

2.16 Refrigeration and air conditioning installations

2.16.1 Refrigeration pipework and accessories

Evidence shall show an understanding of refrigeration pipework and accessories to an extent indicated by the following aspects:

a) Appropriate piping arrangements

Note:

Adequate piping arrangements include those for discharge lines, liquid lines, suction lines, incorporation valves, dryers, site glasses, accumulators, oil separators, heat exchangers, traps and piping for multiple compressor systems

b) Pipe work accessories and their location

Note:

Pipe work accessories include clamps, joiners, fittings and connections.

c) Pipe work installation techniques

2.16.2 Refrigeration pipework layout

Evidence shall show an understanding of refrigeration pipework layout to an extent indicated by the following aspects:

- a) Position of equipment in relation pipework
- b) Requirements for vertical and horizontal pipe runs.
- c) Requirements for oil return and prevention of flood back
- d) Techniques for the prevention of noise and vibration
- e) Pipework insulation requirements

2.16.3 Refrigeration installations, equipment requirements

Evidence shall show an understanding of refrigeration installations, equipment requirements to an extent indicated by the following aspects:

- a) Standards, codes and requirements applicable to installing refrigeration equipment.
- b) Techniques for installing equipment and accessories encompassing:
 - Application of accessories
 - Locating and placing components
 - Terminating piping
 - Maintenance of fire rating integrity.

2.16.4 Refrigeration pipe selection and sizing

Evidence shall show an understanding of refrigeration pipe selection and sizing to an extent indicated by the following aspects:

- a) Use of velocity/pressure drop tables
- b) Pressure drop in lines, components and fittings
- c) Oil migration stabilisation
- d) Refrigerant velocity
- e) Effect of varying system capacity
- f) Oil traps, risers and double risers

- g) Liquid migration
- h) Parallel components and multiplex systems

2.16.5 Refrigeration and air conditioning installations, testing and verification methods

Evidence shall show an understanding of testing and verification to an extent indicated by the following aspects:

- a) Mandatory testing and verification requirements.
- b) Optional testing and their appropriate use
- c) Testing techniques
- d) Visual inspection methods

2.16.6 Split air conditioning system installation

Evidence shall show an understanding of installing split air conditioning systems to an extent indicated by the following aspects:

- a) Relevant codes for the installation of residential split air conditioning systems encompassing:
 - building codes, electrical, health, environmental
- (b) Types, construction, operation and application of residential split air conditioners encompassing:
 - Types: floor and wall mounted, ducted, cassette
 - refrigeration system and reverse cycle
 - control systems
 - air distribution, fans, filters
 - noise and vibration
- c) Installation of unit and pipework encompassing:
 - respect for customers premises
 - unit location and mounting
 - fixing, securing and mounting methods
 - safe lifting, use of ladder and platforms
 - manufacturers installation and start up instructions
 - refrigerant piping: layout, installation, insulation, fastening and covering
 - condensate drains and pumps
- d) Starting up system encompassing:
 - manufacturers start up instructions
 - pressure testing
 - evacuation
 - opening outdoor unit valves
 - checking refrigerant charge: pressures, temperature, sweat line and evaporator superheat
 - adding refrigerant
 - leak detection
 - controls - operating and safety

- customer familiarisation

2.16.7 High pressure refrigerant installation

Evidence shall show an understanding of installing high pressure refrigerant systems to an extent indicated by the following aspects:

a) The function, types, properties, applications, requirements, handling and disposal of refrigerant oils used in the high pressure systems.

b) The essential service tools required to work with high pressure refrigerants encompassing:

- Gauge manifold and hoses
- Vacuum Gauge (Microns)
- Leak Detectors
- Flaring Tools
- Torque wrench for flare nuts
- Refrigerant Scales
- Digital temperature measuring thermocouples

c) Installation, commissioning and service procedures required for high pressure refrigerant systems encompassing:

- Flaring and brazing
- Pressure testing (as per HB40 and AS/NZS1677)
- Evacuation
- Charging and Recharging
- Leak detection
- Recovery

d) The correct safety procedures required to work with high pressure refrigerants encompassing:

- Personal safety protection equipment
- Refrigerant and oil handling
- Material Safety Data Sheets (MSDS)
- HB40, AS/NZS1677, AS2030, copper tube code
- Storage, filling and transport of refrigerant cylinders
- Equipment rooms, job site safety, ventilation and environmental considerations.

