12. REFRIGERATORS

1. Purpose of Equipment

To provide a safe and reliable cold storage facility for vaccines, blood, blood derivatives and drugs.

2. How the Equipment Works

A refrigerator consists of a heavily insulated cabinet with an efficient door seal which prevents heat from the outside entering the cabinet.

The temperature inside a refrigerator is kept low by a closed coiled circuit of copper tubing filled with a 'refrigerant gas'. This 'refrigerant gas' absorbs heat which is then discharged at the back of the refrigerator as room air passes over a closed network of copper tubing. This is the condenser.

The two main types of refrigerator are:

Electric Compressor Model

The electric compressor model has an electric motor and pump. The pump drives the refrigerant gas in a sealed circuit. The required temperature is set by the user and a thermostat controls it automatically.

Kerosene Model

The kerosene model has a burner which is controlled by the user. Heat from the burner pushes the refrigerant gas around the circuit.

In each model there are storage shelves and many will have a small top 'freezer' compartment also.

The refrigerator cabinet should be kept at a temperature of 4 to 8°C and the freezer compartment should be kept below 0°C.

3. Routines and Safety

Refrigerators are badly affected by problems associated with fluctuating electricity supply. High voltage, low voltage and lightning strikes may all cause damage to the refrigerator, resulting in expensive repairs. The refrigerator should be switched off when there is low voltage or an electrical storm; or, better still, a voltage regulator monitor trip switch may be fitted for protection (see Sollatek under Useful Addresses at the back of this book).

Refrigerators should be installed:

- in a clean, dust free, well ventilated area out of direct sunlight
- in the case of a kerosene refrigerator, also away from draughts. They will affect the burner's flame
- away from any heating appliance such as a water boiler
- with a space of at least 15cm around the unit to allow air to circulate and the condenser to cool

- in an upright position on a firm, level base. This is very important as kerosene refrigerators will not work efficiently if they are not upright. If adjustable feet are fitted, adjust these by hand. If adjustable feet are not fitted, level the refrigerator by placing pieces of cardboard under each corner
- if possible place the refrigerator on a small timber pallet which will keep it off the ground by about six inches. This helps to prevent rust forming underneath and improves cooling
- place a ball on top of the refrigerator and adjust the refrigerator until the ball stops rolling. You will then know that the unit is standing level
- if the refrigerator is moved, it should not be tilted excessively and must NEVER be laid on its side. If it has already been moved, and you suspect it might have been tilted or laid on its side, leave it upright for at least four days before switching the power on

Always:

- lock the door if possible
- avoid damaging the unit, in particular the door and seal as an ill-fitting door will cause the temperature to rise
- forbid storage of food or drinks in the refrigerator
- avoid opening the door unnecessarily
- make sure nothing is placed on top of the refrigerator
- defrost the top chamber regularly (there should never be more than 6mm ice)
- keep condenser pipes and compressor or burner chamber clean
- keep both inside and outside of the refrigerator clean by using water and detergent. Do not use abrasives and bleaches. They will scour the surfaces, leaving grooves for micro-organisms to breed

Daily: For both electric and kerosene refrigerators:

- keep a log book, recording the refrigerator's temperature every morning and evening. This will provide a pattern and give you warning of a fault or poor performance when the pattern changes
- check the freezer for excessive ice build-up (6mm thickness is the maximum allowed)
- check that air can circulate well in the cabinet and that it has not been overfilled
- check the door and seal for damage
- check emergency ice packs and water bottles are in place
- check air vents for obstructions such as dust

For kerosene refrigerator:

- check the fuel tank is full
- top up fuel if necessary and make a note in the log book. This will provide a pattern so in time you will know how often this needs to be done
- check flame size and colour. Adjust if necessary
- make sure enough spare clean fuel is available

The door seal forms a sensitive barrier to the entry of heat from the outside.

If the door seal is damaged the system will need to work harder to maintain the required temperature and may, if badly damaged, be unable to reach that temperature.
An easy check on the effectiveness of the seal is to place a sheet of paper between the door seal and the cabinet, then close the door.

If the paper remains firmly in place and is not easily withdrawn then the seal should be satisfactory. This check, of course, must be made around the complete seal.

The thinner the sheet of paper the better as this will give a more accurate result.

