旺耘有限公司

Wang Yun Co.,Ltd.

High Frequency Induction Melting Furnace 250KW

Operation Manual

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Content

I. The operation principle of medium frequency induction melting furnace

i. General outline

Melting Furnace induces high density Eddy Current on metal conductors by the electromagnetic induction of Primary Coil and generates Joule Heat to melt down the work pieces. The characters of this technology are as below:

(1) Heat up work pieces directly to melt down it by electromagnetic induction. The thermal efficiency is good, melting speed is also high and stirs itself automatically.
(2) Improve temperature control for melting metals.
(3) Improve the chemical composition for melting metals.
(4) Reduce fuel cost.
(5) Reduce the cost of air pollution.
(6) Simple and easy to operate.
(7) Improve working environment.

The way to heat up metals of induction melting method is much easier than other method. It is not to heat by outside thermal source but generates induced thermal inside of materials. The thermal loss is the lowest. If you use gas, oil or solid fuel for heating up, most of the thermal energy will be loss through chimney, not to heat up work pieces.

ii. Operation principle

In case of frequency transformation, we use the AC→DC→AC method. It also can transfer 50-60 HZ frequency to AC high frequency directly without transfer to AC first. But the AC→DC→AC method can operate the Silicon Controlled Rectifier more efficiently. Moreover, the existence of DC converter makes wave filtering become easy. Wave filtering can prevent the noises occur in the electric power circuit that could interfere with other electric devices. Wave filtering can also stabilizes DC circuit and simplify the control system of frequency converter.

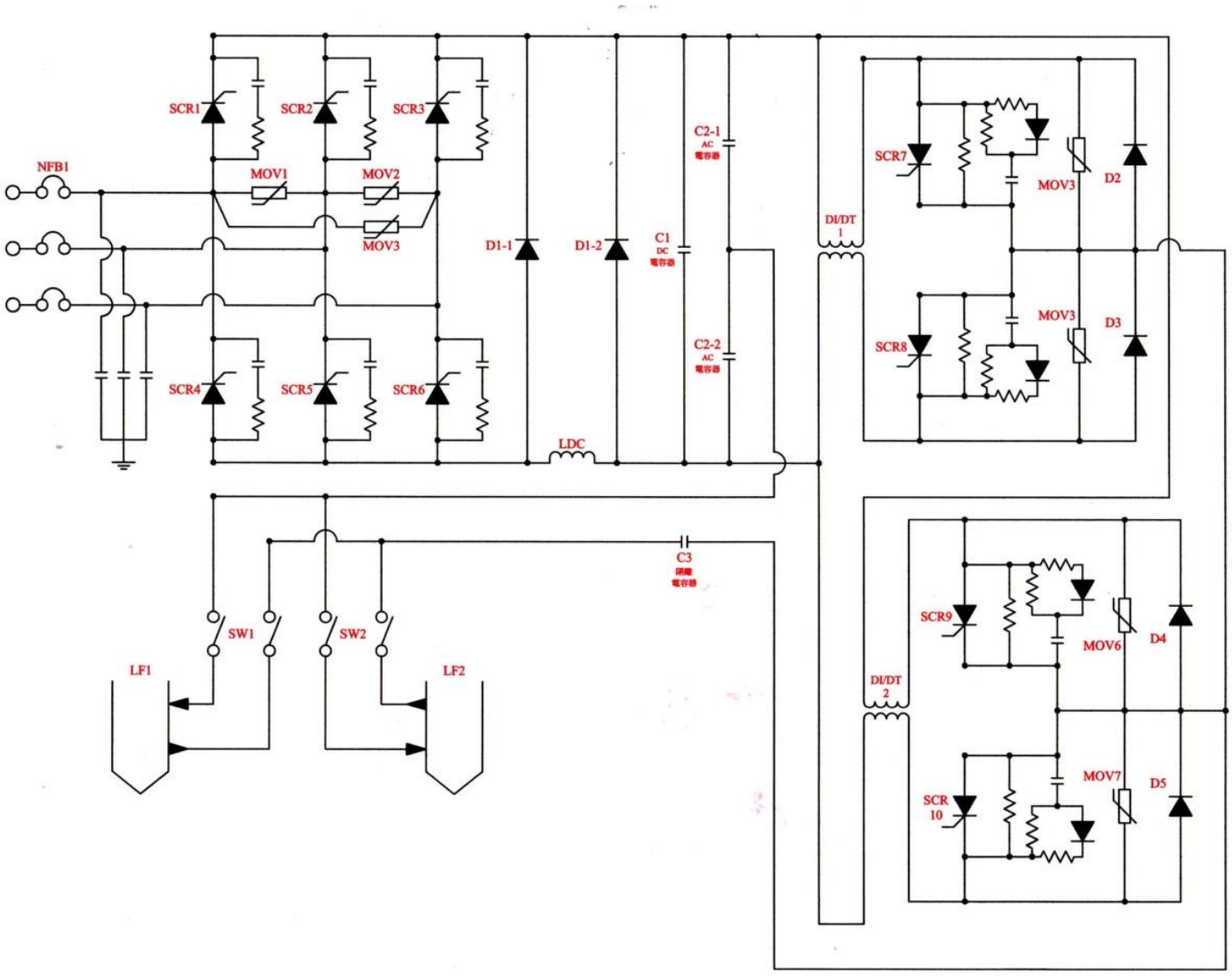
The circuit is described as below: (Annex I)

(1) Three-Phase, 380 ~ 460V AC electric power，pass through the No Fuse Breaker (NFB1), to fit other parts to make sure that the circuit is open in half-wave-voltage and limit the current flow for preventing to damage the diode and Silicon Controlled Rectifier. Pass through the Three Phase Bridge Rectifier (SCR 1-3，D1-3), LC wave filter, circular inductance and more one wave filter condenser(LDC，C1，C2) to transfer to 537-650V DC then flow into frequency converter and Resonant Circuit.

(2) The main part of frequency converter is Silicon Controlled Rectifier (a high speed switch) that controlled by pulse wave signal of printed circuit. The output frequency is not fixed and is variation base on the pulse wave of Silicon Controlled Rectifier (S.C.R.).

(3) Resonant Circuit of frequency converter output high frequency power and transfer to heating coil directly. Transfer electric power to the work piece for melting via electromagnetic induction.

Annex I : Main line diagram

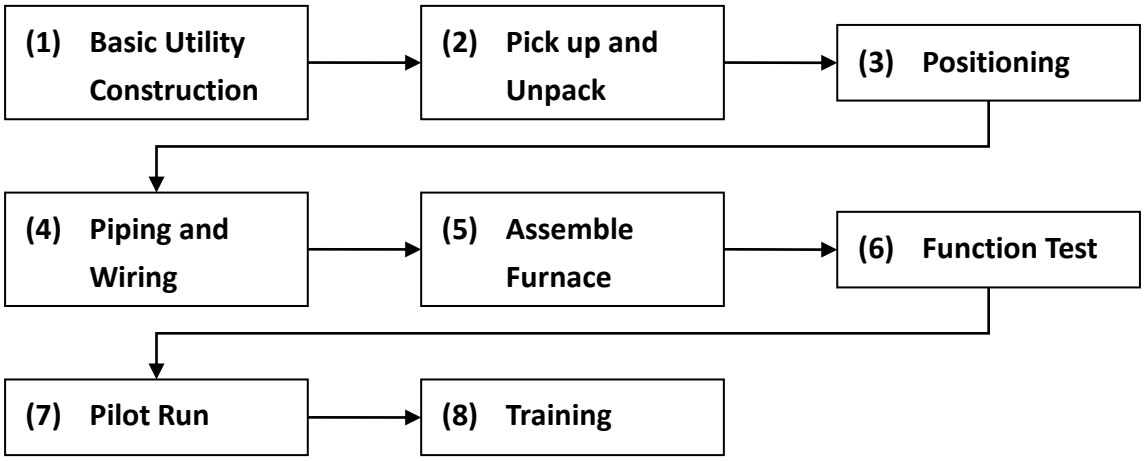


II. Installation and introduction of equipment

i. Installation

When High Frequency Induction Melting Furnace move to costumer site, please follow the engineers from maker to unpack and check inside fixedness of equipment and if there is any visible damage inside and outside of equipment. If there is any damage found, please contact maker immediately.

The installation procedure is shown as below:



(1) Basic utility construction

A. Fully refer to the engineering drawing, if there is any field constraint occurred and need to do some engineering change, please contact maker first.

B. Do grounding in advance.

C. Leave electric wire and cable for main equipment in advance

(2) Pick up and unpack

Unpack to check if there is any damage under senior executive's supervision. Check all of the part and send into warehouse. If there is any short of part, please contact maker immediately.

(3) Positioning

Fix the position of main frame, furnace and cooling tower. Drill the ground base and fix the foot of furnace by expansion bolts. The position of cooling tower should be higher than main frame and emergency water supply tower should be higher than cooling tower.

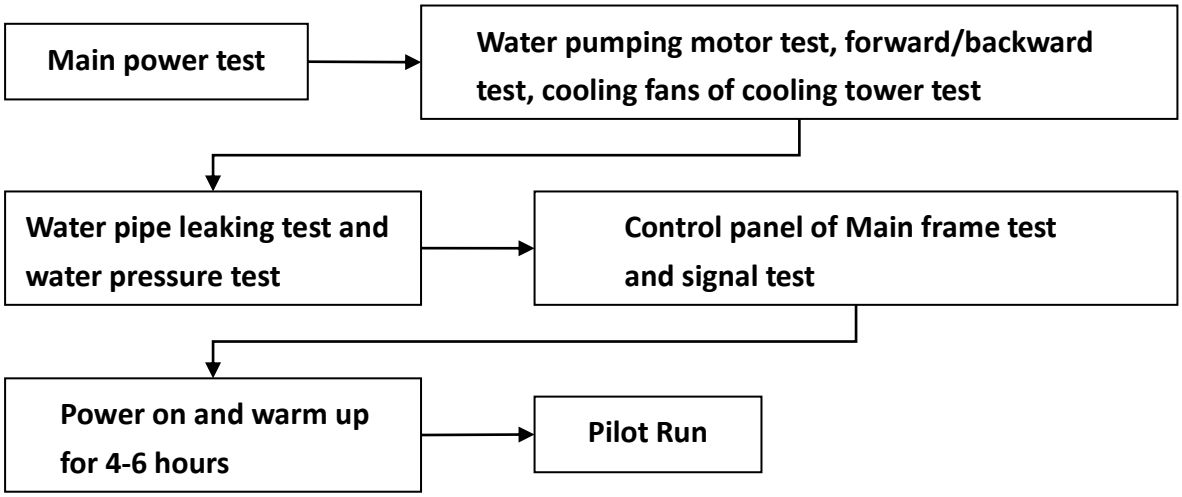
(4) Piping and wiring

Do piping and wiring after positioning. The material of water pipe is related to local climate. Stainless steel and PVC are better in general but PVC is not suit if the winter is cold. Galvanized iron pipe is the next choice. The pipe for main frame and furnace will be installed by maker's engineer and please assign some assistants.

