

11. INCUBATORS FOR BABIES

1. Purpose of the Equipment

To provide a controlled environment for the nursing of premature or very ill babies.

The temperature, humidity and oxygen levels can be selected by the user.

2. How the Equipment Works

The many models of babies' incubators work on the same principle but components and controls may vary.

The general principle is that air is processed before it reaches the baby (Figure 43). An electric fan draws room air through a bacterial filter which removes dust and bacteria. The filtered air flows over an electric heating element. The filtered and heated air then passes over a water tank where it is moistened. It then flows on to the incubator canopy. The incubator canopy is slightly pressurised. This allows expired carbon dioxide to pass back into the room via the vent holes and most of the air to be recirculated. It also prevents unfiltered air entering the system.

Temperature is controlled by a thermostat or thermistor in the canopy or air stream.

Humidity is controlled by the user setting deflector plates against a graduated scale of humidity percentage. These plates control the flow of heated air over the element. This determines the amount of water absorbed. Oxygen may be mixed with the warm humid air as it enters the incubator. The oxygen/air gas mixture is then warmed and humidified by the incubator.

The air pattern is designed to ensure that heat and humidity are distributed evenly.

Incubators have 'access ports' with flaps or diaphragms which fit snugly around the users' arms so that access to the baby is possible. This permits feeding, cleaning, weighing, radiography, transfusing and minor surgery to take place without altering the baby's environment.

3. Routines and Safety

If well cared for, incubators will give 12 to 15 years' good service.

It is very important that they are used in a dust free, well ventilated place. This will reduce the amount of air filtering required.

