

Construction manual for the development of dual energy solar oven for fruits and vegetable drying- The Fruitprotech Dryer

Document identification

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Project title:	Development of automated solar powered fruity drying technology for smallholder farmers in Ghana
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Abstract	This dryer christened as FRUITPROTECH DRYER is developed by a consortium of four. Sustenance Agro Ventures, Eucharía Farms Ltd. Both are agribusinesses based in Kintampo, Ghana and Ujuizi Laboratories in the Netherlands and researchers from the Horticulture department of Kwame Nkrumah University of Science and Technology, Kumasi Ghana. This manual presents the technical specifications as well as operation procedures of the low-entry cost solar drying chamber. The dryer has a raw material capacity of 2 metric tons and takes 8 hours to dry fruits such as mangoes or pawpaws. It has dual energy units and uses both solar and Liquified petroleum Gas (LPG).

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Dryer Manual

Control Panel with humidity and temperature controls that regulate the exhaust vents and hot water inlets

Heat Exchangers

Axial flow reversible Fans

Trays
Perforated SS 304 sheets trays arranged in SS Trolleys with caster wheels

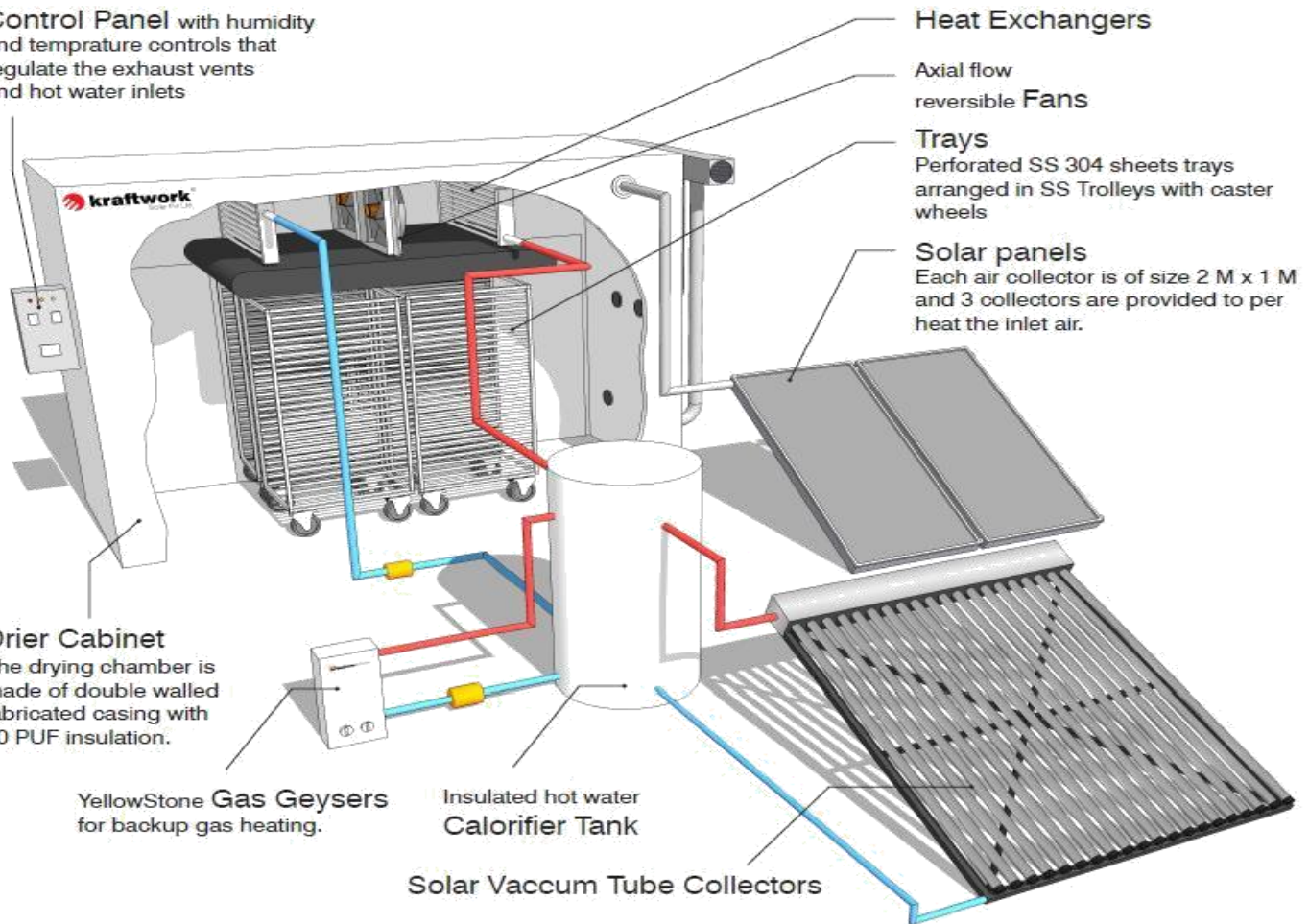
Solar panels
Each air collector is of size 2 M x 1 M and 3 collectors are provided to per heat the inlet air.

Drier Cabinet
The drying chamber is made of double walled fabricated casing with 50 PUF insulation.

YellowStone Gas Geysers
for backup gas heating.

