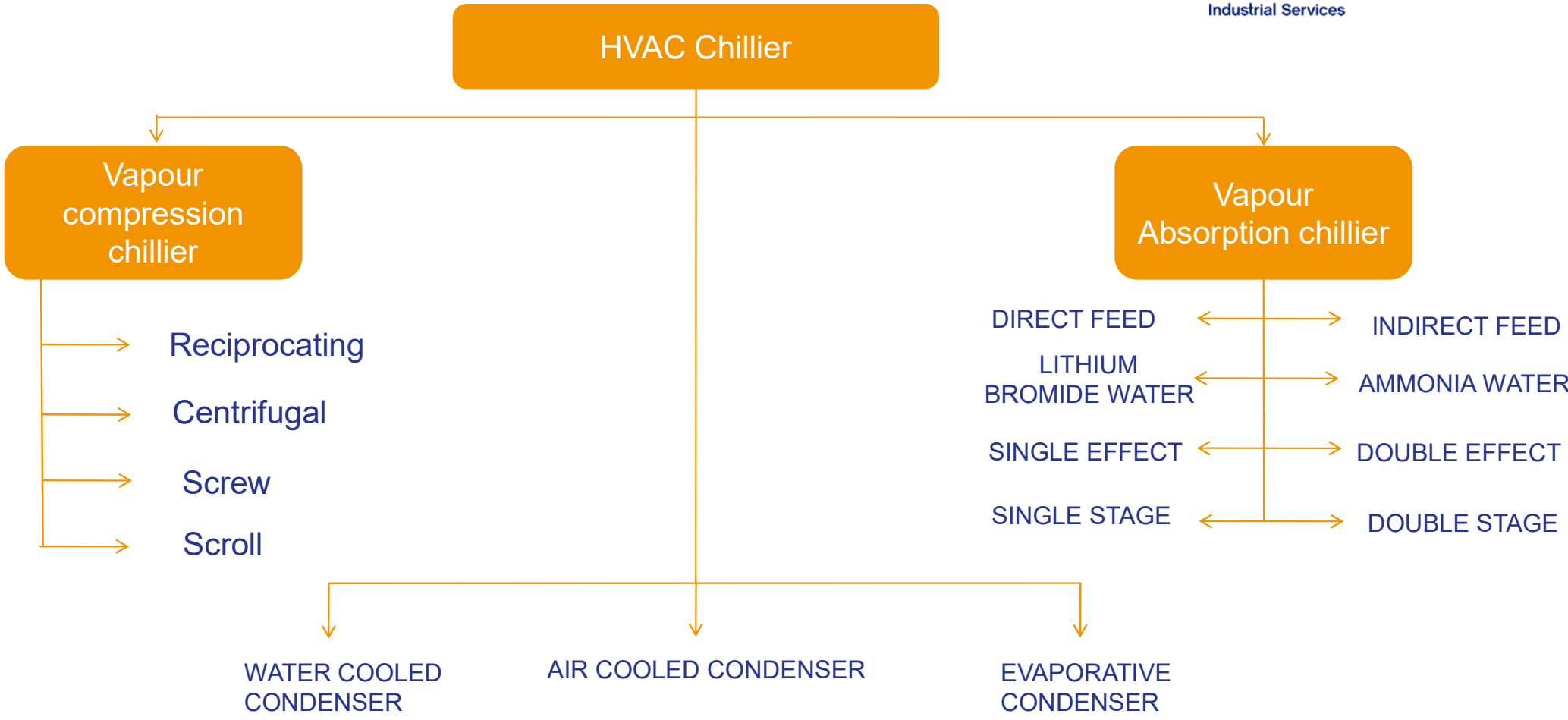
CHILLER

APL KHANDALA

TWO TYPES OF CHILLER



CHILLER CYCLE

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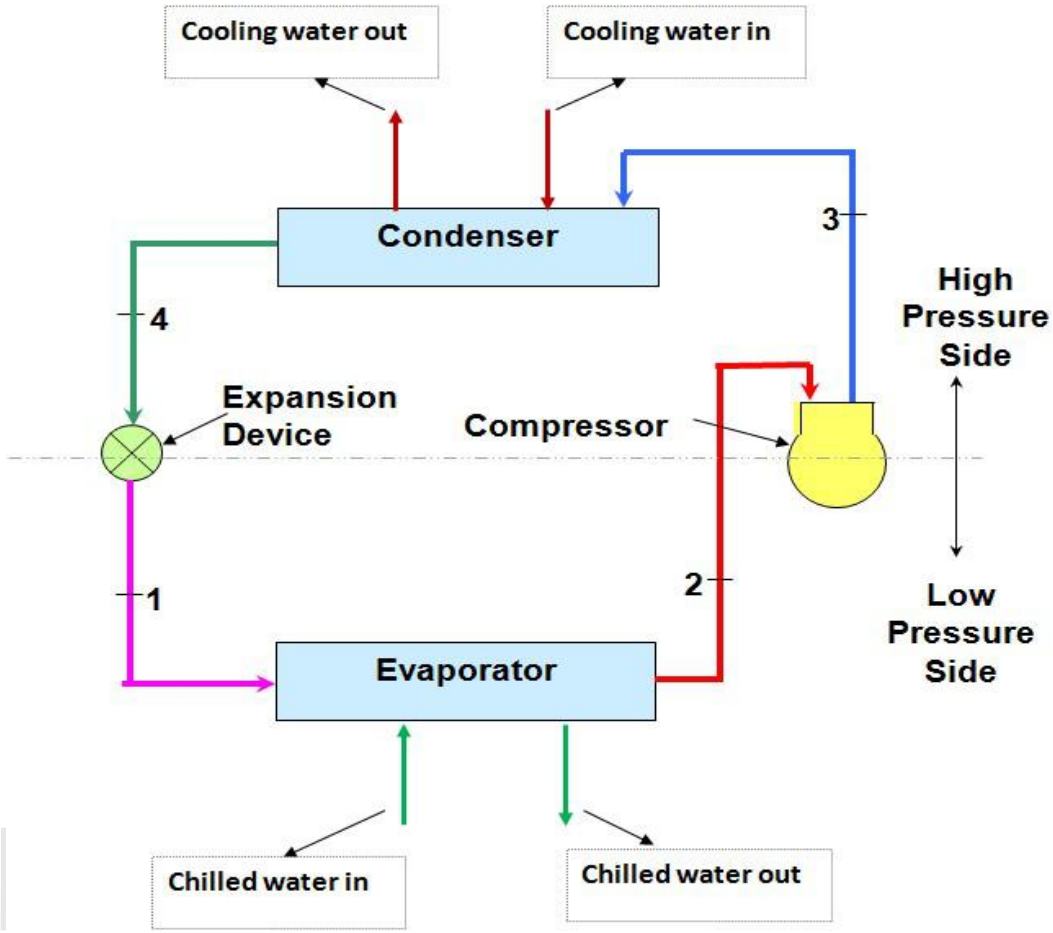
1. VAPOUR COMPRESSION CHILLER



2. VAPOUR ABSORPTION CHILLER

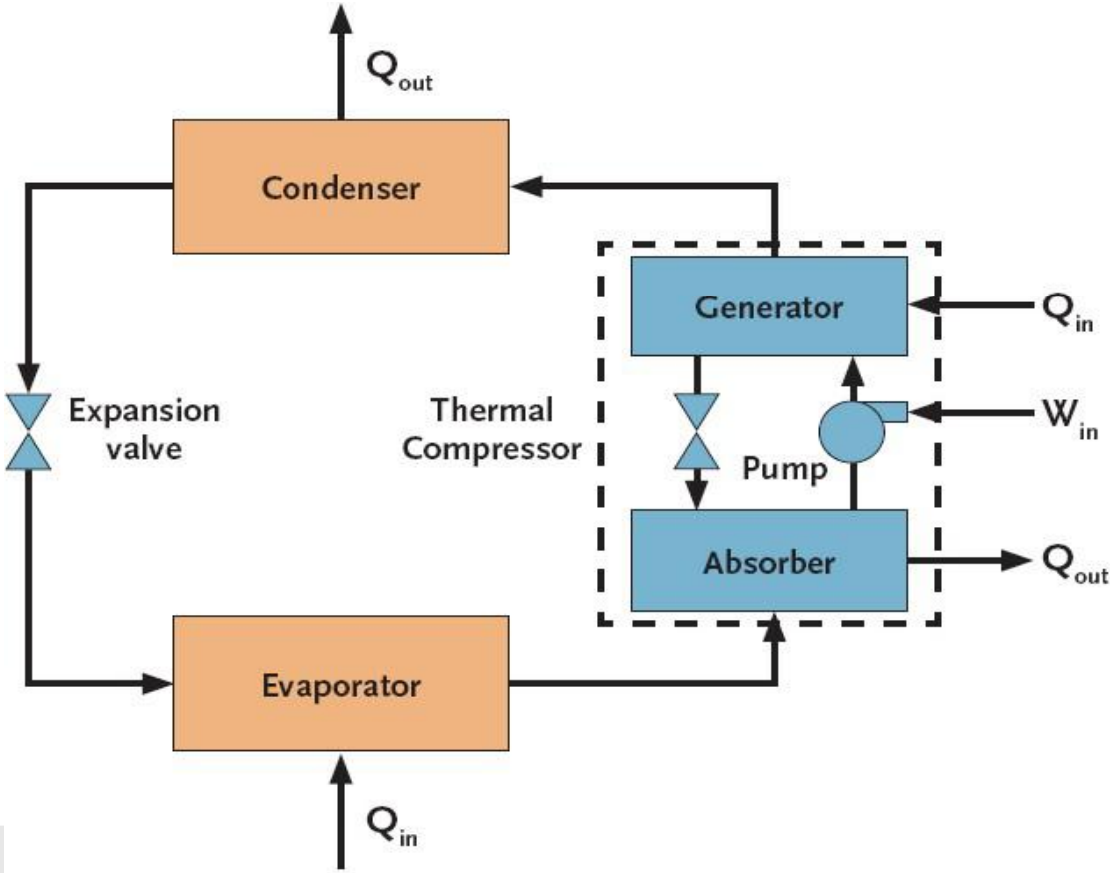


Figure 1 Basic absorption cycle

VAPOUR COMPRESSION CHILLER

Heat addition to refrigerant in evaporator (1-2):

Refrigerant gets vaporized by taking heat from chilled water in evaporator thus serving its prime purpose. Refrigerant comes out of evaporator as vapors but on other side chilled water is produced.

