

UTE NES605 (A to Z qualifier) A

Co-ordinate & manage routine maintenance

Descriptor: Manage resources and information to achieve planned routine maintenance outcomes.

Alignment: Nil.

Specific unit outcomes

This is presented as a composite unit that has five specific units as outcomes, based on the *category* in which competence is achieved. This is done because of the high degree of commonality in process or function. Reporting the unit with the inclusion of a *category* allows for the identification of the necessary training outcomes in terms of the generic and transferable skills and at the same time reflects the work classification(s) generally understood by industry. The specific unit outcomes are:

UTE NES605A A	Co-ordinate & manage routine maintenance (<i>Computer systems</i>)
UTE NES605B A	Co-ordinate & manage routine maintenance (<i>Electrical</i>)
UTE NES605C A	Co-ordinate & manage routine maintenance (<i>Electronics</i>)
UTE NES605D A	Co-ordinate & manage routine maintenance (<i>Instrumentation</i>)
UTE NES605E A	Co-ordinate & manage routine maintenance (<i>Refrigeration & a/conditioning</i>)

Elements	Performance criteria
605.1 Plan and prepare to manage routine maintenance	<p>605.1.1 Management of routine maintenance <i>OH&S policies and procedures</i> is planned and prepared to ensure these are followed</p> <p>605.1.2 Routine maintenance schedules are managed in accordance with <i>requirements</i></p> <p>605.1.3 <i>Appropriate personnel</i> are consulted to ensure routine maintenance is managed effectively</p> <p>605.1.4 Routine maintenance is managed against <i>requirements</i></p> <p>605.1.5 Contribution is made to determine procurement management plan for routine maintenance in accordance with <i>established procedures</i> and checked against <i>requirements</i></p>

Elements		Performance criteria	
605.2	Manage routine maintenance	605.2.1	Mechanisms are used to measure, record and report progress of activities in relation to the agreed routine maintenance schedules and plans
		605.2.2	Routine maintenance is managed in accordance with <i>established procedures</i> and <i>requirements</i> to achieve designated objectives
		605.2.3	Records and documentation of routine maintenance activities are maintained in accordance with <i>established procedures</i> to facilitate quality management and to provide an audit trail
		605.2.4	Results of routine maintenance activities are documented and evaluated in accordance with <i>established procedures</i> to determine compliance with agreed quality standards
		605.2.5	Shortfalls in quality outcomes are reported in accordance with <i>established procedures</i> to enable appropriate action to be initiated
605.3	Inspect and notify completion of work	605.3.1	Quality management issues and responses are reported in accordance with <i>established procedures</i>
		605.3.2	Completion of routine maintenance is <i>notified</i> in accordance with <i>established procedures</i>

Range statement

General

Generic items in this unit are shown in italics, e.g. *established procedures*. The definition and intended scope covered by generic items is described in the Glossary that forms an integral part of this range statement.

Categories

This unit recognises the commonality of skills and knowledge that exists for the unit as well as the additional specific outcome; which is to be reported on. Therefore, competency can be displayed on one, some or all of the following categories and in addition to the respective common underpinning knowledge associated with the selected specialisation:

- (A) *Computer systems*
- (B) *Electrical*
- (C) *Electronics*
- (D) *Instrumentation*
- (E) *Refrigeration and air conditioning*

Currency in unit of competency

In order to maintain currency in this unit on-going competency development is to occur. This would include keeping abreast of any changes in legislation, regulations, procedures, technology and the like related to the scope and application of this unit.

Evidence guide

This Evidence guide is intended to include components defined within the Range statement, of which the Glossary is an integral part. Terms in italics, e.g. *consistent performance*, with respect to the Evidence guide are also contained in the Glossary.

Critical aspects of evidence

Achieving competence

Achievement of this unit of competency is based on each of the following conditions being met:

- demonstrating consistent performance for each element of the unit in the related *category* and *specialisation* which is to be exhibited across a *representative range* of applications; autonomously and to *requirements*.
- meeting the performance criteria associated with each element of competence by employing the techniques, procedures, information and resources available in the workplace for each of the *categories* and areas of *specialisation* undertaken from those listed in the Range statement or Evidence guide.
- demonstrating an understanding of the underpinning knowledge and skills identified for the *categories* and related *specialisation* undertaken in the section, of this unit titled ‘Underpinning knowledge’.

Reporting requirements

The reporting of the judgements about competence must be in the context of the individual unit being assessed and the qualification to be issued. Regulatory requirements in individual jurisdictions may require recording of additional information. Recognition of knowledge and skills transfer may be maximised by recording and issuing transcripts covering additional information. This could be detailed statements about the achievement of knowledge and skills. Any additional reporting is a matter for negotiation between the RTO and its clients.