(5) Assemble furnace

Assemble by user. Maker offer guidance if needed.

(6) Function test



(7) Pilot run

First of all, put steel or iron into furnace and then preheats for sintering and drying for at least 4 hours. Heat up steel to be red but not be melted down. After finished sintering, start to melting steel and have subordinate, Residue Eliminators and Air Gun prepared.

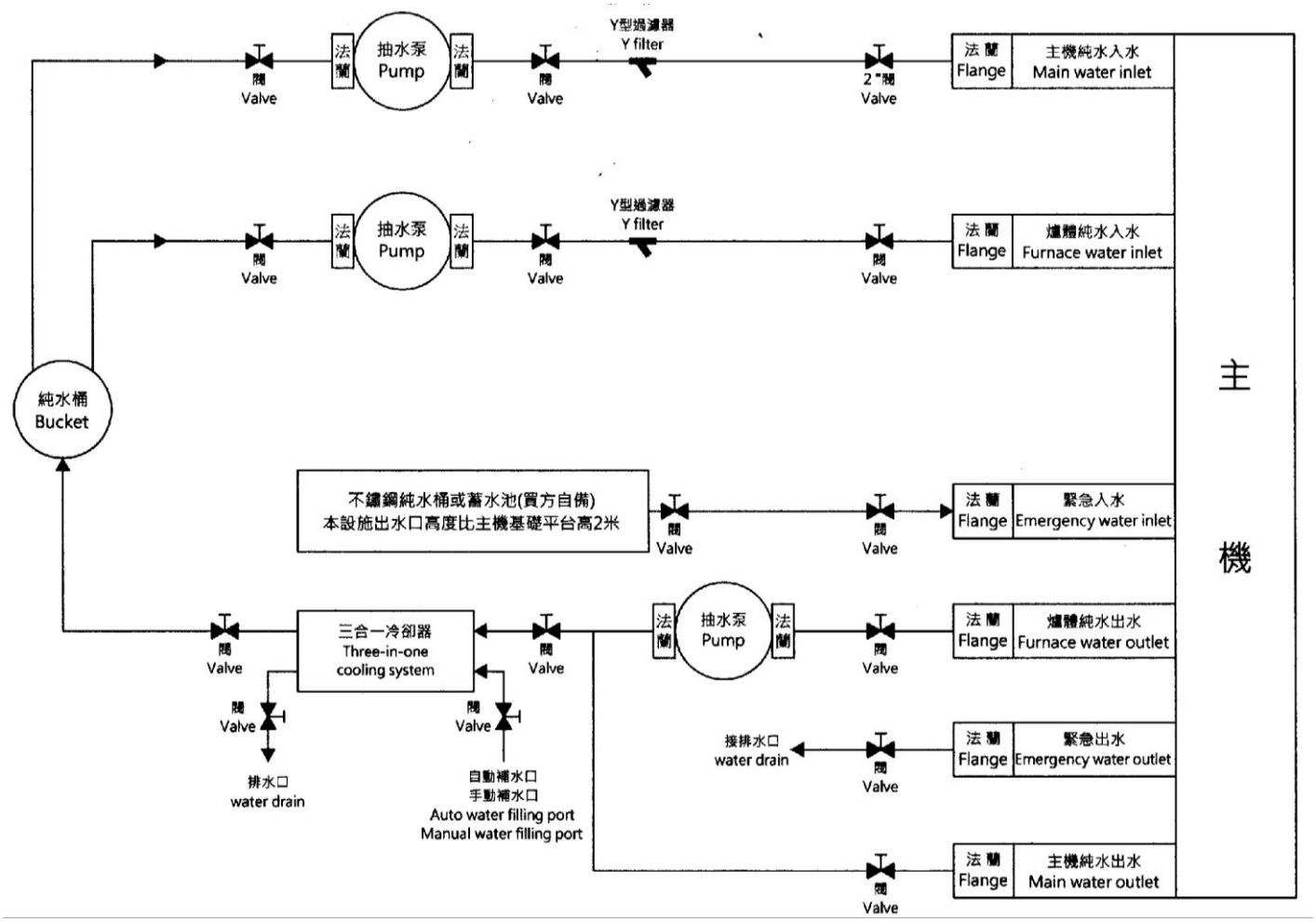
ii. Equipment instruction

Standard component of High Frequency Induction Melting Furnace include one main frame, one cooling water control system, two furnaces and one cooling tower, one water tank for 1-2 ton(s) water. Option parts include temperature detector and large-sized monitor.

System frameworks are described as below :

Control system of cooling water for main frame

(Three-in-one Cooling System)



This design uses the newest High Speed Silicon Controlled Rectifier and High Speed Recirculation Diode to build up a Full-Transistor Frequency Convertible Induction Heating System. All devices installed inside a power control case to prevent people hurt from error touching.

There are two main part of this equipment and described as below :

(1) Main controller

The height of main frame is 180cm and width is 110cm. Leave enough space for opening the door of power control case. The control buttons and adjusting switches are at the left side of power control case. If the cooling water system is placed inside of main frame, then the switch of cooling water system is at the right side of power control case. Circuit breaker is to switch power on/off and is at the up side of the left surface of power control case. Pressure meter and temperature meter are at the right up side of front surface.

Functions instruction of the panel on main frame:

A. Main power lamp on :
   It indicates that main frame is power on and three-phase AC power is converted to DC power.

B. High frequency operating lamp on :
   High frequency is outputted to furnace.

C. Abnormal start lamp on :
   The host operation is failure, need to check to exclude the problem.

D. High frequency limit lamp on :
   It indicates that the frequency is high to the higher limit.

E. Power control on :
   The main controller function is normal and can set the output range.

F. Power limit lamp on :
   Power output is full loading, main frame will do limit control automatically.

G. Voltage limit lamp on :
   Furnace voltage is at limit.

H. TOT limit lamp on :
   After silicon controlled rectifier stop conducting electricity and before close the forward voltage safely, a minimum time interval is needed. This time interval is called turn-off-time. Dense and magnetism material may lead to TOT limit lamp on under curie temperature.

I. Outer water temperature lamp on :
   The lamp on when the temperature of cooling water for furnace body coil is too high.

J. Inner water temperature lamp on :
   The lamp on when the temperature of outlet of cooling water for main frame is too high.

K. Outer water pressure lamp on :
   The lamp on when the pressure of cooling water for furnace body coil is too low.

L. Inner water pressure lamp on :
   The lamp on when the pressure of inlet of cooling water for main frame is too low.

M. Furnace body switch lamp on :
The lamp on when switching error occur during switch furnace or when error occur during opening water valve.

N. Leaking test lamp on :
Melt leaking or furnace humid.

O. Capacitor failure lamp on :
Resonance capacitor failure or internal pressure is too high, cause the pressure switch trip or failure.

P. KW meter :
Show the power of high frequency output.

Q. FV meter :
Show the voltage of the two ends of furnace.

R. HZ meter :
Show the frequency of high frequency output.

S. Leaking teat switch :
To test if the leaking test is normal.

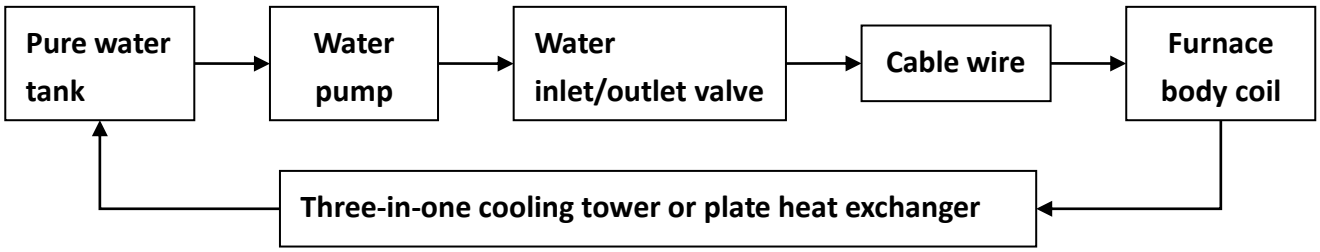
T. Rectification on :
Press to start rectification output.

U. High frequency start button :
Press to start high frequency output.

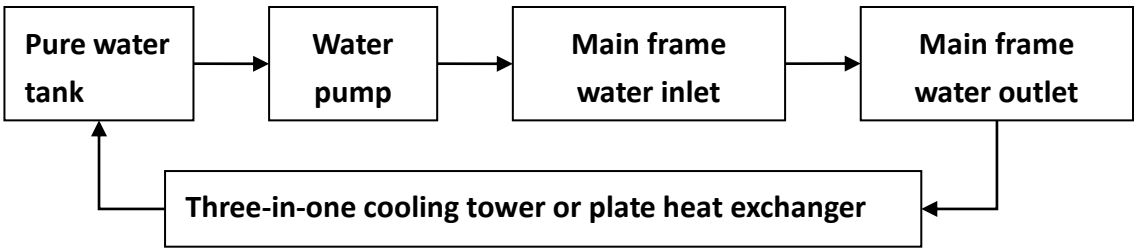
V. High frequency off :
Press to close high frequency output

(2) Cooling water system :

A. Furnace body cooling system



B. Main Frame cooling system



III. Operation procedure

i. Start up (daily operation)

(1) Check if there is any crack or corrosion of furnace.
(2) Open inlet and outlet water valves of furnace.
(3) Check if the water level is high enough. Resupply water if level is low.
(4) Start up water pumps for main frame cooling water and furnace cooling water.
(5) Check if there is leakage of circulating water. Check if there is any leakage of connecting point of main frame cooling water pipe.
(6) Close the power control case and close the furnace body switch gate.
(7) Press on the No fuse breaker (N.F.B) and the green power control lamp and red trouble lamp are on.
(8) Press red " High frequency off " button and turn off the red trouble lamp. The yellow main power lamp is on.
(9) Make sure the power knob is at zero position, press the green " High frequency start " Button, the system is now ready.
(10) Fill materials carefully and softly. Absolutely free of oil and impurity on materials. Put materials as closely as possible to prevent bridging. Bridging may lead to corrosion of furnace lining and even melt to perforation.
(11) Turn the power knob clockwise to increase power, the pressure and frequency meter will both going up slowly.
(12) If voltage limit or TOT limit occur, decrease power till the voltage limit lamp and TOT limit lamp are off. Wait for a while and increase power again.

ii. Normal operation

Only few manual operations required during melting. What operator needs to do is adjust the power knob. The ideal condition is to keep the highest power output under “power limit” till melting finished at pouring temperature. Operator should monitor melting process carefully and well know the reading of meters. Any red lamp on is indicate a abnormal situation and have to check equipment immediately. The inlet temperature of cooling water and reading of meters need to be record. The outlet temperature of cooling water needs to be check after melting finished. Operator has to report any abnormal and find out the root cause. Connect maker if needed to make sure equipment running normally.

iii. Stopping procedure

The most important character of non-core melting furnace is able to produce intermittently. The fewest time needed before able to take out materials after stop furnace. There are several points to be taken care when stop furnace to prevent damage to furnace lining and crucible by thermal shock.