Compression of refrigerant vapors in compressor (2 - 3):

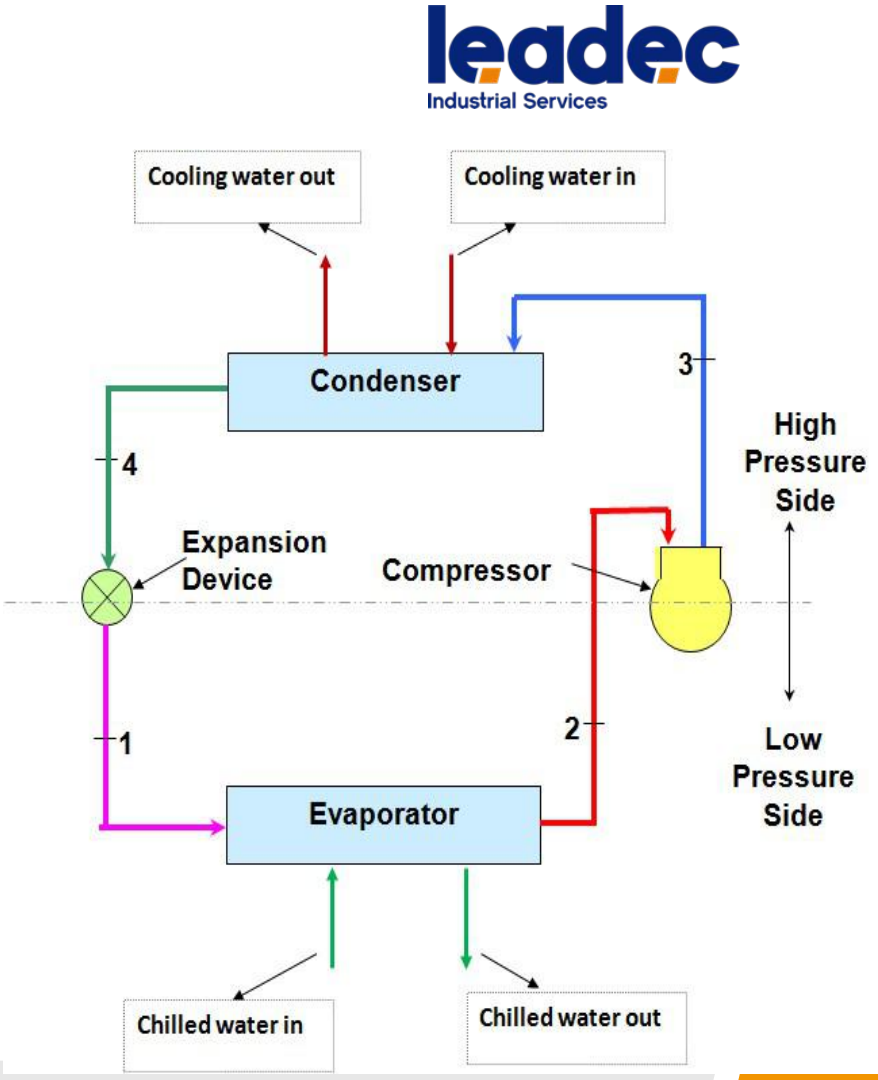
Refrigerant vapors come out of evaporator and then compressed by chiller compressor to high pressure and temperature. Compressor requires energy input for its working and hence electric energy is supplied to it.

Heat rejection by refrigerant in condenser (3 - 4) :

Similar to evaporator ,but reverse is happening here. Refrigerant rejects its heat to outside cooling liquid or air .In this way, refrigerant gets condensed and outside media is heated. outside media e.g. cooling water may be cooled by cooling tower and recycled again into condenser.

Expansion of refrigerant in expansion valve (4 -1) :

Refrigerant in condensed form coming out of condenser is expanded in expansion valve and its pressure and temperature is reduced to level of evaporator so that above cycle is repeated again. .



VAPOUR ABSORPTION CHILLER

1. Absorption chiller is a machine which operates based on vapor absorption refrigeration cycle. This cycle consists of four major heat exchangers, (generator, condenser, evaporator and absorber) with two kinds of solution, (refrigerant and absorbent).
2. During this cycle high pressure will prevail inside generator and condenser, while inside evaporator and absorber there will be low pressure. The cycle starts with input waste heat in the generator. As a result of this heat input, the solution in the generator will be separated into refrigerant and weak solution.
3. The refrigerant in the vapor form will enter into condenser and will change into liquid. The solution part will enter absorber, since there is a pressure difference between condenser and evaporator, the refrigerant will flow inside evaporator and will absorb heat from cooled water that is in circulation inside evaporator.
4. Consequently, the temperature of circulated water decreases and then it is used for air-conditioning purpose. The evaporated refrigerant will then enter absorber where it will be mixed with weak solution, the mixture will then get the liquid state and finally it will enter generator and the cycle is repeated.

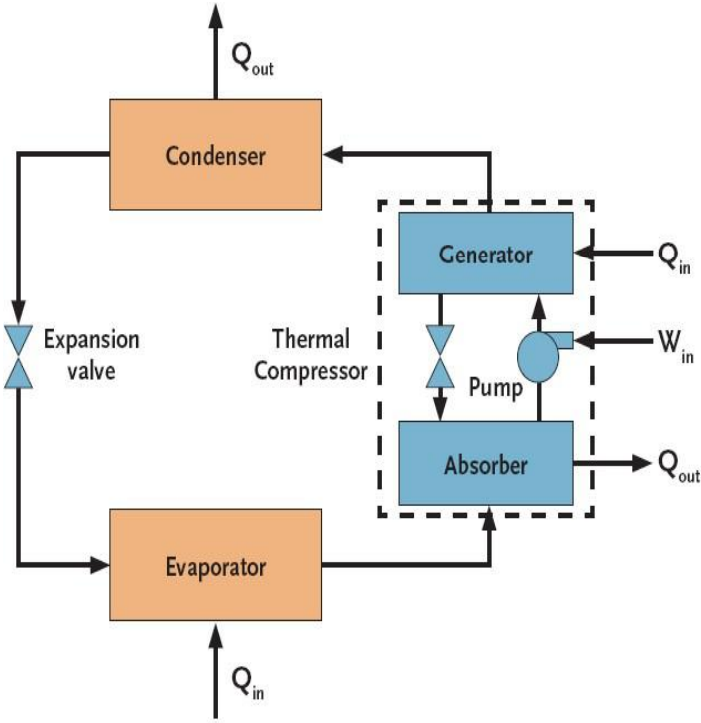


Figure 1 Basic absorption cycle

CHILLER SPECIFICATION

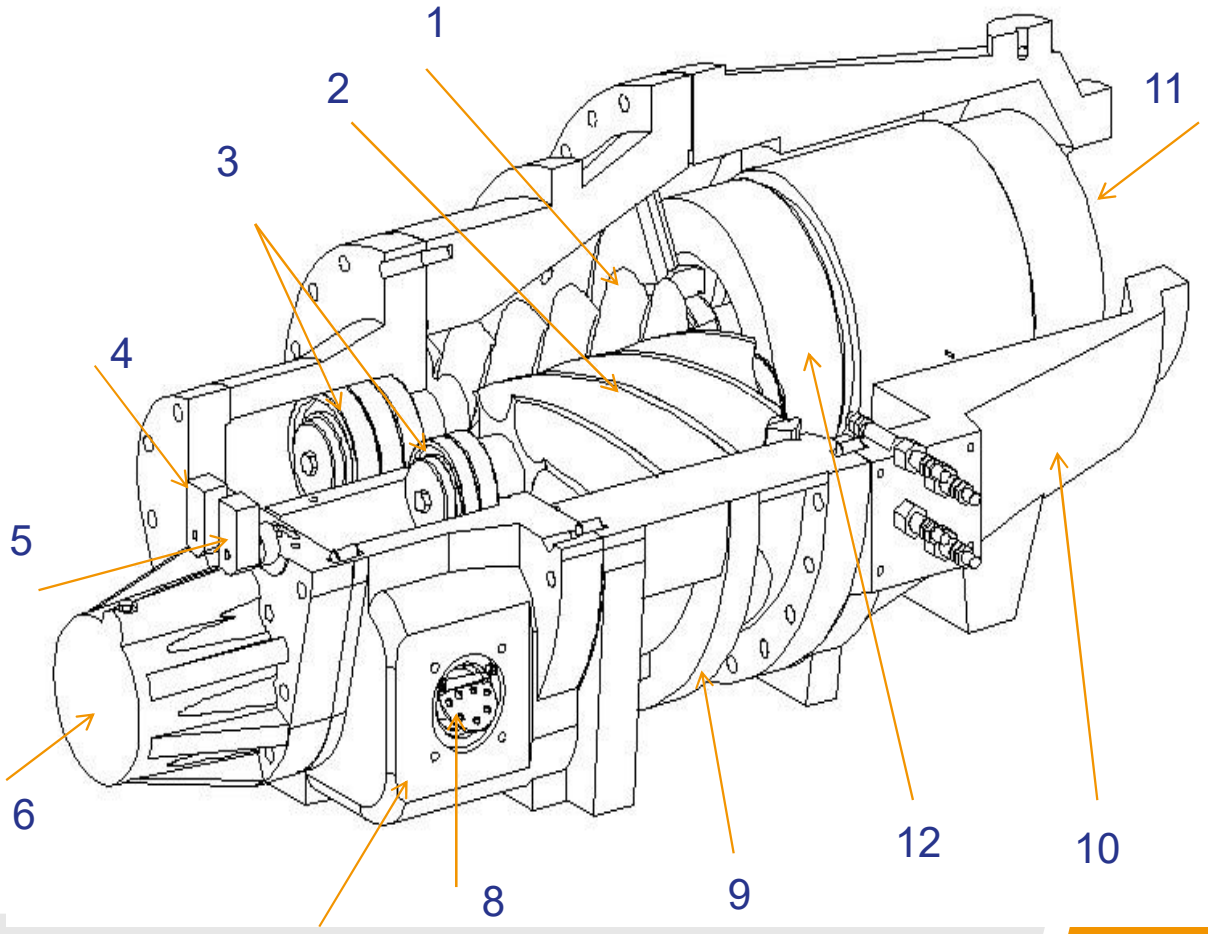
- MAKE:- TRANE
- MODEL NUMBER:- RTHD E1C1F1 ,
- TYPE :- RTHD WATER COOLED SCREW CHILLER
- CAPACITY:- 200 TR .
- CONNECTED LOAD :- 213 KW
- REFRIGRENT :- R134A
- EVAPORATOR PRSSURE ON FULL LOAD :- 40-55 PSIG
- CONDENSER PRSSURE ON FULL LOAD :- 85-120 PSIG

MAIN PARTS OF CHILLER

1. COMPRESSOR .
2. EVAPORATOR .
3. CONDENSER .
4. EXPANSION VALVE .
5. STARTER .
6. TEMP SENSORS .
7. PRESSURE TRANSDUCER.
8. SOLENOID VALVES .

ROTARY SCREW TYPE COMPRESSOR PARTS

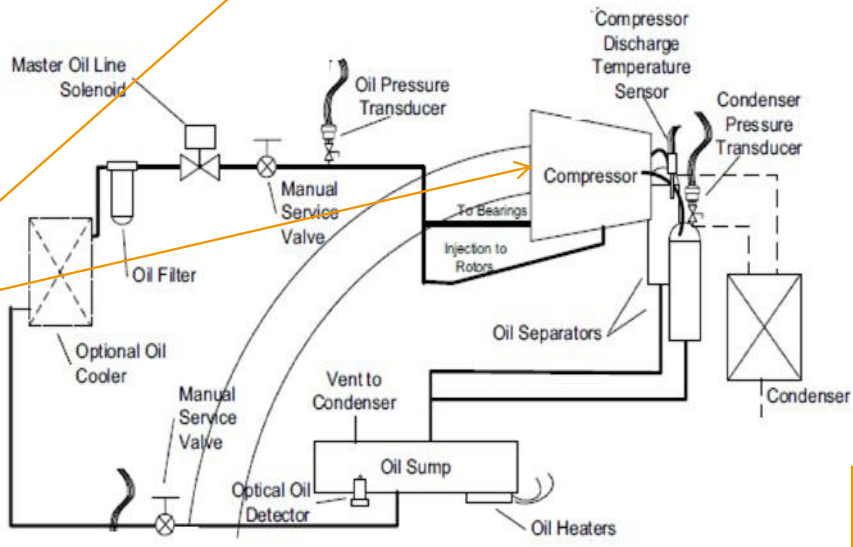
1. MALE ROTOR .
2. FEMALE ROTOR .
3. BEARING .
4. UNLOAD SOLENOID .
5. LOAD SOLENOID .
6. PISTON HOUSING .
7. BEARING HOUSING .
8. DISCHARGE CHECK VALVE.
9. ROTOR HAUSING .
10. MOTOR HOUSING .
11. SUCTION.
12. MOTOR STATOR .



COMPRESSOR

1. **COMPRESSOR MOTOR :-** A two-pole, hermetic,(3000RPM) squirrel-cage induction motor directly drives the compressor rotors. The motor is cooled by suction vapour drawn from the evaporator and entering the end of the motor housing .