Insulated hot water Calorifier Tank

Solar Vaccum Tube Collectors



The Kraftwork Dryer. The principles underlying the operations of this Kraftwork dryer greatly informed the technical principles of the Fruitprotech dryer.



The dryer is made of 20ft shipping container that has been modified into a drying chamber/ cabinet. It is lined with stainless steel plate that is the inner lining. Between the inner lining and the container wall is walled with insulated 50mm thick fiber mat.

Within the chamber, there are two pairs of heat exchangers / radiators and in between the pair is installed with 4X2HP reversible axier fans that blow air through the heat exchangers/ radiators at alternate direction at pre-determined time intervals to circulate hot air within the chamber / cabinet.

On top of the drying chamber or cabinet, there are 2x2 pairs of vent at each end of the breath of the container that serves as chimneys for the moist air to escape. The chimneys are at the opposite breath ends of the container. They serve as chimneys or vents for moist air to escape.

Heat source:

The drying chamber/cabinet gets its source of heat from three main sources namely:

- Solar water heater
- Gas boiler
- Electricity (electric coil heater)

Principles:

Solar



The solar is the primary source of heat for the dryer system. Solar water heater is installed on the roof of the factory. Hot water from the solar heater feeds into the boiler which is mounted on the 20ft container. A 0.5HP water pump then circulate the hot water from the boiler to the heat exchangers within the dryer cabinet through and back. (The water is sent from the radiator through insulated copper pipes to the radiator/ heat exchangers) for the fan to blow hot air from the surface of the radiator/heat exchangers to the drying cabinet to effect drying.

The used cooled water in the radiator / heat exchangers by the action of the pump goes back to the solar heater system on the roof top. The pump sucks the water from the radiator and the hot water in the boiler follows.

LPG

Another primary source of heat is LPG. Gas goes into the gas burner that is mounted on the boiler, in case there is low sun radiation such as cloudy weather, rainy weather or at dusk or night, the gas burner is used to boost the temperature of the water in the boiler and the circulation goes on as the solar.

Electricity (electrical coil water heater)

The electric heater coil is installed in the solar water heater system hot water reservoir tank. In case there is low radiation from the solar heater and shortage of gas, electricity can be used to heat the water in the solar water heater system for the dryer to continue to operate as the other primary source.

Boiler



The boiler is a squared shaped comprising of a gas burner and tank that contains 10 litres of water. Heated water from the solar heater enters the water tank of the boiler. The gas burner is turned on and further heats the water in the boiler container.

Pump



The pump is a 0.5HP is fitted on the side of the dryer container. The pump sucks warm water from the water pipes of the water exchangers to the water tanks. This sucking moves the water within the whole system.

