



FURNACE & ASSAY  
— S U P P L I E S —

# **Furnace Operation and Maintenance** **Manual**

Model: Electric 20 Place Fusion Furnace

Voltage: 220v

Fuel Type: Electric

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## Spare Parts List.

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FAS-145-BKT	Electric 20 place Fusion Furnace Rebuild Kit
FAS-204	No. 6 Muffle
FAS-213	Vent Tube No. 6 &7
FAS-302	Furnace Tile 560*480*25mm
FAS-209	Heating Elements Sil/Carbide 20*500*1000
FAS-214	15Kva, 220v Multi-Tap Transformer
FAS-216	220v -110v Control Transformer50*60Hz
FAS-406	Thermocouple element type K 250 plus 75mm
FAS-407	Thermocouple sheath Inner 250*10mm
FAS-408	Thermocouple sheath Outer 250*15mm
FAS-416	Element Clips 16mm
FAS-417	Element Straps 16mm (25A)
FAS-419	Amp Meter 72Sq mm 0-30Amp DC
FAS-509	Door Switch OMRON D4D-1121N
FAS-515	Contactors ABB A50-30-11 110v
FAS-521	Switch P3-63 Main Rotary Switch
FAS-603	Ceramic Anchor Complete 3"
FAS-608	Thermocouple Wire Type K (per Meter)
FAS-648	Omron E5CZ-R2MT Temp Controller
FAS-801	Kaowool Blanket 128Kgx25mm
FAS-1008	Refractory Mortar Per 2Kg

# Installation

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1. Unpack furnace from crate and store in dry area. The furnace usually has timber supports installed inside for transport. Remove before operation.
2. Furnace requires a min of 1 metre space around it to carry out maintenance / repairs
3. Install fuel supply. This must be carried out by a qualified technical person.
4. Before connecting power supply make sure ALL electrical connections are tight, and have not become loose in transit.
5. For door operation air is required to run the Festo pneumatics. Connect air supply to the filter on the furnace.  
Min 3.5cfm
6. Electrical connection is 3 phase with Earth. Connection is made at the terminal strip inside electrical cabinet. Once connection is made, before turning on power, CHECK all other connections as they may have come loose during transport.
7. BEFORE STARTING CHECK THAT ALL EXHAUST DUCTING IS IN PLACE.

# Installing Elements

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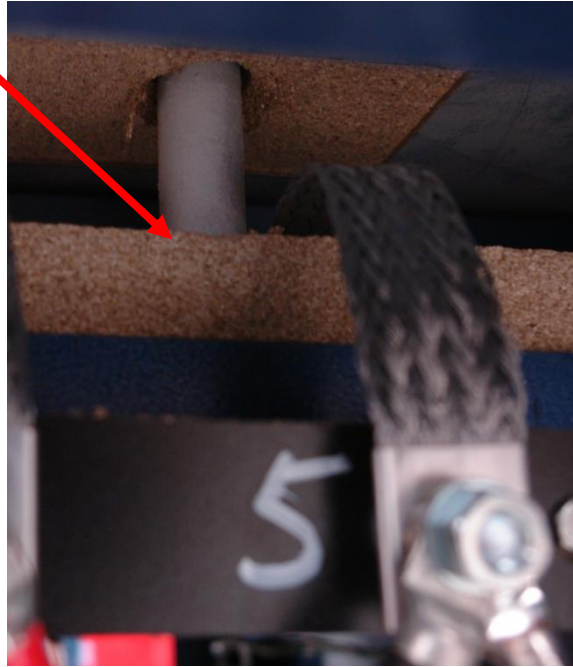
When installing elements be careful not to force any into position.

The elements are fragile, and if too much pressure is put on them or if they hit the floor of the furnace they may break.

It is best to install the elements before the muffle chamber is in if possible, as then you can have two people to guide the elements through the bottom holes.



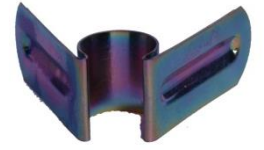
When installing, make sure that the elements sit flat on the element holder underneath the body.



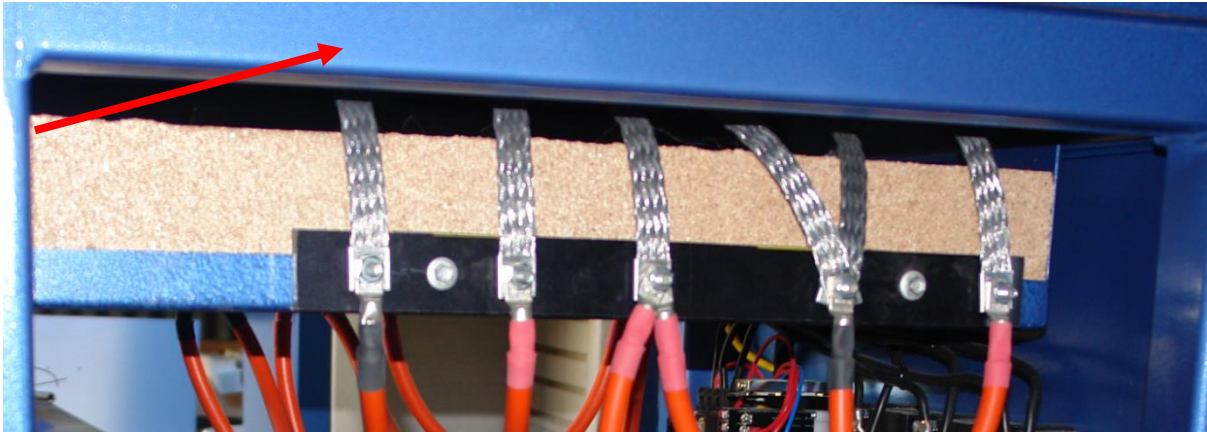
Once all the elements have been installed wrap the element straps around the elements and secure with an Element Clip, making sure that you have a good connection. (Connection diagram on next page)



Check that none of the straps and clips are touching the frame or the top cover.