2. **COMPRESSOR ROTOR** :- R series compressor has two rotor , male and female which provide compression .
   The male rotor is attached to, and driven by the motor, and the female rotor is, in turn, driven by the male rotor .
   it is positive displacement device and cooling provided by evaporator suctioning t the motor . There is no physical contact between the rotors and compressor housing. Oil is injected into the bottom of the compressor rotor section .
   Although this oil does provide rotor lubrication .

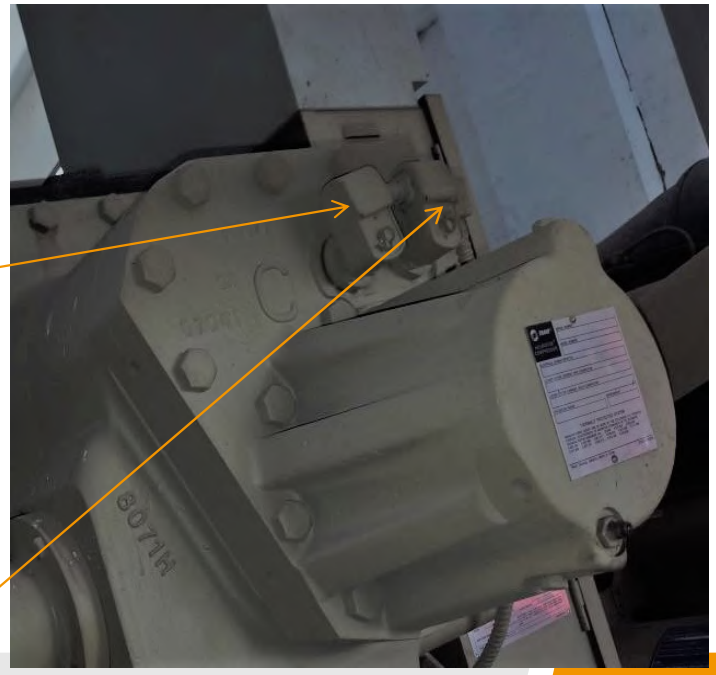


COMPRESSOR LOAD UNLOAD VALVE

- Two valves used in compressor Load and unload valves .
- Compressed vapour flowing in to and out of the cylinder governs piston movement, and is controlled by the load and unload solenoid valves.
- Load , Unload solenoid valve base on cooling system requirement .
- For loading the compressor load valve should be open .
- For unloading the compressor unload valve should be open .
- The pressurized vapour flow then enters the cylinder and, with the help of the lower suction pressure acting on the face of the unloader valve, moves the slide valve over the rotors toward the suction end of the compressor.

1.UNLOADING SOLENOID VALVE

2.LOADING SOLENOID VALVE .



COMPRESSOR DISCHARGE TEMP SENSOR (4B27)

1. All of the temperature sensors used on CH530 are negative temperature coefficient (NTC) thermistors .

2. It located on compressor discharge line .

3. The thermistors all have a base resistance of 10k Ohms at 77 F (25C).

4. The sensors have a probe range of -40 to 120 F and should have an accuracy of ± 1F.

5. 0deg C = 32 deg Fahrenheit .

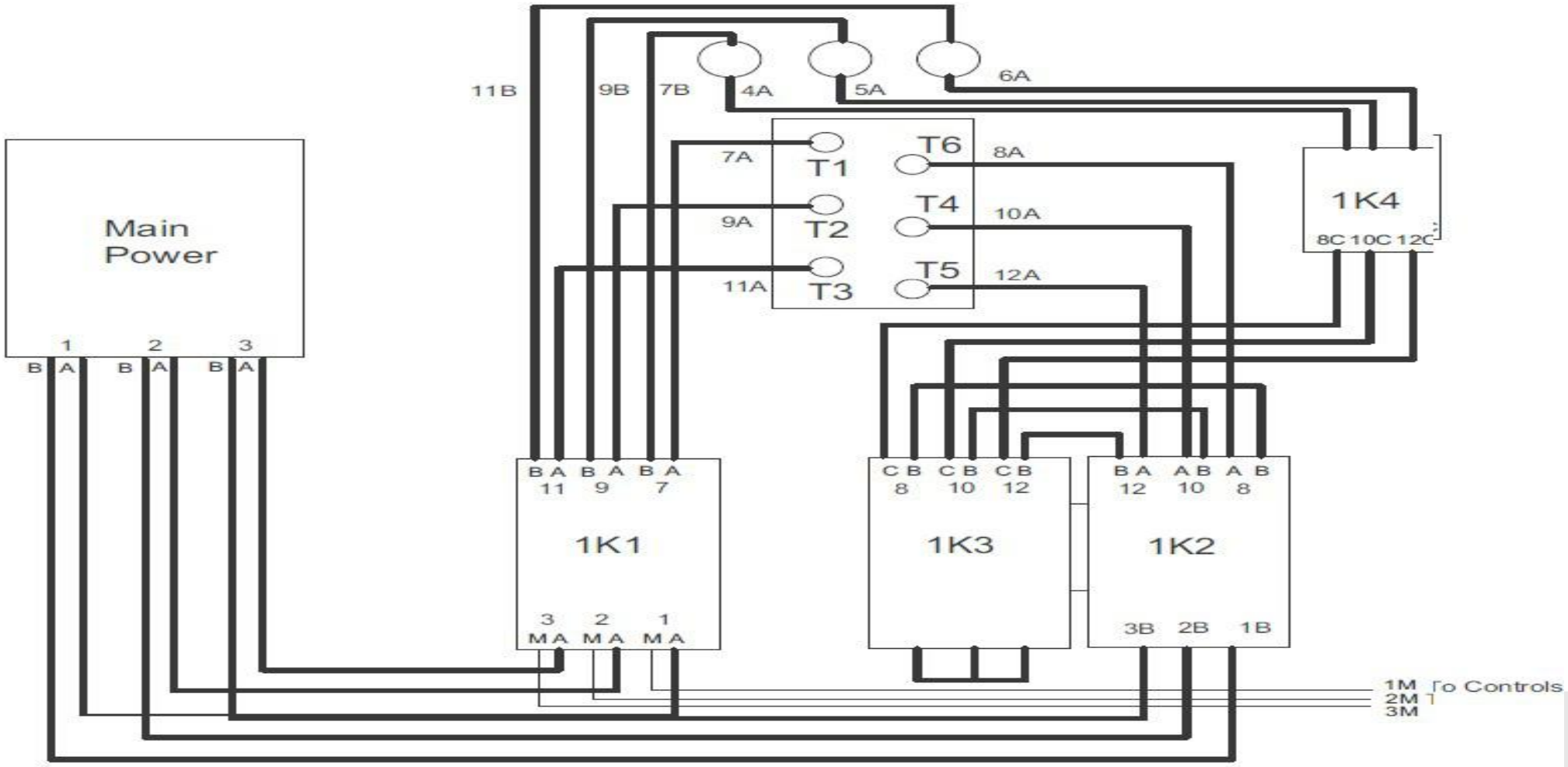
6. 1deg c = 33.8 deg Fahrenheit .

7. -1deg c = 30.2 deg Fahrenheit

COMPRESSOR TRANSITION STARTER

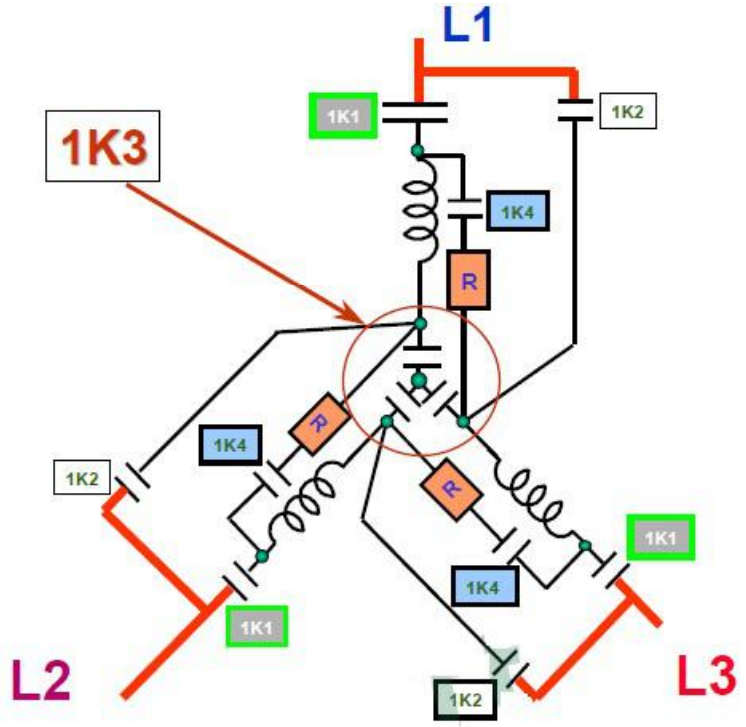
1. MAIN INCOMING SUPPLY .
2. CURRENT TRANSFORMER.
3. 1K1 MAIN CONTACTOR .
4. 1K3 STAR CONTACTOR .
5. 1K2 DELTA CONTACTOR .
6. MOTOR CONNECTION .
7. TRANSITION RESISTOR .
8. 1K4 TRANSITION CONTACTOR .