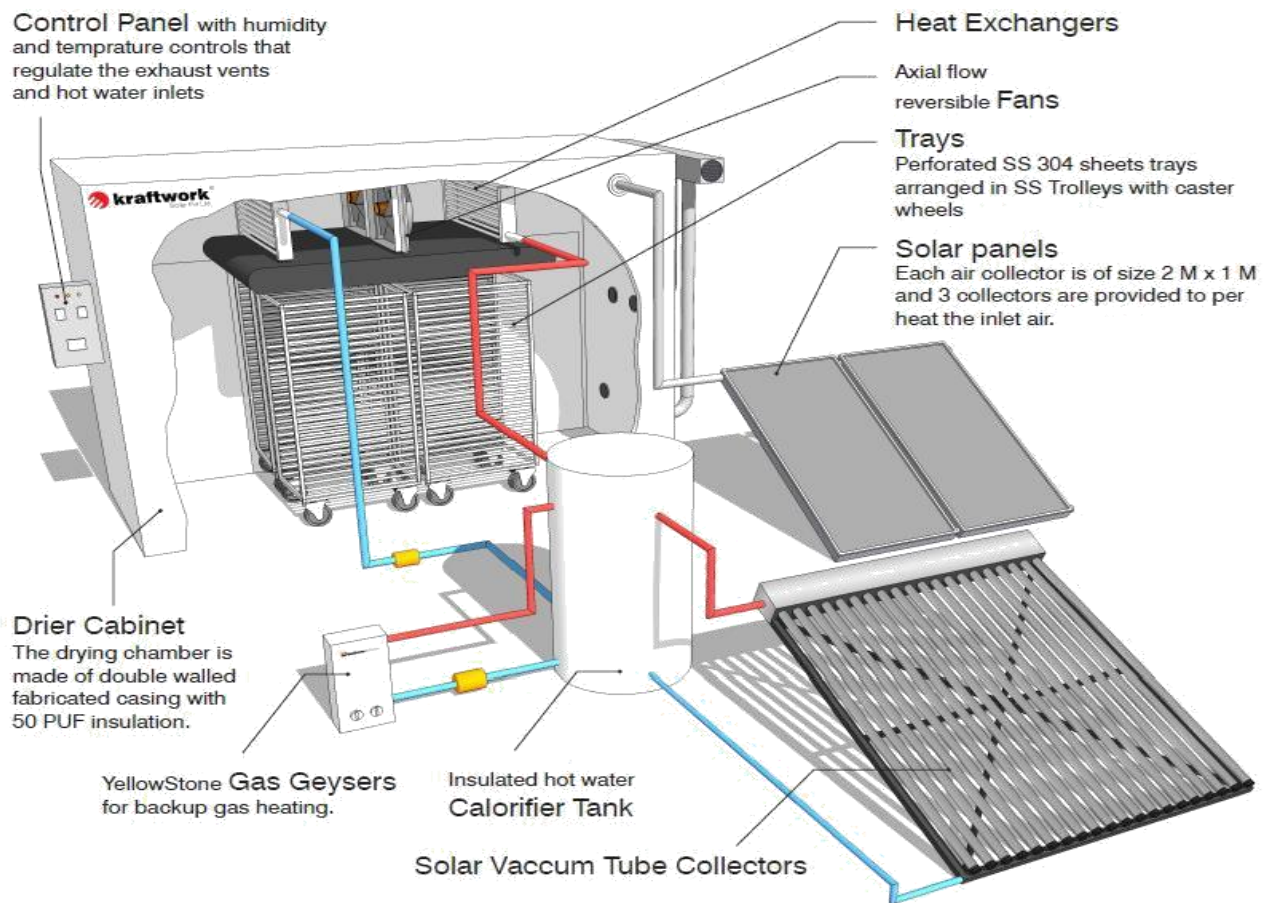
Trolleys



Movable trolleys with wheels are used to load fresh sliced mangoes. There are 12 trolleys that are filled with 30 trays. Immediately the trolleys are full they are sent into the oven to prevent contamination.

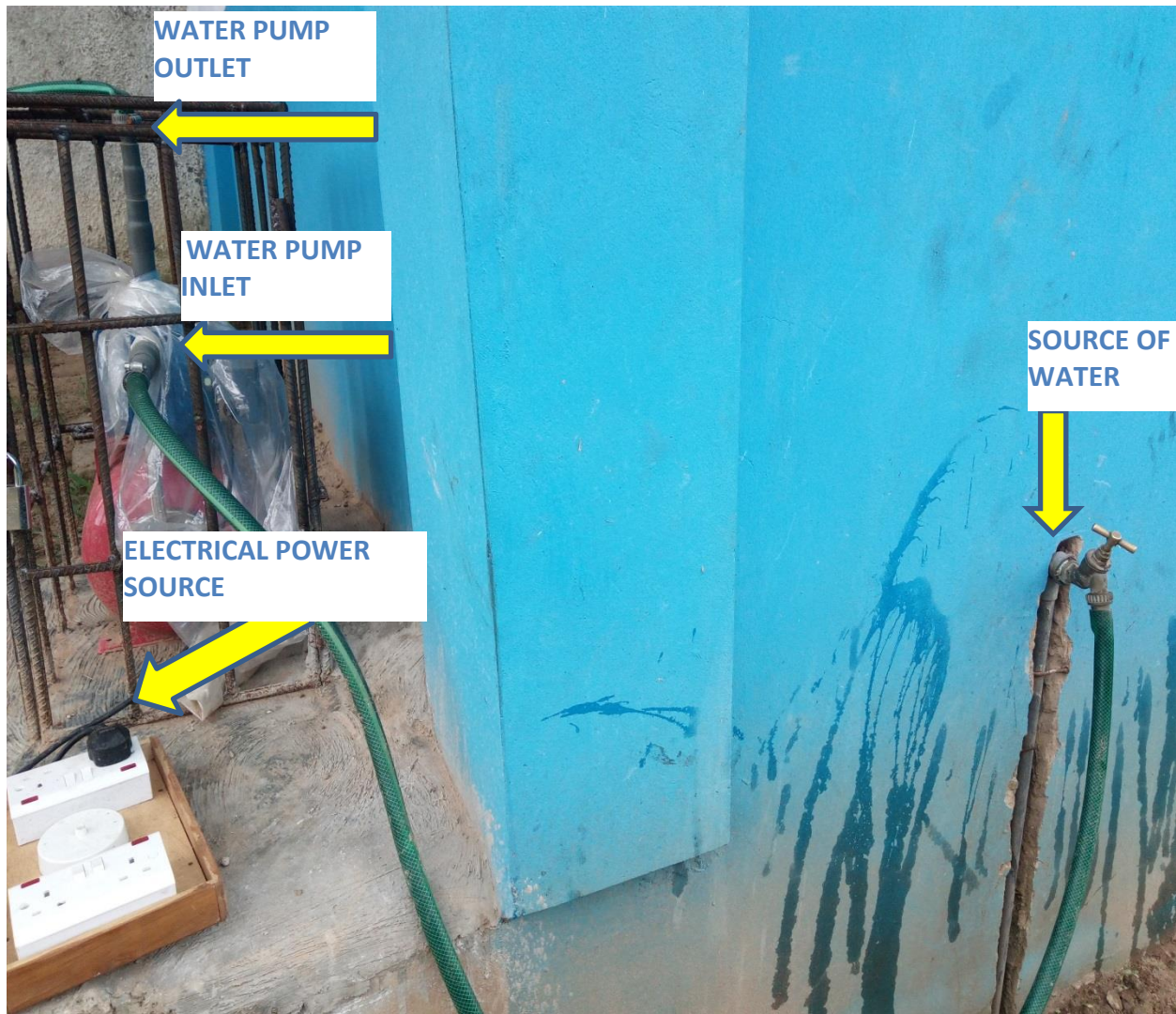
Trays

The trays are shelved in the trolleys which are made of wood and nylon strings. These trays are sheeted with net which the sliced fruits are spread on. There are 30 trays for each trolley.