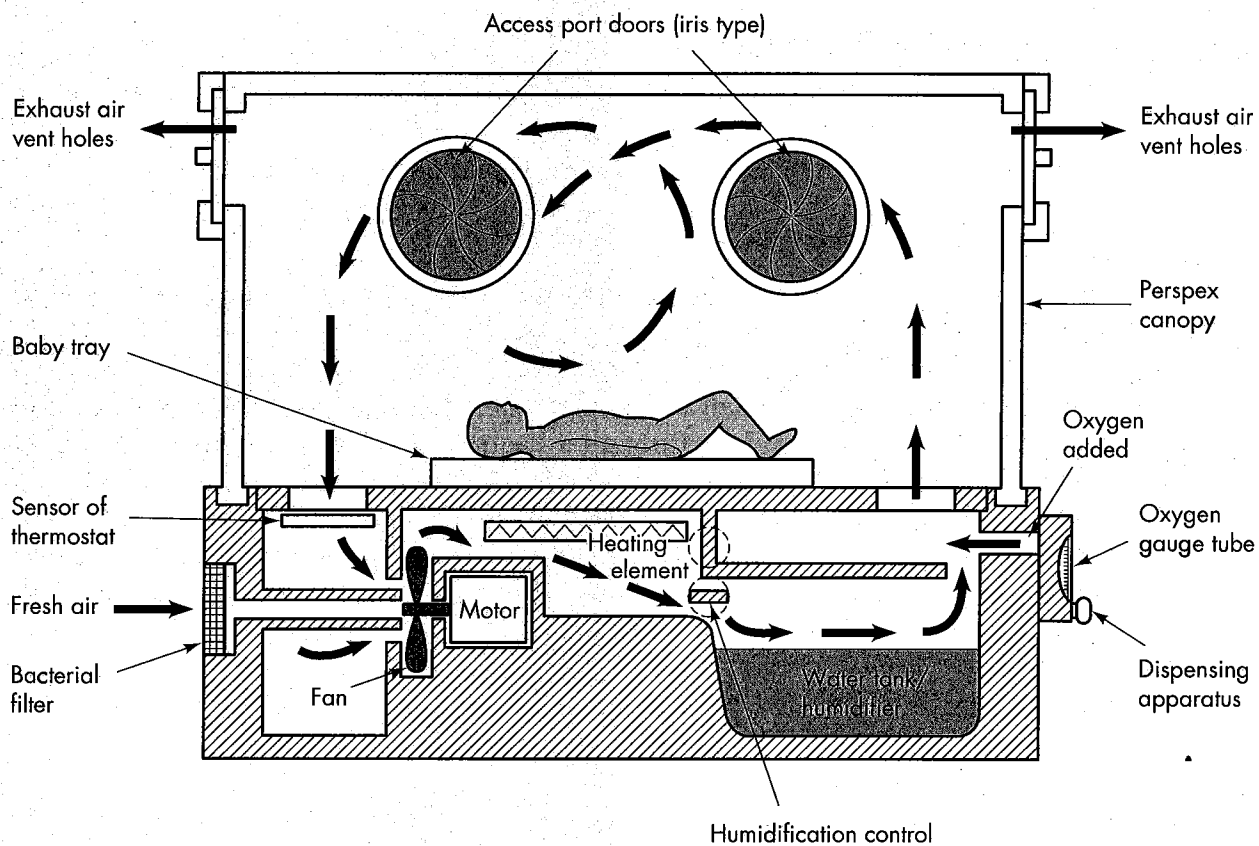


Figure 43: Basic incubator layout and air flow

i. Routines

Daily:

- check incubator is clean
- check access port doors are working satisfactorily and do not spring open
- check electrical mains lead and plug for damage
- check water filler point is in good condition
- check cradle tilt is correct and can be adjusted easily
- drain off water tray. Run machine for 30 minutes to dry tray. Refill tray with sterile water just before re-use
- if oxygen is used, check connection and concentration levels
- check wheels or castors for wear or damage
- carry out functional tests (see below)

An oxygen monitor should be used to measure the concentration of oxygen in the incubator: see the section on the oxygen monitor in Chapter 7b.

Daily check:

Breathe onto the oxygen monitor sensor several times. The reading should drop slightly (by approximately 3%).