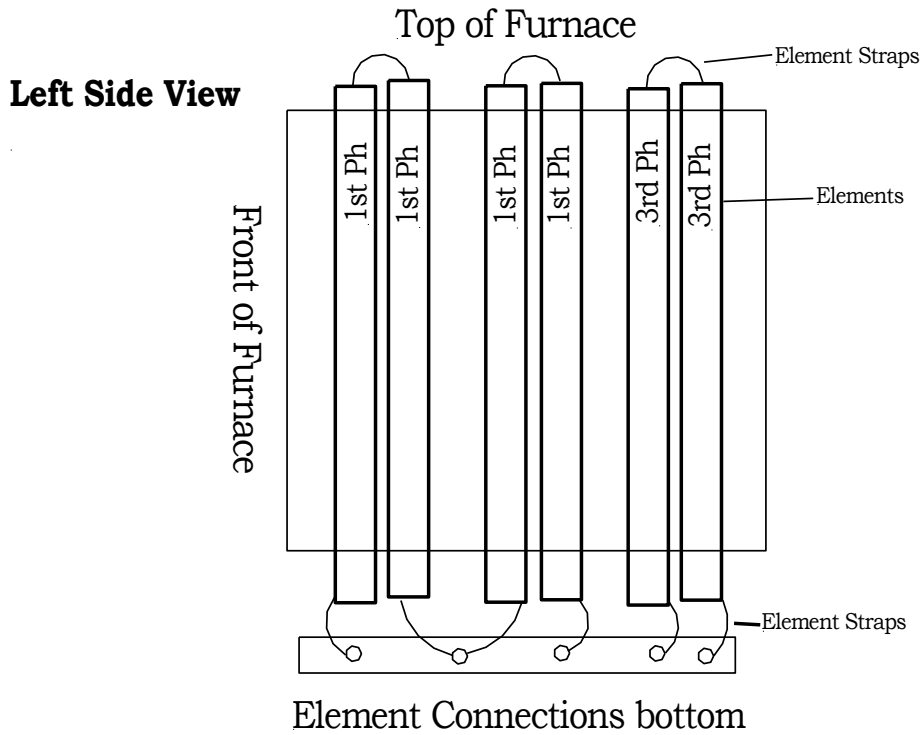
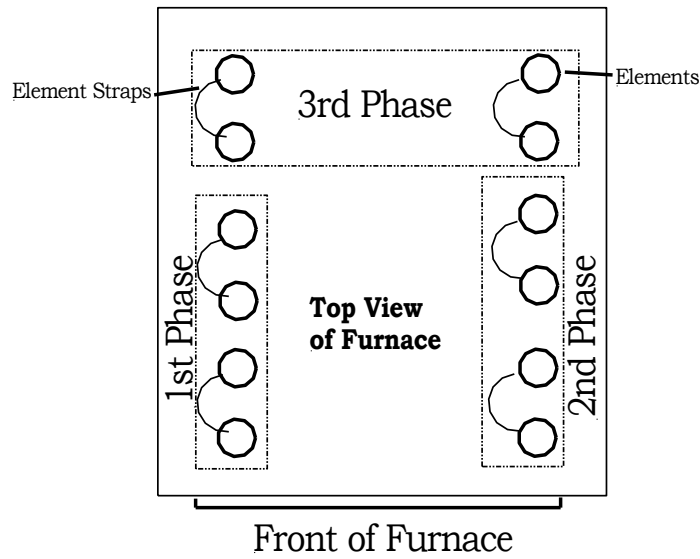
Element Clip



Check that all nuts holding the connections (straps) are tight.

Replace covers then install the muffle if not already installed.

# Element Connections



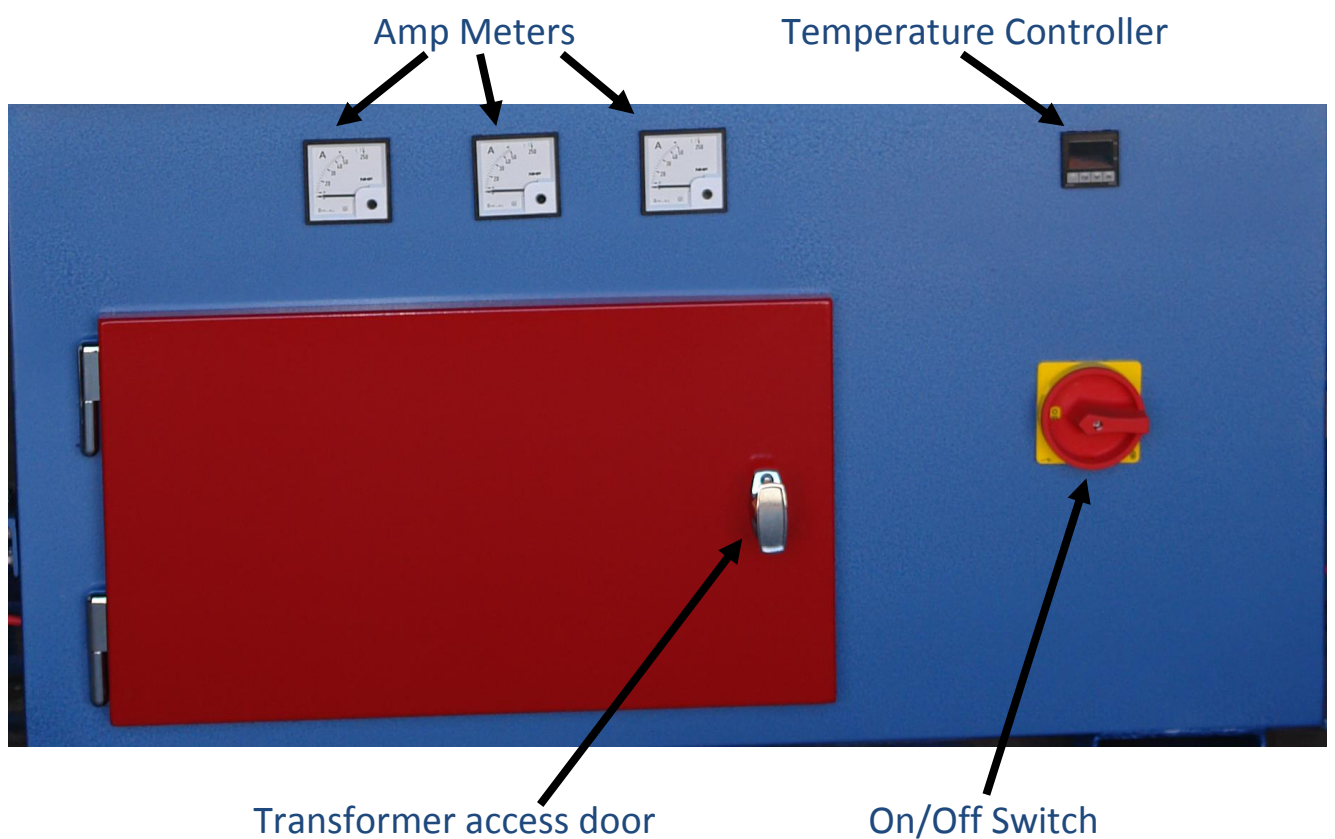
NOTE: Element connections from front to back is that the first 4 elements are 1st or 2nd phase (depending on the left or right side of the furnace) and the rear 2 Elements are part of the 3rd phase (on both sides).



