of Refrigerant:

Service technicians can be exposed to two refrigerants when working on domestic refrigeration systems. These two refrigerants are R12 and R134a. Refrigerant R12 was phased out in 1996 and is classed as a controlled substance because of its harmful effect on the Ozone Layer. R134a is regarded as a greenhouse gas, however propane is used extensively overseas and may eventually be used in Australia.

The Codes of Good Practice (HB40.3) and all legislative requirements must be followed when working on domestic systems.

Domestic Refrigerators:

Modern refrigerators can be classified into four headings:

1. Cyclic Defrost
2. Automatic Defrosting
3. Frost – Free.
4. Manual Defrost

Cyclic Defrost: Reference (ARAC, page 7.3)

The cyclic defrost refrigerator defrosts when the compressor cycles off. This type of refrigerator usually has a plate heater fitted to the back of the evaporator mounted in the food compartment. Note: Fig.1. The freezer will not defrost each cycle as this section does not accumulate as much frost because its door is open less than the food compartment.

Cyclic Defrost refrigerator Freezer

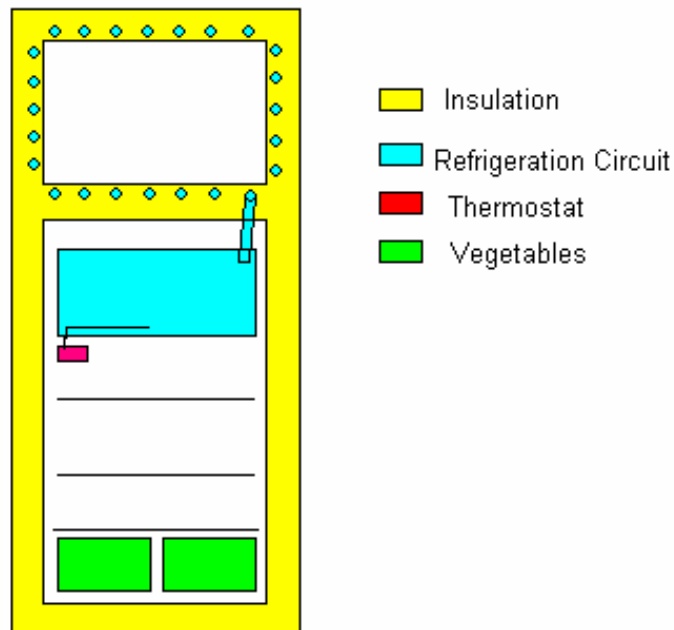
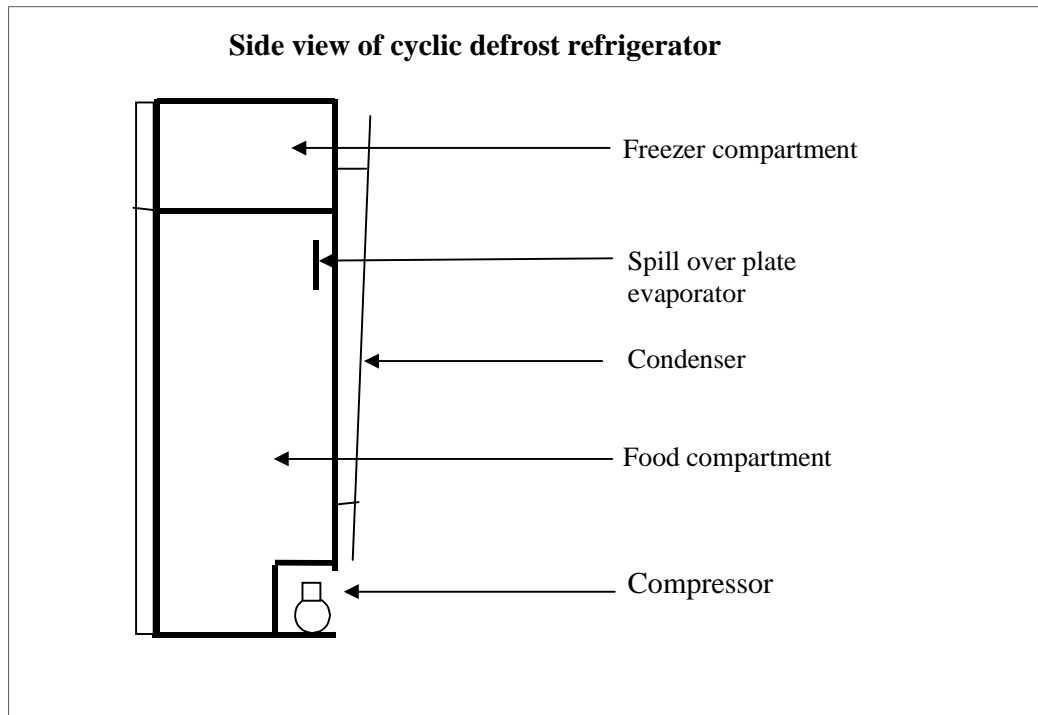


Figure .1.



Operation:

