

Refrigeration / Air Conditioning Systems Circuit Drawings

Student Resource Package No: NR 24

Nominal Student Hours: 24 Hours.

Delivery: Competence in this training program can be achieved through either a formal education setting or in the workplace environment.

Recognition of Prior Learning:

The student/candidate may be granted recognition of prior learning if the evidence presented is authentic and valid which covers the content as laid out in this package.

Package Purpose:

This package provides the student with the underpinning knowledge and skills to construct refrigeration / air conditioning wiring, piping and equipment layout circuit diagrams on various types of systems.

Suggested Resources:

Australian Refrigeration and Air Conditioning Vol 1&2.
Various Manufacturers Service and Installation Manuals.

Assessment Strategy:

The assessment of this package is holistic in nature and requires the demonstration of the knowledge and skills identified in the student package content summary. To be successful in this package the student must show evidence of achievement in accordance with the package

Competence:

This package should be supported by workplace exposure to the various applications under the guidance of a licensed mentor.

Contents:

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Assessment:

Grade Code: 72

GRADE	CLASS MARK (%)
DISTINCTION	≥ 83
CREDIT	≥ 70
PASS	≥ 50

Assessment Events

The assessment in this package is to be progressive that is marks will be allocated for each drawing exercise these marks are to be added and averaged to give a total mark out of 100%

Example: 6 drawings each drawing is marked out of ten.

- Drawing No: 1 = 7
- Drawing No: 2 = 6
- Drawing No: 3 = 7
- Drawing No: 4 = 8
- Drawing No: 5 = 8
- Drawing No: 6 = 9
- Drawing No: 7 = 8
- Drawing No: 8 = 9

Total marks = 62

Therefore: $\frac{62}{80} = 0.775 \times 100 = 77.5\%$ Total marks achievable = 100.

Note: in this example the student has achieved 77.5 out of a total of 100 marks

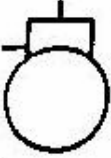

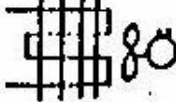
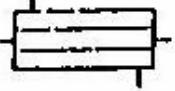

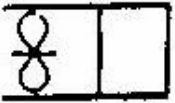
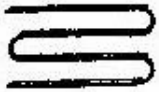
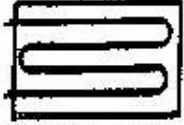

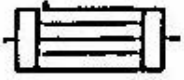
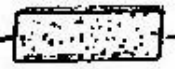

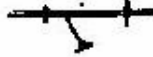

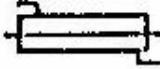
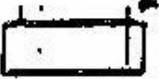

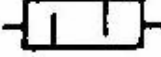

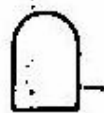




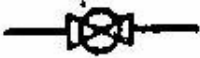







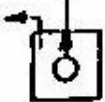


Resources required:












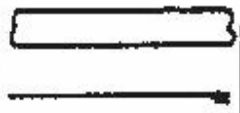






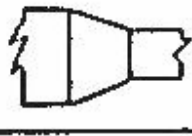




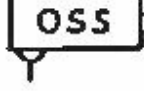
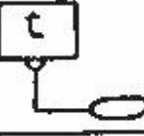




- A4 Project Book (with blank page on one side and writing page on the other).
- Ruler.
- Circular Templates.
- Red, Black, Blue and Green Pens
- Liquid white out not required.
- ***Free hand drawings will not be marked and the correct symbols and colour coding must be used.***

Electrical Symbol Sheet

Conductor	Lamp	Push Button (NC)
Conductor junction	Motor Permanent Split capacitor	Push Button (NO)
Conductor cross over	Flow control	Motor Shaded Pole
Earth	Contactor coil	Two Way Switch With Centre-off.
Circuit breaker	Fuse	Temperature Dependant Resistor (Thermistor)
Normally open	Heater	Low Pressure Control Close on Rise
Normally closed	Capacitor General	Triple Pole Switch
Thermostat Open on Fall Close on Rise	Time Delay Relay (NO)	Defrost Timer
Thermostat Open on Rise Close on Fall	Low Pressure Control Close on Fall	Overload Switch Opens on Rise
Dual Pressure Control	Manual Reset Oil Pressure Failure Control	Air Conditioning Control Station Heat Cool
Current Coil Relay	Voltage Coil Relay	Solid State Relay