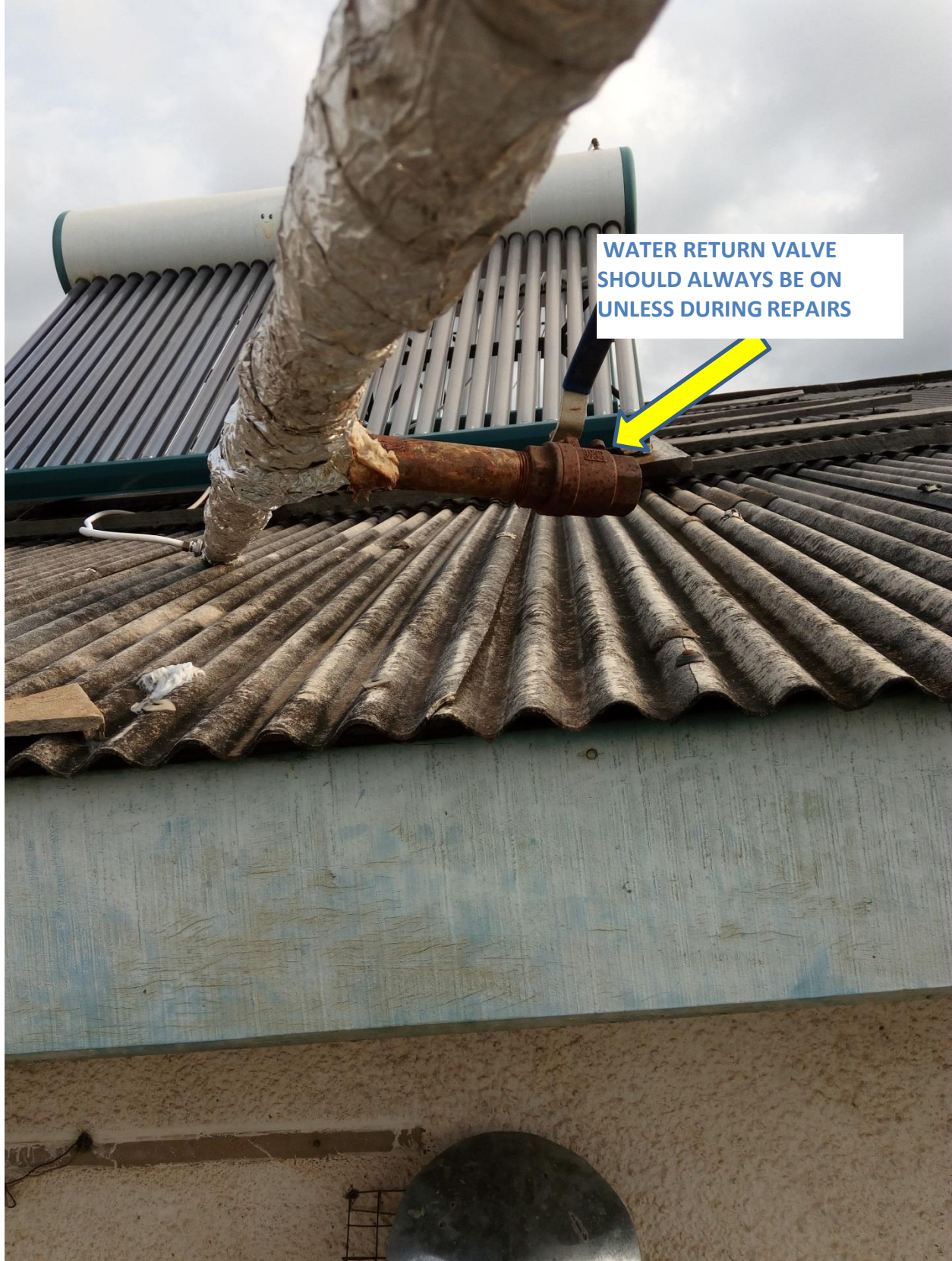
DRYER OPERATION

CONNECT WATER PUMP TO SOURCE OF WATER AND POWER SUPPLY. ALWAYS MAKE SURE THERE IS WATER IN THE WATER PUMP BEFORE PUTTING POWER SUPPLY ON (THE WATER PUMP HAS TO BE COVERED WITH PLASTIC SO THAT WATER DOES NOT GO INTO THE PUMP CONTROL BOARD, BE IT RAIN OR ANY OTHER WATER FROM ANY OTHER SOURCE)



FILL WATER HEATER TANK VIA SOLAR TANK INLET AND ALWAYS MAKE SURE THE TANK HAS A MINIMUM OF 50% WATER IN THE HEATER TANK DURING OPERATIONS. KEEP TOPPING UP WITH WATER WHEN WATER LEVELS GO DOWN