# Starting up Furnace

Turn on power. (if 415v check that electrician has included a neutral wire to the furnace. All the control equipment needs a neutral wire.)

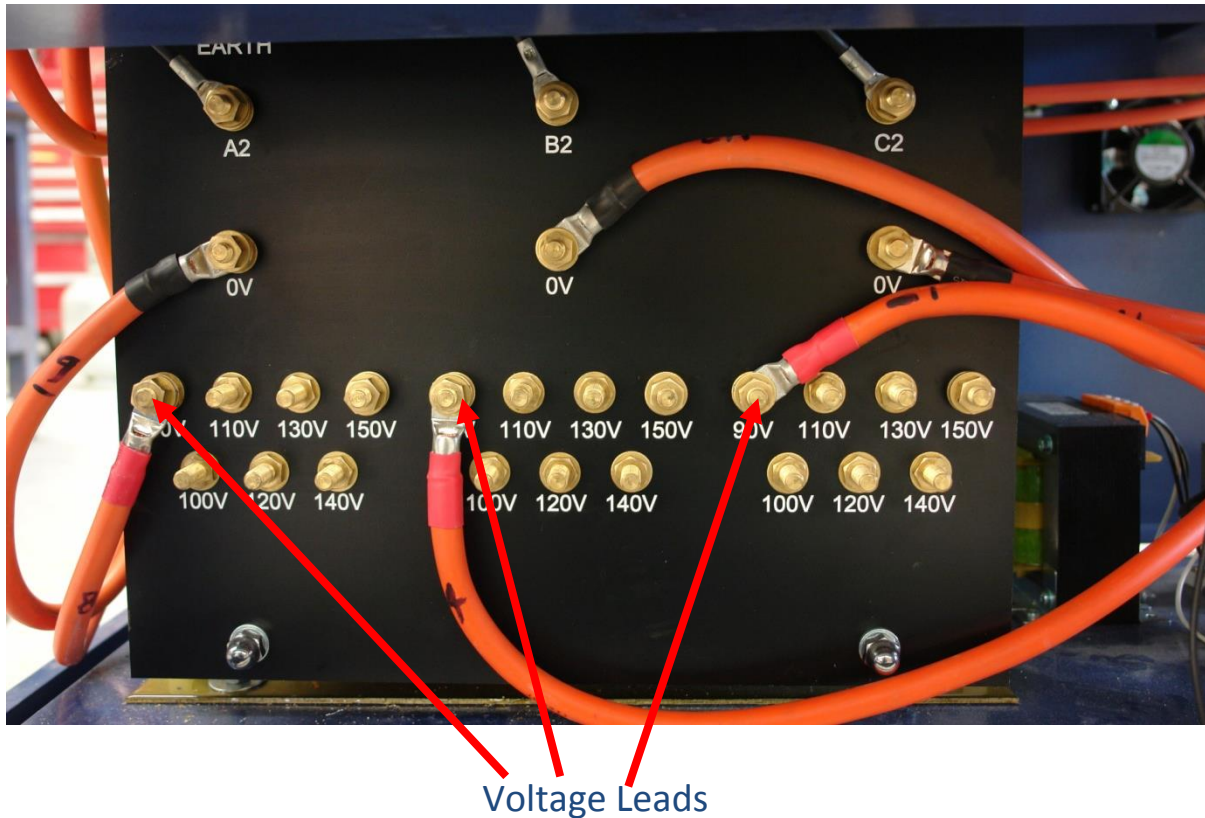
Set Temperature controller to desired temperature.



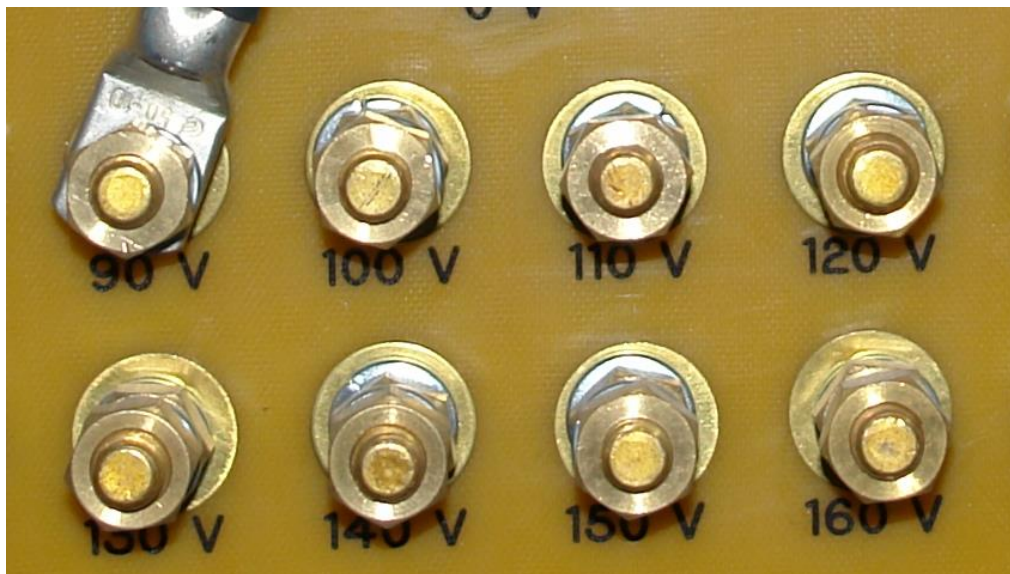
As you look at the furnace you will see 3 amp meters.  
There is an Amp meter for each phase.

At start up the amps will slowly climb up to 15 amps (approx 1/2 hour) If this does not happen after this time you will need to increase the voltage.

Isolate power then open the transformer access door.



Move your voltage leads (only) to the next voltage setting. You will see these clearly. 90v, 100v etc.



Optimum amps for operating is 30amps for the fusion and 15 amps for the cupellation furnace.

Once you have done this then slowly warm up the furnace to cure the refractory.