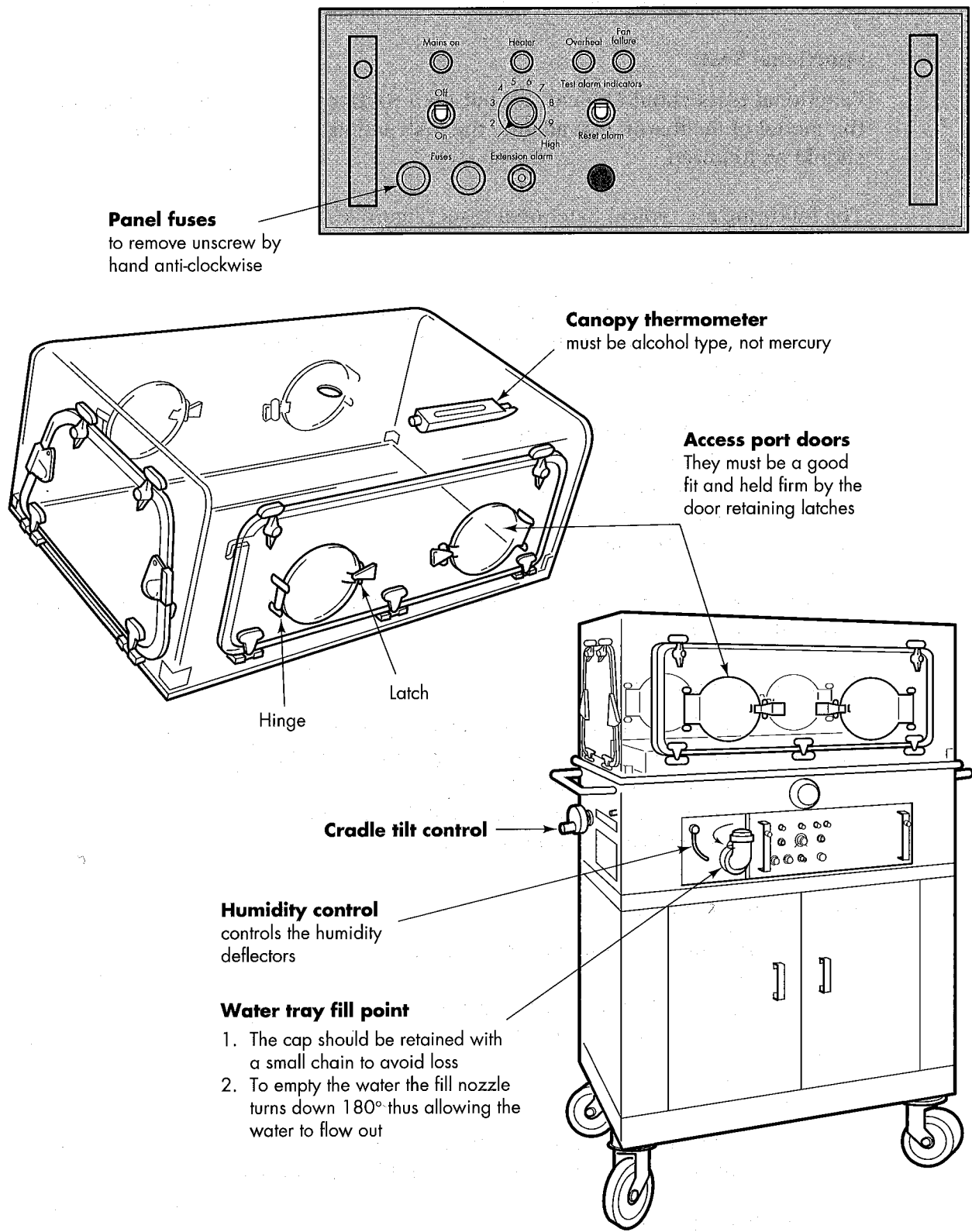


Figure 44: Typical alarm panel and canopy

Every other day carry out the following check:

Put the oxygen monitor sensor in normal room air. After a minute or so, adjust the calibration knob on the monitor so that a reading of 21% is obtained.

Functional Tests:

Functional tests should be carried out on a routine basis. They vary according to the model of incubator. If available, the instructions in the manufacturer's manual should be followed.

The following are typical functional tests (Figure 44):

Test 1: Switching on

- connect incubator to AC power outlet
- switch incubator power switch ON (leave the heater control switch OFF or at minimum)
- check:
 - power indicator lamp is ON
 - overheat lamp is ON
 - fan fail lamp is ON
 - alarm is SOUNDING
 - heater lamp is OFF

If any one of the above does not occur, withdraw the incubator from service and inform the Maintenance Officer.

Test 2: Heater operation

- press down the alarm re-set switch (this will cancel alarms)
- turn temperature control knob clockwise FULLY
- check the heater lamp goes ON
- turn temperature control knob anticlockwise
- check the heater lamp goes OFF

Test 3: Alarm operation

- press upwards the test/reset switch
- check:
 - all indicator lamps light up
 - audio signal SOUNDS

Test 4: Motor operation

- press test/reset button to reset alarms
- listen to the motor. The sound should be smooth and not loud

Test 5: Thermometer check

As the heater lamp does not always indicate that the heater is working check the thermometer in the canopy

Test 6: Temperature check

Before using the incubator:

- set temperature control to mid-point. Run for 10 minutes
- check:
 - canopy thermometer shows an increase in temperature
 - heater lamp is on (in some machines it pulsates)

Maintenance of incubator after each patient and before putting back into service after storage:

After each patient take the incubator out of service for cleaning and checking. Moist warm conditions are ideal for bacterial growth and **CLEANING MUST BE THOROUGH.**

Cleaning:

- disconnect machine from electrical supply
- dismantle machine down to heater and fan if possible (Figure 45)
- wash each part with a cloth wrung out in warm soapy water (70°C) to which an antiseptic (such as chlorhexidine) has been added
- dry each part thoroughly and quickly
- make a note of the date on which the incubator is cleaned. (When a clean incubator is needed, the most recently cleaned one should NOT be selected)

If necessary and if laboratory facilities are available, swabs may be taken from the incubator after cleaning.

Weekly:

Wash or change filters when dirty: **NEVER** reverse them. Dirty filters increase oxygen concentrations to dangerous levels

If the air filter is washable

- wash in warm water with detergent. **DO NOT** use soap
- dry thoroughly

If the air filter is not washable and is dirty:

- replace
- if new filters are not available, cotton wool, lint, coffee filters or filter cones used in suction pumps may be inserted temporarily. Before using such substitutes, check the effect on oxygen concentration levels with an oxygen monitor.

DO NOT use the incubator without the air filter in place

Every six months:

The incubator must be inspected and overhauled by a qualified technician
This must include a full electrical and earth safety check

Calibration Tests (yearly):

a. Temperature test:

This test should be carried out when room temperature is 20 to 25°C.