2.16.8 Fault-finding and diagnostic techniques

Evidence shall show an understanding of fault-finding and diagnostic skills to an extent indicated by the following aspects:

a) Establish an accurate description of the fault situation by appropriate questioning of client or operator

- Demonstrate questioning techniques to efficiently and effectively obtain from a client/operator a description of a fault situation.

b) Confirm the fault history and symptoms through observation and application of first-line tests.

- Demonstrate ability to draw valid conclusions from observations. Identify concepts of broad first-line testing.

c) In the absence of the client or operator, to establish the symptoms through application of systematic tests and observation.

- Identify appropriate diagnostic tests for given symptoms using manufacturers' charts, handbooks, specification sheets.
- Use results of systematic tests to identify symptoms.

2.16.9 Commissioning - HVAC systems

Evidence shall show an understanding of commissioning - HVAC systems to an extent indicated by the following aspects:

a) Fundamentals

- building specifications/requirements/responsibilities
- building codes
- local government regulations
- human comfort - comfort chart
- reporting procedures
- review fluid mechanic principles
- pre-commissioning checks
- calibration of instruments, data collection and recording, documentation

b) Air systems

- Air testing and balancing
- air flow
- pressure
- temperature
- fan testing
- air balancing procedures
- leakage testing
- system capacity calculations

c) Hydronic systems

- hydronic tab instruments
- fluid flow
- pressure
- temperature
- pumps: pump curves and system curves
- pump testing
- hydronic
 - balancing procedures
 - general
 - compensation method
 - balancing valves
 - capacity calculations

d) Plant and equipment

- controls
- heat exchangers

- chillers
- boilers
- cooling towers

2.16.10 Commissioning commercial / industrial refrigeration systems

Evidence shall show an understanding of commissioning commercial/industrial refrigeration systems to an extent indicated by the following aspects:

a) Fundamentals

- Building specifications/requirements/responsibilities
- Building Codes
- Local Government regulations
- Design conditions
- Reporting procedures
- Review fluid mechanics principles
- Pre – commissioning checks

b) Air Systems (excluding air balancing)

- Air Tabulation instruments
- air flow
- pressure
- temperature
- fan testing
- leakage testing
- system capacity calculations

c) Hydronic Systems

- Hydronic tabulation instruments
- fluid flow
- pressure
- temperature
- Pumps
- Pump curves and system curves
- Pump testing
- Hydronic
- balancing procedures
- general
- compensation method
- Balancing valves
- Capacity calculations

d) Refrigeration Systems

- AS1677
- HB40
- Pressure testing
- Evacuation

- Charging
 - Control setting
 - Commissioning reports
 - System performance and capacity
- e) Plant and equipment
- Controls
 - Heat exchangers
 - Chillers
 - Boilers
 - Cooling towers

2.16.11 Air conditioning drawing

Evidence shall show an understanding of air conditioning drawing to an extent indicated by the following aspects:

- a) Standards, regulations and codes
- b) Architectural and mechanical drafting conventions encompassing:
- Fire, hydraulic, electrical layout diagrams,
 - Sketching of pipework circuits and mechanical services,
 - Drawing standards and symbols,
 - Working, detail and assembly drawings,
 - Ductwork layouts and conventions,
 - Pipework layouts and conventions,
- c) Computer aided drawing techniques

2.16.12.1 Energy management fundamentals

Evidence shall show an understanding of energy management fundamentals to an extent indicated by the following aspects:

- a) Typical energy sources and characteristics
- supply authorities
 - standard units of measurement
 - electricity
 - steam
 - hot water
 - high temperature hot water
 - town gas
 - LP Gas
 - solar
 - waste heat
 - petrol
 - diesel
- b) Energy Usage
- office lighting