The stopping procedure is recommended as below:

(1) Pour put all of the melt as possible, if can’t , have the furnace body slant.

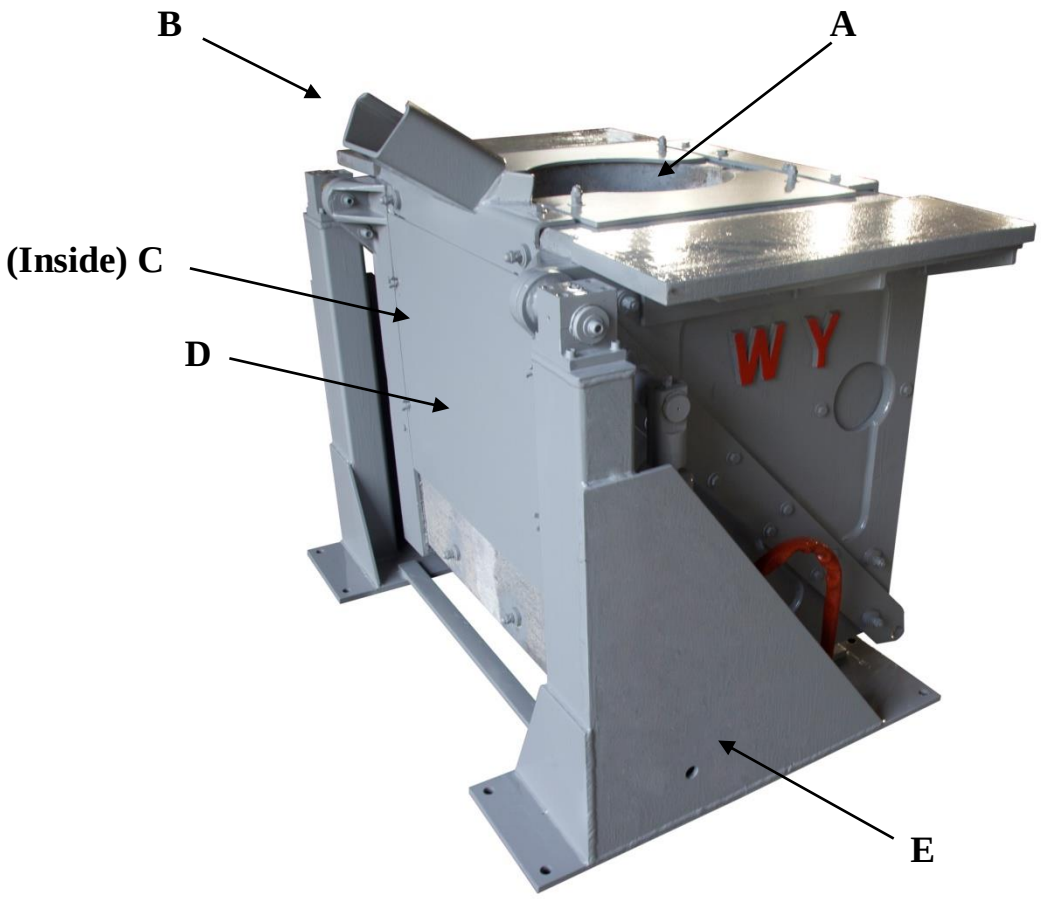
(2) Before press the " High frequency off " button, turn power knob to zero. Although it normally hurt nothing if you press " High frequency off " button at high power. Before control board of frequency converter accepts the " stop " command, it will turn down the frequency converter to origin state. But turn down the power is the way to prevent abnormal control.

(3) Press " High frequency off " button.

(4) Two minutes later, disconnect the No fuse breaker (N.F.B). The delay time between switch off frequency converter and disconnect power is to cool down equipment.

(5) Keep cooling water valves open for furnace body to slow down the cool down speed in order to prevent thermal shock of furnace lining and crucible. Keep the water pressure for furnace coil cooling water at least 1kg/cm2 to prevent from formation of air foam. Air foam could make local pressure rise up to split the pipe , or another damages.

iv. Furnace body structure (as below)



A. Furnace body feeding mouth
B. Furnace mouth
C. Furnace body bakelite side panels
D. Furnace body flap (front)
E. Furnace body support

IV. Operation safety and points for attention

i. Points for foundry's attention

Following are general points for attention for foundry and not cover all operation type. We recommend customers to modify or extend according their own operation.

(1) Only related person can use the channels for melting and pouring.
(2) Do not pile up stuff around equipment to interfere the channels.
(3) Operator should wear heatproof and fireproof overalls, protective footwear, helmet and protective eyeglasses.
(4) Use appropriate fireproof material as furnace lining for the melting object metal. Make sure to fully dry and sinter the furnace lining according to maker's recommendation.
(5) Use appropriate type of crucible for the melting object metal. Please follow crucible maker's specification.
(6) Use appropriate crucible holder if move melt with crucible.

ii. Points for operator's attention

All of the induction heating and melting equipment are working with high voltage. If you follow the operation rules, it is safety and efficiency to operate the equipment and is reliable and easily to be maintained.

This equipment has many safety devices to protect operators and operator must obey the following points:

(1) Have the door of power supplying case locked and let required people keep the keys.
(2) Have all safety covers closed and all devices are at the right position. Have the safety cover opened during equipment running is dangerous for operators.
(3) Before open any door of power control case, make sure the power switch is off. When anyone is working at power control case, basement, converge bus or furnace body, put a caution symbol in front of main power switch to avoid anybody to switch on the power.
(4) When feeding raw materials, keep the materials dry and free of combustible and liquid. Combustible and liquid in the melt could lead to intense vaporization even boiling or explosion.
(5) Be careful when feed low melting point material into high temperature melt to avoid intense vaporization.
(6) Please well known the chemical composition of the metal for melt. Some chemical reaction could damage to equipment.
(7) Take care of the feed in sequence for different material.
(8) Avoid any container that possible with liquid inside to be mix into the material. Liquid could lead to intense vaporization or spout out the melt.
(9) Check the furnace lining before feed in raw material and take out material. Any abnormal must be fixed immediately to avoid melt leaking. Melt leakage could melt down coil and touch with cooling water to cause an explosion. It is extremely dangerous.

(10) Prevent materials from bridging during melting. Bridging could make temperature of local melt too high to damage to furnace lining. If bridging is formed, have the furnace slant to let the melt surface touch with the bridging and supply only 75% power. After the bridging melt, have the furnace back to vertical.
(11) Operators have to follow the rules and keep good mental condition.

iii. Points for maintenance worker's attention

(1) Read operations manual and maintenance instruction in detail and discuss with maker's technical personnel.
(2) Well known the equipment and danger zones before try to do any maintenance.
(3) Do not enter the power control case before put a caution symbol in front of main power breaker.
(4) Use two independent methods to hold the furnace when working close to the slanted furnace.

V. Maintenance

i. Furnace body maintenance and emergency processing

(1) Please mix the furnace building materials follow maker's recipes.
(2) Do not mix any impurity into furnace building materials.
(3) Could put mica and asbestos between furnace lining and coil then put in fireproof materials.
(4) Well mix furnace building materials and feed in repeatedly with small quantity each time. Then hit the furnace building materials to become toughly with furnace building tools. Repeat these procedures to build up furnace building materials to the position 30mm under the top and finish with wet building method.
(5) Do not damage the coils during building furnace. If coil mortar fall off, repair it and absolutely do not mix with water glass.
(6) Lubricate the bearing of furnace body with oil or grease.
(7) Wrap the exposed water cooling electric cable and water pipe with asbestos cloth.
(8) Furnace lining normally won't be damaged under correct furnace building and maintenance within limit safety melting runs. If furnace lining is over corroded or cracks occurred, the situation should be repair even destroy and rebuild furnace.
(9) It could be an indication of lining wear through if the outlet temperature of cooling water is higher than usual or more molten ashes appear. Need to be noticed.
(10) If melt leak out during melting process, please switch off main power immediately and pour out all melt.
(11) Prepare a dry sand hole with dry sand and the size is able to contain the melt inside of the furnace. Cover the poured out melt with dry melt to prevent hurt from thermal radiation.

(12) If the melt unfortunately pass through the furnace body, coil is break and high temperature melt touch with the cooling water to cause an explosion, personnel leave for safety at first and close the inlet/outlet valves of cooling water if possible. Do not take any action before the situation is stable.

ii. Main controller maintenance

(1) Open the door of main frame without supplying power. Blow off dust with air gun and clean corners with small paintbrush. Do not damage control circuits and electric devices.
(2) Clean anything adhere to the electric conduction copper plate that may induce a sparkle.
(3) Lubricate the copper plate for furnace body switch with electrification lubricant. If there is a lot of dust, clean with dry cloth and diesel oil before lubrication.
(4) Check if there is any over heat or discoloration for all screws, electric cables, buses and devices.
(5) Check if there is any leakage for all connecting parts of water pipe.
(6) Check if the connecting points of control circuits and relays are loosened.
(7) Make sure all screws are tightened and all tools are taken out.