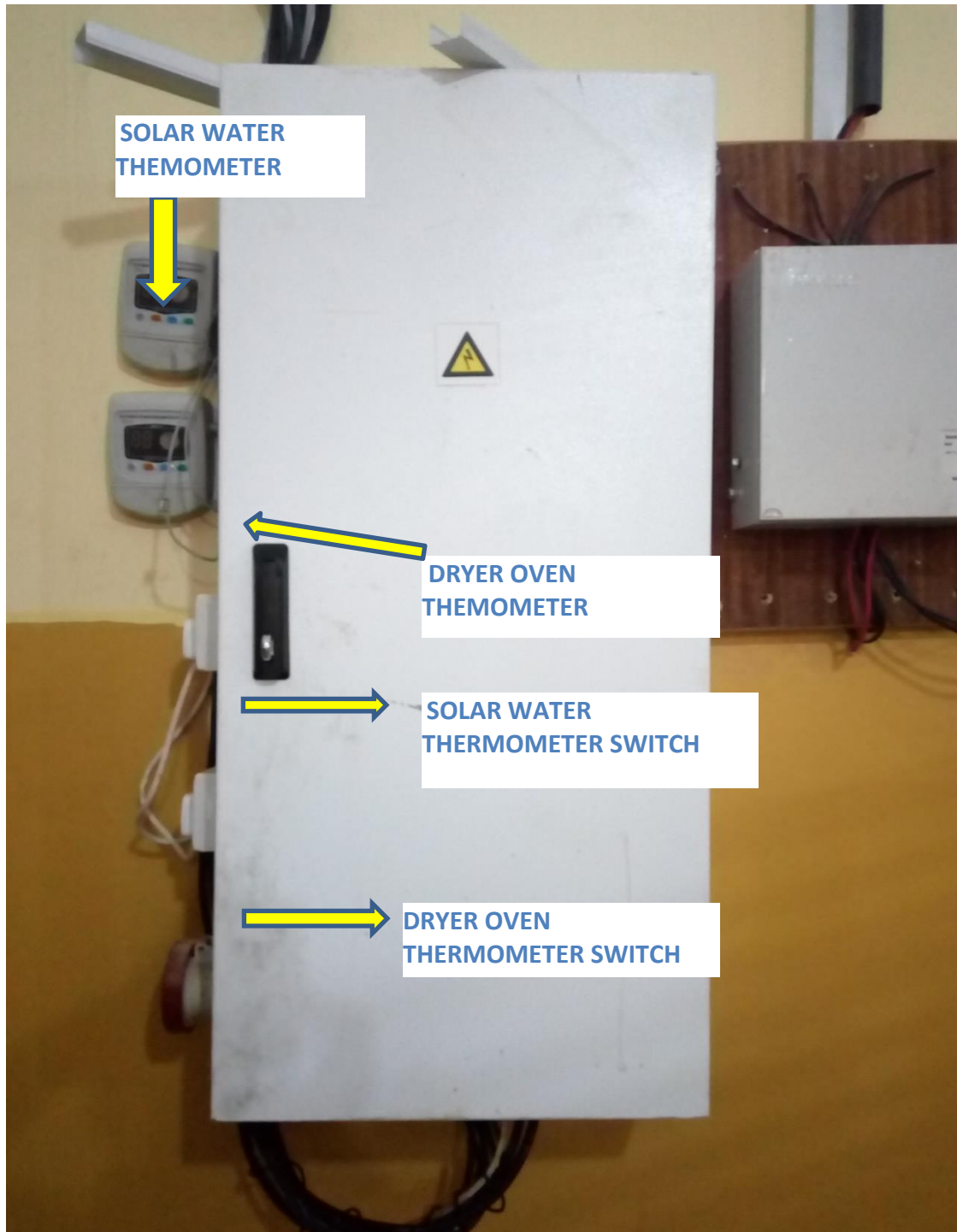
MAKE SURE THE ON RADIATOR VALVE WHICH WILL SEND WATER THROUGH THE PIPES INTO THE RADIATOR