If the seal is found to be defective then, depending on the model, the door may be adjusted or the door seal replaced.

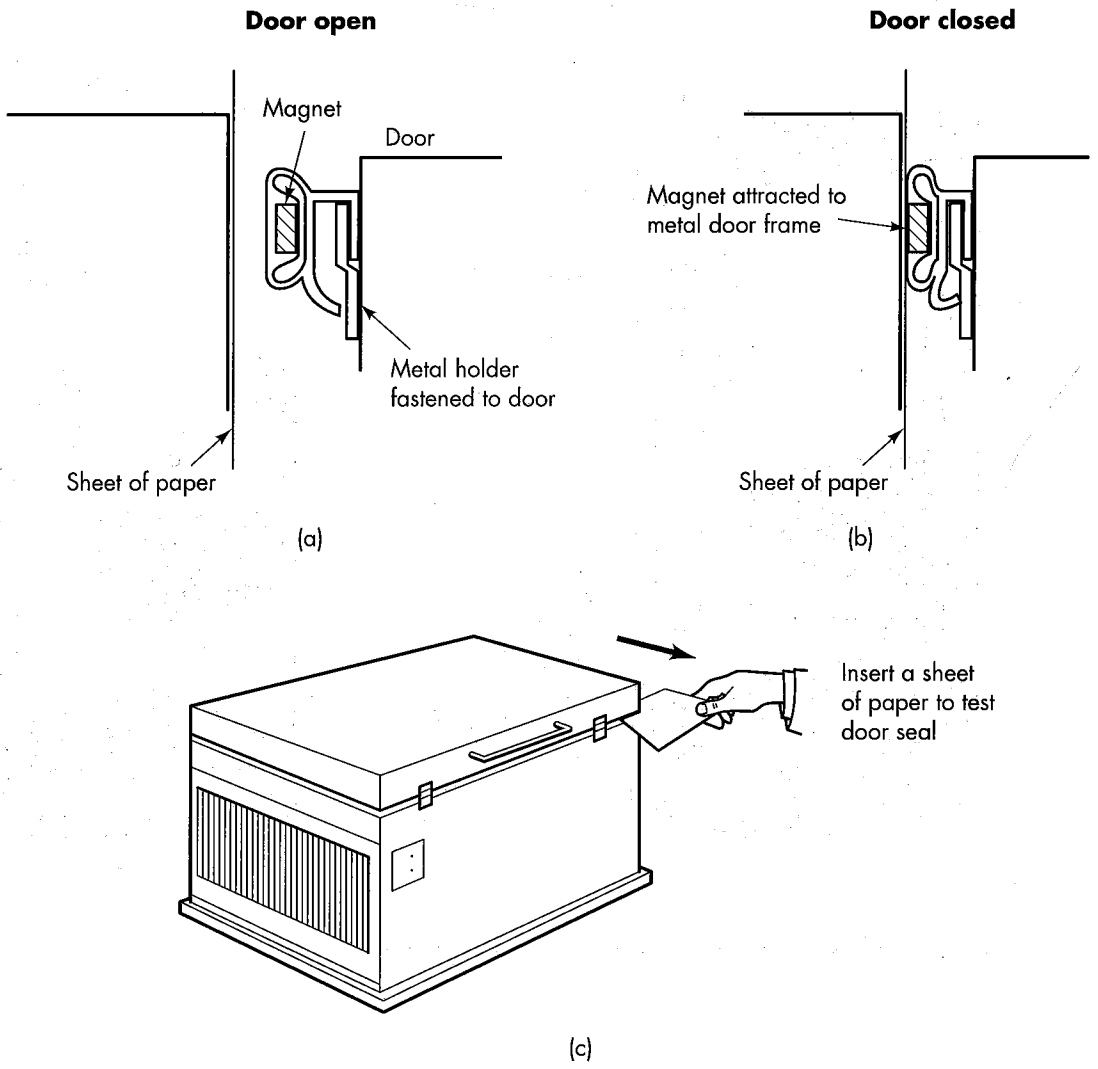


Figure 46: Door seal check

Remove the burner from the refrigerator and wipe over with a clean cloth.

Check the wick and trim evenly or replace if required.

Check the burner glass for damage.

Check the fuel level and top up if required. Filter the new fuel through a filter cloth.