iii. Routine maintenance list

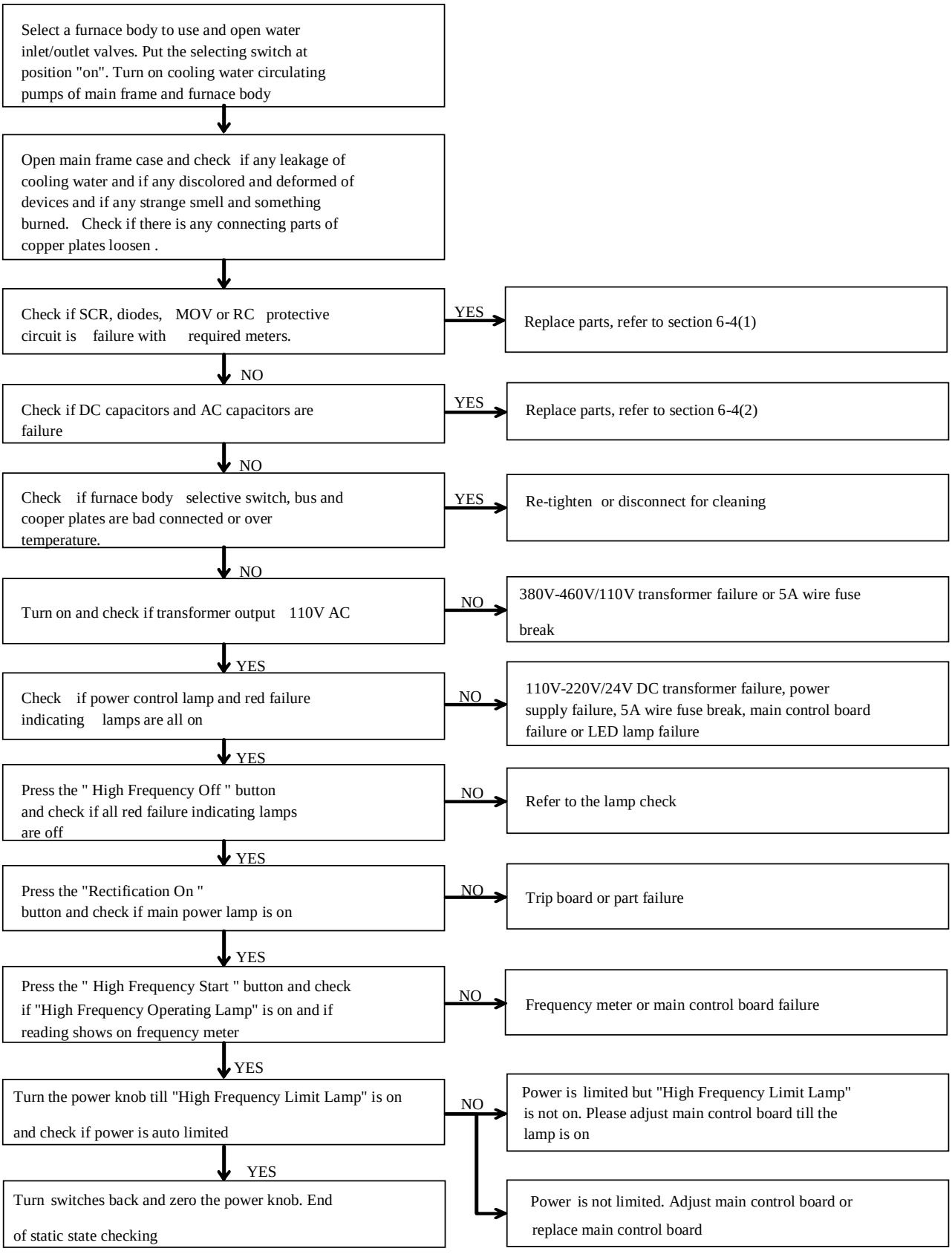
NO.	Check list	Daily	Monthly	Quarterly	Semi-annual	Depends
1	Check refractory material of furnace lining and fix or rebuild it if needed	✔				
2	Check if indicator lights work functionally	✔				
3	Check if the timer of cooling system works functionally	✔				
4	Check if there is any leakage for all connecting parts of water pipe and re-tighten it		✔			
5	Clean dust inside of power supply case with CDA		✔			
6	Check if any of copper plates and connecting parts of electric cables is loosen and re-tighten it		✔			
7	Check if there is any looseness for all connecting parts of electric devices and re-tighten it		✔			
8	Check if all water flow switches work functionally	✔				
9	Check if temperature switch works functionally	✔				
10	Check and lubricate the furnace body switch		✔			
11	Check if capacitors are deformed and leaking oil		✔			
12	Check furnace bodies and lubricate bearings		✔			
13	Clean cooling water tower		✔			
14	Check the connecting points of NFB		✔			
15	Clean heat exchangers and water tank		✔			
16	Lubricate the bearings of cooling fans on water pumps of cooling system		✔			
17	Renew the pure water of close-loop cooling system			✔		

VI. Failure and repair

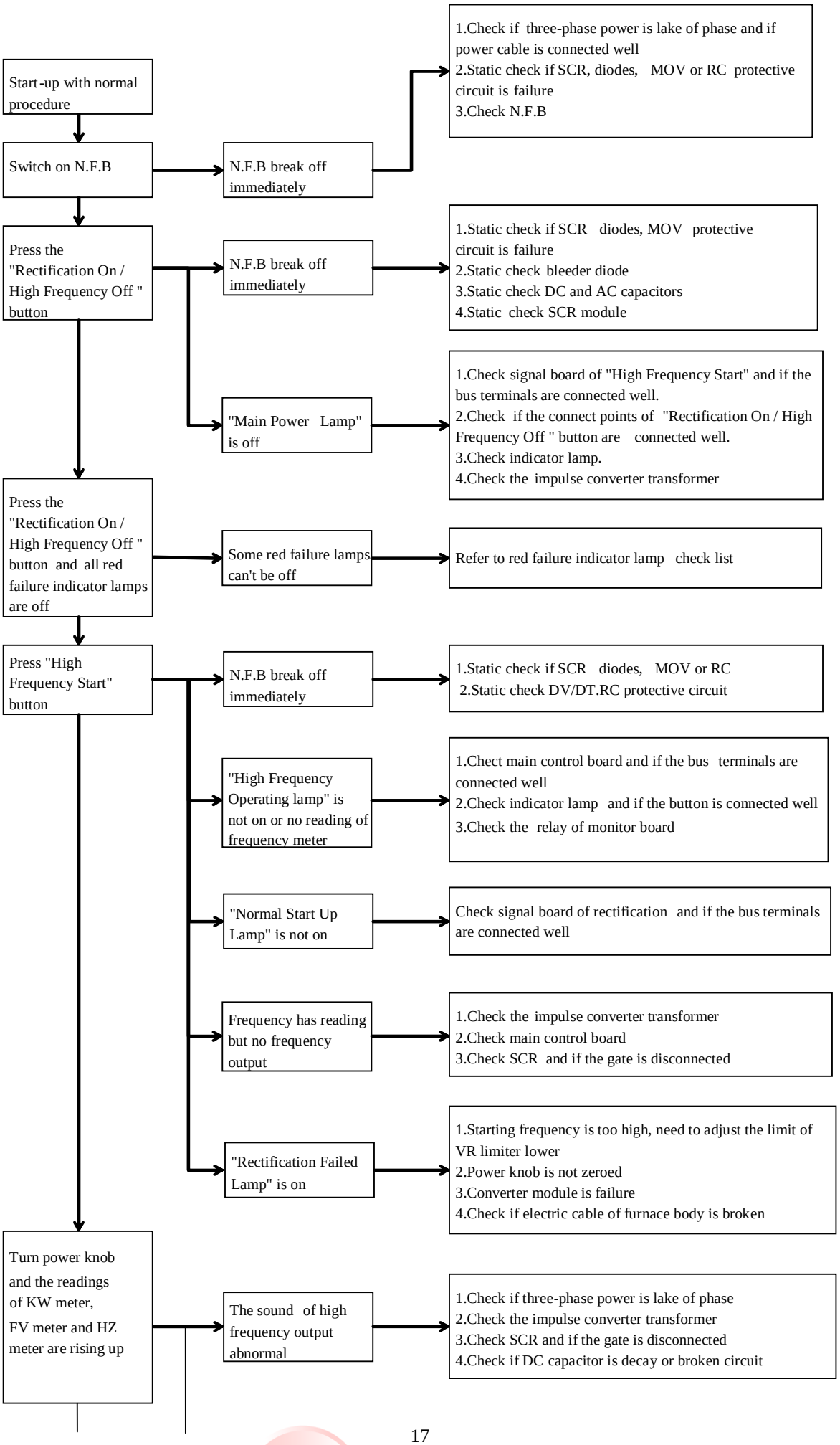
With good preparation and planning, most of the failure can be recovery easily and even just like a little inconvenient. Without good preparation and preventive maintenance, a small abnormal could lead to a serious outcome even damage to equipment and workers.

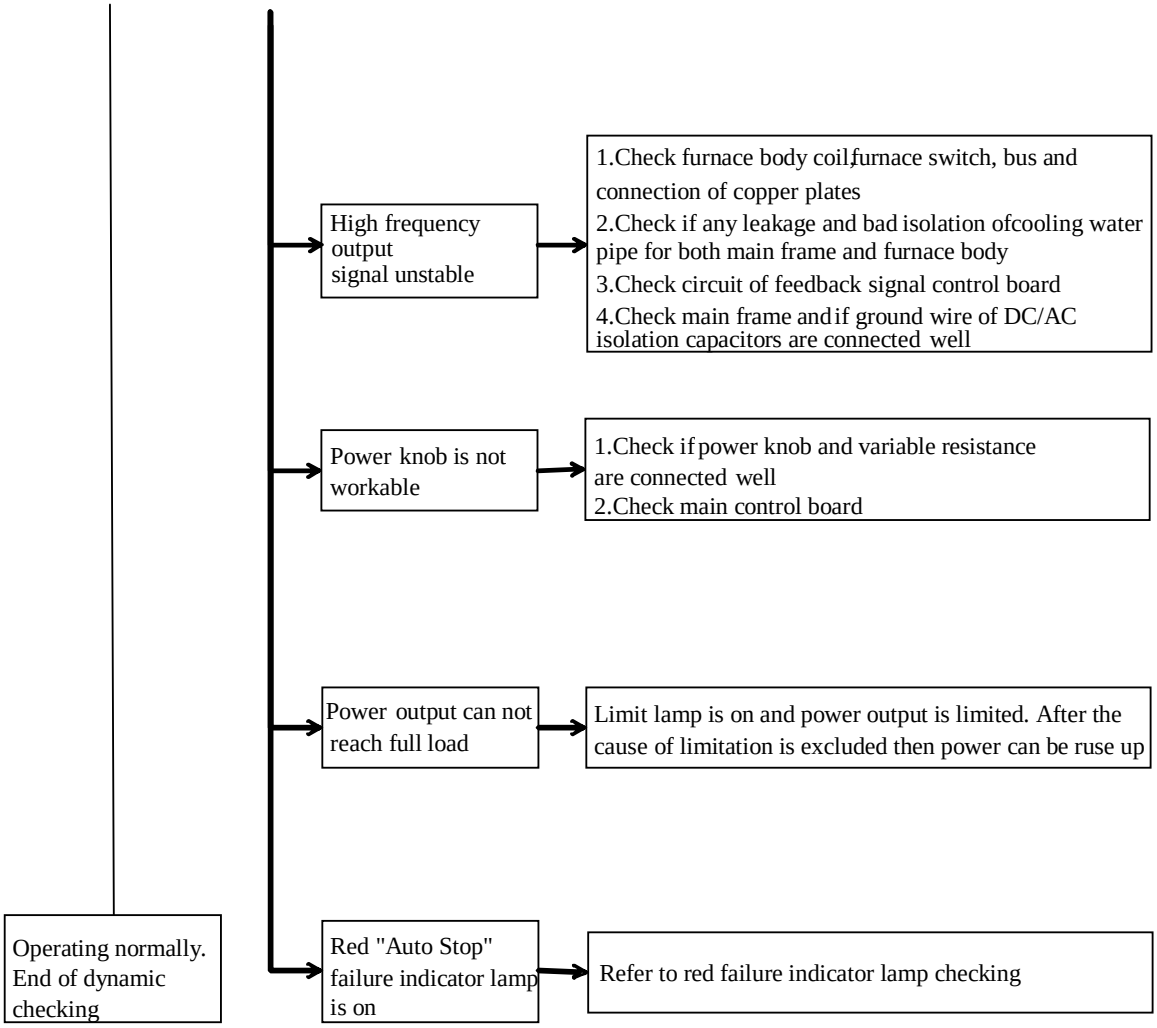
The following flow charts provide a general checking procedure for reference.