Mechanical Symbol Sheets

REFRIGERATION / MECHANICAL DRAWING SYMBOLS				
COMPRESSOR 	MOTOR COMPRESSOR 	AIR COOLED CONDENSER 	WATER COOLED CONDENSER 	EVAPORATIVE CONDENSER 
FORCED DRAUGHT EVAPORATOR 	BARE PIPE EVAPORATOR 	PLATE EVAPORATOR 	FINNED EVAPORATOR 	WATER CHILLER SHELL & TUBE 
DRYER 	LIQUID INDICATOR 	Y TYPE STRAINER 	OIL SEPARATOR 	HEAT EXCHANGER 
RECEIVER HORIZONTAL 	RECEIVER VERTICAL 	MUFFLER 	SUCTION ACCUMULATOR 	SURGE TANK 
GENERAL VALVE 	3 WAY VALVE 	ANGLE VALVE 	PRESS RELIEF VALVE 	GLOBE VALVE 
MANUALLY OPERATED 	DIAPHRAGM OPERATED 	FLOAT OPERATED 	SOLENOID OPERATED 	ELECTRIC MOTOR OPERATED 
CHECK VALVE 	REVERSING VALVE 	LOW SIDE FLOAT 	HIGH SIDE FLOAT 	CAPILLARY TUBE 

REFRIGERATION / MECHANICAL DRAWING SYMBOLS				
Solenoid Valve 	EPRV 	CPRV 	Int: TXV 	Ext: TXV 
AIR SUPPLY FITTING 	AIR EXHAUST/ RETURN 	FAN GENERAL 	FAN PROPELLER 	PUMP 
AIR FILTER 	DUCT GENERAL SYMBOL 	DAMPER MULTIBLADE PARALLEL 	DAMPER MULTIBLADE OPPOSED 	DAMPER FIRE 
CANVAS CONNECTION 	DEFLECTING DAMPER 	VANE ELBOW 	TRANSFORMATION DUCT 	AUTOMATIC DAMPER 
LOW PRESSURE 	HIGH PRESSURE 	DUAL PRESSURE 	OIL FAILURE CONTROL 	THERMOSTAT REMOTE BULB 
DISCHARGE PIPE <u>RED</u>	SUCTION PIPE <u>BLUE</u>	LIQUID PIPE <u>GREEN</u>	WATER PIPE <u>BLACK (GREY)</u>	GAUGE 
DIRECTION OF FLOW 	CROSSING PIPE CONNECTED 	CROSSING PIPE NOT CONNECTED 		

Sample of A4 Drawing Layout

NAME	DRAWING TITLE	DATE:

Details:

- 10mm boarder
- 12 mm name, title and name blocks

Electrical Colours:

- Red for active
- Blue for neutral
- Green for earth
- Black for components

Refrigeration Colours:

- Red for discharge
- Blue for suction
- Green for liquid
- Black for water pipe and components.

Drawing Exercise No: 1

Low Temperature Freezer Cabinet (R404A)

Aim: To construct the refrigeration piping and electrical wiring diagrams for the wall mounted low temperature freezer cabinet in the workshop in accordance with the following details:

Details:

Electrical wiring diagram:

- 415 volt power supply.
- Isolation switch / circuit breakers, fuses etc.
- D.O.L. compressor contactor.
- Shaded pole evaporator fans operate continuously.
- Electric element / defrost cycle.
- Defrost timer: time initiated time or pressure terminated
- Defrost and drain heaters.
- High limit safety thermostat for heater protection.
- Ant-sweat cabinet rail heaters.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration system.

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions

With the system operating gather all the required information to construct the electrical and refrigeration drawings in you're A4 project book.

You should do a rough copy first and check with your teacher before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

Determine and list all the refrigeration and electrical controls settings as indicated below to allow for automatic operation and safety control to ensure compliance with the relevant codes and legislative requirements:

- Cabinet thermostat to maintain an average cabinet temperature of -20°C.
- High limit safety heater thermostat.
- LP/HP safety controls.
- Compressor contactor overload
- Defrost timer.
- Evaporator pressure regulating valve (EPRV).
- TX valve superheat?
- Describe how would adjust the TX valve superheat

Drawing Exercise No: 2

Split Ducted Air Conditioning System (R22 / 18 kW)

Aim: To construct the refrigeration piping and electrical wiring circuit diagrams for a split ducted air conditioning system in accordance with the following details:

Details:

Electrical wiring diagram:

- 415 volt power supply
- Isolation switch / circuit breakers, fuses etc
- Three phase scroll compressor.
- Crankcase heater to operate on compressor off cycle.
- D.O.L. compressor contactor.
- Two permanent split phase condenser fan motors.
- One permanent split capacitor three speed evaporator fan motor
- ON/OFF control switch.
- Heat Cool selector switch.
- Return air control thermostat.
- Reversing valve.
- De-ice thermostat
- Low ambient booster heater 3 x 2 kW (three phase star connected DOL)
- Low ambient booster heater thermostat.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration circuit of the air conditioning system..