COMPRESSOR TRANSITION STARTER



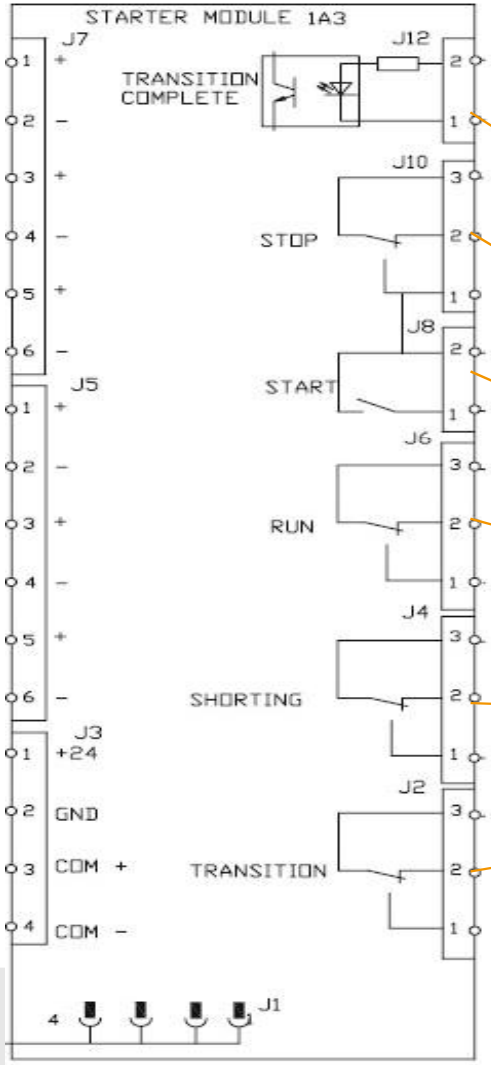
COMPRESSOR TRANSITION STARTER WORKING

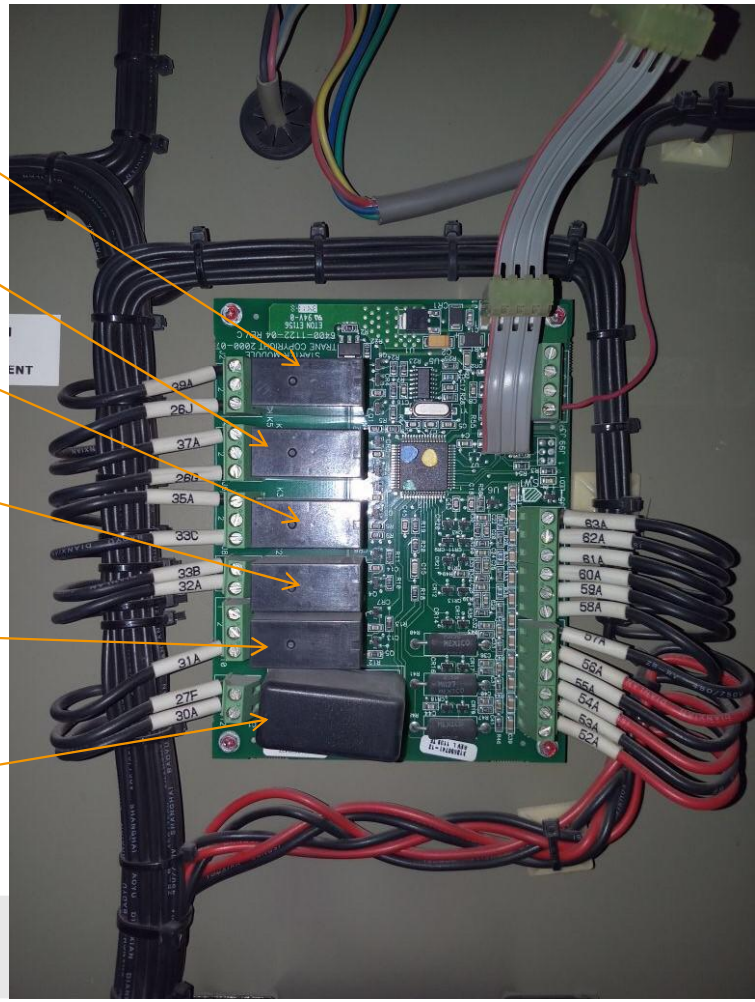
1. CLOSE STAR CONTACTOR FOR 500 Msec AND 1K1 MAIN CONTACOR CHECK FOR NO CURRENT.
2. DE-ENRGISE 1K1 MAIN CONTACTOR AND ENERGISE SHORTING CONTACTOR 1K3 STAR. CHECK FOR NO CURRENT FOR 1Sec 1K3 STAR REMANE CLOSED .
3. SHORTING CONTACTOR 1K3 CONTINOUSLY ENERGISE .
4. IF 1.6 SECONDS AFTER 1K1 MAIN CONTACTOR CLOSED , NO CURRENT WAS DETECTED BY ALL THREE CTs FOR THE LAST 1.2 SECOND , THEN STARTER FAULT.
5. WHEN MAXIMUM PHASE CURRENT DROP LESS THEN 85% OF NAME PLATE RLA FOR 1Sec THEN 1K4 TRANSITION CONTACTOR ENERGISED .
6. INITIATE TRANSITION IN DELTA POWER FLOW THROUGH RESISTOR 100MSEC AFTER 1K4 CLOSES ,SHORTING CONTACTOR 1K3 OPENS .
7. 260 Msec AFTER 1K3 OPEN AND THEN 1K2 DELTA CLOSES AND DELTA CONFIGURATION ALMOST COMPLETED .
8. TRANSITION COMPLETE CONTACT CLOSED AND OPEN 1K4 DE- ENERG RESISTOR .
9. MOTOR RUNNING IN DELTA CONFIGURATION .



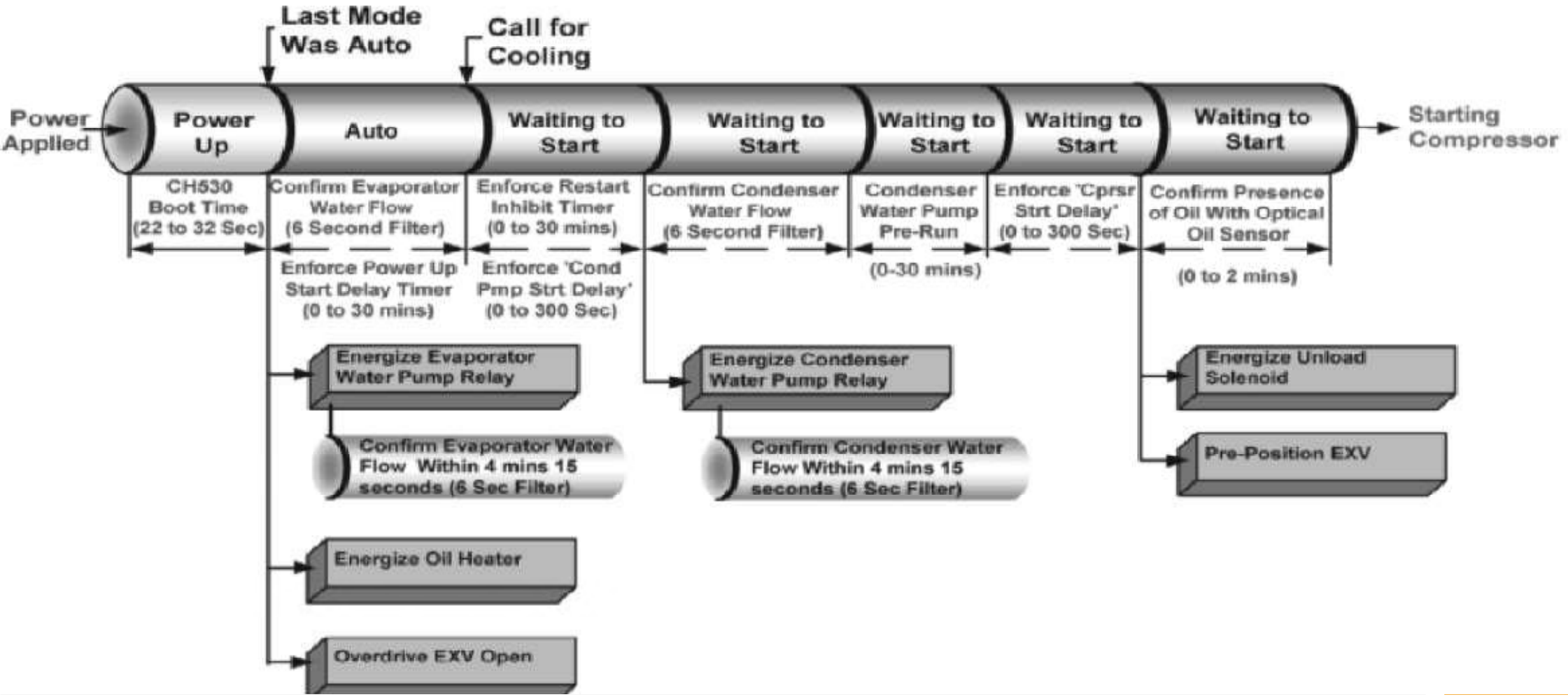
1A3 STARTER MODULE

1. FOR TRANSITION COMPLETE.
2. CHILLER STOP COMMAND.
3. FOR 1K1 ON COMMAND .
4. FOR 1K2 STAR CONTACTOR .
5. FOR 1K2 TO IK3 DELTA MODE .
6. FOR 1K4 TRANSITION CONTACTOR .





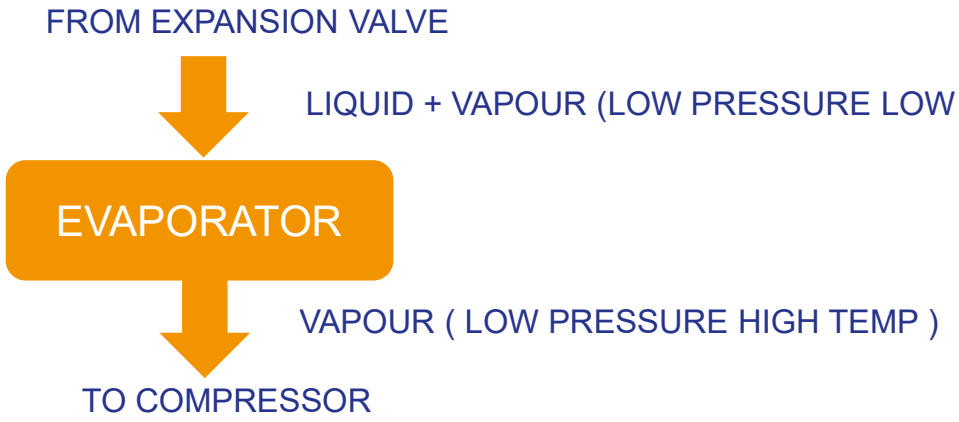
POWER UP FOR COMPRESSOR STARTING



EVAORATOR

1. **EVAPORATOR IS MAIN PART OF CHILLER , EVAPORATION OF REFRIGRENT OCCUR IN EVAPORATOR .**

2. **EVAPORATOR REFRIGRENT LIQUID ENTER AND DISTRIBUTED IN EVAPORATOR TUBES AND IT COOLS THE WATER FLOOWING IN EVAPORATOR TUBES .**



3. **THE REFRIGRENT VAPOUR GENRATED IN THE EVAPORATOR FLOW TO THE SUCTION END OF THE COMPRESSOR AND THAT REFRIGRENT ALSO PROVIDE COOLING TO COMPRESSOR MOTOR .**

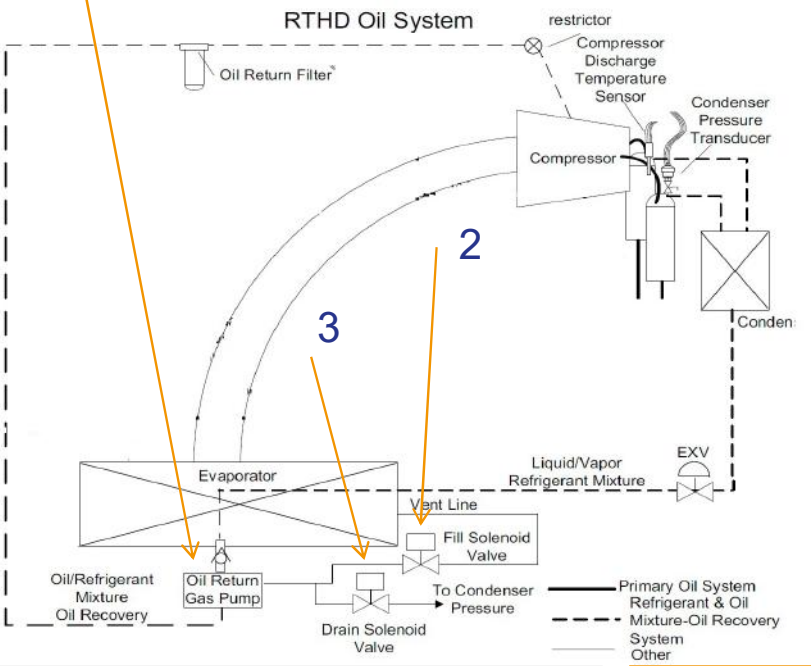
GAS PUMP

1. The gas pump, mounted just beneath the evaporator, is a cylinder with four ports controlled by two solenoids. The pump serves to return accumulating oil in the evaporator to the compressor at regular time intervals.
2. Refrigerant oil-mixture enter the gas pump from bottom of the evaporator .

TWO SOLENOID USE FOR GAS PUMP

- FIRST FILLING SOLENOID OPEN ALLOW REFRIGRENT VAPOUR TO BE VENTED INTO TOP OF EVAPORATOR
- SECOND SOLENOID OPEN TO ALLOW REFRIGRENT AT CONDENSER PRESSURE TO ENTER GAS PUMP

3. VALVE IS USED TO PREVENT REVERSE FLOW TO EVAPORATOR .
4. GAS PUMP IS USED FOR RECOVERY OF OIL/REFRIGRENT MIXTURE AFTER FILTRATION INTO COMPRESSOR.
5. THE OIL THEN COMBINE WITH OIL INJECTED INTO COMPRESSOR AND RETURN TO OIL SUMP VIA OIL SEPRATOR .