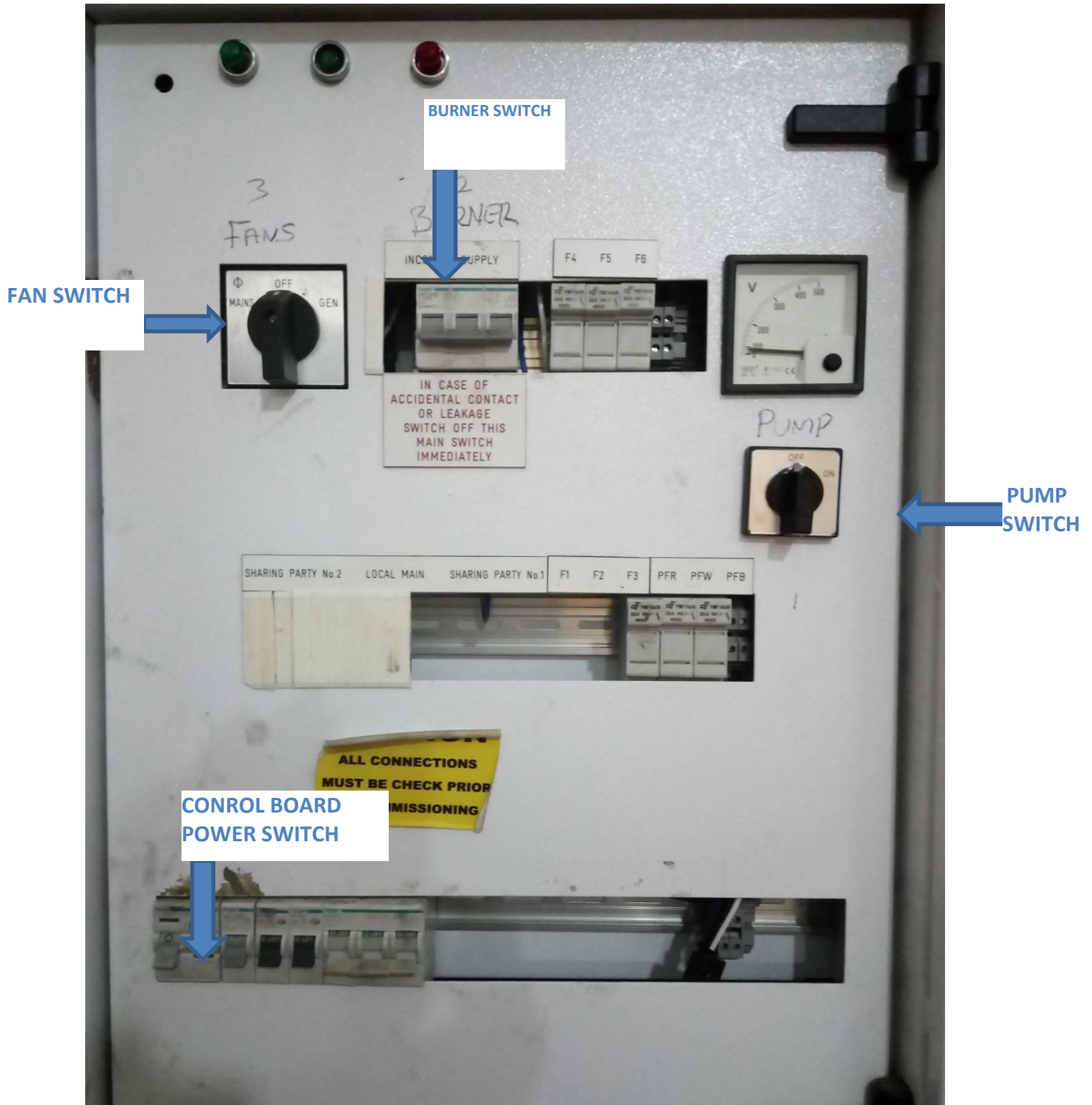
DRYER WATER PUMP HAS TO BE ALWAYS ON AND UNTOUCHED UNLESS BY A TECHNICIAN



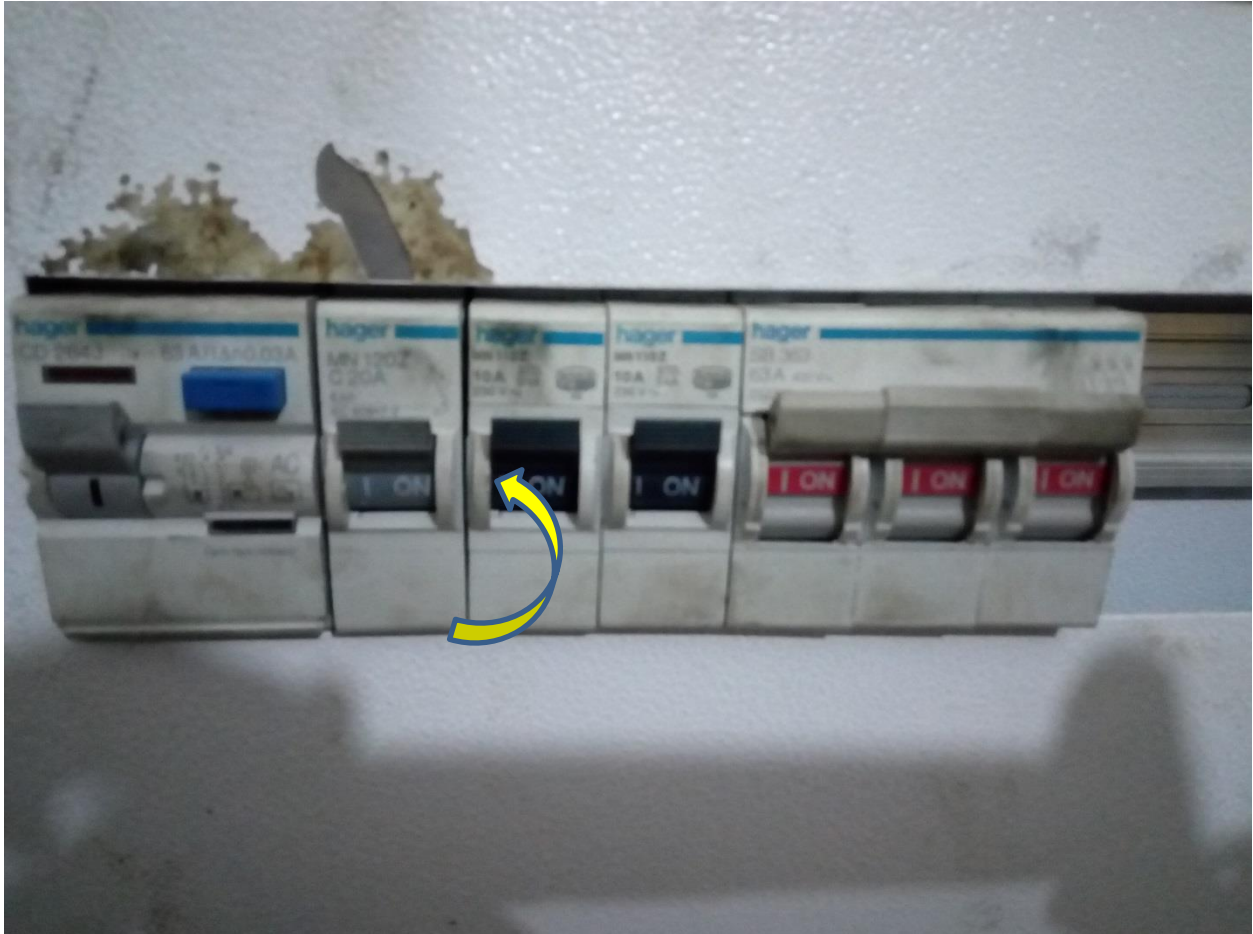
SWITCH ON SOLAR WATER AND DRYER OVEN THERMOMETER