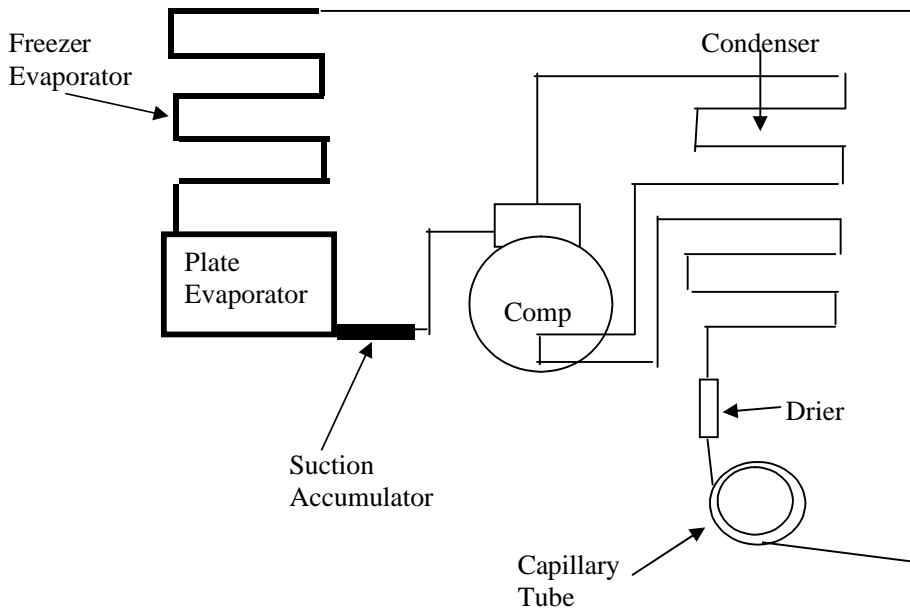
The operating temperature of the food compartment operates at approximately 3°C and the freezer -18°C.

- The refrigeration system operates on a critical refrigerant charge with a capillary tube as the refrigerant metering device.
- The refrigerant enters the low temperature evaporator first and excess liquid spills over to the food compartment plate evaporator which operates at a higher temperature than the freezer.
- Compressor operates when the thermostat is closed and the defrost heater is cycled off.
- When the compressor cycles off the defrost heater (usually located in the drain area under the fridge evaporator) is energised.
- The freezer compartment has to be manually defrosted when the frost builds up to approximately 8mm thick.
- Thermostat sensor is connected to the plate evaporator which has a constant cut-in temperature.
CUT-IN = approximately 3°C (evaporator completely defrosted at this point)

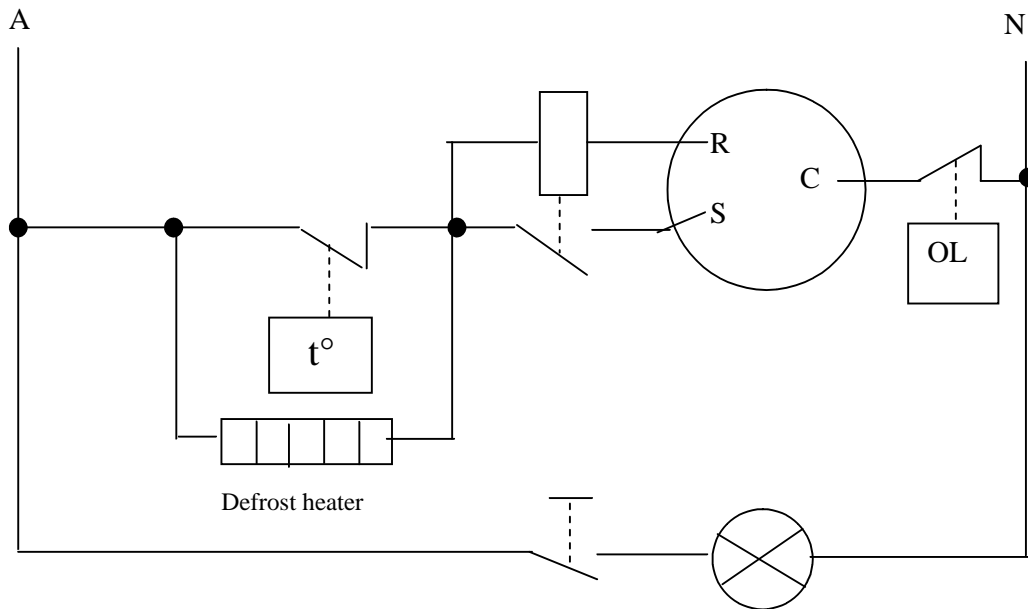
CUT-OUT on evaporator plate temperature. This varies with the thermostat setting.
 For example cut out temperature could be from -8°C down to -14°C.

Note: either a current coil, Potential or solid state relays are used in domestic refrigeration