i. Static state check



ii. Dynamic state check





iii. Check list of red failure indicator lamps

Lamps	Possible Causes	
Outer Water Temperature Lamp on	outlet water temp. of furnace body coil too high	check if pipe jammed or bended
	inlet water temp. of furnace body coil too high	check cooling tower
	cooling tower heat dissipation bad	check cooling fan and cross distributor
	outlet water temp. switch failure or bad connected	replace switch or reconnect
	body coil pipe jammed or power cable bad	clean pipe with pipe cleaner, replace cable or pipe
Inner Water Temperature Lamp on	outlet water temp. of mail frame is high	check if pipe jammed or bended
	heat-exchanger bad	clean with pipe cleaner or disassemble for cleaning
	cooling tower heat dissipation bad	check cooling fan and cross distributor
	inlet water temp. switch failure or bad connected	replace switch or reconnect
	copper pipe jammed	disassemble for cleaning
	part inside of main frame heat abnormal	replace part
Outer Water Pressure Lamp on	inlet water pressure of furnace body too low	check water pump and cooling tower
	flow switch of outer water works abnormal	adjust or replace flow valve
	air remnant in pipe	switch on and off water pump for several times
	water level of cooling water tank too low	supply water manually
	water pump or inlet/outlet valve does not work	check
Inner Water Pressure Lamp on	circulating pure water inside of main frame too low	supply pure water
	flow switch of inner water works abnormal	adjust or replace
	air remnant in pipe	switch on and off water pump for several times
	water pump or inlet/outlet valve does not work	check
Furnace Body Switch Lamp on	furnace body switching error; both of two furnaces are on (or off) is not allowable	operate follow instruction
	micro switch works abnormal	check with multi meter or replace
	inlet water flow switch of furnace body abnormal	adjust or replace
	water inlet/outlet valve does not open or open error	check
Rectification Failed Lamp on	start up frequency of low frequency start too high	check and adjust low frequency limiter with oscilloscope
	power off with nonzero power knob	operate follow normal start/stop procedures
	water leaking at SCR lead to open error	check cooling fan and cross distributor
	SCR failure	replace
Leaking Test Lamp on	too wet with refractory materials for furnace building	lower the sensitivity then adjust back after material dried
	sensitivity is too high	lower the sensitivity
	leaking test detecting board failure	replace
Lack of Phase Lamp on	lack phase of three-phase power input	1.check three-phase power input with multi meter
	power connecting point connected bad	2.check
Note : Press the "Rectification On" button after the causes above are excluded. If the lamp still can't be off, please check the connecting points of terminal of monitoring board or replace the relay.		

iv. Check for parts of main circuit

Check if any part is failure. It is called static checking if no power output from N.F.B.. But testing switch should be “ON” to get input power of N.F.B. when we check control signal board (do testing only when N.F.B. is “OFF”). Checking for parts of main circuit is described as below:

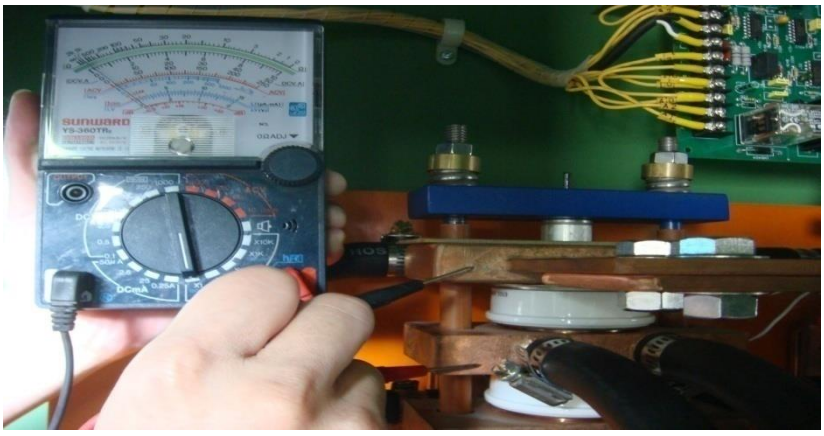
(1) Static check for three-phase rectifier

A. Static checking of rectification SCR (SCR1-SCR6)

A good SCR is not electric conductible. Use R*1 position of multi meter to check. Check two times and change the position of red bar and black bar at second time. Both of the two readings should be high resistance. If the reading is low, the SCR is probably failure.

B. Checking of surge absorber (MOV1-MOV7)

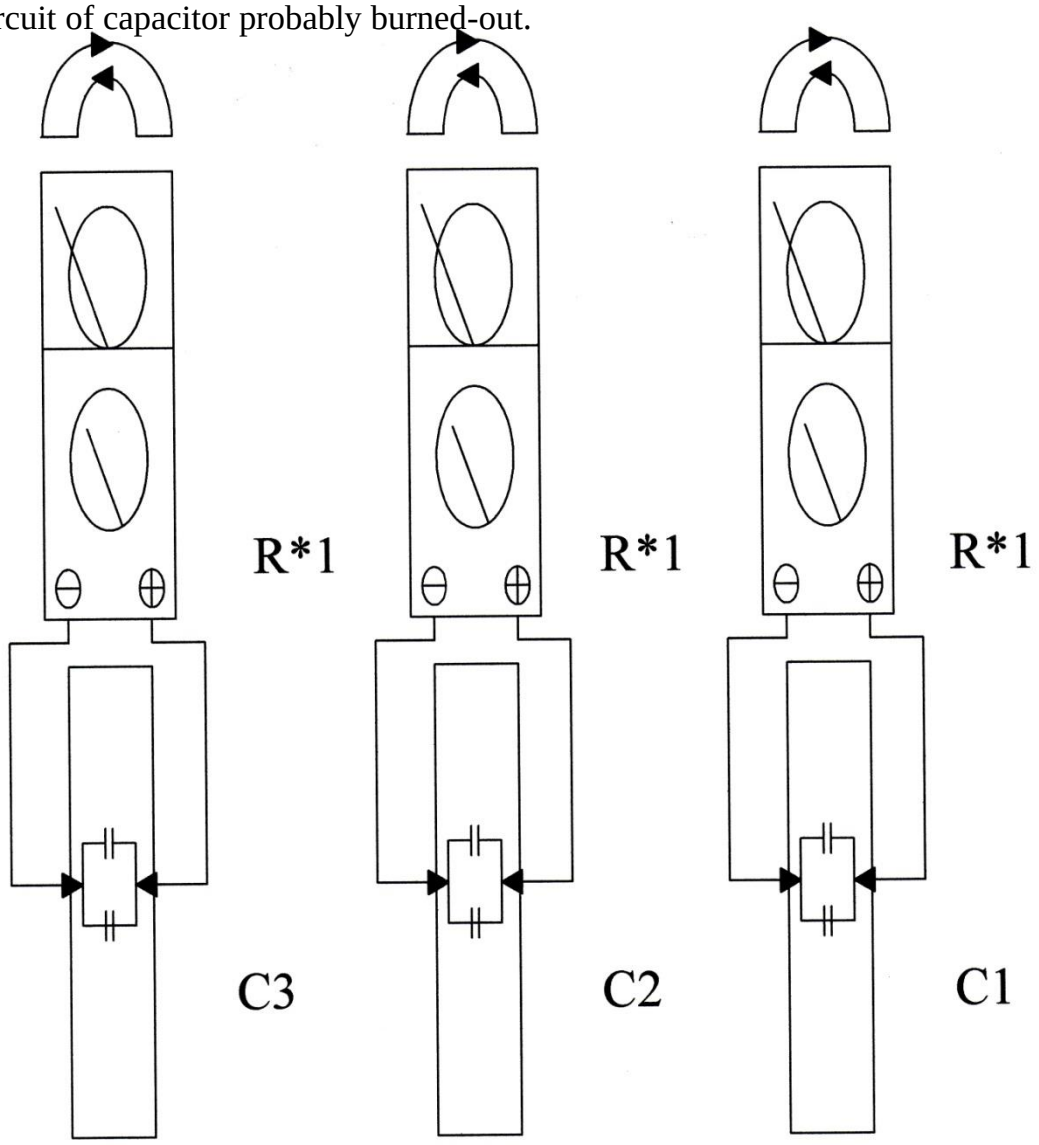
It is not electric conductible normally. If it is low resistance or with visual damaged appearance, it is abnormal. Disconnect cables and check with R ×1 position of multi meter, the reading should be high resistance.



(2) Static check for capacitor

A. Static checking of DC filter capacitor (C1-C2)

Use R ×1 position of multi meter to check. Check two times and change the position of red bar and black bar at second time. One reading should be low resistance (because parallel connection with bleeder diode). Another reading, the indicator should move toward low resistance direction rapidly then turn back to a stable reading slowly. If both readings are low resistance, there probably a short circuit inside of capacitor or bleeder diode failure. If capacitor performs high resistance and charge/discharge inactive, the inner circuit of capacitor probably burned-out.