CONTROL BOARD



SWITCH ON CONTROL BOARD POWER SWITCH



MAKE SURE THE VOLTA IS WITHIN 380 AND 400V



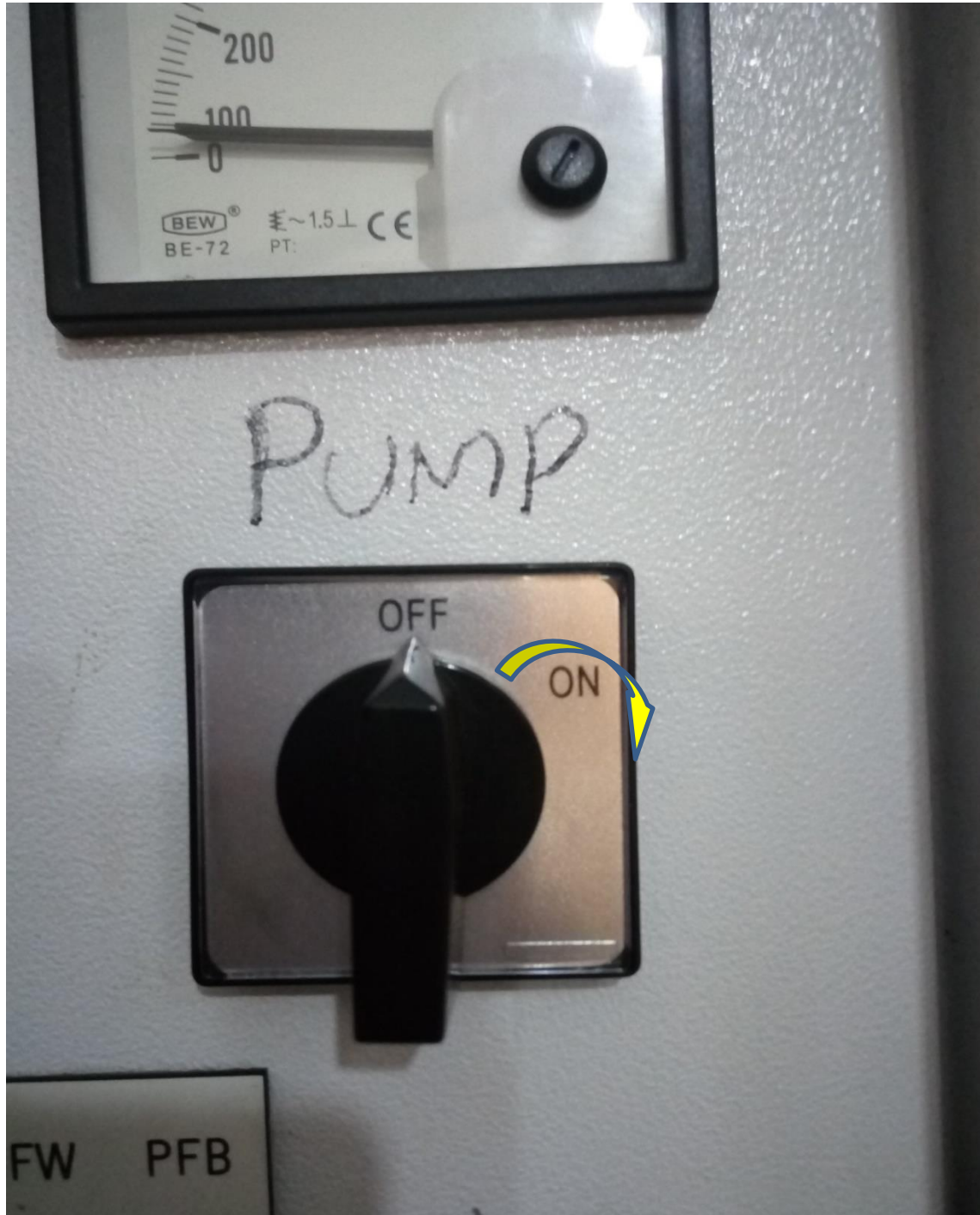
SWITCH THERMOMETER SWITCHES ON. THE TEMPERATURE FOR THE SOLAR TANK AND DRYER OVEN WILL DISPLAY