# Things to Remember about Elements

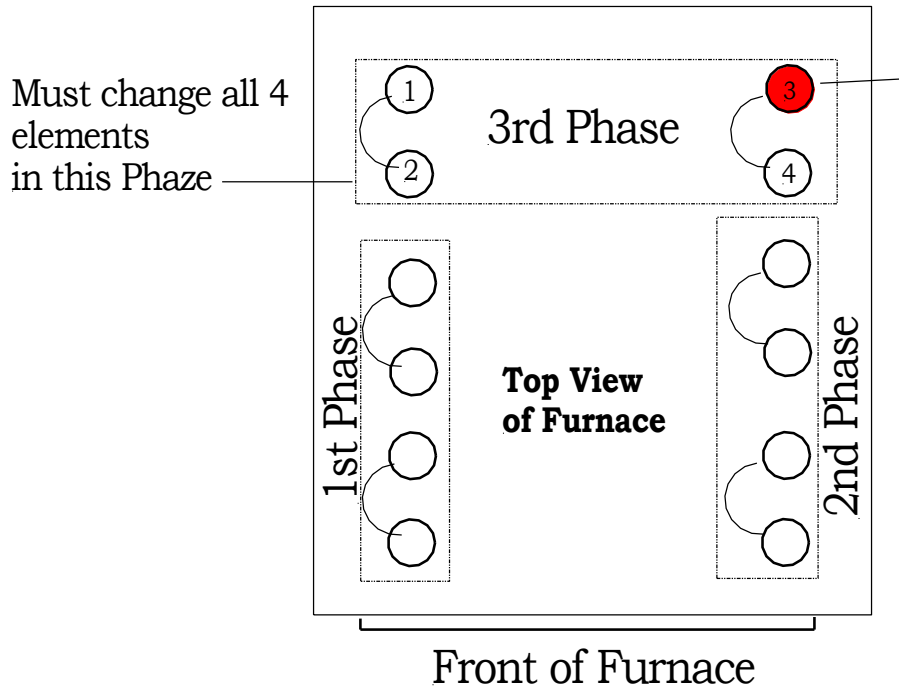
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It is ok to have each phase on different voltages so that you can balance the amps.

E.g. If one phase is only running at 10amps then you can increase the voltage to that phase to run the same as the other phases.



Also if an element breaks or it fails for some reason, you must change all elements in that phase and then reset the voltage tap back to the setting required for new elements.



If you only replace the one damaged element then you will rapidly reduce the life of that element as you will still require higher voltage to operate the other 3 elements left in that phase.

When an element has failed in a phase, most labs replace all the elements and then keep the undamaged elements to one side in case another element is damaged later. They can then replace the older element into that phase without changing the voltage taps and thus save using new elements.

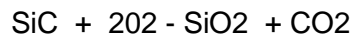
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# SILICON CARBIDE ELEMENTS.

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Generally a heating element made of silicon carbide is gradually oxidised due to its application over long periods, increasing its electrical resistance; that is, aging results. This is due to the partial oxidisation of SiC, which is formed into SiO<sub>2</sub>, diminishing the electrical conductivity of SiC according to the reaction.



To prevent oxidisation and to preclude an increase in electrical resistance, the surface is covered with a film coating, which, being stable without comparison, helps minimise aging and ensures a considerably longer life. When the electrical resistance has increased to about five times the incipient value, the service life of a heating element may be considered expired. In actual application its aging speed depends on the applicable temperature, watt density, operating type (continuous or intermittent), atmosphere in the furnace, and so on.

## EFFECT OF APPLICABLE TEMPERATURE:

The aging speed on SiC varies considerably according to its applicable temperature; the higher the temperature, the quicker the aging speed.

If, however, the density of its surface load is diminished despite high temperatures inside the furnace, silicon carbide elements can be employed over a prolonged time.

## EFFECT OF OPERATING TYPE: (CONTINUOUS OR INTERMITTENT)

Even when the furnace temperature and the watt density remain the same the effect on continuous operation of silicon carbide differs from that of intermittent operation (for instance, operations only during the day); that is, the latter type has harmful influence upon silicon carbide. This is considered due to the fact that SiO<sub>2</sub> formed by the oxidisation of SiC experiences abnormal expansion and contraction at about 250 degrees C (the transformation point of cristobalite), the repetition of which imparts mechanical shocks to the inner structure of the heating element, producing tiny cracks.

## INSTRUCTIONS ON REPLACING PROCEDURES:

When replacing the heating elements, replace all of the elements installed in the same regulating circuit. This will not only ensure their long service life, but will also prove more economical for the following reasons:

Partial replacement of heating elements in a parallel connection will overload the new elements, and that in a series connection will overload the old elements. This will not only disturb temperature distribution but also will impair the service life of the elements. Classify the removed elements according to their electrical resistance, and store them as spares.

BECAUSE SILICON CARBIDE ELEMENTS INCREASE IN RESISTANCE AS THEY AGE, THE POWER SUPPLY TO THE ELEMENTS IS SUPPLIED PER A MULTI-TAPPED TRANSFORMER. THE TAPPINGS ON THE TRANSFORMER FITTED TO THE FURNACE MAY START AS LOW AS 30 VOLTS AND GENERALLY ARE IN 5 TO 10 VOLT STEPS TO AS HIGH AS 150 VOLTS, WITH ONE TERMINAL MARKED COMMON OR TO" VOLTS.

TO INCREASE THE VOLTAGE SUPPLY TO THE ELEMENTS, MOVE ONLY THE CABLES ON THE VOLTAGE TAPS.

DO NOT MOVE THE CABLE MARKED ZERO V (COMMON) UNLESS THE TRANSFORMER IS FITTED WITH 0V + 5V TERMINALS, IN THIS CASE THE MAIN TAPS ARE AT 10 V INTERVALS AND IT IS POSSIBLE TO SPLIT EACH 10V TAP BY MOVING THE LEAD FROM THE 0V TAP TO THE + 5V TAP THEN BACK TO THE 0V TAP ON THE NEXT CHANGE UP ON THE MAIN TERMINALS AND SO ON.

INCREASE IN THE RESISTANCE OF THE ELEMENTS WILL BE EVIDENT BY A SLOWING *DOWN* OF THE RECOVERY TIME ( HEAT-UP) OF THE FURNACE. THIS IS ALSO INDICATED BY THE AMMETER/S.

THE MAXIMUM RECOMMENDED READING ON THE AMMETER/S FOR THIS FURNACE is 25 AMPS.

IT IS POSSIBLE THAT THIS READING MAY BE EXCEEDED BY 10% UPON STEPPING UP THE TRANSFORMER. THIS IS ACCEPTABLE BUT HIGHER READINGS WILL OVERLOAD THE ELEMENTS AND TRANSFORMER.

### **REPLACING ELEMENTS**

SHOULD ONE OR MORE ELEMENTS FAIL PREMATURELY IT IS RECOMMENDED THAT THE COMPLETE SET IN THAT PHASE BE REPLACED.

THE AGED ELEMENTS CAN BE STORED AS SPARES AND GRADED BY THEIR ELECTRICAL RESISTANCE.

PARTIAL REPLACEMENT OF A SET OF ELEMENTS IS **NOT RECOMMENDED**.

### **ELEMENT LIFE.**

AS PREVIOUSLY STATED, THE LIFE EXPECTANCY OF SILICON CARBIDE ELEMENTS DEPENDS ON SEVERAL FACTORS.