Remove baffle and clean with clean cloth and a small amount of clean kerosene.

Clean flue and flue box with the flue brush.

Replace baffle.

Light wick and place burner unit back under cabinet.

Clean flue brush and wash floor clean of soot deposits.

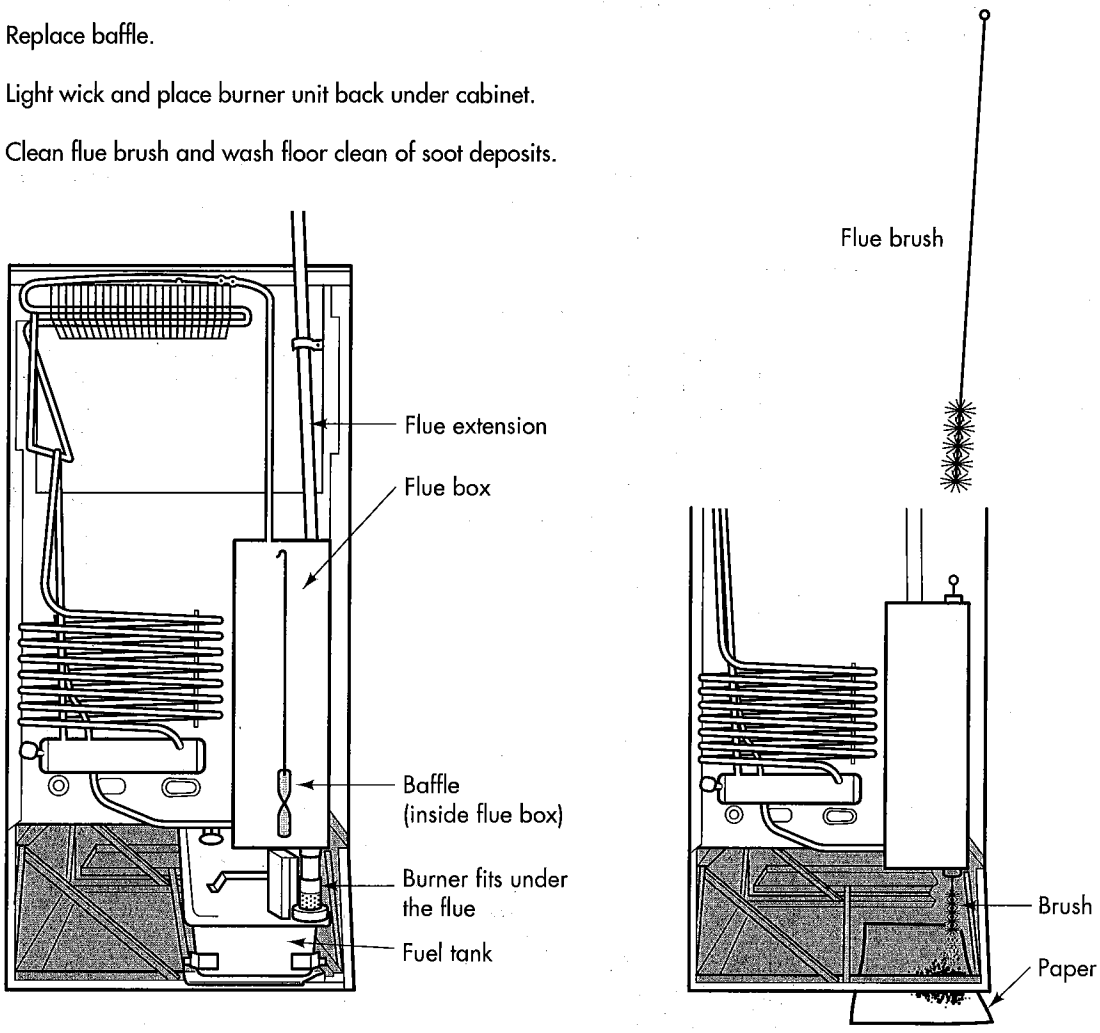


Figure 47: Kerosene refrigerator – cleaning flue and burner

For electric compressor refrigerator:

- make sure the refrigerator is plugged into socket and switched ON
- make sure a notice is displayed near the socket outlet which warns everyone (including cleaners) that the refrigerator is not to be switched off under any circumstances. A 'permanent connection' can prevent this from happening. If this is not available, a length of adhesive tape placed over the switch reminds people 'not to switch off' (see Figure 49)