- make sure that there is no draught and the incubator is far away from heaters and direct sunlight
- check the incubator is assembled correctly
- check the canopy thermometer is in place
- set baby tray in the horizontal position
- direct the bulb of a test thermometer over the centre of the mattress and supported 50mm above it. The test thermometer should be accurate to $\pm 1.0^{\circ}\text{C}$ with scale of 0.5°C .
- fill the water tray and set the control to maximum
- allow the temperature inside the incubator to stabilise with room temperature. Check by taking readings of the canopy thermometer and the room thermometer
- note all readings and file for future use

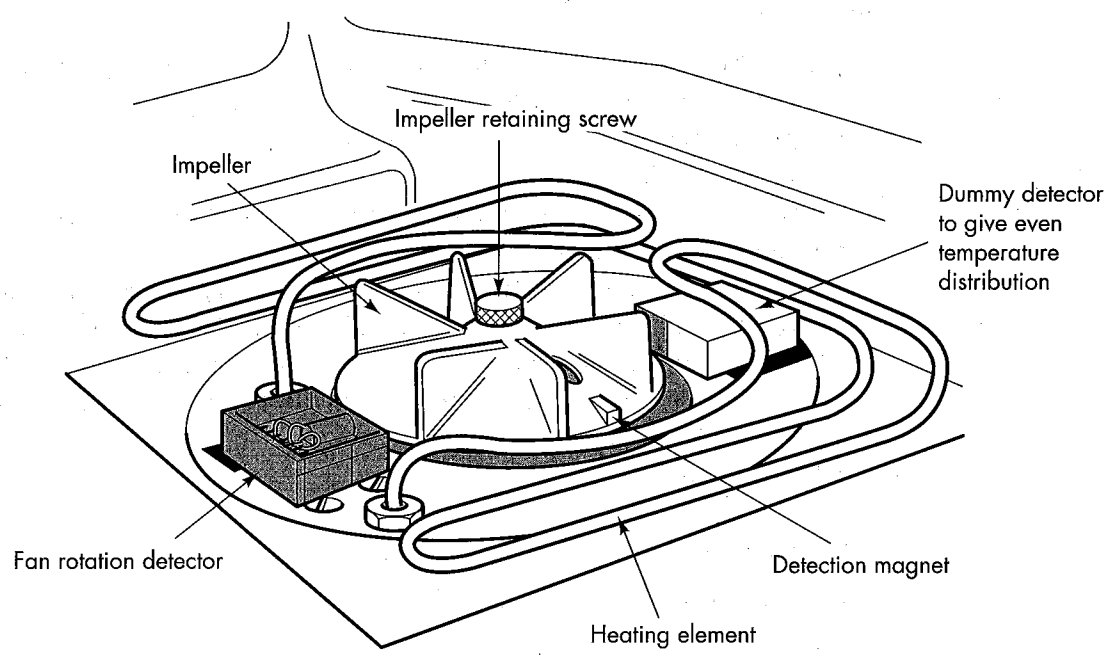
At no time should the canopy thermometer reading and the test thermometer reading differ by more than 1°C

Do NOT select maximum temperature when beginning the test. You may damage the control. Select position 8 and wait 45 minutes before changing the setting to maximum.

b. Control temperature test

- set up incubator in a draught free and direct heat free position with room temperature 20 to 25°C
- check incubator is assembled correctly
- connect incubator to electric mains socket
- set temperature control to mid-point
- switch ON power switch. Cancel alarms
- allow 45 minutes for temperature to stabilise
- set temperature control to a high value
- allow 60 minutes for temperature to stabilise
- compare canopy thermometer with test thermometer every hour for six hours
- note readings and file for future reference

At no time should the test thermometer and the canopy thermometer differ by more than 1°C .



To remove impeller

1. Ensure the incubator is disconnected from the mains power socket outlet
2. Disassemble incubator to gain access to impeller
3. While holding the impeller with one hand to prevent rotation, unscrew the retaining screw anti-clockwise with other hand
4. Lift off the impeller from its spindle
5. When refitting impeller ensure it is fitted correctly with the locating pins. Firmly tighten down the retaining screw otherwise the impeller will become loose and very noisy.