BECAUSE OF THE RELATIVELY LOW OPERATING TEMPERATURE OF CUPELLATION FURNACES, THE INCREASE IN RESISTANCE OF THE ELEMENTS SHOULD REMAIN WITHIN 7 -10% PER 1000 HOURS OF OPERATION.

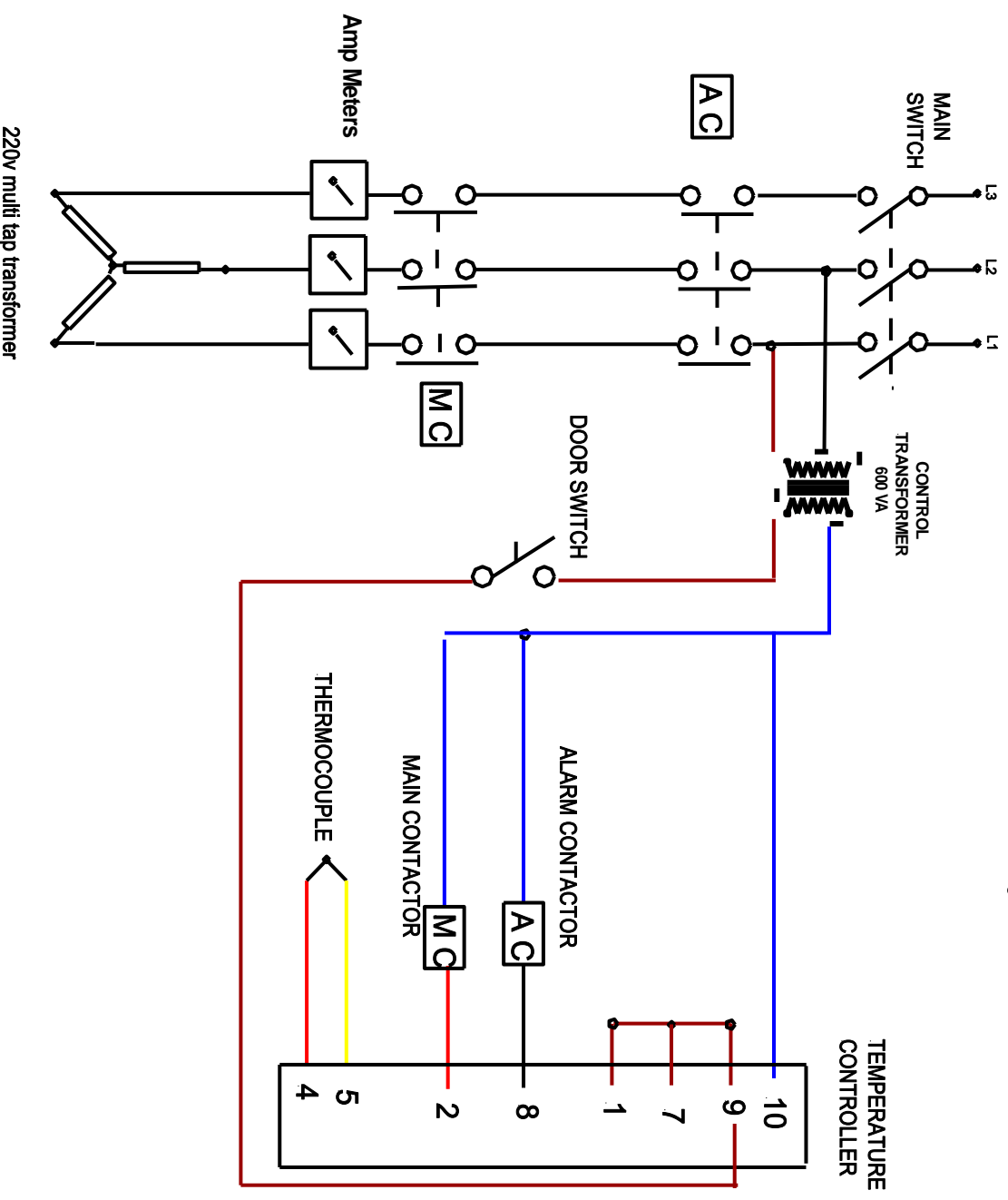
AFTER FITTING A NEW SET OF ELEMENTS, GO BACK TO THE LOWEST TAP ON THE TRANSFORMER TO START.

# Electrical Schematic for Electric 20 place Fusion Furnace 15 kva 220v

220VOLT 3 PHASE SUPPLY

# Furnace & Assay Supplies

- COMPONENTS**
- TEMPERATURE CONTROLLER  
OMRON E5CZ-R2MT FAS-648
  - MAIN CONTACTOR  
ABB A50-30-1 110V FAS-515
  - ALARM CONTACTOR  
A50-30-11 110V FAS-515
  - DOOR SWITCH  
OMRON D4D-1121N FAS-509
  - THERMOCOUPLE  
TYPE 'K' FAS-406
  - MAIN SWITCH  
Moeller P1
  - AMP METERS  
IME 72squimm 0-30 DC
  - ELEMENTS  
20\*500\*1000 FAS-209



220v multi tap transformer

## Maintenance

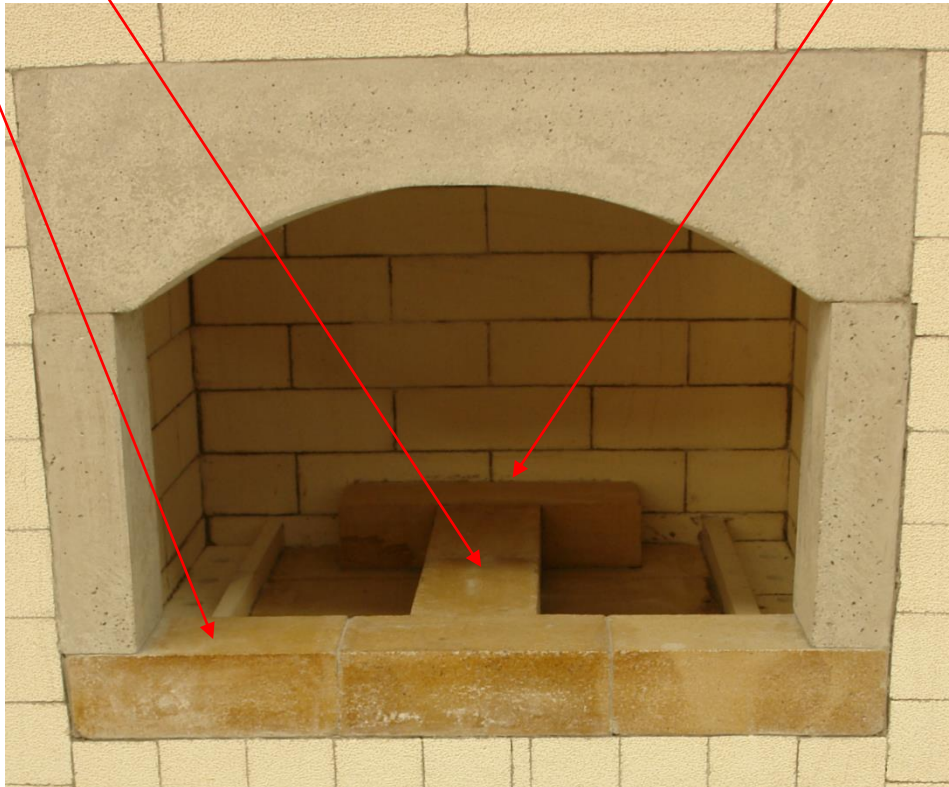
### MUFFLE CHAMBER INSTALL

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#### **Firstly Remove Thermocouple.**

Remove old muffle and vent and ensure that all debris is cleaned out.