1. OIL GAS PUMP.
2. FILL SOLENOID.
3. DRAIN SOLENOID

EVAPORATOR RELIEF VALVE

- EVAPORATOR PRESSURE RELIEF VALVE MUST BE VENTED TO THE OUTDOOR .
- ITS ALSO LOCATED ON THE TOP SIDE OF THE EVAPORATOR.
- CONDENSER RELIEF VALVE DISCHARGE SETPOINT 200psig.
- ONCE THE RELIEF VALVE OPEN AND ITS WILL RECLOSE WHEN PRESSURE IS REDUCE TO A SAFE LEVEL .
- EVAPORATOR RELIEF VALVE FOR SAFETY PURPOSE IF INTERNAL PRESSURE RAISE FROM ACTUAL SET POINT .
- 1KG/CM2=0.9810 BAR

EXPANSION VALVE AND LIQUID LEVEL SENSOR

1. **EXPANSION VALVE AND LQUID LEVEL SENSOR WORKS FOR EVEPORATOR .**

FROM CONDENSER

LIQUID (HIGH PRESSURE , LOW TEMP)

EXPANSION VALVE

LIQUID VAPOUR (LOW PRESSURE,LOW TEMP)

TO EVAPORATOR

1.ELECTRONIC EXPANSION VALVE .

2. LIQUID LEVEL SENSOR .

2. **A LIQIUD LEVEL IS A MEASURMENT DEVICE AND MONITOR EVAPORATOR LEVEL AND GIVES FEEDBACK TO CH530 CONTROLLER . WHICH COMMAND ELECTRONIC EXPANSION VALVE ACT WHEN LEVEL IS LOW VALVE OPEN AND WHEN LEVEL IS HIGH IT CLOSED SLIGHTLY .**
3. **BOTH VALVES FOR MAINTAINING LEVEL IN EVAPORATOR .**

ELECTRONIC EXPANSION VALVE

1. The Electronic Expansion Valve (EXV) is a flow device which regulates the flow of refrigerant to the evaporator in order to match the compressor capacity. This function increases the part load efficiencies.

2. The EXV is positioned by a 24VDC three phase bipolar stepper motor. The electronics to drive the stepper motor are integral to the motor housing. The position of the valve is determined by main processor calculations based on the liquid level control algorithm.

3. If the liquid level rises above the optimum value of 0.0” as displayed on the MP, the EXV will begin to close. If the liquid level falls below the optimum value, the EXV will begin to open.

4. To adjust the position of the EXV, the main processor communicates a step value (0-6386 steps) command to the EXV .

Expansion valve all three positions

EVAPORATOR REFRIGRENT PRESSURE TRANSDUCER (4B25)

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1. Pressure Transducers measure absolute pressure.
2. They have a range of 0 to 475 psi with an accuracy of ± 1.5 psi under steady state conditions.
3. 1 kg = 14.7 psi .
4. 1kg = 0.98 bar .
5. It works through power supply module card .
6. it used to measure evaporator refrigerant pressure and it also located on inlet top side of evaporator .

EVAPORATOR ENTERING AND LEAVING WATER TEMP SENSOR .(4B20 ,4B21)

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1. All of the temperature sensors used on CH530 are negative temperature coefficient (NTC) thermistors .

2. It located on evaporator water entering side and evaporator water leaving side .

3. The thermistors all have a base resistance of 10k Ohms at 77 F (25C).

4. The sensors have a probe range of -40 to 120 F and should have an accuracy of ± 1F.

5. 0deg C = 32 deg Fahrenheit .

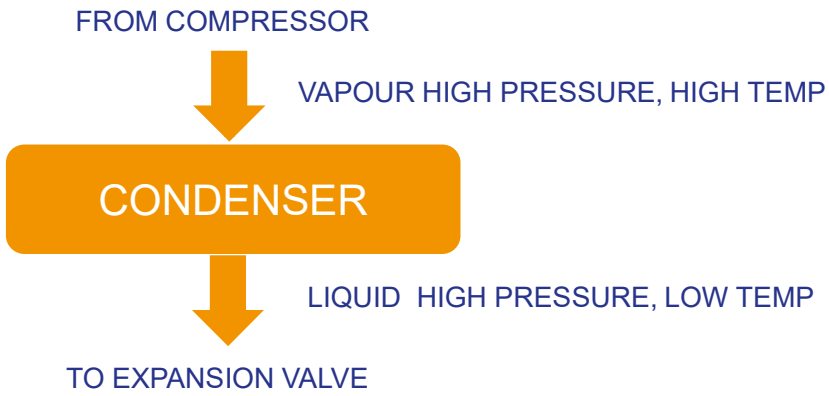
6. 1deg c = 33.8 deg Fahrenheit .

7. -1deg c = 30.2 deg Fahrenheit

CONDENSER

1. COMPRESSED REFRIGRENT VAOUR DISTRIBUTED IN CONDENSE ACROSS TUBES .

2. COOLING TOWER WATER CIRCULATING IN CONDENSER TUBES , ABSORB HEAT FROM THIS REFRIGRENT AND CONDENSE IT .



3. CONDENSER USED TO REMOVE HEAT FROM REFRIGRENT , IT IS REMOVE FEFRIGENT HEAT THROUGH COOLING TOWER CIRCULATING WATER .

CONDENSER ENTERING AND LEAVING WATER TEMP SENSOR (4B22 ,4B23)

1. All of the temperature sensors used on CH530 are negative temperature coefficient (NTC) thermistors .

2. The thermistors all have a base resistance of 10k Ohms at 77 F (25C).

3. 0deg C = 32 deg Fahrenheit .

4. 1deg c = 33.8 deg Fahrenheit .

5. -1deg c = 30.2 deg Fahrenheit .

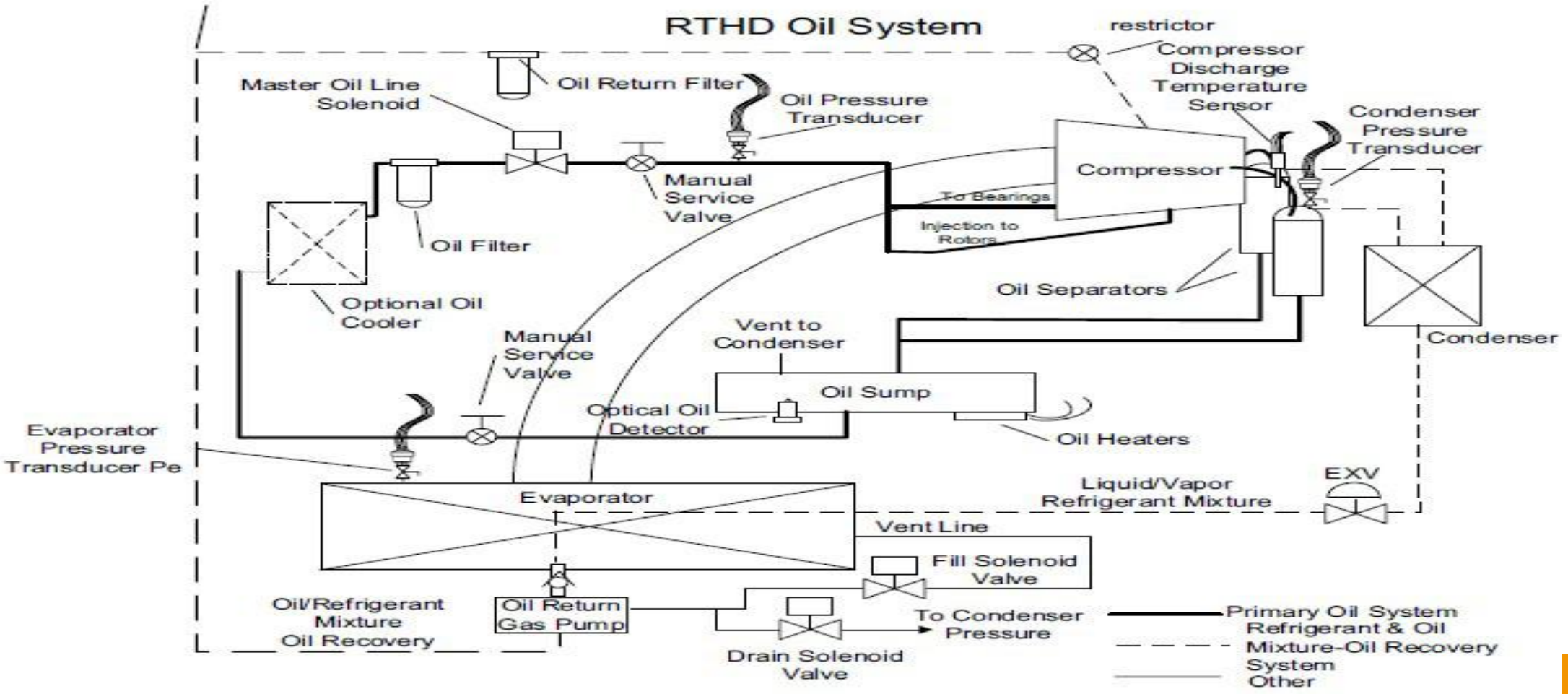
6 It located on condenser water inlet side and condenser water outlet side .

7. The sensors have a probe range of -40 to 120 F and should have an accuracy of ± 1F.

CONDENSER RELIEF VALVE

- PRESSURE RELIEF VALVE MUST BE VENTED TO THE OUTDOOR.
- ITS ALSO LOCATED ON THE TOP SIDE OF THE CONDENSER.
- CONDENSER RELIEF VALVE DISCHARGE SETPOINT 300psig .
- ONCE THE RELIEF VALVE OPEN AND ITS WILL RECLOSE WHEN PRESSURE IS REDUCE TO A SAFE LEVEL .
- Psig IS POUNDS-FORCE PER SEQUARE INCH GAUGE .
- 1PSIG = 0.0689476 BAR

CHILLER OIL FLOW SYSTEM



CONDENSER REFRIGRENT PRESSURE TRNSDUCER (4B26)

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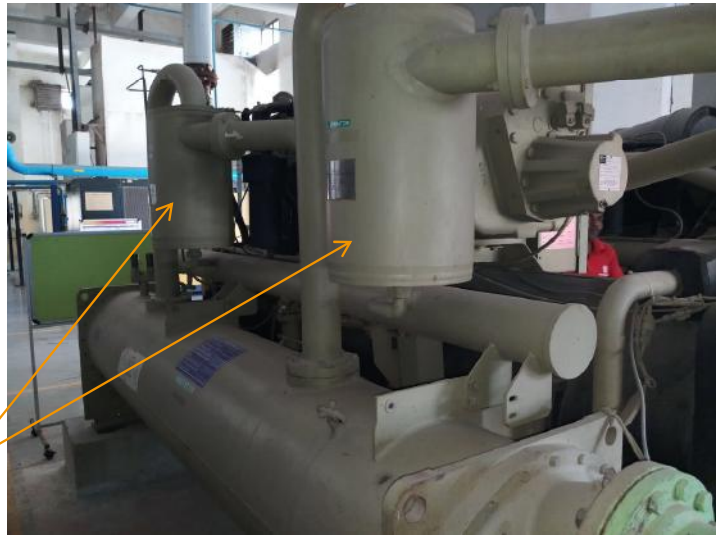
1. Pressure Transducers measure absolute pressure.
2. They have a range of 0 to 475 psi with an accuracy of ± 1.5 psi under steady state conditions.
3. 1 kg = 14.7 psi .
4. 1kg = 0.98 bar .
5. It works through power supply module card .
6. it used to measure condenser refrigerant pressure and it also located on oil separator .

OIL SEPRATOR

- TWO OIL SEPRATOR USED FOR 200TR, RTHD MODEL .
- TWO VERTICAL TYPE CYLINDER USED FOR OIL SEPRATION .
- WHEN OIL INJECTED INTO COMPRESSOR ROTOR AND IT MIXES WITH COMPRESSED REFRIGRENT AND THAT DISCHARGE DIRECTLY TO OIL SEPRATOR .
- OIL AND REFRIGRENT MIXTURE DISCHARGE INTO THE OILSEPRATOR BY CNTRIFUGAL FOCRE AND COLLECT ON THE WALL OF THE CYLINDER DRAIN TO THE BOTTOM OF THE OIL SEPRATOR CYLINDER .
- THE ACCUMULATED OIL AND DRAIN OUT OF THE CYLINDER AND COLLECTED IN THE OIL SUMP AND GAS INTO THE CONDENSER .