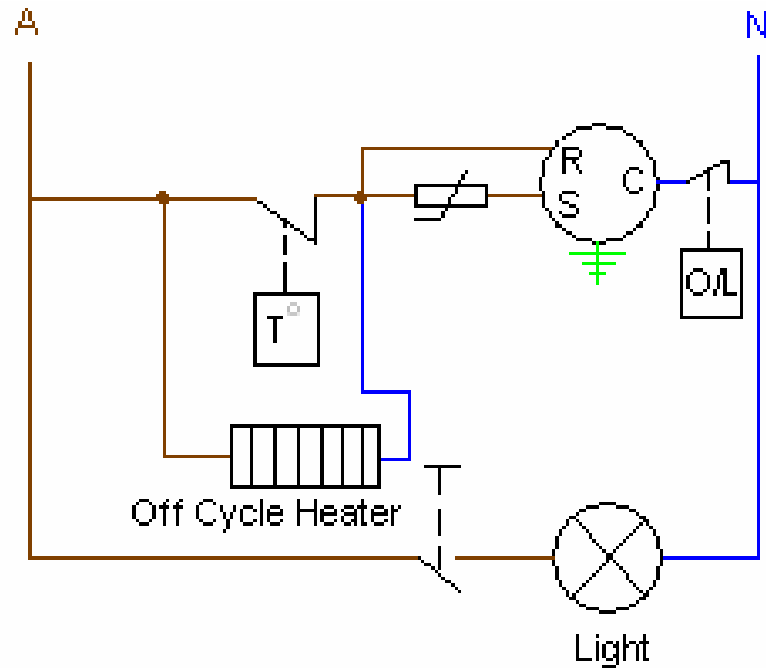
Refrigeration Circuit Diagram



Electrical Wiring Diagram



Cyclic defrost refrigerator with current coil relay

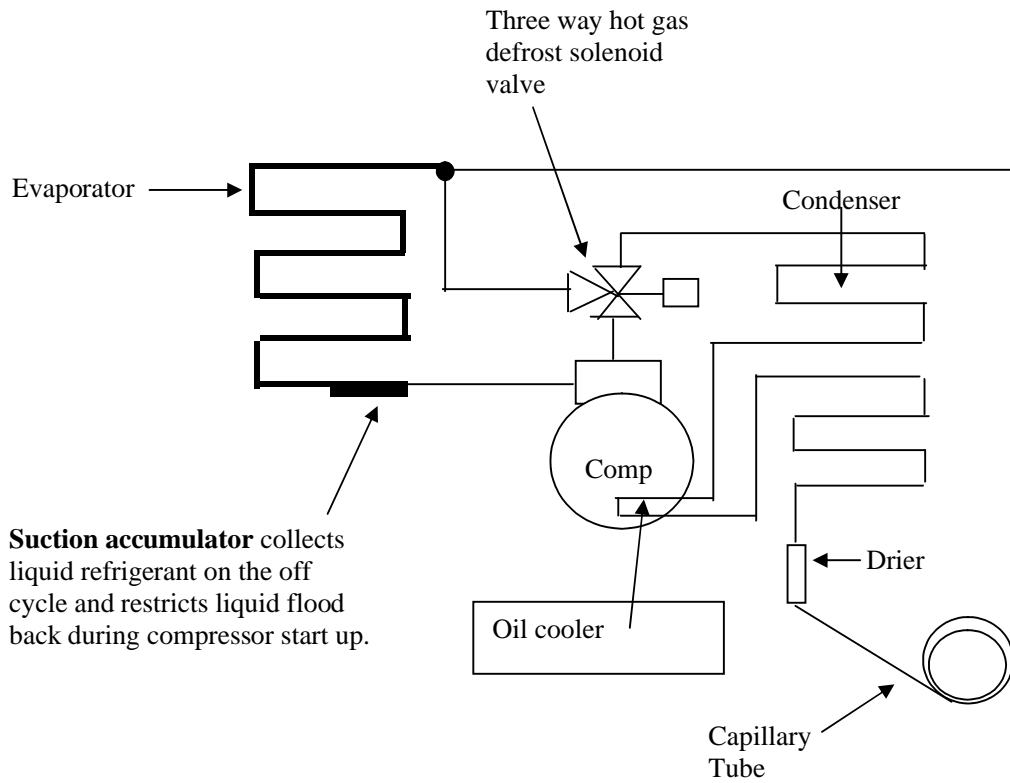


Cyclic Defrost Refrigerator with Solid State Relay

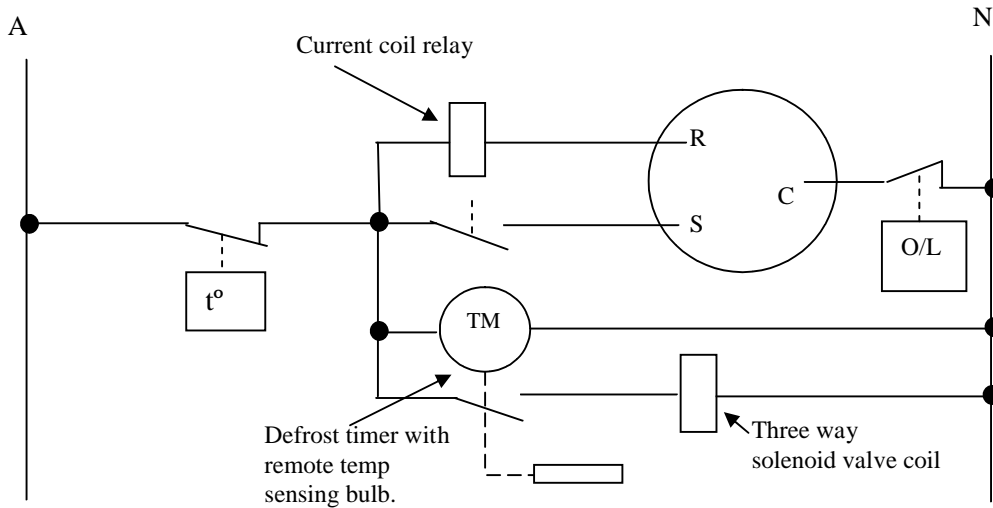
Automatic Defrosting Refrigerator Reference (ARAC, page 7.1)

The automatic defrosting refrigerator consists of a defrost timer that energises a three way solenoid valve and allows the hot discharge vapour from the compressor to enter the evaporator (note circuit below). The defrost timer only controls the three way solenoid valve because the compressor must be operating to supply the hot discharge refrigerant to the evaporator. (*Note: the defrost timer is only energised when the compressor is operating and it is time initiated and temperature terminated*).

When used on a no frost refrigerator the evaporator fan must be switched off during the defrost cycle.



Suction accumulator collects liquid refrigerant on the off cycle and restricts liquid flood back during compressor start up.



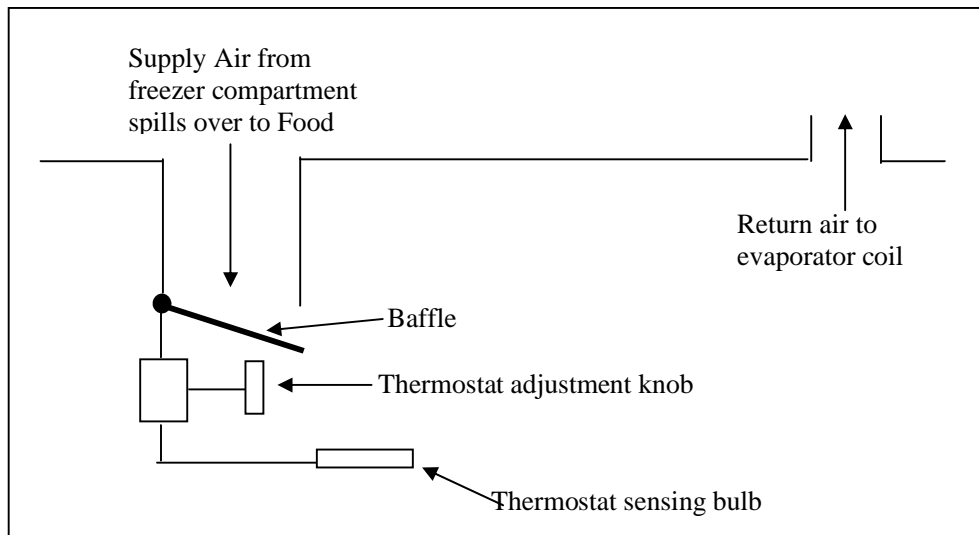
Frost Free Refrigerator Reference (ARAC, page 7.5)