(3) Static check for frequency converter

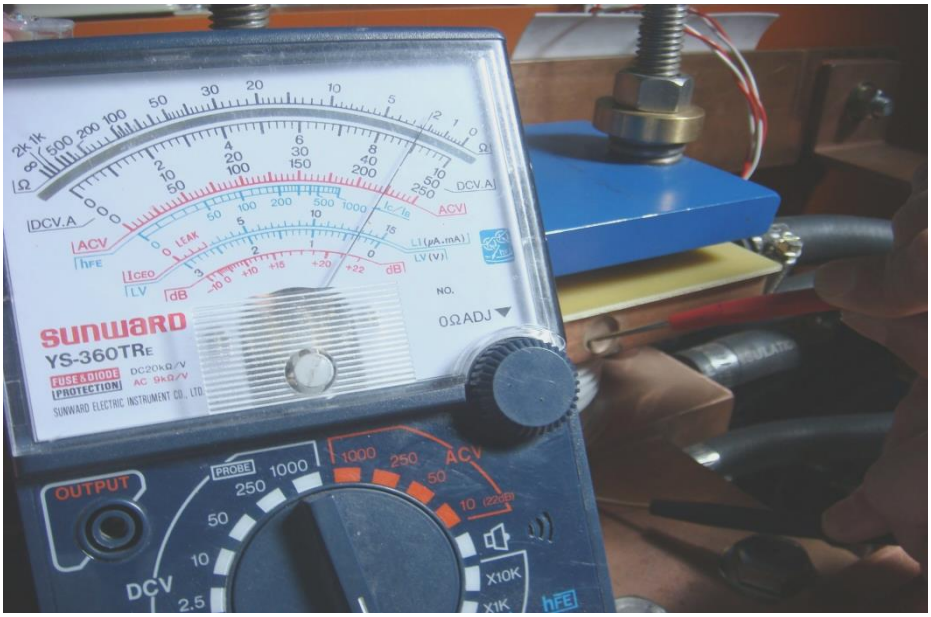
In the frequency converter, SCR(SCR5-SCR6) is in parallel with the diode (D5-D6), so the measured state shows the characteristics of the diode, one appears high resistance, one appears low resistance state, so is normal, abnormal situation is as follows :

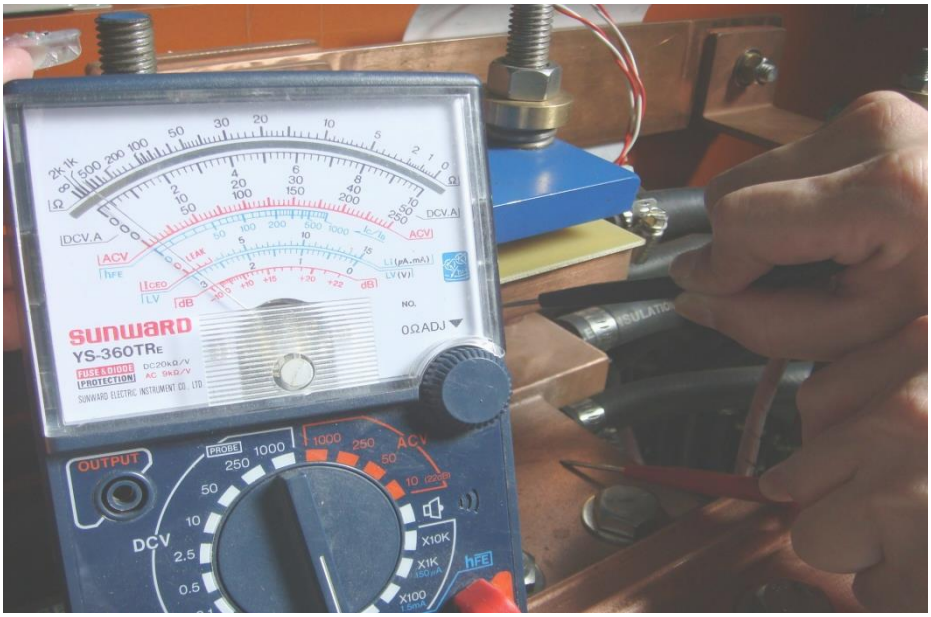
Both - Way high resistance :

This situation isn't happen easily, maybe the test rod and the test point of contact between the poor, or meter problems.

Both - Way low resistance :

Probably the SCR, diode or MOV is failure, remove parallel circuit and measure personally to determine the damaged parts.





VII. Appendix

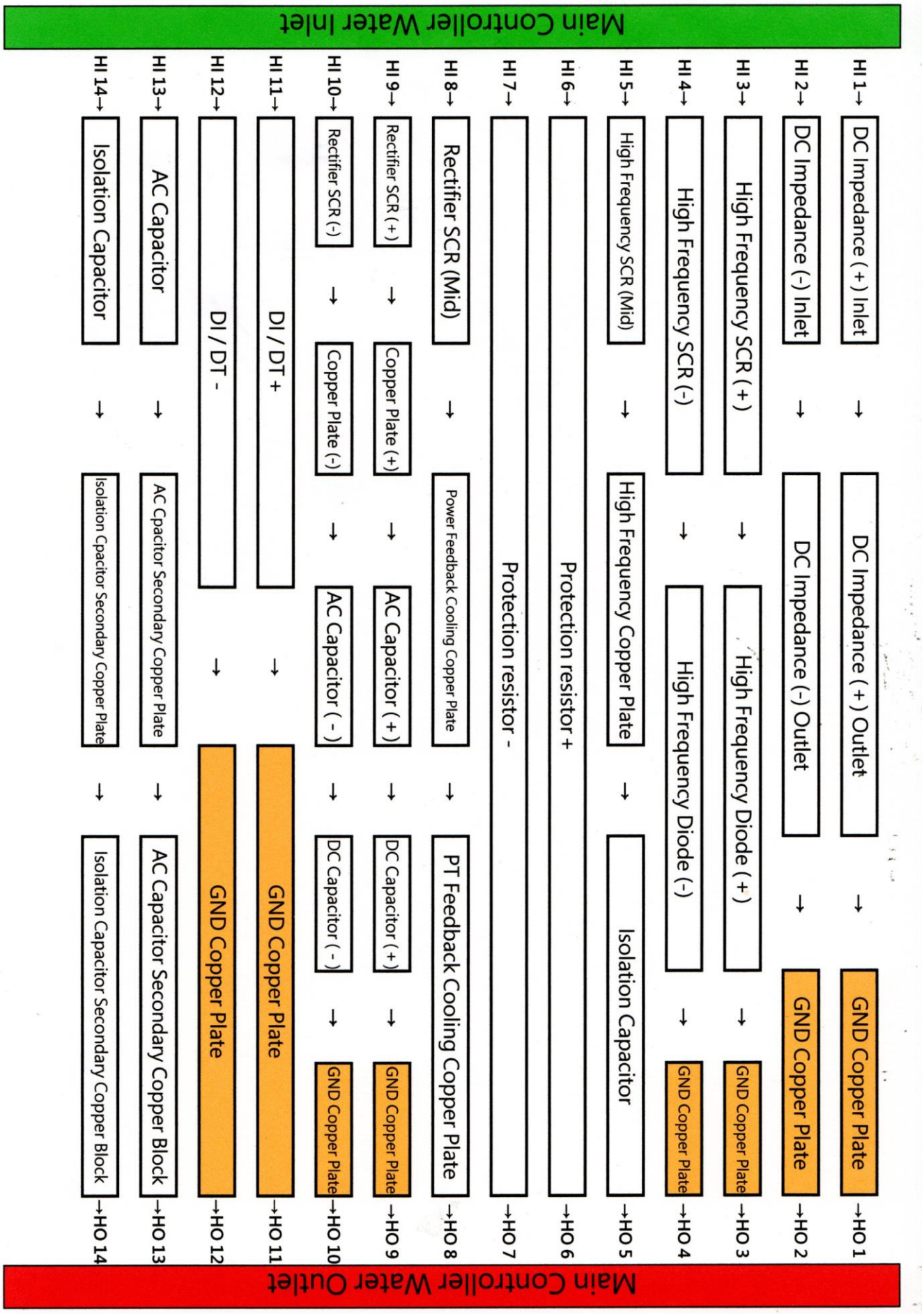
i. Standard and option parts of medium frequency induction furnace

No.	Name	Quantity	Addition Item	Note
1	Main controller	1 Set	A. 250 kW 1 Set	
2	Furnace body	1 Set	A. 300 kg - Hydraulic 1 Set	
3	Cooling system	1 Set	A. Closed circuit cooling tower SCT - 45 1 Set B. Pump 5HP 2 Sets	
4	Equipment accessories	1 Set		
5	Operation manual	1 Set		

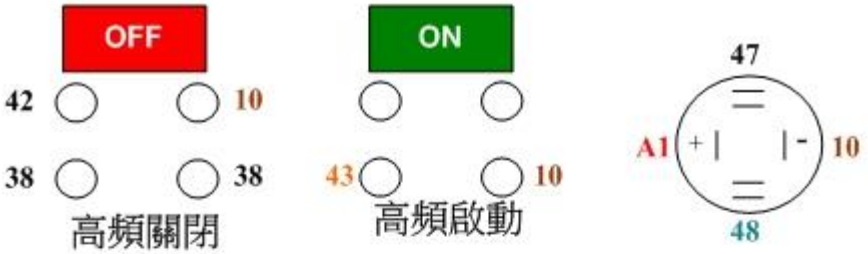
ii. Consumable parts list

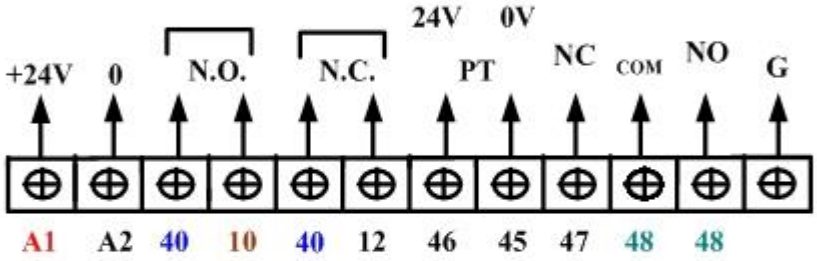
Part name	Model NO.	Quantity	Applying
Rectifier SCR	C440	6	Three - Phase rectifier
Bleeder diode	D600R	1	DC copper plate
High frequency SCR	T03320P	4	Converter
High frequency diode	D04120S	4	Converter
Surge absorber (MOV)	TNR 20E821K	4	AC Power protective
Fuse	700VAC,800A	2	Three - Phase protective
Temperature switch	75 ℃	14	Outlet water of furnace body detecting
Temperature switch	70 ℃	6	Outlet water of main frame detecting
Pressure switch	AC 110V 3A 1.2 - 2.4 Kg f / cm^2	1	Inlet water control for main frame and furnace body
AC capacitor	1400VAC , 150uF 18.75uF × 8	2	Resonance circuit
Isolation capacitor	2000VAC,70uF 8.75 × 8	2	Resonance circuit
Three - Phase protective capacitor	0.5uF × 3,650VAC	3	Three - Phase power
Protective capacitor	0.5uF,625VAC 3000Hz	4	Protective resistor
High frequency pulse board	KTNM - 01A	1	Converter SCR touch off
Main control board	3000 Hz	1	Convert and feedback to control circuit
Leaking test board	KTRC - 03	1	Melt leaking test circuit