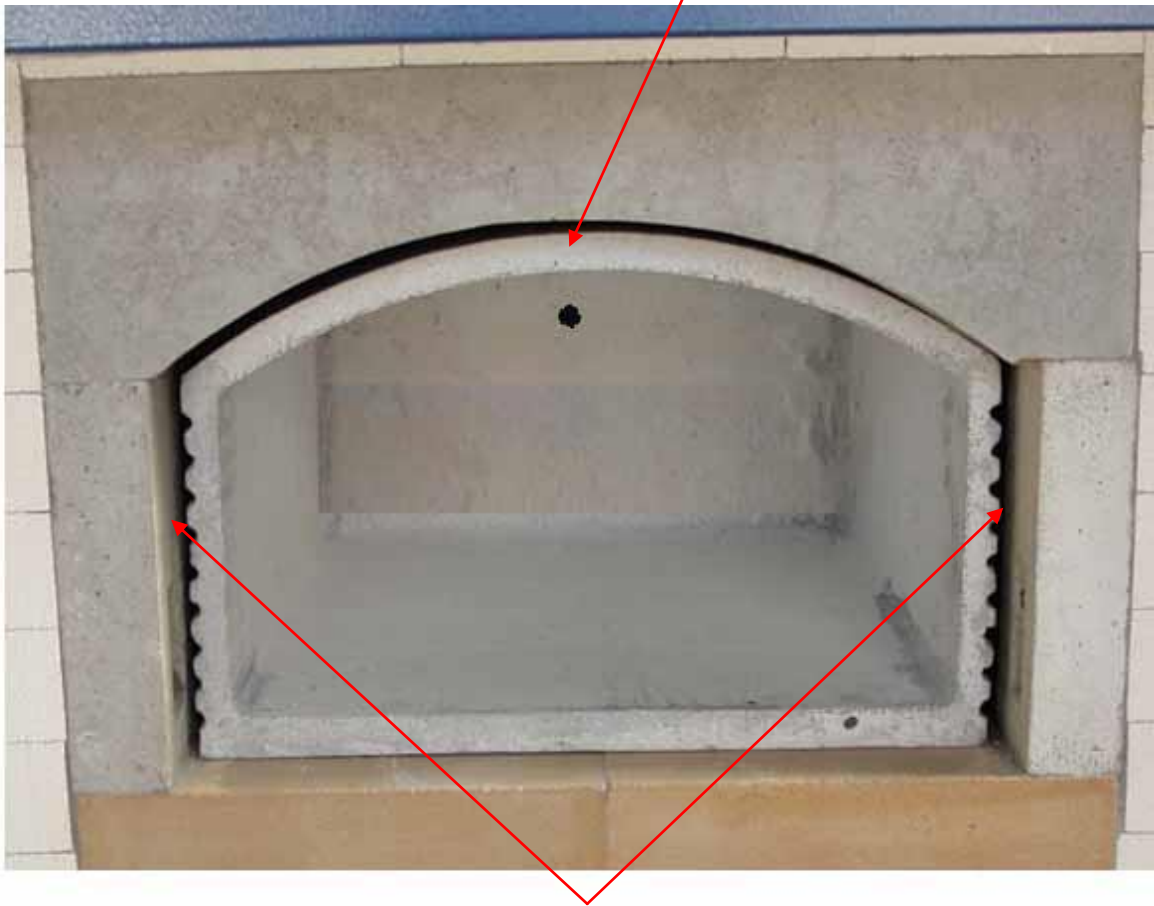
Before installing new muffle you must make sure that the back wall, back ledge and front ledge are clean and smooth.



**Note:** If the back wall, back ledge and front ledge are not cleaned properly, the muffle will not sit correctly, meaning the muffle will not work correctly, and will not last as long.



Depending on size of muffle, lift in by hand or place into position with forklift. (put tynes together and pick up via roof of muffle)



Position new muffle in place, make sure it is pushed right to the back wall and try to leave even gaps either side of the muffle.

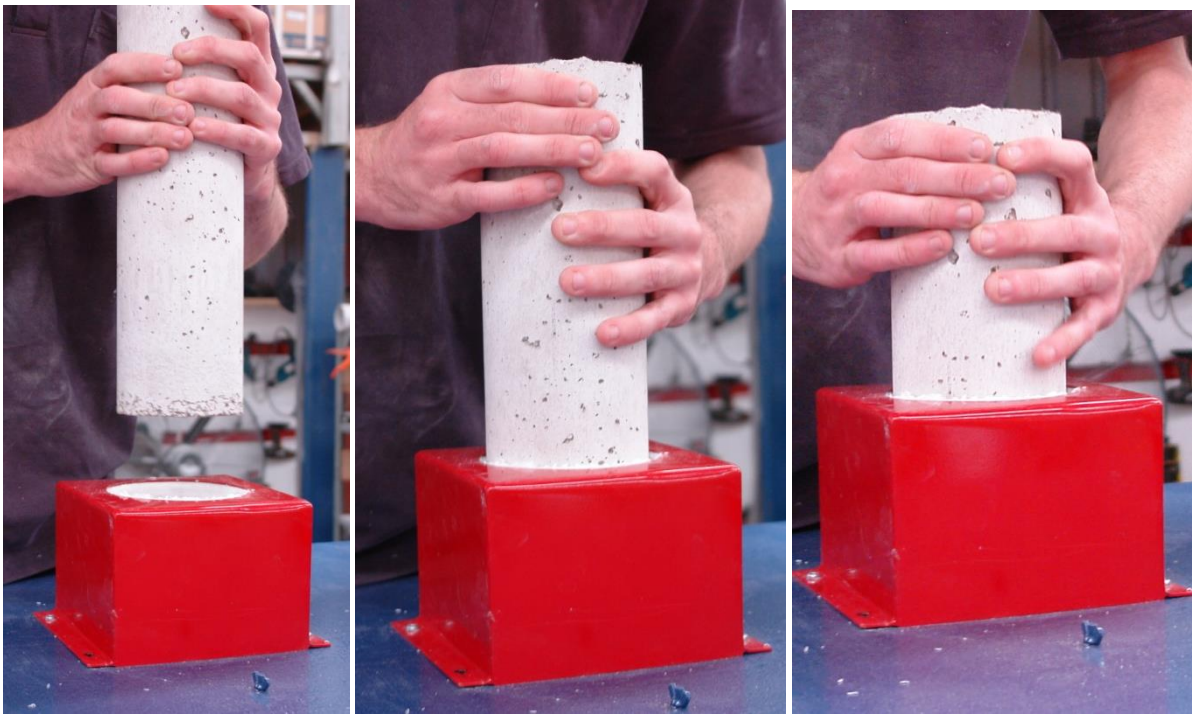
Once muffle is in position, cut Lengths of 25mm Kaowool (20mm wide x length of roll 610mm) and stuff around muffle. Make sure it is a tight fit and do not leave any gaps. Replace Thermocouple.