Frost free refrigerators have one cross finned coil evaporator with a fan circulating air over it. The majority of this air is diverted to the freezer section with only a small percentage diverted to the food compartment section. The amount of air diverted to the food compartment section is controlled by a baffle which opens and closes in response to the thermostat. (Note drawing below).

Operation:

Frost free refrigerators require approximately 3 defrost periods per day as the saturated evaporator refrigerant temperature can be as low as -25°C causing ice build up on the evaporator coil which reduces air flow across the coil and lowers evaporator capacity.

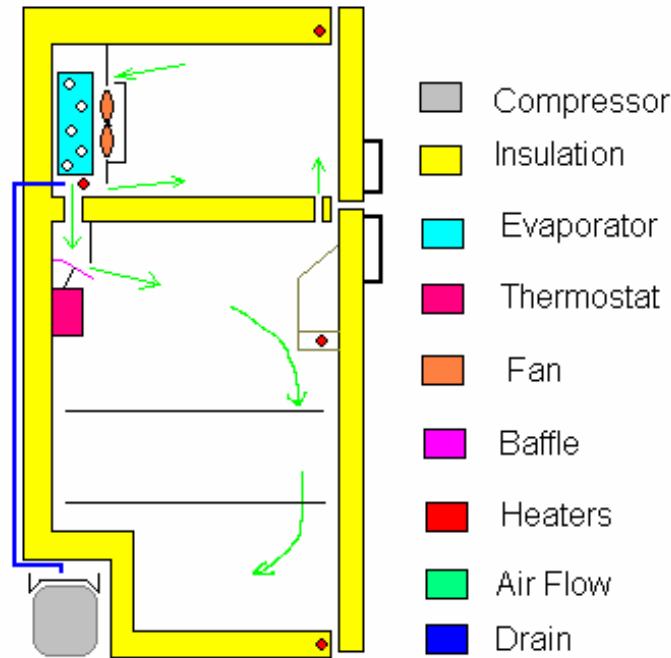
- Thermostat cycles the compressor on freezer compartment temperature.



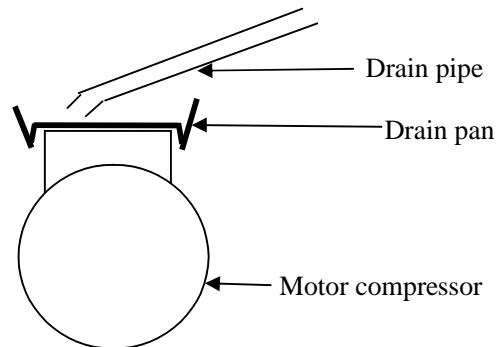
- Defrost timer is energised when the thermostat is in its closed position which initiates defrost cycle approximately every 6 hours of running time for a period of around 27 minutes + or - 10%.
- After a period of time the evaporator fan delay thermostat closes which energises the evaporator fan motor. (Approximate settings for fan delay thermostat: close - 10°C and opens at 0°C). **The fan delay prevents moisture and hot air entering the freezer compartment after the defrost cycle.**
- Defrost and drain heaters are energised through the timer contacts and the high limit safety thermostat.
- After a period of time the high limit thermostat or timer will de-energise defrost and drain heaters which ever comes first. (Time or temperature).
(*Note: high limit thermostat: closes at -10°C and opens at 6°C approx.*)

- The food compartment temperature is maintained by the amount of air directed into this section of the refrigerator via the baffle which is operated by the thermostat.
Note below:

Frost Free Refrigerator / Freezer



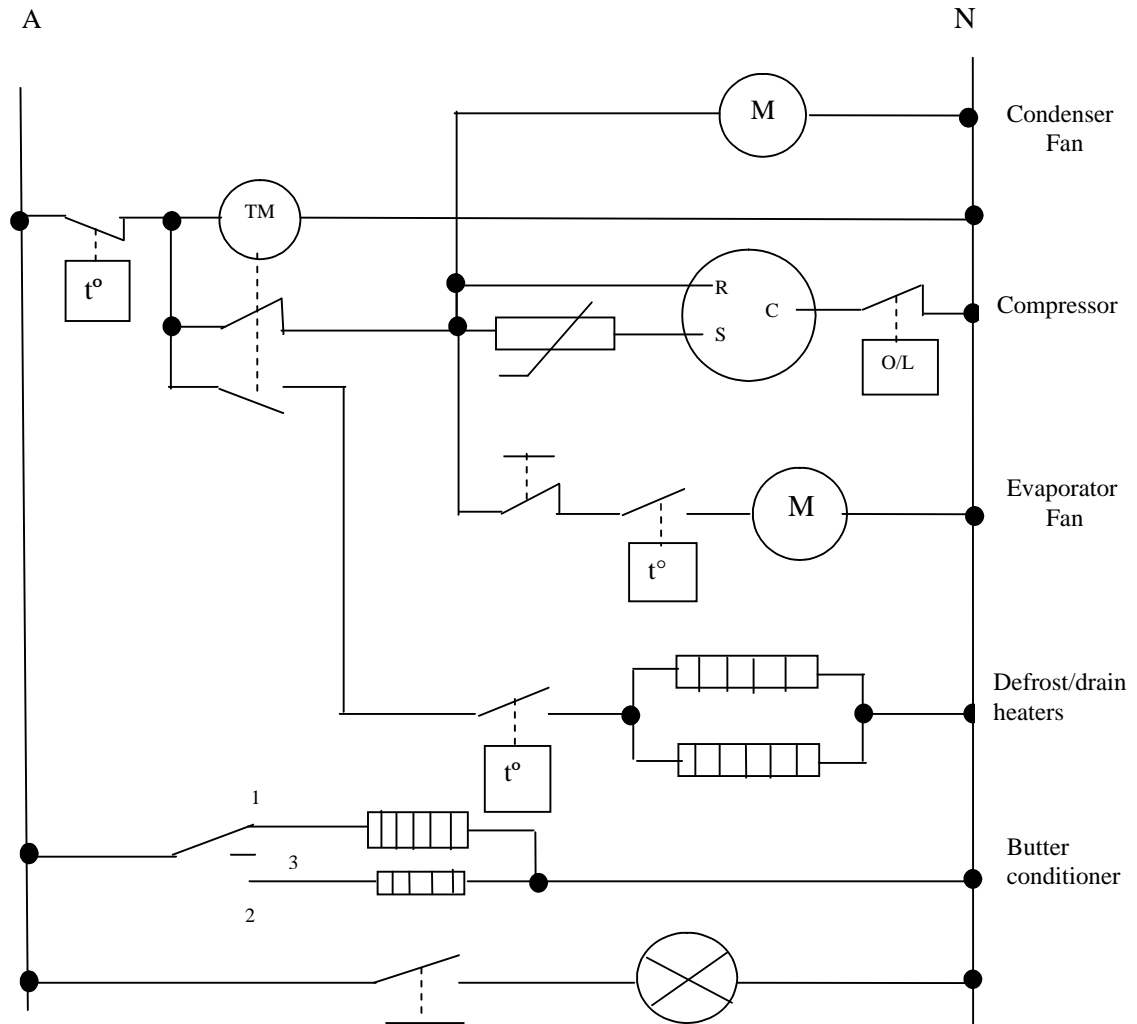
It should be noted that the water gathered from the defrost cycle is drained to a defrost drain pan made of plastic and mounted on top of the motor compressor. Heat generated from the compressor evaporates the water. Note diagram below. Alternatively the hot gas from the compressors discharge line is diverted thru a drain pan, which dissipates the drain water.



Note: to reduce moisture or any ice build up around the doors part of the condenser circuit is attached to the inner cabinet lining around the door jambs to act as an anti-sweat

heater. Another method is to install electric mullion heaters around the door jambs that are low wattage and operate continuously.

Electrical Wiring Circuit Diagram No Frost Refrigerator



Butter conditioner: 1 = low 2 = medium 3 = cabinet temperature.

Note: both resistors are of different resistances.

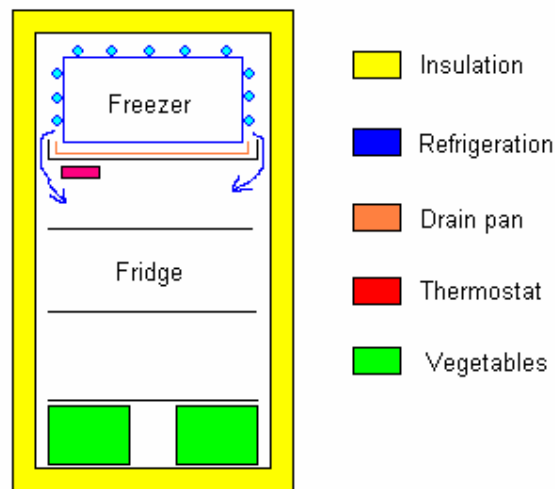
It should also be noted that modern refrigerators are fitted with ice making and chilled water supply facilities and even an internet connection.

The vast majority of frost free refrigerators incorporate a condenser fan motor for the cooling of the compressor and the condenser which is housed in the bottom of the cabinet.

Manual Defrost Refrigerator

The manual defrost refrigerator is much simpler in its construction in that it consists of a single evaporator which needs to be manually defrosted when the ice thickness reaches approximately 8mm. Defrosting is done by turning the refrigerator off and allowing the water to collect in the defrost drain pan immediately under the evaporator.

Manual Defrost Refrigerator / Freezer



“Push Button” Manual Defrost

A push button is incorporated into the thermostat. Once depressed, it will not reset until the evaporator temperature reaches the pre-determined thermostat cut in point.

Domestic Deep Freezers Reference (ARAC, page 7.8)

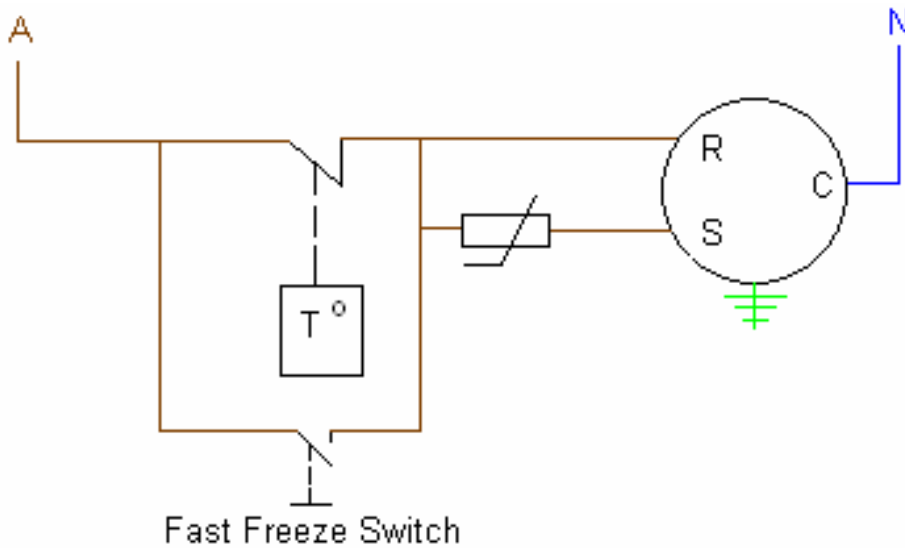
These can either be an upright or chest type style usually with plate evaporators. Some types of chest freezers have the inside liner of the cabinet utilised as a plate evaporator and the outer casing as a plate condenser.