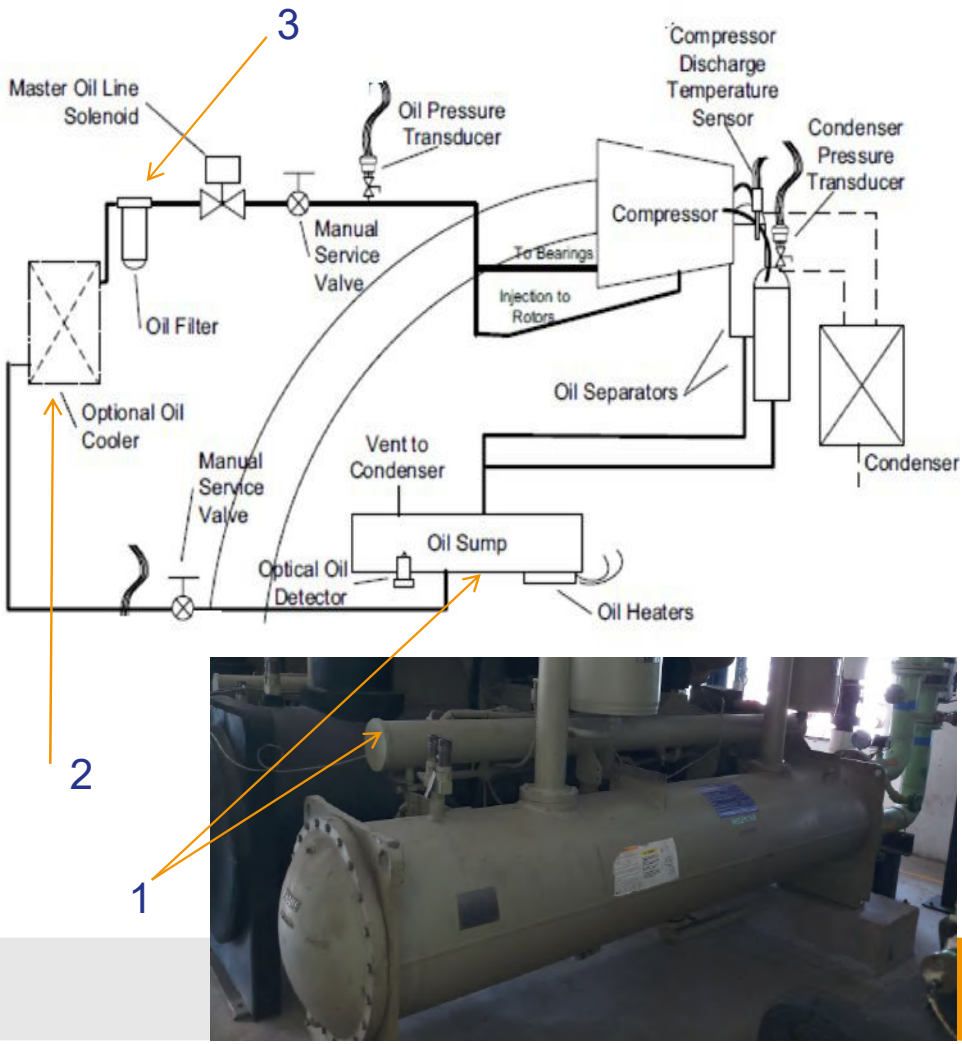
OIL RETURN CYCLE

1. **OIL SUMP:-** OIL FLOW IN CHILLER CIRCUIT FOR LUBRICATION FROM OIL SUMP TO COMPRESSOR . OIL SUUMP IS USED TO COLLECT OIL FROM COMPRESSOR OIL SEPRATOR . IT PSSSES THROUGH MANUAL SERVICE VALVE , OPTICAL OIL COOLER , OIL FILTER , MASTER OIL LINE SOLENOID, MANUAL SERVICE VALVE .

OIL UESD FOR TWO PURPOSE

- BEARING LUBRICATION & COOLING
- COMPRESSOR OIL INJECTION

2. **OIL COOLER** :- IT IS A HEAT EXCHANGER , IT LOCATED NEAR THE OIL FILTER . IT DESIGENED TO TRANSFER ONE TON HEAT FROM OIL TO THE SUCTION SIDE .
3. **OIL FILTER** :- OIL FILTER IS USED TO REMOVE ANY IMPURITIES THAT COULD FOUL THE COMPRESSOR INTERNAL OIL SUPPLY GALLRIES .THIS ALSO PREVENT EXCESSIVE WEAR OF COMPRESOR ROTOR AND BEARING .



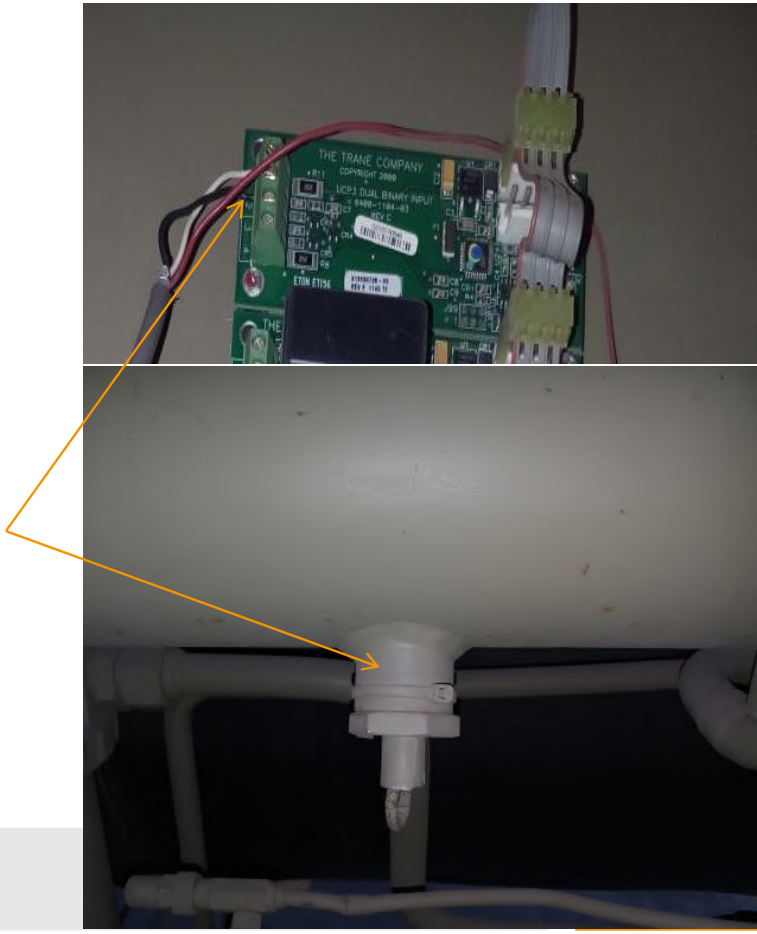
OIL LOSS LEVEL OPTICAL SENSOR (4B2)

1. The oil level detector is located in the oil sump.

2. The sensor uses infrared light reflected off the inside of a conical prism, back to a detector to sense the difference in refractive index of the prism /oil interface relative to that of the prism/vapor interface.

3. The optical sensor is should be separated from the refrigerant .

4. Optical oil level sensor used for measure compressor oil level , its operating voltage is 24vdc and it always gives feedback to controller in wet and dry condition .



HIGH PRESSURE CUTOFF SWITCH (4B29)

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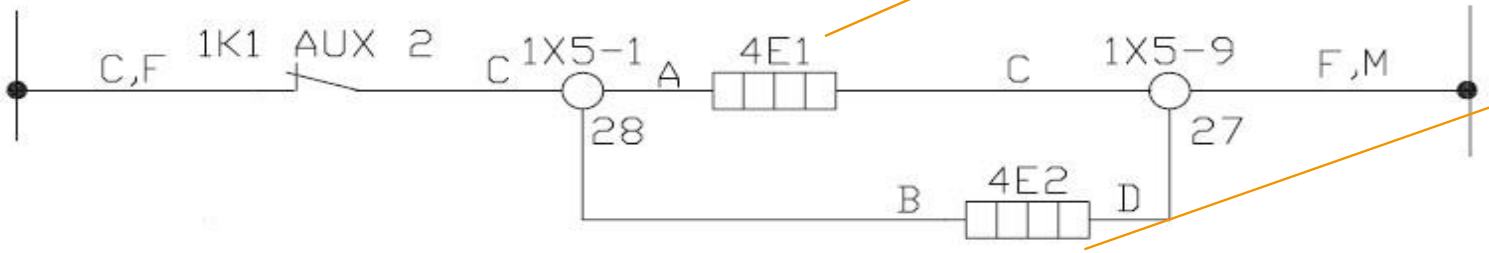
- HIGH PRESSURE CUTOFF SWITCH LOCATED ON OIL SEPRATOR TO CONDENSER LINE .
- IT SHOULD BE NC ON OPERATING PRESSURE , WHEN PRESSURE ACROSS ITS RANGE MORE THEN 120 PSI THAT TIME IT OPEN AND CHILLER STOP .
- IT UESD FOR SAFETY PURPOSE .
- ITS OPERATING VOLTAGE 110VAC .
- WHEN PESSURE MORE THEN 120 PSI THAT TIME CHILLER GOES TO TRIP THROUGH 1A3 STARTER MODULE .

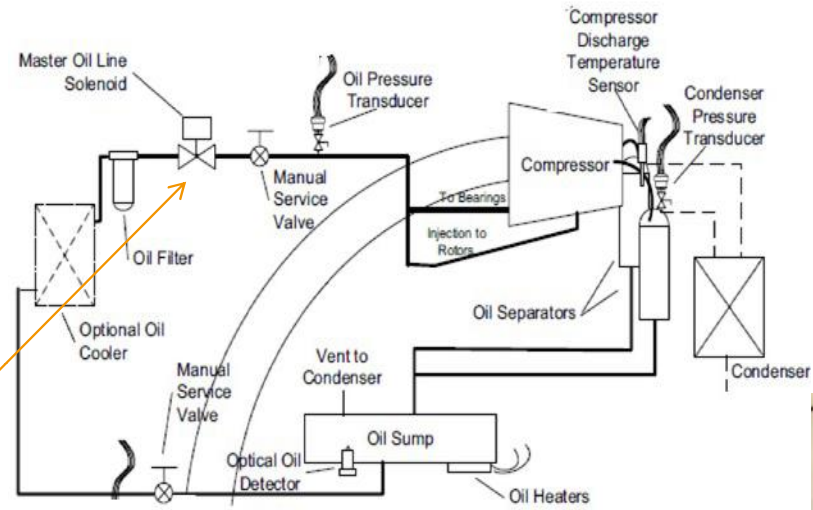
OIL SUMP HEATER (4E1, 4E2)

- TWO HEATER 4E1 AND 4E2 USED FOR OIL SUMP .
- IT IS ALSO INTERLOACK WITH COMPRESSOR 1K1 MAIN CONTACTOR , IT SHOULD BE ON WHEN CHILLER IS IN OFF CONDITION .
- IT USED FOR REGULAR HEATING TO LUBRICANT OIL FOR WET CONDITION .
- ITS OPERATING VOLTAGE IS 110 VAC .