To test the fan fail alarm

After removing the fan impeller:

1. Plug in incubator to mains power socket and switch on
2. Reset alarms by pressing reset switch
3. Switch on mains power switch on control panel
4. The fan fail alarm light should glow and audio buzzer sound
5. Press reset switch to cancel buzzer
6. Switch off power switch and unplug from mains
7. Refit impeller and reassemble

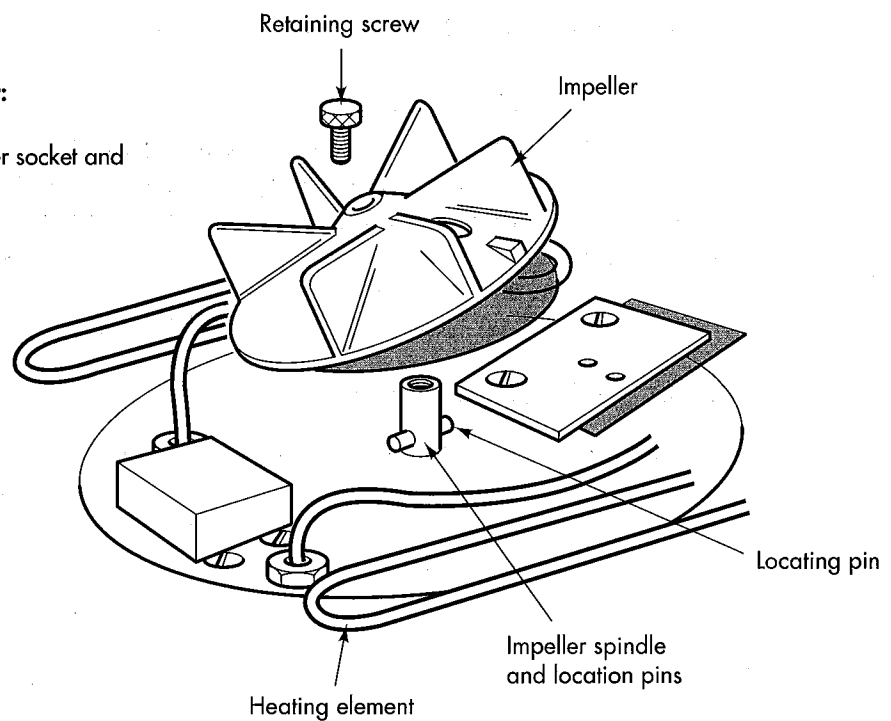


Figure 45: Removing the fan impeller and testing the fan fail alarm

c. *Overheat alarm test*

- set up incubator in a draught free and direct heat free position with room temperature of 20 to 25 °C.
- check incubator is assembled correctly
- set incubator heater to maximum
- using an electric fan heater or hair dryer, gradually increase the canopy temperature by turning the heat source on and off
- check canopy and test thermometers. The alarm should sound and the heater should switch off automatically when the temperature reaches 39-41°C, depending on measurement technique and specific model. Do take care not to overheat the canopy. This could ruin the equipment
- switch off incubator
- allow to cool

d. *Functional test*

Carry out the functional tests as described above.

e. *Fan fail alarm test*

See Figure 45.

- switch off incubator and disconnect from electric power mains
- dismantle the incubator
- remove the fan impeller
- reassemble the incubator (for safety reasons)
- switch ON power switch. Cancel alarms
- check fan fail alarm lamp and audio alarm work satisfactorily
- dismantle the incubator
- refit fan impeller. Make sure this is fitted correctly. If it is not the machine becomes very noisy
- reassemble the incubator

f. *Power fail alarm test*

- disconnect incubator from electric power mains
- switch ON the power switch on control panel
- check power fail lamp and audio alarm work satisfactorily
- if not:
 - replace battery
 - repeat test

Should any of the above tests fail:

- the machine must be checked and repaired by a qualified technician

g. Oxygen flow and leak test

- remove the air intake filter
- plug the hole
- connect oxygen supply to the incubator
- set oxygen flow rate at 5 litres per minute
- with a finger, block inlet tube where it enters the incubator canopy
- check all incubator joints for oxygen leaks
- apply solution of water and detergent with toothbrush to each joint. Small bubbles will appear if oxygen is leaking
- tighten all joints

DO NOT use soap and water to check for oxygen leaks

h. Thermometer repair

Alcohol thermometers, not mercury thermometers, must be used

If the alcohol column becomes broken:

- gently warm the thermometer in the incubator until the column rises to the top of the rise tube
- cool the thermometer, standing upright, in a refrigerator if possible

ii. Safety

Do make sure the incubator is used in a clean dust free area away from direct sunlight, radiators and draughts

Do keep the incubator well away from flames and lighted cigarettes

Do use only sterile or distilled or clean rain water in the incubator; change water daily