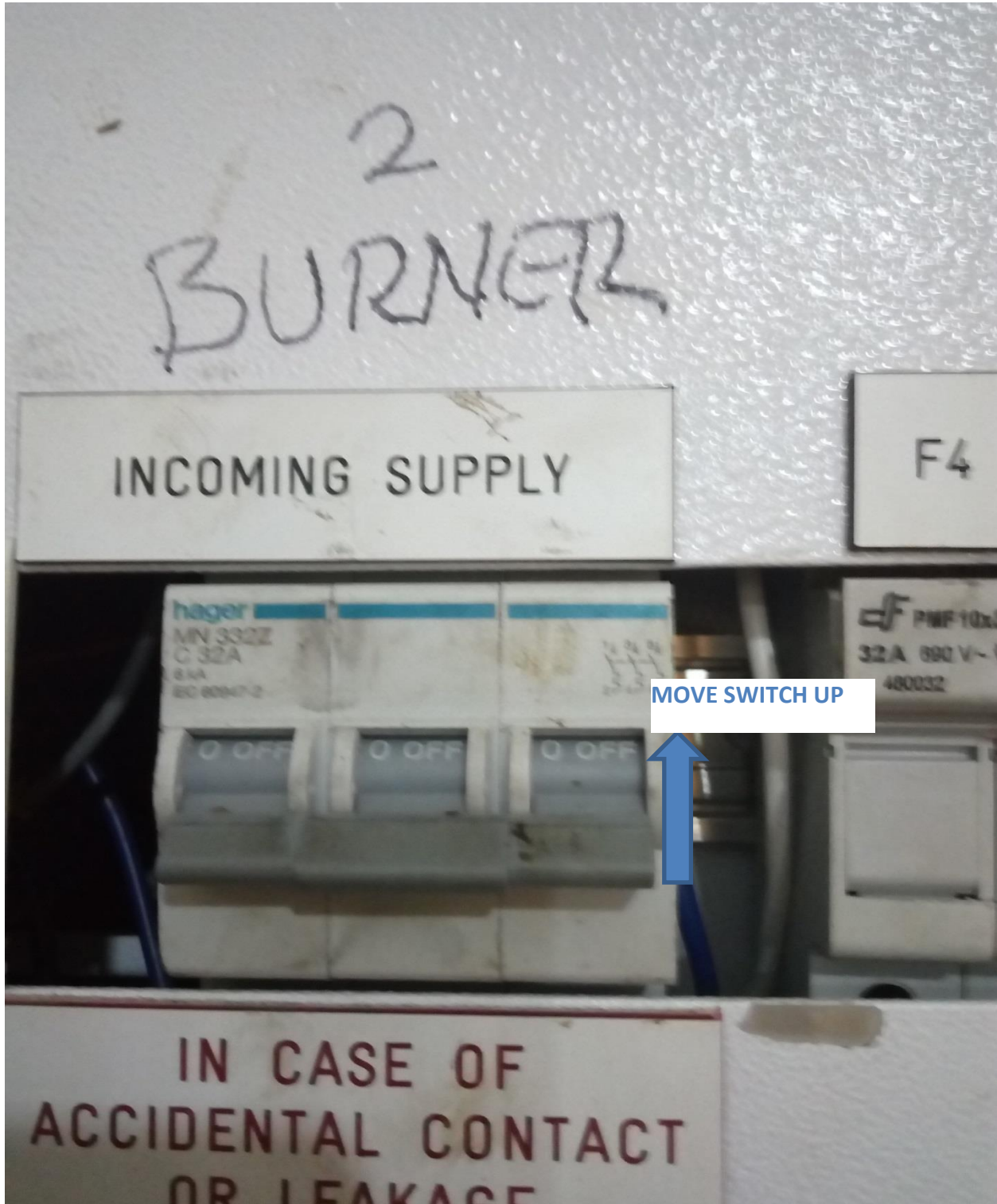
LOAD DRYER WITH TROLLEYS AND CLOSE DRYER DOOR



SWITCH ON PUMP



SWITCH ON BURNER



SWITCH ON FANS. TURN TO GEN WHEN USING GENERATOR POWER AND MAINS WHEN USING DIRECT ELECTRICITY.



ALWAYS MONITOR THE READINGS OF THE TEMPERATURE OF THE DRYER OVEN HOURLY AND RECORD IN THE DRYER MONITORING FORM.

1. MAKE SURE TEMPERATURE IS WITHIN 60°C AND 65°C.
2. PUT OFF BURNER WHEN DRYER OVEN TEMPERATURE IS ABOVE 65°C AND PUT IT ON WHEN ITS BELOW 60°C
3. MONITOR THE WATER HEATER MONITOR. WHEN WATER LEVEL IS LOW IT WILL INDICATE ON THE SCREEN
4. ALWAYS MAKE SURE WATER IS NOT LESS THAN 50% LOW IN THE SOLAR TANK
5. START CHECKING ON THE DRYING FRUITS AFTER 10 HRS AND KEEP MONITORING THE MOISTURE LEVEL PHYSICALLY BY FEELING AND TASTING.
6. WHEN SATISFIED WITH THEIR DRYNESS OF THE FRUIT:
 1. TURN OFF THE FANS
 2. TURN OFF THE BURNER
 3. TURN OFF THE PUMP
 4. TURN OFF CONTROL BOARD POWER SWITCH
 5. CLIMB THE DRYER AND CLOSE THE RADIATOR VALVES.
7. OPEN DOORS OF DRYER OVEN FOR 10 MINS TO ALLOW THE OVEN TO BE COOL
8. REMOVE TROLLEY TO COOLING AREA FOR FURTHER COOLING OF THE DRIED FRUITS
9. AFTER THE DRYER OVEN IS COOLED CLEAN AND SANITISE THE OVEN.