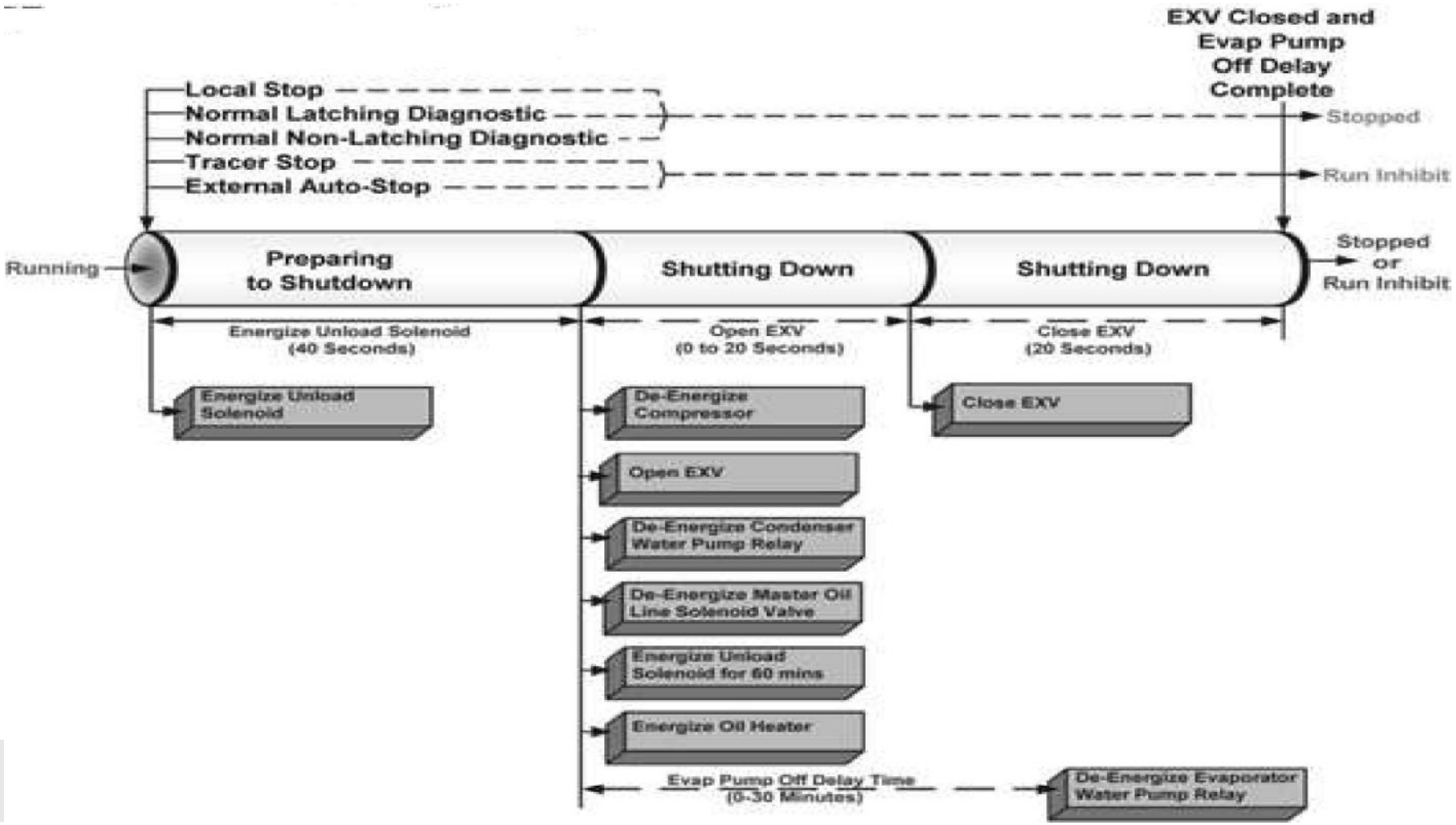


MASTER OIL LINE SOLENOID (4Y3)

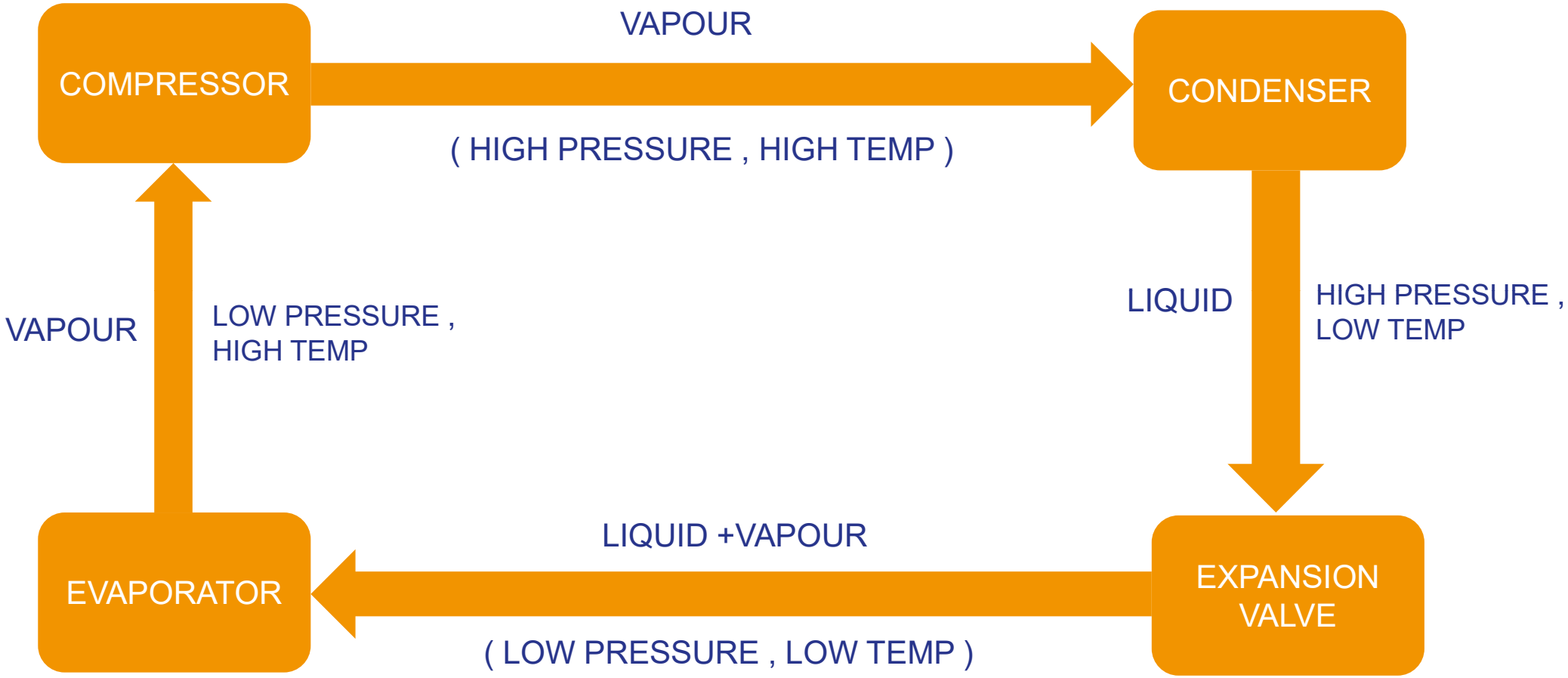
- IT CONNECTED BETWEEN OIL SUMP TO COMPRESSOR LINE .
- MASTER SOLENOID VALVE OPERATING VOLTAGE IS 110 VAC .
- IT ALSO INTERLOCK WITH COMPRESSOR TRANSITION STARTER MAIN CONTACTOR 1K1 .
- MASTER SOLENOID VALVE ALSO PLAYS MAIN ROLE FOR COMPRESSOR BEARING LUBRICATION AND COOLING .



CHILLER NORMAL SHUTDOWN AND STOP



PROCESS FLOW



POWER SUPPLY MODULE

1. **The CH530 power supply has no communication capabilities. It provides 24VDC to the LLIDs (LOW LEVEL INTELIGENT DEVICE). The power supply module provides 24VDC power to support all of the module and LLIDs functions Like temperature sensors , low voltage binary inputs , high voltage binary inputs , analog input/output , relay output , pressure transducer , EXV stepper driver , liquid level sensor input .**

2. **The input voltage on the power supply is 23 to 30 VAC and the output voltage is 22.8 to 25.2 VDC.**

3. **LED S is lit it implies that there is a good DC output voltage being produced by the board. Output for terminals J1, J3, J4, J5 and J11 are the same. The voltage output should be within ± 5%.**

4. **There is a 3.0 amp fuse on the power supply. If this fuse is open LED will not be on and there will not be any voltage out. This fuse can be replaced.**

1. MAIN 27 VAC INPUT FOR CARD
2. FOR LLIDs .
3. FOR CH530 CONTROLLER .
4. POWER SUPPLY FUSE .
5 . INDICATION LED .

CH530 COMMUNICATION SYSTEM

- Dyna View provides bus management . It collect data , status diagnostic information and communicate command to starter module and LLID bus (Low level intelligent device) .
- The CH530 uses IPC3 protocol based on RS485 signal technology and communicating at 19.2 kbaud to allow 3 rounds of data per second on a 64 device network .
- Higher level module exist only as necessary to support system level control and communication . It control the compressor starter , running and stopping . it used for compressor motor protection .
- The main processor communicate to each input and output devices like pressure , temperature sensor low voltage binary input , analog input / output all connected to four wire bus.
- The communication system interface to building automation system (BAS) .

DYNA VIEW DISPLAY AND INTERFARENCE (1A1)

1. The display on DynaView is a 1/4 VGA display with a resistive touch screen and an LED backlight. The display area is approximately 4 inches wide by 3 inches high [102 mm x 60 mm].

2. In this touch screen application, key functions are determined completely by software, and change depending upon the subject matter currently being displayed.

3. Radio buttons show one menu choice among two or more alternatives, all visible . Action buttons appear temporarily and provide the user with a choice such as Enter or Cancel.

4. Spin values are used to allow a variable set point to be changed, such as leaving-water set point. The value increases or decreases by touching the increment (+) or decrement (-) arrows.

5. Hot links are used to navigate from one view to another view.

CARDS AND RELAYS

1. 1A1 :- FOR OIL LOSS OPTICAL SENSOR .
2. 1A4 :- SOLID STATE STARTER FULT AND HIGH PRESSURE CUT OUT SWITCH.
3. 1A5 :- FOR COMPRESSOR LOAD UNLOAD SOLENOID VALVE .
4. 1A6 :- FOR OIL RETURN GAS PUMP SOLENOID VALVE
5. 1A2 :- POWER SUPPLY MODULE .
6. TRANE 400 :- CONTROLLER .
7. TB :- 110VAC CONNECTOR TB FOR DISTRIBUTION .
8. 1A3:- FOR STARTER MODULE .
9. 1A8:- FOR ICE BUILDING STATUS OUTPUT AND MASTER SOLENOID VALVE .
10. 1A7:- FOR CONDENSER AND CHILLED WATER FLOW SWITCH INLETLOCK.
11. 1A9:- CONDENSER AND CHILLED WATER PUMP STARTER .
12. 1A10:- OPERATING STATUS PROGRAMING RELAY
13. T/F :- STEP DOWN TRANSFORMER 415 TO 27 ,110VAC