The advantage of a chest deep freezer is that air does not spill out when the lid is opened. However the contents are not readily accessible when they are stacked inside.

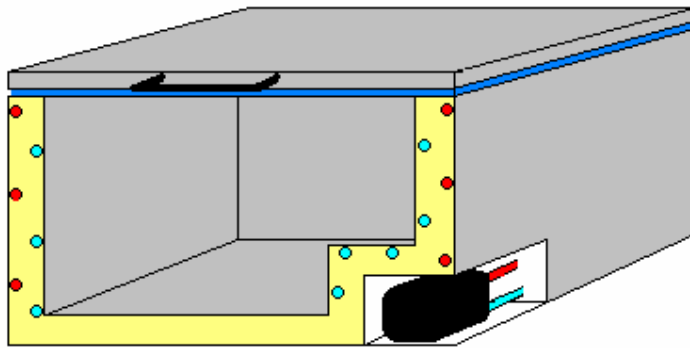
Most upright freezers have plastic doors on each shelf to minimise air spillage, however a large amount of air still escapes. This is replaced by warm moist air which condenses to water and forms ice on the evaporator coils. The contents are much easier to access in comparison to the chest type.

Many upright deep freezers now available are forced draught which are identical to the frost free refrigerators but without the food compartment.

Domestic deep freezers are often equipped with a fast freeze switch. This simply overrides the thermostat by being connected in parallel with the thermostat.

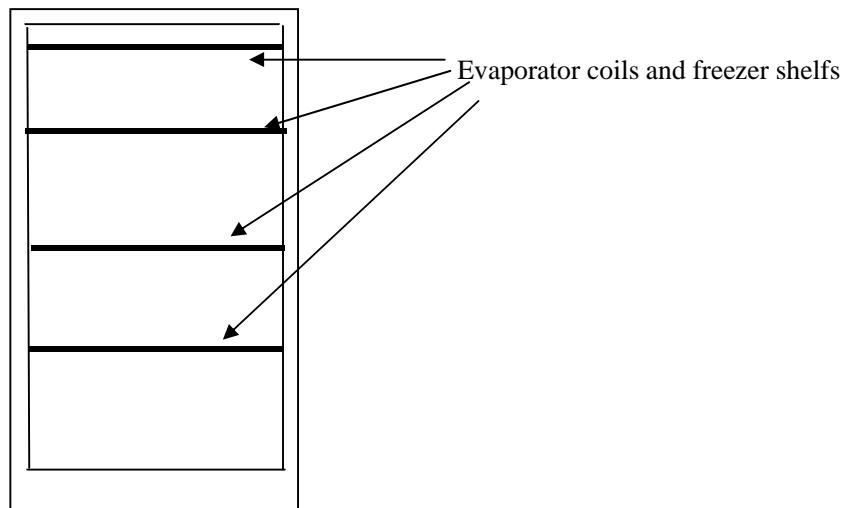


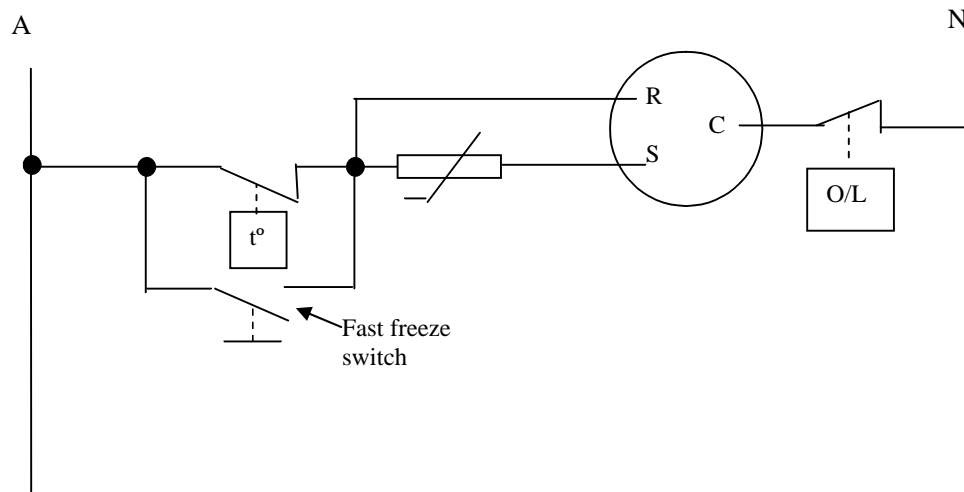
Cut Away View of Domestic Chest Freezer



- Evaporator
- Condenser
- Insulation
- Compressor
- Magnetic Gasket

Domestic upright deep freezer



Electrical circuit diagram (chest type / upright deep freezer)**Refrigerant charging of domestic refrigerators / freezers:**

“Reference should be made to the current Codes of Good Practice”

On completion of evacuation domestic refrigerators should be charged with refrigerant to the manufactures specifications. This is usually done by using an accurate set of scales and charging by weight.

Domestic refrigerators and freezers do not require much refrigerant which can be between 70 to 450 grams.

If the manufacturers refrigerant charge is not known the refrigerant should be added to the system until the frost line from the evaporator ends just before coming out of the cabinet (when the fridge has reached the required temperature).

Note: When evacuating a domestic refrigerator or deep freezer a “vac stat” should be used to determine vacuum and should be no more than 500 microns.