Weekly: For electric and kerosene refrigerators:

- check freezer and defrost if necessary. If you find there is a need to de-frost weekly, the door and seal may require adjustment (Figure 46)

For kerosene refrigerator:

- clean flue, flue box, and burner (Figure 47)
- trim wick
- check fuel; if dirty, empty and refill with clean fuel
- clean burner chamber

If the refrigerator will not be in use for a long period, drain the fuel tank to prevent corrosion

Defrosting: for both electric and kerosene refrigerators

- transfer stock to another refrigerator or cold box
- turn off refrigerator
- open door and leave it open until all ice has melted

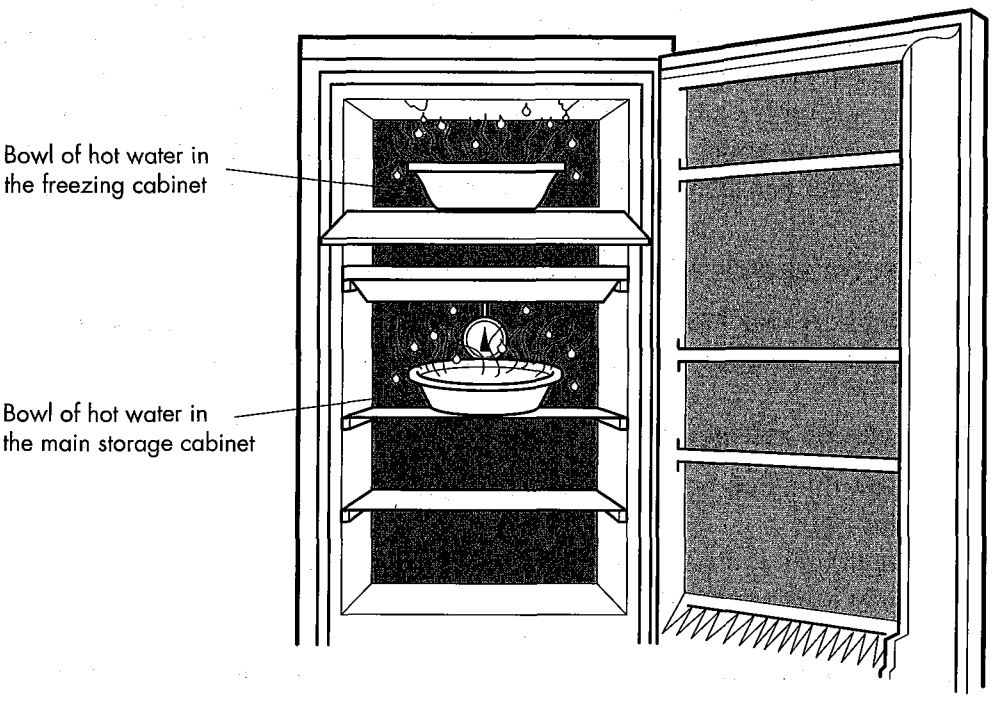
To quicken the melting:

- place bowls of hot water on shelves. Keep the door open (Figure 48)
  Do NOT use an instrument to dislodge ice as this can damage the unit
- when all the ice has melted, wash all surfaces with warm water and detergent
  Do NOT use abrasives or bleach
- dry all surfaces with a clean, soft, dry cloth
- close door and turn on the refrigerator
- re-stock shelves WHEN REQUIRED TEMPERATURE HAS BEEN REACHED

Monthly:

For kerosene refrigerator:

- check for visible damage
- clean off any patches of rust and repaint
- clean condenser tubes with a soft brush
- clean door seal and apply a little talcum powder
- turn off burner and allow to cool
- clean out burner chamber with a soft brush
- relight burner



In order to speed up the defrosting procedure bowls of hot water can be placed on the shelves.

Figure 48: Defrosting using bowls of hot water

To discourage people from disconnecting the refrigerator from its socket outlet, it is advisable to fix a length of tape over it.

A notice written in bold lettering fixed next to the socket outlet warning people that the refrigerator is not to be disconnected is advised.

The notice should also include the emergency procedure to be adopted if the refrigerator breaks down or there is a power failure.