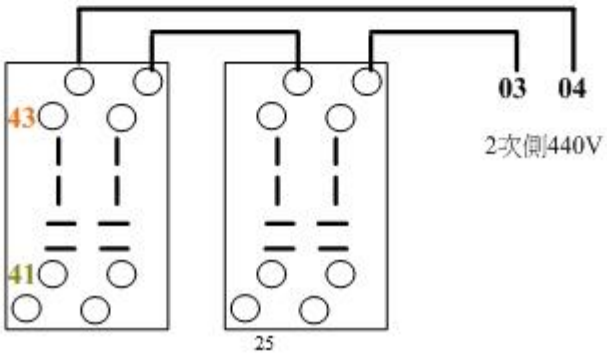
iii. Main controller cooling system piping drawing



iv. Circuit diagram - Trip board

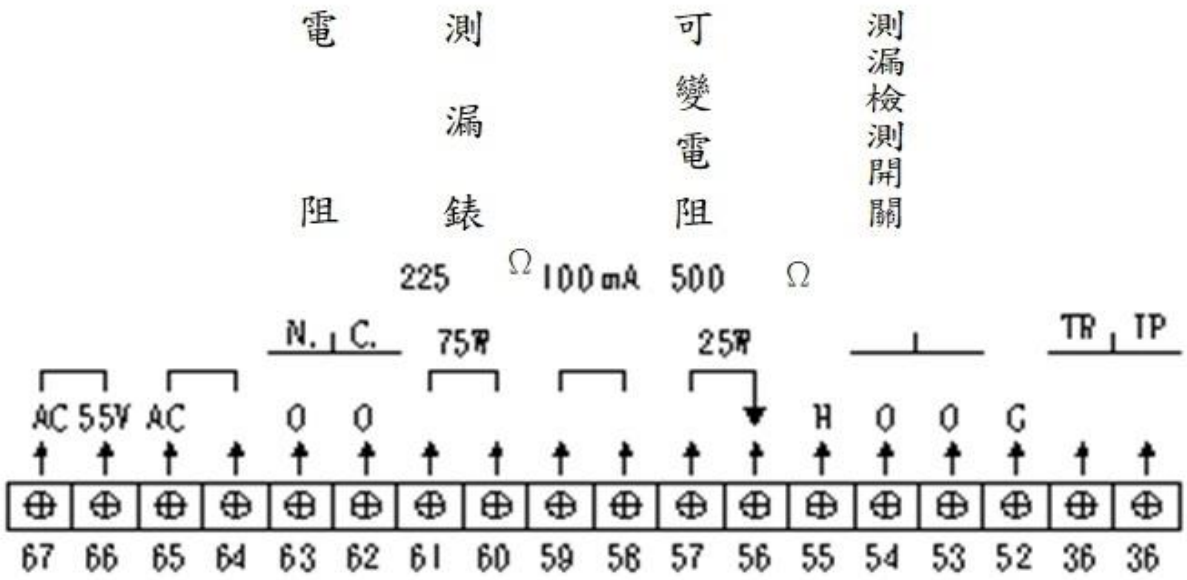




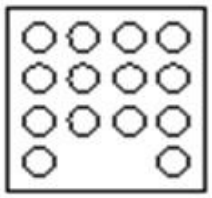


v. Circuit diagram - Leakage plate

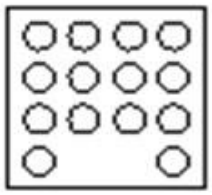
(1) Old version



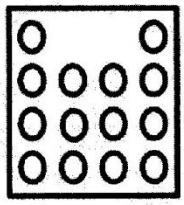
12VDC Relay



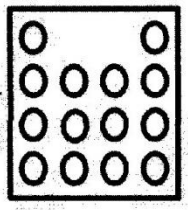
24VDC Relay



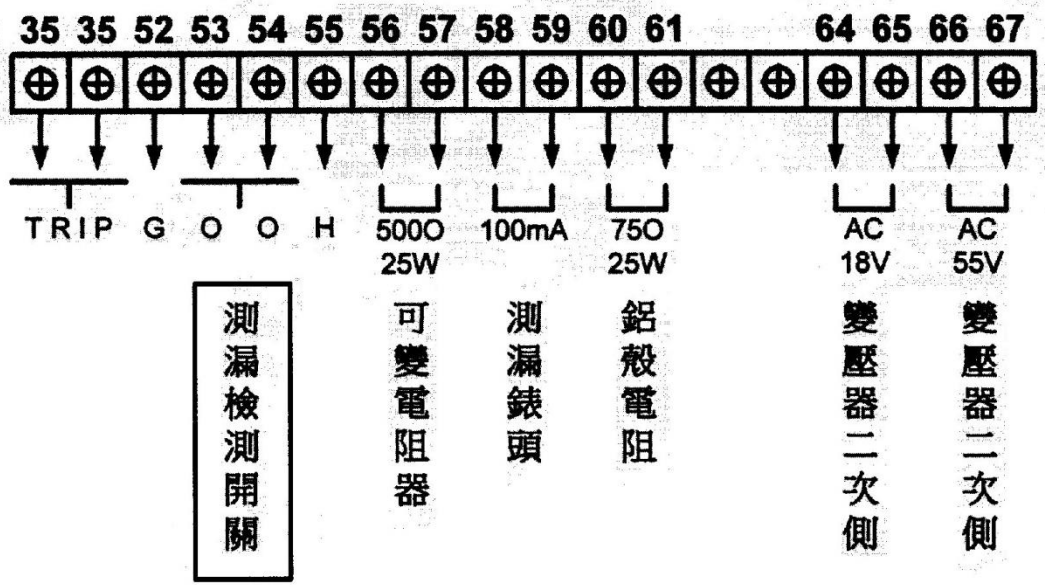
(2) New version



12VDC Relay

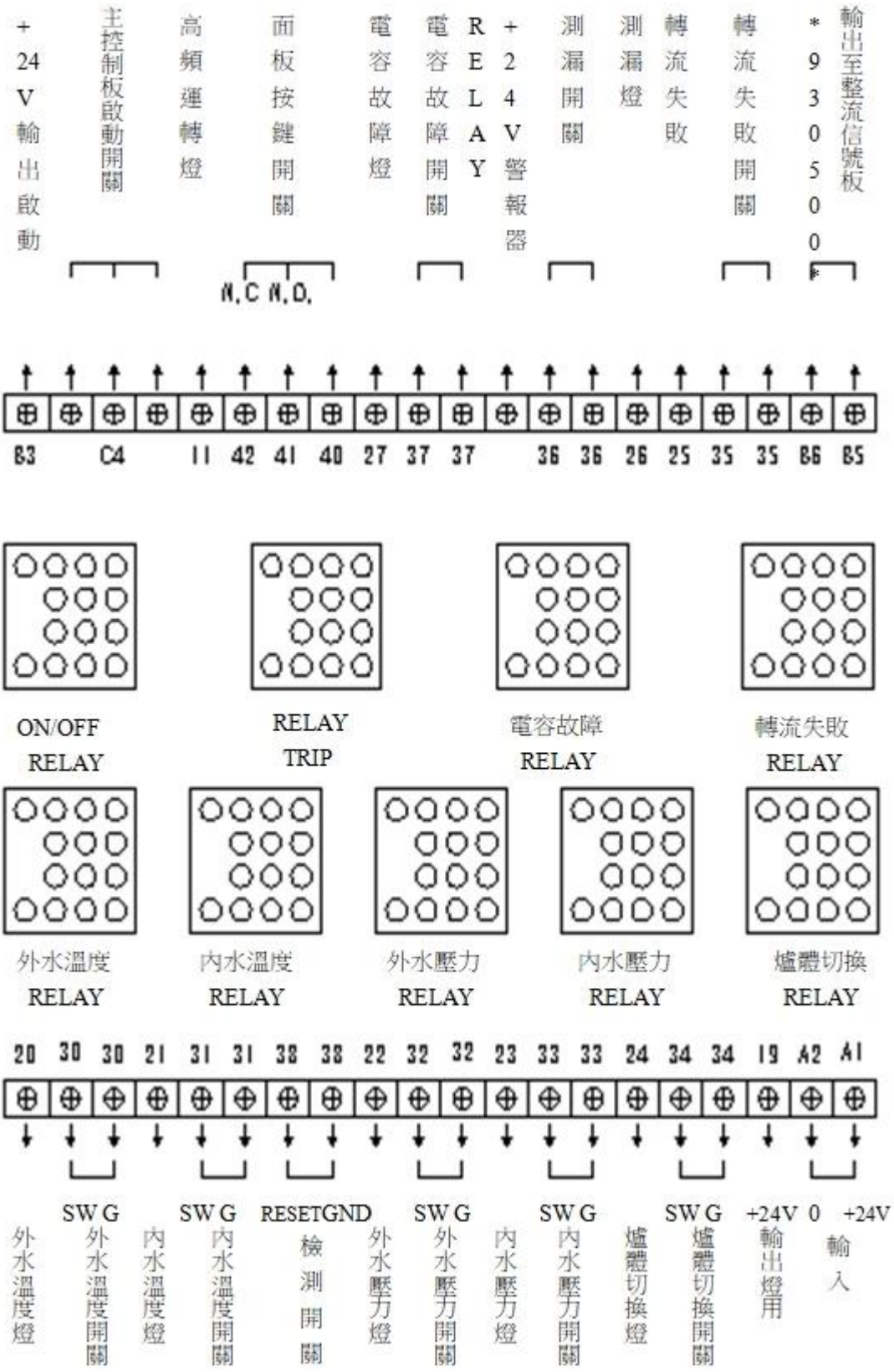


24V

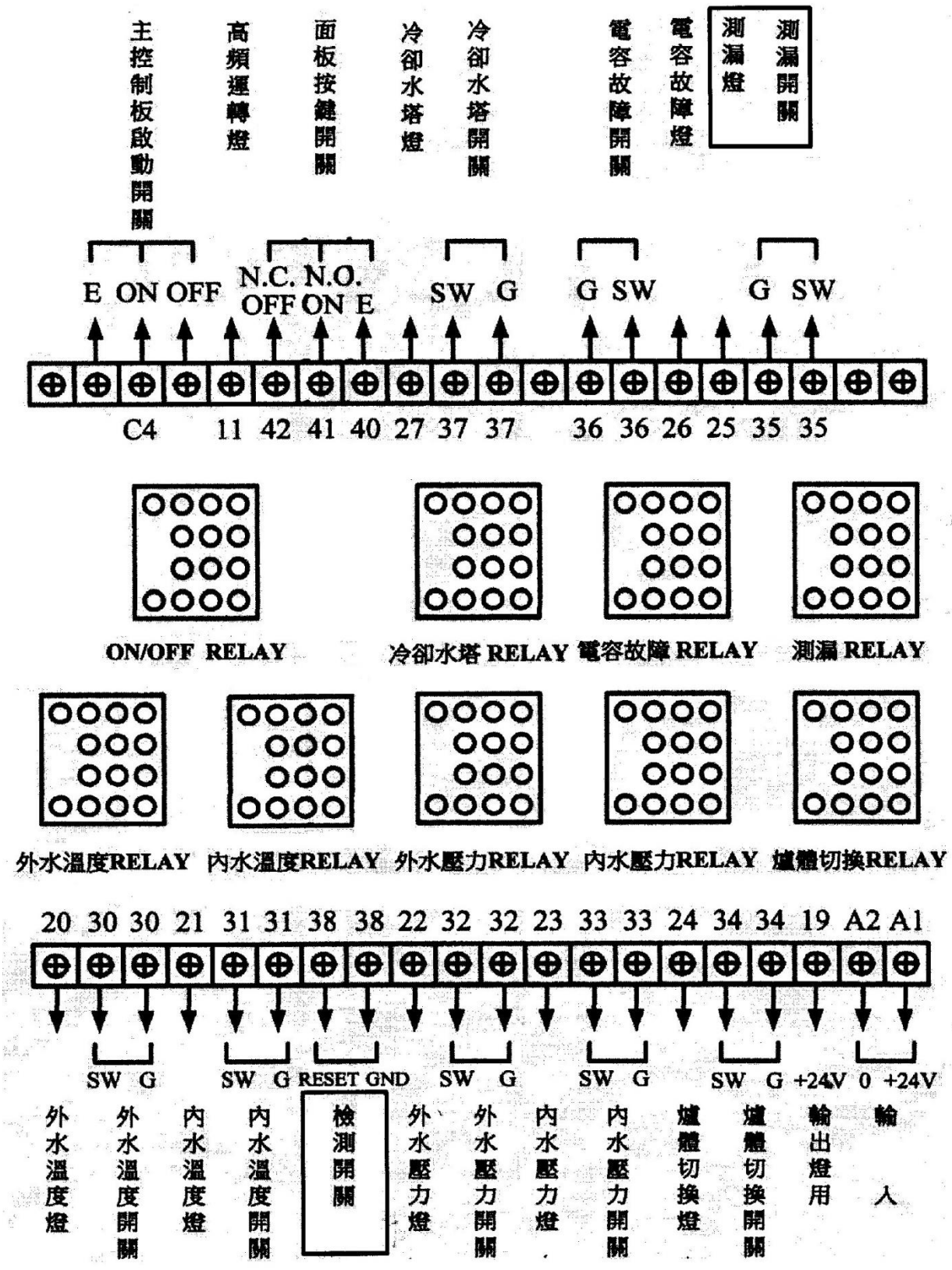


vi. Circuit diagram - Monitoring board