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions

From the information supplied and support form your teacher / mentor construct the refrigeration piping and electrical wiring circuit diagrams into you're A4 project book.

You should do a rough copy first and check with your teacher / mentor before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

1. Describe in your own words the purpose of a suction line accumulator:
2. What is the main purpose of the de- ice thermostat?
3. To provide optimum performance for a split ducted air conditioning system on what side of the house would you place the outdoor unit and give your reason why?
4. Why is it necessary to have a crankcase heater install around the compressor sump?
5. At what saturated evaporator temperature SET of the refrigerant should this system operate at.

Drawing Exercise No: 3

Medium Temperature Storage Room (3°C) Refrigerant R134a

Aim: To construct the refrigeration piping and electrical wiring diagrams for a medium temperature storage room in accordance with the following details:

Details:

Electrical wiring diagram:

- 415 volt power supply
- Isolation switch / circuit breakers, fuses etc
- Three phase squirrel cage induction compressor drive motor (10kW).
- Crankcase heater to operate on compressor off cycle.
- Star Delta compressor contactor.
- Two three phase star connected squirrel cage induction condenser fan motors.
- Four permanent split capacitor evaporator fan motors
- Thermostat to cycle a liquid line solenoid valve on room temperature.
- HP cycling control on one of the condenser fan motors.
- LP/HP Safety controls
- Evaporator fans to operate continuously.
- Provide room lighting via a two way switch.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration circuit of the system.

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions.

From the information supplied and support form your teacher / mentor construct the refrigeration piping and electrical wiring circuit diagrams into you're A4 project book.

You should do a rough copy first and check with your teacher / mentor before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

Determine and list all the refrigeration and electrical controls settings as indicated below for the attached medium temperature system to allow automatic operation and safety control to ensure compliance:

1. Cabinet thermostat to maintain an average room temperature of 3°C.
2. LP/HP safety.
3. Compressor contactor overload.
4. What should the TX valve superheat be set at ?
5. Describe how you would adjust the TX valve super heat.

Drawing Exercise No: 4

Package Air Conditioning System (36 kW)

Aim: To construct the refrigeration piping and electrical wiring diagrams for a package air conditioning system in accordance with the following details:

Details:

- Package unit has a dry expansion evaporator and fitted with a shell and tube condenser.
- Remote cooling tower and condenser water pump.
- Operates on one zone.
- Resistance heater elements (2 banks of three heaters with each rated at 3 kilo watts (kW). Note each bank to be star connected.
- Thermostat to control office area (one stage cooling / two stage heating).
- Include all the necessary cycling controls and safety to provide for both automatic and safe operation of plant and equipment.
- Ensure oil pressure safety control, limited compressor start relay, air and water pressure safety controls are included.

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions.

From the information supplied and support form your teacher / mentor construct the refrigeration piping and electrical wiring circuit diagrams into you're A4 project book.

You should do a rough copy first and check with your teacher / mentor before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

1. What is the purpose of the cooling tower thermostat and list the cut and cut out settings.
2. The safety high pressure control cuts out even though it has been adjusted correctly. List at least three possible causes:
3. Why is it necessary to have regular maintenance on cooling towers?
4. What is the purpose of a three way modulating water valve installed in the leaving and return water of the condenser.
5. The evaporator becomes iced up. List three possible causes.

Drawing Exercise No: 5

Medium Temperature Storage Room (2°C) Refrigerant R22

Aim: To construct the refrigeration piping and electrical wiring diagrams for a medium temperature storage room in accordance with the following details:

Details:

Electrical wiring diagram:

- 240 volt power supply
- Isolation switch
- Split phase motor compressor.
- Potential coil relay coil relay.
- Start and run capacitors in compressor circuit.
- Two permanent split capacitor condenser fan motors.
- Thermostat to cycle evaporator fans on room temperature.
- HP cycling control on one of the condenser fan motors.
- LP/HP Safety controls
- Two permanent split capacitor evaporator fans to operate continuously.
- Provide room lighting via a two way switch.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration circuit of the system.

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions.

From the information supplied and support form your teacher / mentor construct the refrigeration piping and electrical wiring circuit diagrams into you're A4 project book.

You should do a rough copy first and check with your teacher / mentor before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

- 1 Describe the function and operation of the potential coil relay.
- 2 What is the main purpose of a start capacitor?.
- 3 What is the main purpose of the condenser fan HP cycling control
- 4 List the following control settings:
 - Room thermostat
 - Low pressure control
 - High pressure control
 - High pressure condenser fan cycling control.