Do check that all downstream tubing is non-toxic and odour-free

Do keep children away from the machine

Do make sure that any adhesive used to repair the canopy of the incubator is non-toxic

Do use an oxygen monitor to check the oxygen concentration in the canopy, if administering oxygen

Do clean incubator with warm water, detergent and antiseptic ONLY

Do take swabs of the incubator for laboratory examination if there is any possibility of cross-infection

Do keep baby's clothing away from air vents and sensors

Do make sure each machine is cleaned and checked after use and before storage

Do keep chambers dry when not in use

Do make sure the incubator is checked by a qualified technician every six months

DO NOT use the incubator where there are odours or volatile gases or liquids

DO NOT place anything on the canopy of the incubator

DO NOT smoke near the incubator

DO NOT use oil on the incubator

4. How to Use the Equipment

If the manufacturer's manual is available, follow the instructions given.

Because there are many types of incubator in use in hospitals, the following are general guidelines only:

- i. check the incubator is clean and has been checked since its previous use
- ii. check the cradle tray is fitted correctly
- iii. fill the water tray with sterile water (or distilled water or clean rainwater)
- iv. check the air filter is in place
- v. check that the incubator is not in a draught nor in direct sunlight
- vi. plug the incubator into the mains power socket and switch ON
- vii. carry out the functional tests described above

If the incubator passes all tests, it is now ready for use.

REMEMBER to return the incubator for cleaning and checking after use.

5. Simple Fault-finding and Maintenance

If an incubator develops a fault, a spare incubator should be brought into use. If this is not available, an electric fan heater and warm clothing for the baby, including a woolly hat, may be used. Needless to say the incubator should be repaired as quickly as possible.

Example a:

The incubator does not work:

- check the machine is plugged into the electric mains socket and that both switches (socket switch and machine switch) are ON

If the mains ON power lamp does not glow check socket outlet

If socket outlet is working check the mains lead

If mains lead is satisfactory the machine has a fault:

- switch off and unplug the machine from the mains socket
- replace fuses on the control panel one at a time
- after *each* change of fuse:
 - plug machine into socket outlet
 - switch on

DO REPLACE EACH FUSE ONCE ONLY. If a replaced fuse blows, then the machine has a short circuit problem and MUST be examined by a qualified technician

DO REPLACE EACH FUSE WITH A SPARE FUSE OF THE SAME SIZE (e.g. a 13 amp fuse should be replaced with another 13 amp fuse ONLY). Do not use a piece of wire as this can be *extremely dangerous*

If machine still does not work call a qualified technician. The machine has an internal fault.

REMEMBER to see that any fuse taken out of stock is reordered so that a supply is always available.

Example b:

The alarms do not work:

- replace battery
- recheck

If alarms still do not work call a qualified technician. The machine has an internal fault

Example c:

Overheat alarm operates continuously:

- press reset alarm switch

If still not satisfactory call a qualified technician. The machine has an internal fault

Example d:

Overheat alarm does not work:

- check the incubator is assembled correctly
- check airducts are not displaced or obstructed

If all are satisfactory and machine still does not work call a qualified technician. The incubator has an internal fault.

Example e:

Overheat alarm works at incorrect temperature limits:

- check incubator is not in direct sunlight
- check position of canopy thermometer
- check correct thermometer is in place
- check incubator is assembled correctly
- check air ducts are not displaced or obstructed

If all are satisfactory and alarm still operates incorrectly call a qualified technician

Example f:

Fan does not work:

- check fan impeller is fitted correctly
- check fan impeller is not damaged
- check incubator is assembled correctly
- reset alarm switch

If fan still does not work call a qualified technician

Example g:

The audio alarm is not working:

- call a qualified technician

Example h:

Incubator not heating when heater lamp is ON:

It is likely that the main heating element needs replacing.

In some incubators, the heating element consists of standard light bulbs which are easily replaced.

ONLY replace bulbs with spare bulbs of the same WATTAGE, e.g. 40 watt bulb MUST be replaced by another 40 watt bulb ONLY. IF IN DOUBT USE LOW WATTAGE BULBS ONLY.

If the incubator still does not heat call a qualified technician

Example i:

Temperature control is not working correctly:

- check the incubator is not in a draught or near a fan
- check the incubator is not in direct sunlight
- check the incubator is assembled correctly
- check air ducts are not displaced or obstructed

If all are satisfactory call a qualified technician

6. Spares

A full set of spare parts should be held in store. A list of these may be given in the manufacturer's manual or obtained from the manufacturers on request.