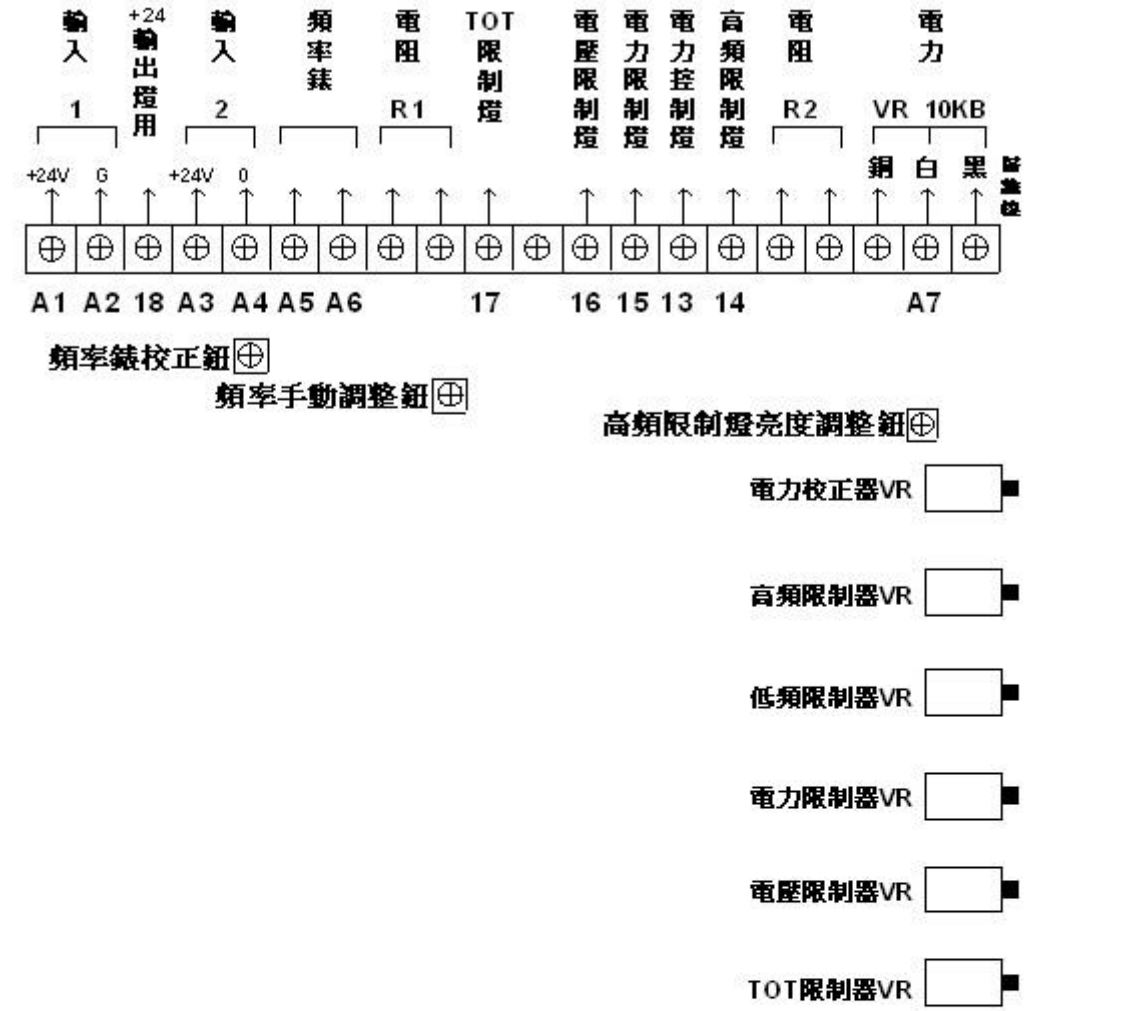
(1) Old version

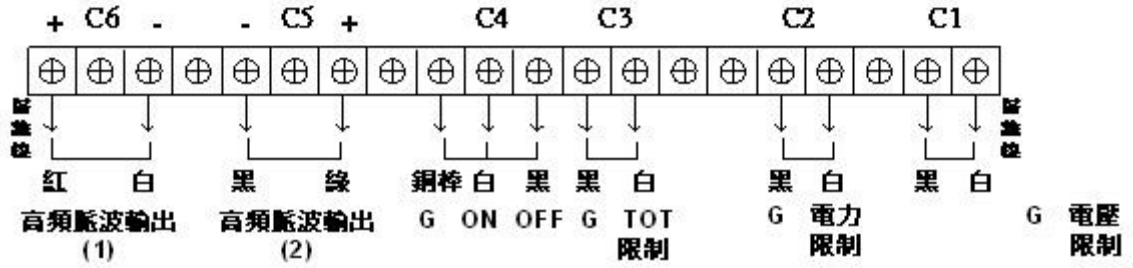


(2) New version

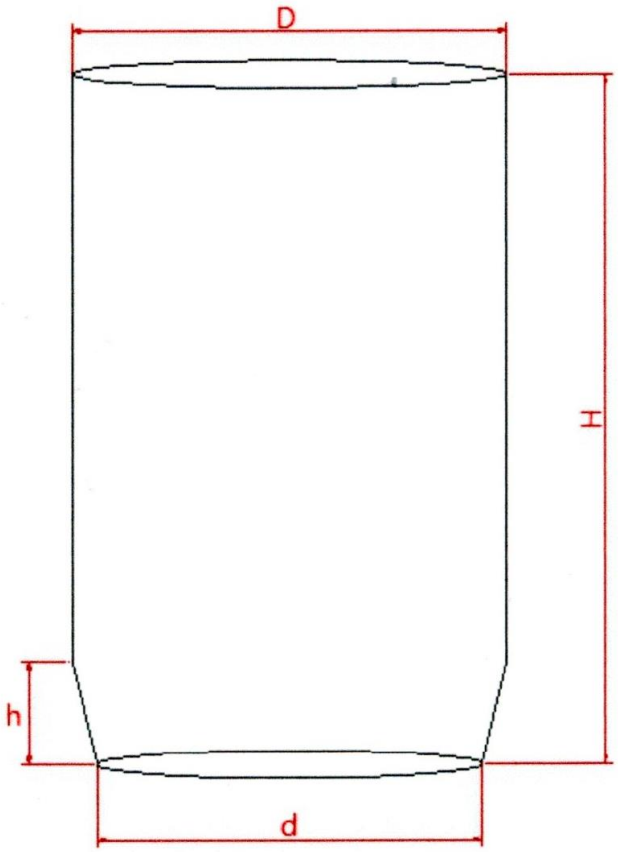


vii. Circuit diagram - Main control board





viii. Furnace Lining Specification Sheet



爐體容量 (Kg)	線圈直徑 (mm)	D (mm)	d (mm)	H (mm)	h (mm)
25	220	130		300	
30	230	140		330	
50	250	160		380	
60	280	170		380	
80	300	200		380	
100	340	220		380	
120	340	230		420	
150	360	260		420	
200	400	280		475	
250	420	300		510	
300	460	330	280	510	100
500	560	400	350	580	100
600	590	420	360	630	100
700	620	450	400	630	100
1000	690	520	450	790	100
1500	790	630	560	830	150
2000	790	630	560	930	150