Drawing Exercise No: 6

Low Temperature Freezer Room (R404A)

Aim: To construct the refrigeration piping and electrical wiring diagrams for a low temperature freezer room in accordance with the following details:

Details:

Electrical wiring diagram:

- 415 volt power supply.
- Isolation switch / circuit breakers, fuses etc.
- Semi-hermetic part winding motor compressor.
- Time delay relay to prevent condensing unit from short cycling.
- Part Winding compressor contactor.
- 4 permanent split capacitor evaporator fans operate.
- Evaporator fan delay thermostat.
- Remote condenser.
- Two three phase star connected squirrel cage induction condenser fan motors.
- Electric element / defrost cycle.
- Defrost timer: time initiated time or pressure terminated,
- Defrost and drain heaters.
- High limit safety thermostat for heater protection.
- Ant-sweat door jamb heaters.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration system.

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions

With the system operating gather all the required information to construct the electrical and refrigeration drawings in your A4 project book.

You should do a rough copy first and check with your teacher before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

Determine and list all the refrigeration and electrical controls settings as indicated below for the attached low temperature system to allow automatic operation and safety control to ensure compliance with the relevant codes and legislative requirements:

- Cabinet thermostat to maintain an average cabinet temperature of -25°C.
- High limit safety heater thermostat.
- LP/HP safety controls.
- Compressor contactor overload
- Defrost timer.
- Crankcase pressure regulating valve (CPRV).
- TX valve superheat?
- Describe how would adjust the TX valve superheat

Drawing Exercise No: 7

Split Air Conditioning System (R22 / 7 kW)

Aim: To construct the refrigeration piping and electrical wiring circuit diagrams for a split air conditioning system in accordance with the following details:

Details:

Electrical wiring diagram:

- 240 volt power supply
- Isolation switch / circuit breakers, fuses etc
- Single phase permanent split capacitor compressor motor.
- Crankcase heater to operate on compressor off cycle.
- Two permanent split phase condenser fan motors.
- One permanent split capacitor three speed evaporator fan motor
- ON/OFF control switch.
- Heat Cool selector switch.
- Return air control thermostat.
- Reversing valve.
- De-ice thermostat

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration circuit of the air conditioning system..

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions

From the information supplied and support form your teacher / mentor construct the refrigeration piping and electrical wiring circuit diagrams into you're A4 project book.

You should do a rough copy first and check with your teacher / mentor before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

- 1 Describe in your own words the main purpose of the reversing valve:
- 2 When changing a faulty reversing valve what precautions should you implement?
- 3 Why do the evaporator fan motors have a run capacitor?
4. Describe how you would charge the system with refrigerant to ensure maximum capacity.

Drawing Exercise No: 8

Hotel and Club Beverage Cooling System Installation (R134A)

Aim: To construct the refrigeration piping and electrical wiring circuit diagrams for a typical hotel / club beer cooling system in accordance with the following details:

Details:

- One condensing unit for the whole system. (Remote air cooled condenser).
- Remote air cooled condenser (two permanent split capacitor fan motors).
- Two instantaneous beverage coolers. (Beverage temperature 2°C)
- Beverage package and keg room (room temperature 4° - 7°C).
- Two permanent split capacitor fan motors (package and keg room)
- Thermostat cycles liquid line solenoid valve (package and keg room on room temperature.
- Two bottle cabinets (suction line solenoid valves cycle on LP control).
- LP control used as a cycling and safety control for condensing unit.
- HP safety control for condensing unit.
- HP cycling control for one of the condenser fan motors.

Details:

Electrical wiring diagram:

- 415 volt power supply.
- Isolation switch / circuit breakers, fuses etc.
- D.O.L. compressor contactor.

Refrigeration piping diagram:

- Include in your diagram all interconnecting components and controls within the refrigeration system

Procedure: On the attached page in your project book include the aim, procedure and conclusion questions

With the system operating gather all the required information to construct the electrical and refrigeration drawings in you're A4 project book.

You should do a rough copy first and check with your teacher before entering the final edit into your project book

Note: *Use the correct page layout, colour coding and symbols as outlined at the front of this package.*

Conclusion:

1. Describe how you would adjust the saturated evaporator temperature on each of the instantaneous beverage coolers
2. What is the purpose of the suction line solenoid valve on each of the bottle cabinets:
3. Why does an instantaneous beverage cooling system require an oil separator?
4. Why is it necessary to have a surge tank installed in a beverage cooling system?
5. The suction line is frosting all the way back to the compressor. What do you think would cause this problem?