Review Questions

Q.1 What is meant by a controlled substance? _____

Q.2 The two main refrigerants used in domestic refrigeration are: _____

Q.3 Explain how the defrost cycle of a cyclic defrost refrigerator is achieved: _____

Q.4 The defrosting of the freezer section of a cyclic defrost refrigerator should be done when and how: _____

Q.5 Construct an electrical circuit diagram for a cyclic defrost refrigerator using a current coil relay in the space provided below:

Q.6 Describe how the defrost cycle operates on an automatic defrosting refrigerator:___

Q.7 What is the main purpose of a suction line accumulator?_____

Q.8 What would be the expected saturated evaporator temperature for a frost free refrigerator? _____

Q.9 Describe the main purpose of the evaporator fan delay thermostat when used in a frost free refrigerator and what would be the expected cut in and out temperatures of this thermostat:_____

Q.10 How many defrost periods and the length of time for each period would a frost free refrigerator require?_____

Q.11 Describe how the temperature of the food compartment in a frost free refrigerator is controlled:_____

Q.12 How is the resultant water from the defrost cycle disposed of in a frost free refrigerator?_____

Q.13 In the space provided draw a complete wiring circuit diagram for a frost free refrigerator. Include in your drawing a butter conditioner.

Q.14 When should a manual defrost refrigerator be defrosted and how? _____

Q.15 List the two main types of domestic freezers: _____

Q.16 What is the main advantage and disadvantage of a chest type deep freezer? _____

Q.17 What are two disadvantages of an upright deep freezer? _____

Q.18 In the space provided draw a complete wiring circuit diagram for a chest type deep freezer. Include in your diagram a solid state relay and a fast freeze switch.

Q.19 Describe two ways in which you would charge a domestic refrigerator with refrigerant: _____

Q.20 How much refrigerant would you expect a domestic refrigerator to hold and how could you find out?_____

Q.21 What is the Maximum reading required on a vac stat before charging a domestic refrigerator with refrigerant?_____

Q.22 List the additional components that a frost free refrigerator requires in comparison to a cycle defrost refrigerator:_____

Q.23 How is moisture, prevented from forming around the doors of a cyclic or frost free refrigerator?_____

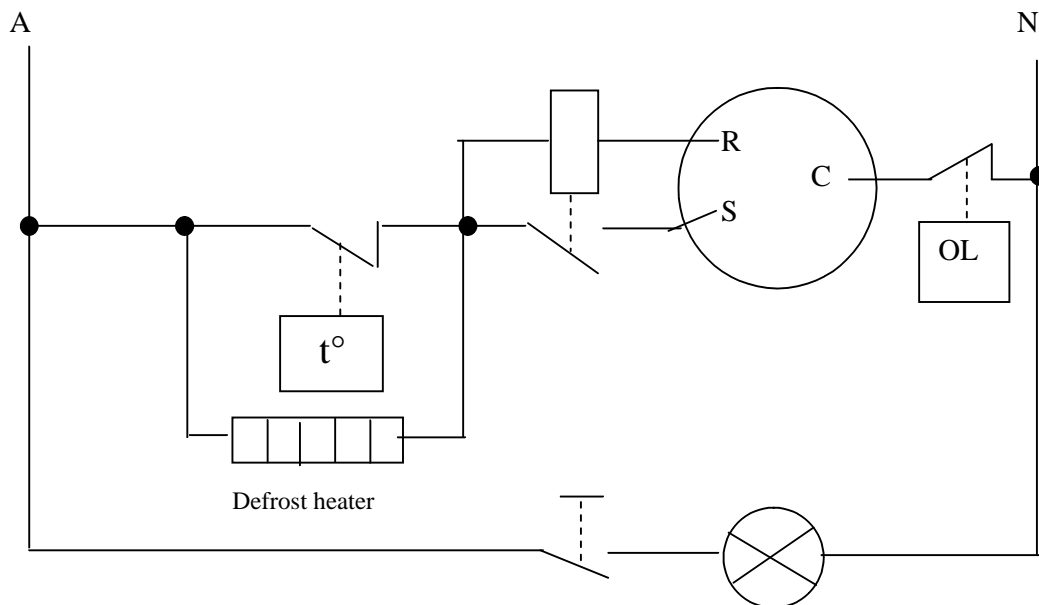
Q.24 Name the three types of compressor start relays used in domestic refrigerators and freezers:_____

Q.25 What type of temperature control does a cyclic defrost refrigerator use?_____

Answers to Review Questions:

Section No: 1

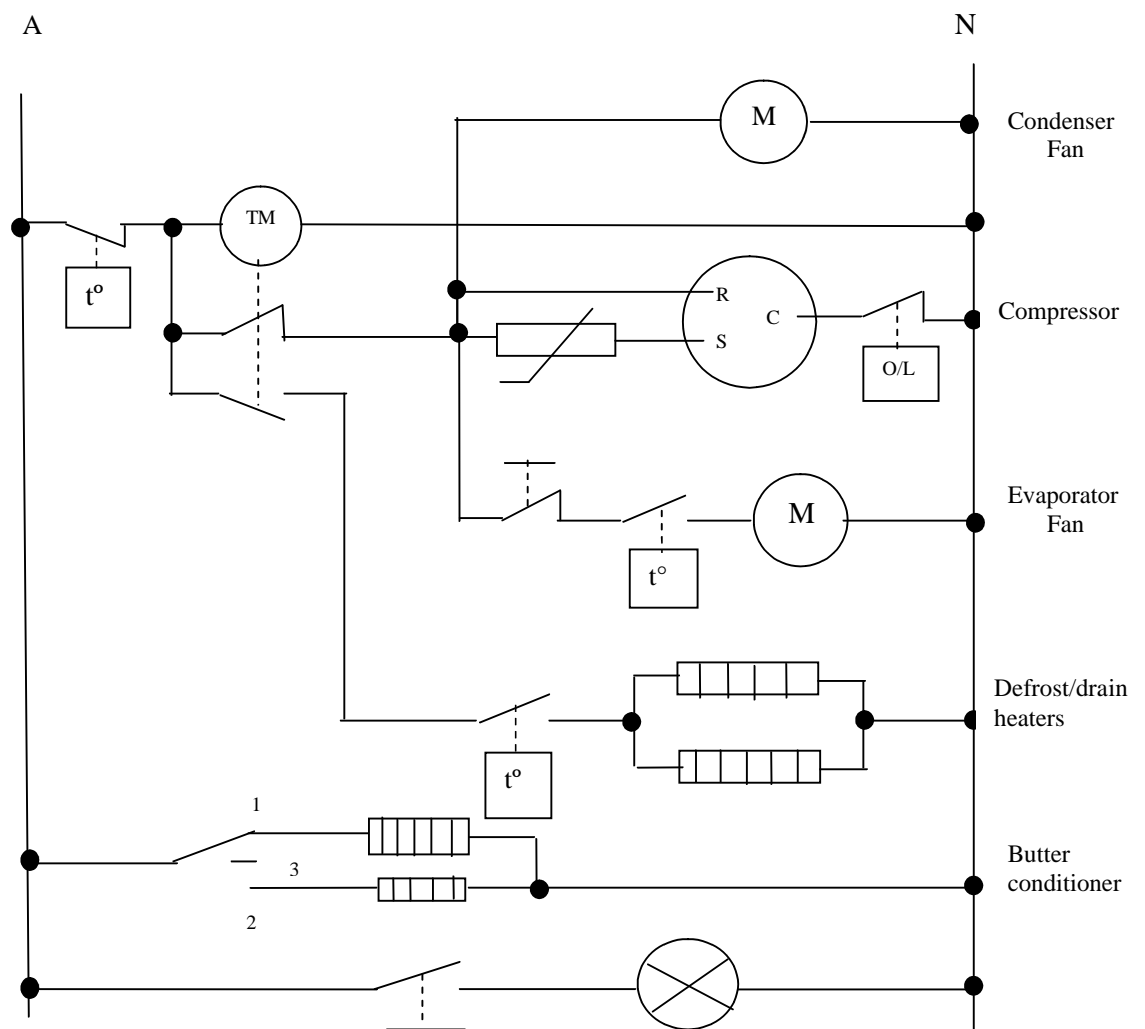
- Q.1 It has a harmful effect on the Ozone Layer and cannot be released into the atmosphere.
- Q.2 R12, and R134a
- Q.3 Defrosts when the compressor is on its off cycle a plate heater assists the process. The thermostat has a constant cut in temperature of around 3°C.
- Q.4 Manually by turning the refrigerator off and should be defrosted when the ice thickness reaches approx 8mm.
- Q.5



Cyclic defrost refrigerator with current coil relay

- Q.6 The defrost timer energises a three way solenoid valve and injects hot discharge refrigerant vapour from the compressor into the start of evaporator. The compressor must be operating.
- Q.7 Collects liquid refrigerant on the off cycle and restricts liquid flood back during compressor start up.
- Q.8 -25°C

- Q.9 The fan delay thermostat prevents moisture and hot air entering the freezer from compartment after the defrost cycle.
10. 4 defrosts / day at approximately 27 minutes duration.
 11. Air directed into the section from the freezer compartment and controlled by a baffle which is operated by a thermostat.
 12. The defrost water enters a plastic pan mounted on top of the compressor. Heat generated by the compressor evaporates the water.
 - 13.

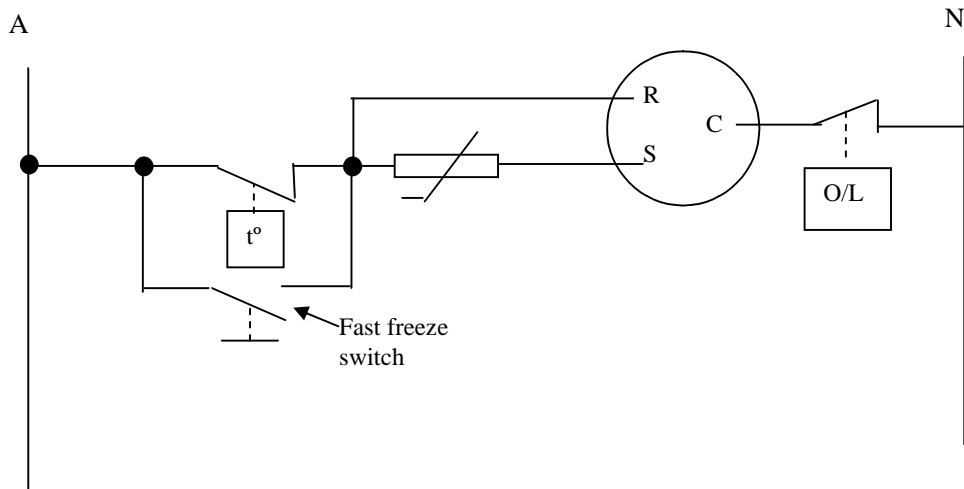


14. When the thickness of the ice reaches approximately 8mm.
15. Chest and upright.
16. Advantage does not spill air out when the lid is open. Disadvantage contents not readily accessible.

17. Advantage contents much easier to access. Disadvantage air spills out when the door is opened.

18.

Electrical circuit diagram (chest type / upright deep freezer)



19. By measuring the amount of refrigerant required using a “dial a charge” and dumping refrigerant in the system as a liquid. In accordance with the manufacturers listed charge,

If the manufacturers refrigerant charge is not known the refrigerant should be added to the system until the frost line from the evaporator ends just before coming out of the cabinet.

20. 70 – 450 grams
 21. 500 microns
 22. Evaporator fan, Defrost timer, Defrost & Drain Heaters, High Limit Thermostat, Thermostat Baffle Plate and Evaporator Fan Delay Thermostat.
 23. Mullion heaters or part of the condenser circuit attached to the inner cabinet.
 24. Current Coil & Solid State.
 25. Constant cut in thermostat.