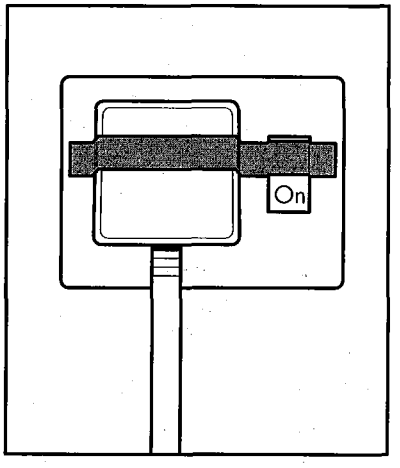


Figure 49: Tape over switch socket

For electric compressor refrigerator:

- check for visible damage
- clean off any patches of rust and repaint
- clean condenser tubes with a soft brush
- clean door seal and apply a little talcum powder
- switch off and unplug
- with a soft brush clean out compressor
- check mains lead and plug for visible damage
- make sure connections have not become loose
- plug in and switch on
- if a permanent connection is not in place, check that a warning notice saying 'Do not switch off' is in place; check that the switch is taped (Figure 49)

4. How to Use the Equipment

Always refer to the manufacturer's instructions for specific advice on the equipment you are using. The following are general guidelines only.

Nothing should be placed inside the refrigerator until it has reached the required temperature.

It is wise to store ice packs in the freezer compartment. If the refrigerator breaks down for any reason, they can be used to delay the temperature rise or used in a cold box when transferring stock to another refrigerator. Sealed water bottles placed in the lower space of the refrigerator cabinet will also delay a rise in temperature. Their contents should not be drunk (Figure 50).

Every hospital should have a plan of what to do if a refrigerator breaks down. It should be displayed on or near the unit and every staff member should be trained to carry it out.

Kerosene refrigerator

As kerosene refrigerators vary, follow the manufacturer's instructions whenever possible. The following are general directions:

i. remove the burner unit
ii. check the fuel tank is full
iii. check the wick is clean and trimmed correctly
iv. turn the wick up to 5mm
v. light the wick and adjust the flame. Usually on small refrigerators the flame should be yellow and on large refrigerators the flame should be blue. Check with the manual if available
vi. make sure the flame spreads around the whole wick and burns evenly. If the flame smokes, lower the wick slowly
vii. replace the burner
viii. check the flame, remembering: the larger the flame, the colder the inside of the refrigerator
ix. place the thermometer inside the cabinet
x. check the flame every hour, and the temperature every four hours, until required temperature is reached and is stable

xi. stock shelves, including ice packs and water bottles
xii. leave the thermometer inside the cabinet and lock the refrigerator if possible
xiii. check temperature and flame every morning and evening
xiv. note readings in the log book