If spares are bought locally, they should be fitted by a qualified technician.

Make sure that the faulty part is returned and that you order its replacement at the same time.

Whenever possible have a repair or replacement checked by a qualified technician.

For local maintenance the following spares should be stocked:

- a spare incubator for emergency use
- air filters
- plug
- plug fuses (if required)
- main circuit fuse
- control panel fuses
- 3-core flexible cable
- fan impeller
- access port doors with screws
- castors or wheels
- non-toxic plastic adhesive (for repairing canopy)
- canopy thermometer (alcohol)
- test thermometer
- oxygen flowmeter
- gaskets for access port doors and base
- water tray
- oxygen fuel-cell
- indicator lamps
- batteries for alarm circuit
- toothbrush and detergent (for detecting oxygen leaks)
- paint and paintbrush (to prevent rusting of stand and trolley when paint is chipped)

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

Always refer to the manufacturer's instructions

To keep this equipment in good working order for as long as possible, before each use:

- i. check that the incubator is clean
- ii. make sure the electrical mains lead is not damaged or frayed
- iii. check plug
- iv. check the access port doors are fitting well
- v. check the incubator is assembled correctly
- vi. check the cradle tilt can be adjusted
- vii. drain the water tray, allow to dry for 30 minutes and refill with sterile water
- viii. check joints for oxygen leaks:
with a toothbrush, apply a 0.5% detergent solution over the joints. Small bubbles will appear if there is a leak. NEVER use soap as this can cause an explosive mixture.
- ix. check oxygen concentrations in the canopy
- x. check wheels or castors for damage or wear
- xi. make sure the air filter is in place
- xii. carry out functional tests

Functional tests vary according to the model of incubator. If available, the instructions in the manufacturer's manual should be followed.

The following are typical functional tests

Test 1: Switching on

- connect the incubator to the AC power outlet
- switch incubator power switch ON (leave the heater control switch OFF)
- check:
 - power indicator lamp is ON
 - overheat lamp is ON
 - fan fail lamp is ON
 - alarm is SOUNDING
 - heater lamp is OFF

If any one of the above does not occur, withdraw incubator from service and inform the Maintenance Officer

Test 2: Heater operation

- press down the alarm reset switch (this will cancel alarms)
- turn temperature control knob clockwise FULLY
- turn temperature control knob anticlockwise
- check heater lamp goes ON and OFF

Test 3: Alarm operation

- press upwards the test/reset switch
- check:
 - all indicator lamps light up
 - audio signal SOUNDS

Test 4: Motor operation

- press test/reset button to reset alarms
- listen to the motor. The sound should be smooth and not loud

Test 5: Thermometer check

As the heater lamp does not always indicate that the heater is working check canopy thermometer

Test 6: Temperature check

Before using the incubator:

- set temperature control to mid-point. Run for 10 minutes
- check:
 - canopy thermometer shows an increase in temperature
 - heater lamp is on (in some machines it pulsates)

Report to the Maintenance Officer:

- any visible damage to the incubator, the electrical power lead and plug
- any oxygen leak
- any other fault or difficulty with the incubator

Follow these SAFETY points:

- Do keep incubator well away from flames and lighted cigarettes
- Do make sure that the incubator is used in an area which is clean and as dust free as possible
- Do make sure that the incubator is away from draughts and radiators and out of direct sunlight
- Do use water for the machine which is sterile, distilled or clean rain water; change water daily
- Do make sure all downstream tubing is non-toxic and odour free
- Do keep children away from the incubator
- Do keep baby's clothing away from air vents and sensors
- Do make sure the incubator is cleaned and checked after use and before storage
- Do keep chambers dry when not in use
- Do wash incubator surfaces with water and detergent to which an antiseptic solution has been added
- Do check oxygen concentrations in the canopy when oxygen is being fed into the incubator

Do send swabs from the incubator to the laboratory for testing if there is any possibility of cross-infection
Do make sure the incubator has a full engineering check every six months

Do NOT smoke near the incubator
Do NOT use the machine near odours, volatile gases or liquids
Do NOT place anything on the incubator canopy
Do NOT use toxic adhesives when repairing the incubator canopy; ventilate the canopy well for several hours after performing repairs