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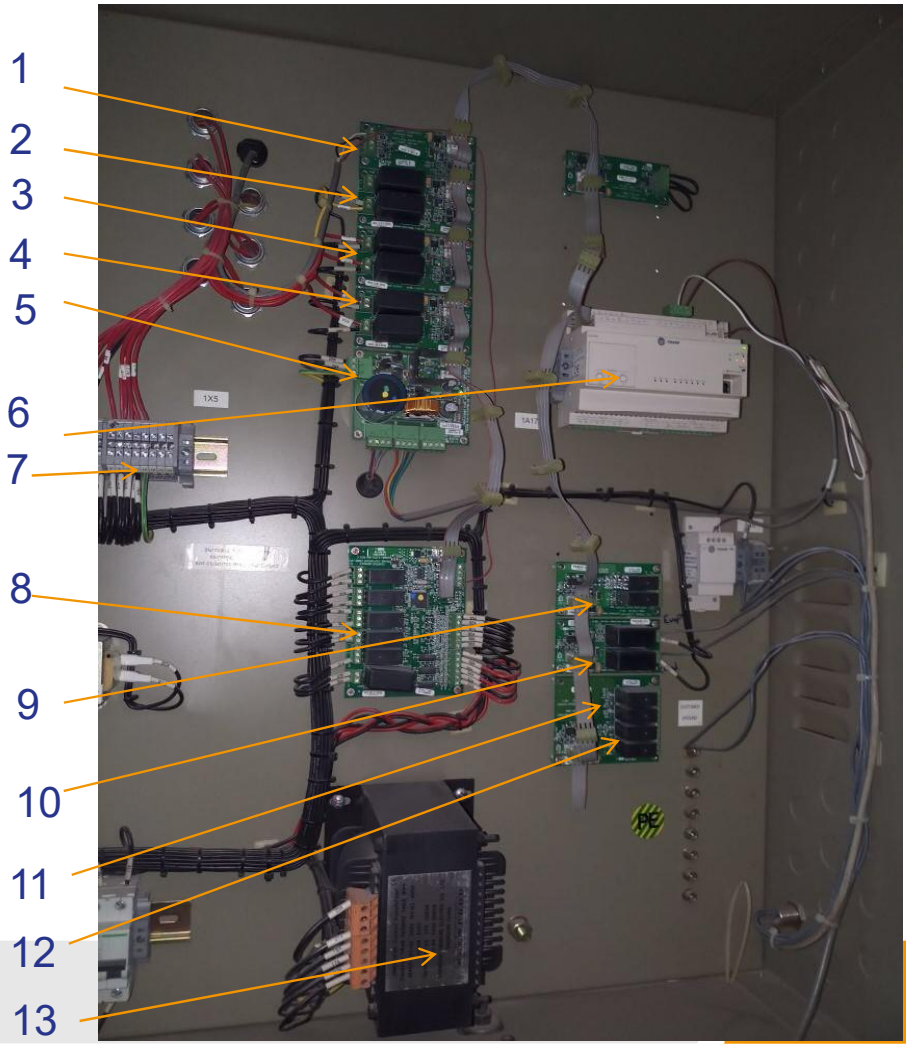

TRANE UC400 CONTROLLER

1. The Tracer UC400 controller is a programmable general purpose BACnet, microprocessor-based, Direct Digital Controller (DDC).
2. Trane VAV units have been made with either pneumatic, analog electronic, or microprocessor controls. It used for temperature control , flow ventilation control , flow tracking control.
3. Inputs include a twisted/shielded communication link, zone sensor, duct temperature sensors (optional), Occupancy Sensor (optional), Discharge Air Temperature (DAT) and/or Supply Air Temperature (SAT), CO2 sensor, and 24 VAC power

   <u>There are 15 LED in front of controller .</u>
4. Marquee LED green for power and operating normally , Red for low power and malfunction.
5. Blinks red when an alarm exists.
6. The TX LED blinks green at the data transfer rate when the Tracer UC400 controller transfers data to other devices on the link.
   - The RX LED blinks yellow at the data transfer rate when the Tracer UC400 controller receives data from other devices on the link.
7. - The TX LED blinks green at the data transfer rate when the Tracer UC400 controller transfer data to other devices on the IMC bus.
   - The RX LED blinks yellow at the data transfer rate when the Tracer UC400 controller receives data from other devices on the IMC bus.
8. B0 to B9 Shows solid green when corresponding binary output is on.s

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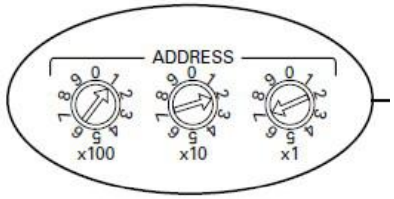
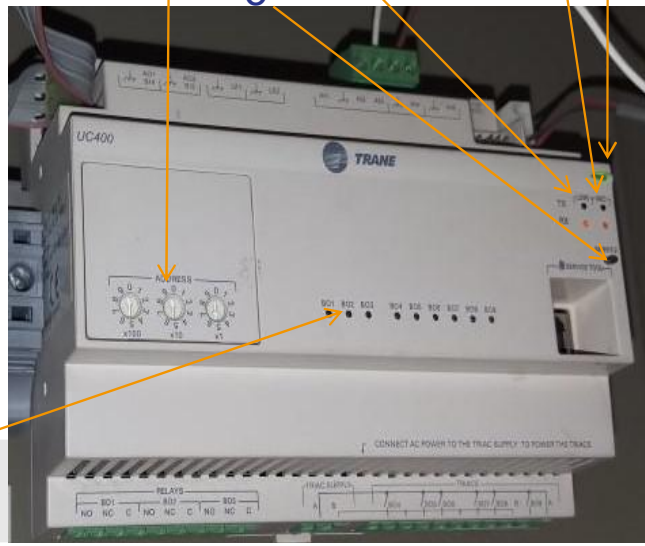
The three-digit address setting is used as both the BACnet MAC address and the BACnet device ID.





WHAT IS PSI ,PSIA,PSIG

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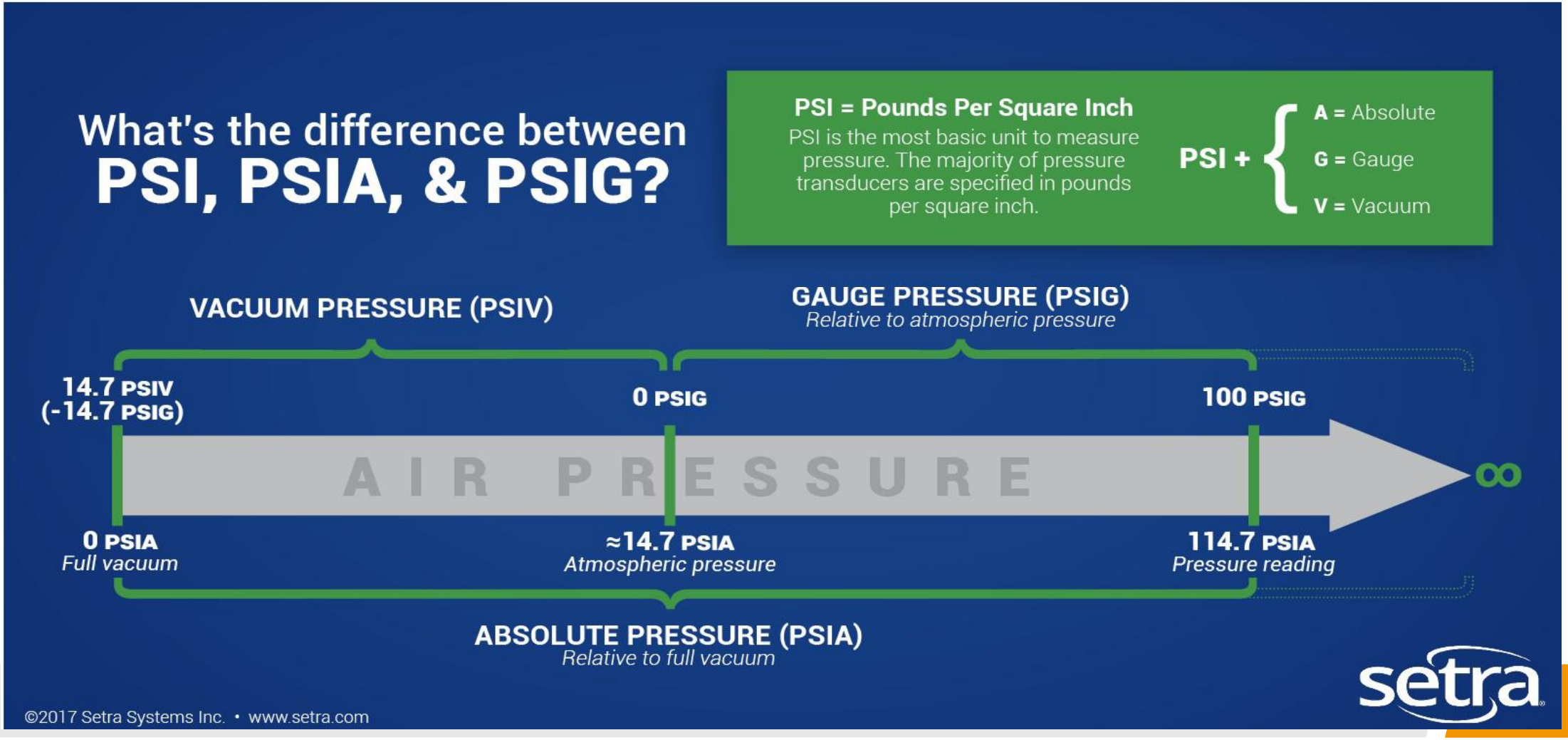

Definitions for chiller

1. **Tons of refrigeration (TR):** One ton of refrigeration is the amount of cooling obtained by one ton of ice melting in one day: 3024 kCal/h, 12,000 Btu/h or 3.516 thermal kW.

2. **Net Refrigerating Capacity.** A quantity defined as the mass flow rate of the evaporator water multiplied by the difference in enthalpy of water entering and leaving the cooler, expressed in kCal/h, tons of Refrigeration.

3. **kW/ton rating:** Commonly referred to as efficiency, but actually power input to compressor motor divided by tons of cooling produced, or kilowatts per ton (kW/ton). Lower kW/ton indicates higher efficiency.

4. **Coefficient of Performance (COP):** Chiller efficiency measured in Btu output (cooling) divided by Btu input (electric power).

5. **Energy Efficiency Ratio (EER):** Performance of smaller chillers and rooftop units is frequently measured in EER rather than kW/ton. EER is calculated by dividing a chiller's cooling capacity (in Btu/h) by its power input (in watts) at full-load conditions. The higher the EER, the more efficient the unit. s

CHILLER FORMULAS

COFFECIENT OF PERFORMANCE (COP) = KW REFRIGERATION EFFECT / KW INPUT POWER

COP = 0.293 X ENERGEY EFFICENT RATIO

COP = 3.156 / (KW / TON RATING)

ENERGY EFFICENCY RATIO (EER) = 12 / (KW / TON RATTING)

EER = 3.413 X COP

EER = 12 / (KW / TON RATING)

POWER PER TON (KW / TON) = KW INPUT / TON REFFIGERATION EFFECT

KW / TON RATING = 12 / EER

KW / TO RATING = 3.512 / COP

HOW TO CALCULATE NET REFRIGREATION CAPACITY

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$$TR = Q \times Cp \times (Ti - To) / 3024$$

- 1 TR of refrigeration = 3024 kCal/hr heat rejected.

- Q is mass flow rate of coolant in kg/hr .
  Cp is coolant specific heat in kCal /kg deg C
  Ti is inlet, temperature of coolant to evaporator (chiller) in °C
  To is outlet temperature of coolant from evaporator (chiller) in °C

calculation for Tr = 120 x 1000 x 1 (Evp in – Evp out)/ 3024
= 120 X 1000 X (12 – 7) / 3024
TR = 198.41

HOW TO CALCULATE POWER PER TON

$$\text{Power per ton} = \frac{\text{Measured compressor power kw}}{\text{Net Refrigeration Capacity}}$$

$$= 213 \text{ KW} / 200 \text{ TR}$$

$$= 1.065 \text{ KW/TR}$$

ENERGY EFFICENCY RATIO

$$EER = \frac{\text{Btu/h Refrigeration Effect}}{\text{watt input}}$$

$$= 12000 / (\text{kw/ton})$$

$$= 12 / 1.065$$

$$= 11.26$$

COFFICENT OF PERFORMANCE

$$COP = \frac{\text{KW Refrigeration Effect}}{\text{KW input}}$$

$$= 3.516 / (\text{kw/ton})$$

$$= 3.516 / 1.065$$

$$= 3.30$$

THANK YOU

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