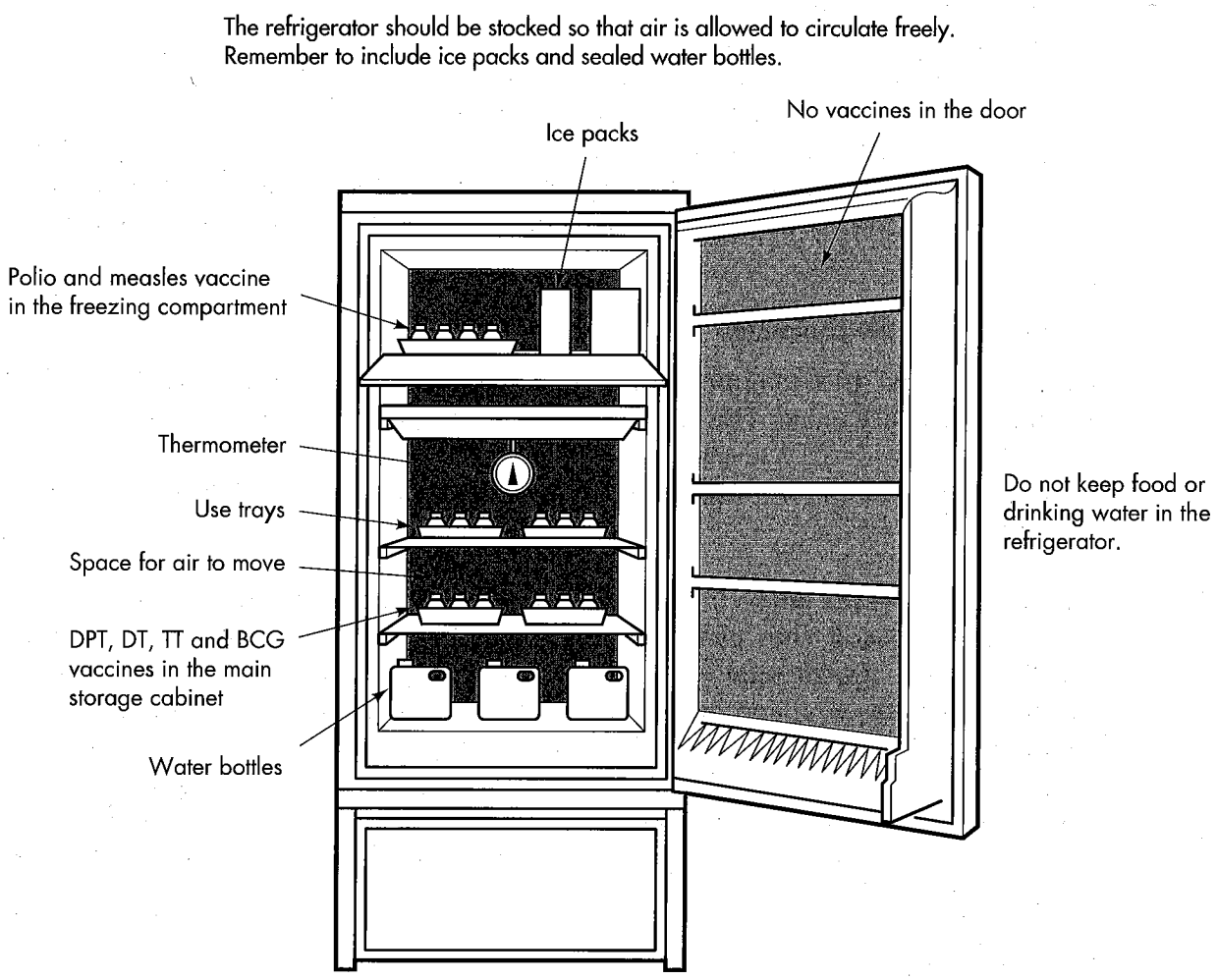


Figure 50: Stocking the refrigerator

Electrical compressor refrigerator

Follow manufacturer's instructions whenever possible. The following are general directions:

i. plug refrigerator into electric mains socket
ii. check 'do not switch off' notice is in place
iii. place adhesive tape over switch (Figure 49)
iv. place the thermometer inside the cabinet
v. switch ON
vi. run the unit for 24 hours, checking the temperature every 4 hours
vii. adjust the thermostat control knob until the required temperature is reached and is stable. This may need to be carried out in stages as most control knobs are marked in numbers, not temperatures.

If the manufacturer's manual is available:
- follow instructions

If the manufacturer's manual is not available:
- start at high settings and work down to low settings

viii. when the required temperature is reached and is stable, stock shelves, including ice packs and water bottles
ix. leave the thermometer inside cabinet and lock the refrigerator
x. check the temperature of the refrigerator every morning and evening
xi. note readings in the log book

5. Simple Fault-finding and Maintenance

In case a refrigerator breaks down or the electricity supply fails for a long time, each hospital must have a plan for maintaining refrigerated stock at the required temperature.

Cold boxes, large enough to contain the complete contents of the refrigerator, should be available for transferring stock to another unit.

The plan must be displayed and staff trained to carry it out.

Example a:

The refrigerator is not working:

Kerosene refrigerator:
- check flame: relight or adjust as necessary

If wick will not relight:
- check oil level
- trim wick
- relight

If satisfactory but the refrigerator is still not working, it needs to be repaired by a qualified technician

Electrical compressor refrigerator:
- check electrical main socket outlet

If satisfactory:
- check mains lead

If satisfactory but the refrigerator is still not working, it needs to be repaired by a qualified technician

Example b:

Temperature of refrigerator is rising:

For both kerosene and electrical compressor refrigerators:

- check refrigerator is not in direct sunlight or near a heater
- check the door is sealed correctly (Figure 46)
- check freezer compartment for ice build up. It should not be more than 6mm deep. Defrost if necessary
- check stock is packed correctly. It should not be packed too tightly. There must be room for air to circulate around it – Figure 50
- check ice packs. Remove unfrozen ones
- check refrigerator is at least 15cm away from a wall. There must be room for air to circulate around the condenser
- check ventilation of the room

For kerosene refrigerator:

- check flame for flickering; remove from draught if necessary
- check flame is large enough; adjust if necessary and check again for smoke
- check colour of flame; adjust if necessary
- check flame is even; trim wick if necessary
- check flame for smoke; adjust flame if necessary
- check fuel is clean; replace if necessary
- check lamp glass; replace if broken and reposition if necessary
- check flue and baffle (Figure 47); clean if necessary

For electrical compressor refrigerator:

- check thermostat setting and adjust to a higher number if necessary. Check temperature every hour and note readings in log book
- open refrigerator door
- press internal light switch: if the light does not go off, replace the switch. The switch should turn off automatically when door is closed. If it is faulty, the light stays on and raises the temperature inside the refrigerator

6. Spares

a. Kerosene refrigerator:

- ice packs
- sealed water bottles
- complete burner unit
- kerosene
- filter cloth
- funnel
- wick trimmer
- wick
- lamp glass
- bottle of refrigerant gas (according to the make and type of refrigerator)
- coil of copper tubing (according to the make and type of refrigerator)

b. Electrical compressor refrigerator:

- ice packs
- sealed water bottles
- main circuit fuse
- plug fuse
- plug
- length of mains lead
- thermostat and compressor (according to the type and make of refrigerator).
- bottle of refrigerant gas and coil of copper tubing (according to the type and make of refrigerator).

7. User Checklist (to be displayed on or near equipment)

Always refer to the manufacturer's instructions

Kerosene refrigerator

To keep this equipment in good working order for as long as possible:

Daily:

i. check temperature and enter readings in the log book every morning and evening
ii. check the cabinet is not packed tightly and that air can circulate freely between stock
iii. check ice packs and water bottles are in place
iv. check the refrigerator has a space of 15mm to allow air to circulate around the condenser
v. check that the room is well ventilated and the refrigerator is not in direct sunlight or near a heater (e.g. water boiler)
vi. check the freezer for ice build-up. Do not let it become more than 6mm deep
vii. check the door is sealing correctly
viii. check the fuel tank is full of clean fuel
ix. note in the log book when fuel is added to the tank
x. check the flame for size (the larger the flame, the colder the refrigerator)
xi. check the flame for colour (yellow in a small refrigerator, blue in a larger refrigerator)
xii. check there is spare fuel
xiii. check the burner unit is clean and the wick is trimmed
xiv. check the refrigerator is level

Report to the Maintenance Officer:

- any visible damage
- any fault or difficulty

Kerosene burner:

If the burner is not used for long periods:

- drain the fuel tank to prevent corrosion
- check the burner unit is clean

Follow these SAFETY points

Do turn off the burner, allow it to cool and remove from the refrigerator before carrying out any cleaning
Do clean up any spilt kerosene with water and detergent

Do NOT smoke when working with a kerosene burner
Do NOT keep food or drinks in the refrigerator
Do NOT open the door of the refrigerator unless it is necessary

8. User Checklist (to be displayed near the equipment)

Electric compressor refrigerator

To keep this equipment in good working order for as long as possible:

Daily:

i. check temperature and enter readings in the log book every morning and evening
ii. check the cabinet is not packed tightly and that air can circulate freely between stock
iii. check ice packs and water bottles are in place
iv. check the back of the refrigerator has a space of 15mm to allow air to circulate around the condenser
v. check that the room is well ventilated and the refrigerator is not in direct sunlight or near a heater (e.g. water boiler)
vi. check the freezer for ice build-up. Do not let it become more than 6mm deep
vii. check the door is sealing correctly
viii. check refrigerator is plugged in and switched ON
ix. check notice 'do not switch off' is in place
x. check mains switch is taped

Report to the Maintenance Officer:

- any visible damage
- any fault or difficulty

Follow these SAFETY points

Do switch OFF and remove plug from mains supply before carrying out any cleaning

Do NOT keep food or drinks in the refrigerator
Do NOT open the refrigerator door unless necessary