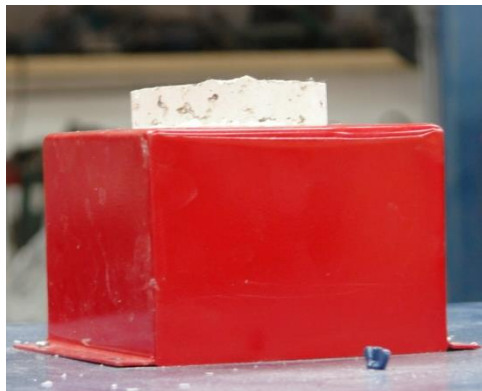
Once all kaowool is installed smear a thin layer of mortar over the kaowool and lip of muffle



## Installing Vent Tube



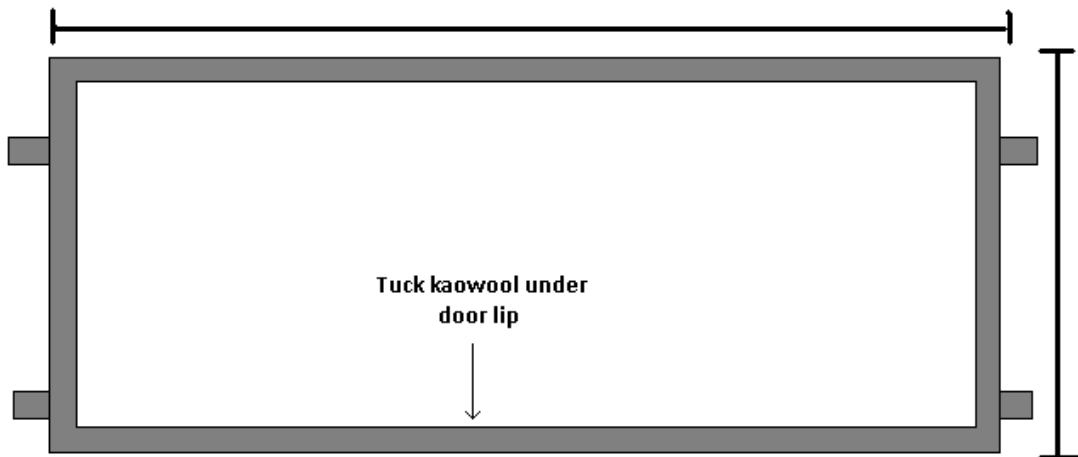
Put a small amount of Mortar on the bottom of the Vent Tube.  
Once you have done this simply slide the vent in place.



# Repacking door

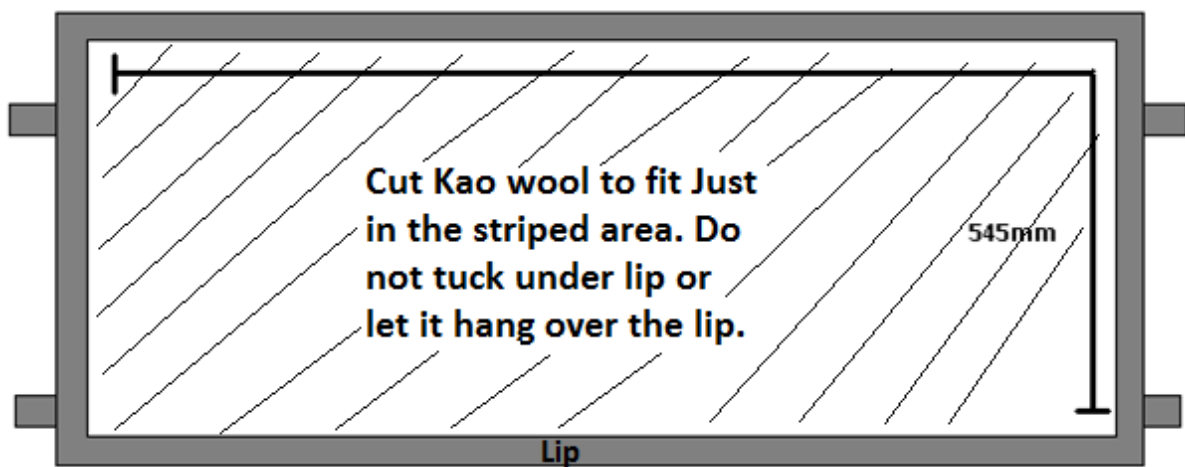
## First, second and third layer

1. Cut 3 x 25mm Kaowool (or 1 x 50mm & 1 x 25mm kaowool) wide. and Fill the inside of the door, making sure all 3 layers are tucked under the door's lips.