- air conditioning systems
 - refrigeration systems
 - security systems
 - computer systems
 - standby/emergency systems
 - lifts and escalators
- c) Energy auditing process
- energy costs and tariffs
 - energy consumption
 - predicting future costs
 - plotting consumption trends
 - historical data
 - collecting information using surveys
 - comparisons of actual to recorded usage
 - energy balance
 - instrumentation
 - building management systems
 - estimating savings potential
- d) System operation for energy efficiency
- types of systems
 - efficiency in building structures
 - operation of a vehicle fleet
 - proportion total energy consumption against individual systems
 - passive building design
 - preventative maintenance procedures
 - monitoring building management systems
 - operation of major and minor plant
 - inappropriate energy management procedures
 - building plant control systems
 - Australian standards/local authority requirements
 - case studies
- e) Implementing energy management procedures for a building
- recording base year data
 - climatic conditions for locality
 - establishing energy costs and tariffs
 - building and systems surveys
 - pay back period
 - survey analysis
 - energy conservation procedures
 - informing stockholders
 - recommendations and documentation
 - implementation issues

- monitoring, evaluation and follow up

2.16.12.2 Energy management

Evidence shall show an understanding of energy management to an extent indicated by the following aspects:

- a) Identification of major energy consuming plant
 - review of HVAC system components
 - lighting systems
 - building energy profiles
- b) Methods of energy conservation
 - review of energy conserving strategies
 - house keeping
 - time schedules
 - lighting control
 - good maintenance practices
 - filters, fans, appropriate set points, dead bands etc.
 - HVAC system control
 - night cycle
 - optimum stop/start
 - purge cycles
 - chiller/boiler/cooling tower sequencing
 - economy cycles (based on temperature or enthalpy).
 - supply air reset
 - condenser water temperature reset
 - electrical load control
 - power demand control
 - load limiting
 - load shedding
 - set point relaxation
 - ventilation cycles
- c) Tests and data collection procedures
 - use of BMS for data collection (trending)
 - use of data recorders (loggers)
 - monitoring of building operations generally
- d) Analyse results from test data
 - compare against standards (BOMA)
 - review current practices against ideal
 - total consumption vs peak load
 - electricity tariffs and implications
- e) Methods of reducing energy usage
 - plant retrofits
 - controls - application of strategies in 2

- plant - fixed OA to economy, boiler to electric reheat, constant volume to VAV etc. cost/benefit (payback).

2.16.13 Building management systems

Evidence shall show an understanding of building management systems to an extent indicated by the following aspects:

a) Functions of a BMS

- autonomous Functions
- input
- output
- general I/O
- installation management items
- energy management
- risk management
- information processing
- objectives
- building running costs
- smoke control as per AS 1668 part 1

b) BMS hardware

- system architecture
- communication devices
- substations
- PC's
- interfaces with other systems

c) Input and output functions

- digital inputs/outputs
- digital output with status feedback
- analogue input/output
- sensors
- alarms

d) Energy management

- night cycle
- optimum stop/start
- time and event programs
- night purge
- outside air percentage control
- enthalpy control
- power demand control
- duty cycle
- presence detection
- lighting control

e) Information processing functions

- computer systems
 - central system management
 - programs
 - system configuration and security
 - operator - machine interface
 - data points
- f) Risk and maintenance management
- system files
 - fire, intruder control
 - access control

2.16.14 Management of indoor air quality

Evidence shall show an understanding of management of indoor air quality to an extent indicated by the following aspects:

- a) Indoor air quality factors
- interactive nature of pollutants
 - comfort criteria
 - source of odours
 - pathway from source to occupants
 - occupant activities
 - impact on productivity
- b) Cause of IAQ problems
- moisture
 - mould and mildew
 - bacterial growths
 - asbestos and other particulate
 - volatile chemicals produced in the building
 - chemical products
- c) HVAC systems
- types of HVAC systems
 - system components
 - duct cleaning
 - system commissioning
 - operation of system
 - damper adjustment
- d) Measurements
- common parameters to measure
 - measurement devices available
 - instrument calibration
 - analysing and interpreting results
 - laboratory tests
 - standards

e) Resolving IAQ problems

- conducting IAQ investigations
- the walk-through
- building history
- HVAC system information
- occupant interviews
- troubleshooting

f) IAQ management

- building IAQ profile
- location of potential IAQ problems
- procedures to control IAQ
- communication
- response to complaints
- equipment preventive maintenance
- chemical inventory