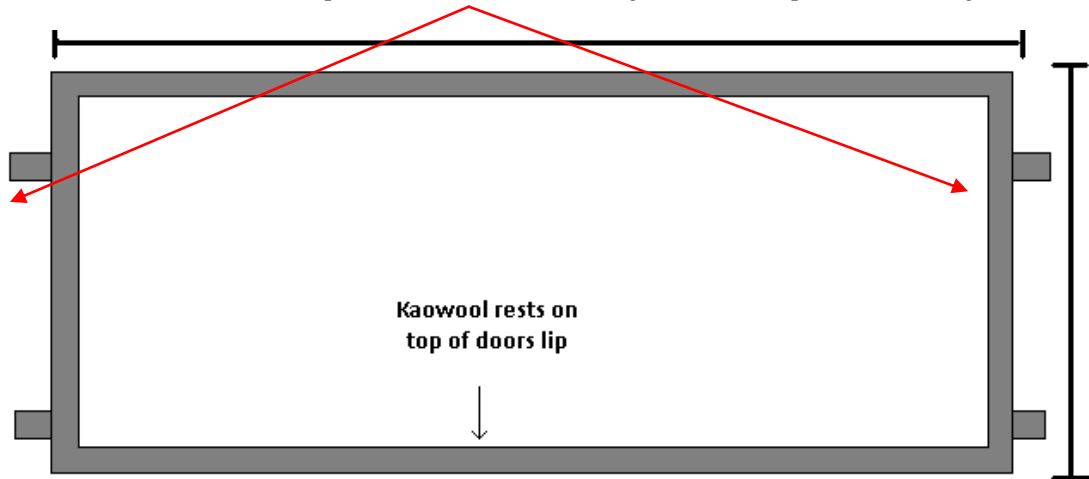
## Fourth Layer

2. Cut 25mm Kaowool so it fits on the inside lip of the door.

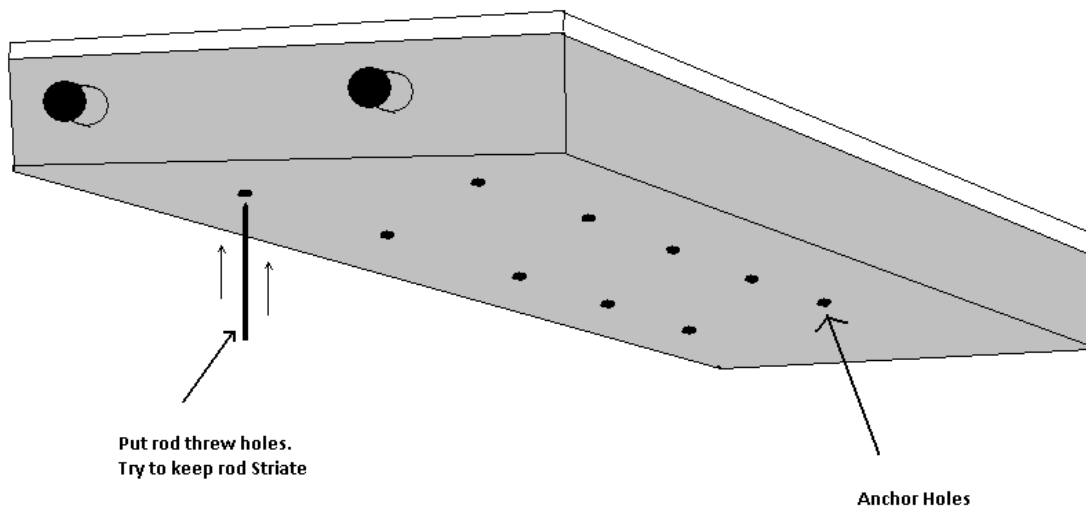


## Final layer

3. Cut 25mm Kaowool to the length of the door plus 40mm (width = roll width) and place so that a 20mm overhang of kaowool is present on the edges shown.

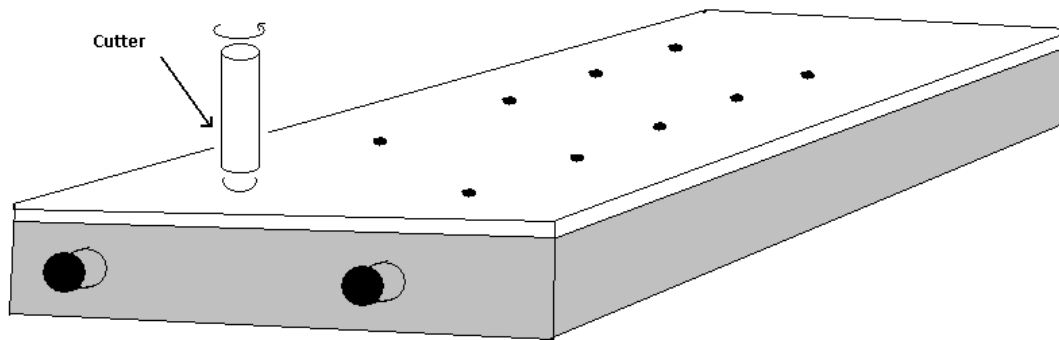


4. Using a guide like a screw driver, push up through the existing anchor holes in the door's body, keeping the guide straight until it comes through top layer of kaowool. Once guide is through wiggle around to make a slightly bigger hole.

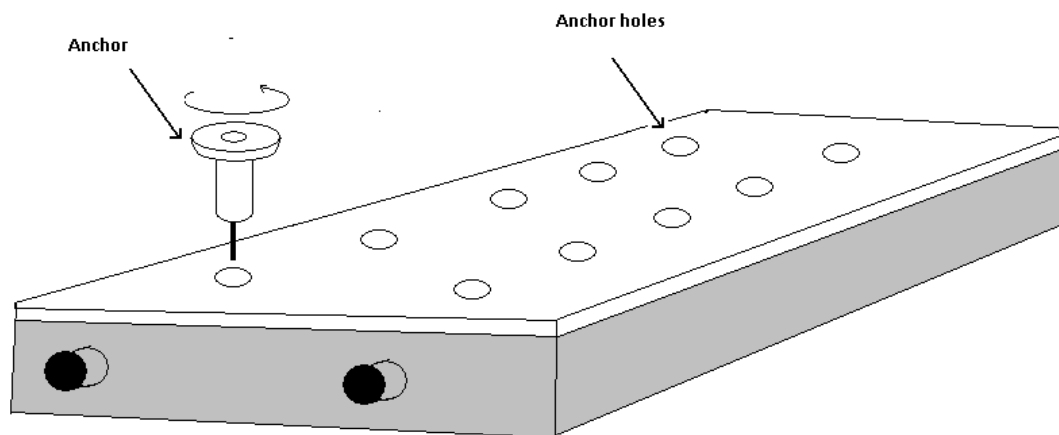


5. Place a screw driver through the hole (kaowool side up) then the cutter over the screwdriver (a piece of pipe with a circumference of about 25mm by 100mm long with a mark about 50mm up)

Keeping the cutter at 90 deg, cut down to marked line in cutter (50mm) and pull out. Knock out kaowool stuck in cutter. Once cutter is pulled out there is a hole big enough to place anchor through.



6. Screw anchors into holes cut out by cutter in kaowool until the bolts come through the pre drilled anchor holes in the door's body. Once bolt is through secure with a wing nut.



7. Once all anchors have been installed, use a straight edged, flat piece of wood and a sharp knife to cut off overhang kaowool. Place flat piece of wood under the top lip of kaowool. Place straight edge onto the top later of kaowool making sure the straight edge is lined up flush with the outer lip of furnace door top and bottom. Push straight edge down firmly and cut off excess kaowool.