2.16.15 Computer aided drafting

Evidence shall show an understanding of computer aided drafting to an extent indicated by the following aspects:

a) Specific procedures

- Creating symbols for library files
- Program specific commands
 - Speed enhancement
- Configuring the digitising tablet

b) Methodology for creating layers

- Name
- Colour
- Linetype

c) Methodology for drawing variables

- Limits
- Grid
- Snap
- Dimensions
- Text
- Units

d) ISO drawing sheets

e) Advanced drawings

f) Multiple three dimensional views

- Setting up environment on screen
- Top view
- Front and side views
- Three dimensional views

g) Movement through space

- Draw on any created views
 - Relocate coordinate system as necessary
- h) Creation of views
- Creation of three dimensional geometric shapes
 - Creation of three dimensional complex view by:
 - Manipulation of drawing planes
 - Location of geometric shapes
- i) Editing
- Use of function to facilitate modification of geometric shapes in completion of a three dimensional view
- j) Display of three dimensional view
- Wire Line
 - Solid Face
 - Isometric
 - Perspective
 - Orthographic
- k) Saving
- Use of assembly drawing file for plotting

2.16.16 Refrigeration system components and piping

Evidence shall show an understanding of refrigeration system components and piping to an extent indicated by the following aspects:

- a) Standards and Codes encompassing:
- AS1677, detailed understanding
 - AS 3666, overview
ozone protection regulations
 - IAR Ammonia Data Book
 - ANSI/IAR standards
 - ANSI/ASHRAE Mechanical Refrigeration and IAR
 - bulletins and standards
- b) Calculation of capacity in heat exchangers encompassing:
- $Q = UA \text{ (LMTD)}$
 - $Q = mc \otimes t$
 - $Q = m \otimes h$
- c) Evaporators encompassing:
- commercial types and applications
 - coil bypass factor
 - effects of evaporator TD on space humidity
 - effects of air circulation on product conditions
 - selection criteria and selection tables
- d) Condensers encompassing:
- commercial types and applications

- effects of ambient conditions
- condenser control
- heat rejection factor
- condenser TD
- selection criteria and selection tables

e) Compressors encompassing:

- types and applications
- capacity
- displacement
- volume flow rate
- theoretical capacity
- total volumetric efficiency
- effect of operating conditions, including suction
- pressure drop and superheating
- actual capacity
- power
- theoretical requirement
- effects of operating conditions
- actual requirements
- post defrost loads
- pull down torque requirements, high, medium and low back pressure compressors
- selection tables, motor selection

f) Liquid expansion devices

- types, operation and applications
- effects from sub-cooling
- distributor types, operation and applications
- selection tables

g) System load balance point encompassing:

- graphical representation

h) Line sizing an design

- velocity tables
- pressure drop in lines and fittings
- oil migration stabilisation
- refrigerant velocity
- effect of varying system capacity
- oil traps
- risers
- double risers
- liquid migration
- design for parallel components and multiplex systems

i) Automatic controls

- fin spacing, suction temp to evaporator suction

- hot-gas bypass valves
- electronic control of valves PLC control
- refrigerant regulating valves
- solenoid valves
- condenser pressure regulating valves
- evaporator pressure regulating valves
- crankcase pressure regulating valves
- cycling controls
- pressure-stats
- thermostats,
- defrost controls
- monitoring and alarm controls
- refrigeration automation systems
- control strategies
- control modes

2.16.17 Retrofitting refrigeration systems

Evidence shall show an understanding of retrofitting refrigeration systems to an extent indicated by the following aspects:

- a) Systems and refrigerants suitable for retrofitting encompassing:
 - Code and regulation for retrofitting a refrigeration system.
 - Suitable refrigerants for retrofitting into existing systems.
- b) Retrofitting a refrigerant into a system encompassing:
 - Retrofit procedures.
 - Selection of refrigerant, oil and components.
- c) Procedures for modify an existing system to meet the requirements of the alternative refrigerant encompassing:
 - Evaluating performance of a system prior to being retrofitted.
 - Testing refrigerant oil in accordance with industry standard.
 - Reclaiming and evacuate system.
 - Removing and replacing components.
 - Pressure testing, evacuating and charging.
- d) Procedures for commissioning a retrofitted system to the prescribed standard encompassing:
 - Setting operational and safety controls.
 - Testing electrical components.
 - Adjusting controls and checking system operation.
- e) Evaluating key performance factors of a system before and after a retrofit.