Maintaining competence

Consideration should be given to periodic evaluations of skills and knowledge within this unit that are critical to safety, operation of plant and equipment and the like, particularly where relevant skills and knowledge are not frequently practiced.

Context of assessment

Competency will be determined on evidence of having *consistently performed* across a *representative range* of applications which includes such things as *apparatus, circuits, wiring systems, plant, equipment, tools, accessories, components* and the like relative to that required for the *category* undertaken within and relevant to this unit of competency; autonomously and to requirements. Equivalent evidence from other sources is also acceptable.

Interdependent assessment of units

Nil.

Underpinning knowledge

This section specifies the knowledge and skills required to underpin the elements and performance criteria relevant to the unit. This, with other aspects of evidence, will ensure that an individual is able to transfer and apply such knowledge and skills to new situations and environments.

This section includes that set of knowledge and skills additional to that specified in the above mentioned section titled ‘Interdependent assessment of units’.

Since this unit covers a range of *categories* each having multiple *specialisations* a content listing is provided below. Each *category* has all of the required underpinning knowledge and skill listed even though this sometimes results in duplication between *categories*.

Category: Computer systems (A)

Common

Data link operations.

Use of asynchronous data link hardware and software

Awareness of occupational health and safety for mains operated electronic equipment when installing hardware

Start/stop protocol options: data rate, number of data bits, number of stop bits, even/odd/no parity bit

Use of synchronous data link hardware and software

Recognition of format for OSI high level data link control (HDLC) and 802.2 logical link control (LLC) including data flow control: receiver ready (RR), receiver not ready (RNR), poll/final (P/F) bit, module counters

Recognition of format for link negotiation commands, link connection and disconnection commands, link layer control service access point (LSAP) and 802.1 defined addresses

OSI HDLC and 802.2 LLC protocol options: data rate, clock encoding, number of octets, half/duplex

Recognition of format for OSI HDLC and 802.2 LLC error procedures: frame reject (FRMR), frame discarding

Correlation of end user error messages with abnormal traffic

Computer networks.

Protocols and the OSI model: rationale for layered protocols; goals of layered protocols; network design problems; communication between layers; the layers

Terminal networks: terminal characteristics; character mode networks – terminal multiplexer; statistical multiplexer, terminal switching exchange; block-mode networks; multidrop lines, poll-select; terminal network protocols, binary synchronous control (BISYNC) formats, protocol operation, user interface, protocol performance; high-level data link control; frame formats, frame types

Delay analysis: introduction to queuing theory; the M/M/I queue in equilibrium; networks of M/M/I queues

Network layer: virtual circuits, datagram; routing algorithms; congestion; bridges, routers, brouters, gateways internetwork protocol, TCP, IPX, XNS

Local area networks: topologies; types of LAN's – ethernet, token ring, token bus, network installation, planning, performance outcomes

Operating system (multiuser).

Operating systems: history; functions of the system

Multiuser and multitasking operating systems: real time applications; interleaved processing techniques; multiprogramming; multitasking; time-sharing; virtual storage; multiprocessing

Language translators: compilers; interpreters; assemblers

File and disk organisation: files and directories; protection and permissions; listings; file location; classification

System command and calls: commonly used commands; retrieving; saving; deleting; copying; creating; printing; linking

Input/output redirection: meaning of; method of achievement

Batch, script or equivalent files: purpose; structure; commands

System utilities: sorting; windowing; device drivers

Computer systems architecture.

Historical milestones in computer architecture; Von Neumann architecture; non Von Neumann architecture; fetch decode execute cycle

Bus architectures: address, data and control; 8/16/32 wide busses; multiplexed and non multiplexed; Von Neumann bottleneck; synchronous, semi-synchronous and asynchronous data transfer; design considerations – reflections and termination, crosstalk, receivers, transceivers and hysteresis; drivers, open collector and tristate; single user and multiuser busses – IBM PC, VME, UNIBUS

System support: instruction pre-fetch pipeline, BIU, EU; DMA devices – cycle steal and burst modes; peripheral CHANNEL support; co-processors and bus interface; typical interrupt structures – intel, Motorola, PDP-II Zilog

CPU Architecture: registers, ALU and control unit; bit slice, Harvard, stack oriented CPUs; machine code and conventional machine; instruction set considerations; addressing modes – direct, indirect, indexed; the micromachine control unit and data pathways; hard wired and microcoded control unit; horizontal versus vertical microcode considerations; gate array, ASICS

Parallel processing: Flynn's taxonomy – SISD, SIND, MISD AND MIMD; data pipeline, multiple functional units, interleaved memory, vector and array processors; parallel machines – transputer, hypercubes, connection machines, dataflow machines

Operating system considerations: multiprogramming systems, time-sharing; virtual memory – overlays, physical address space, virtual address space, paging, working set, thrashing, page replacement, segmentation

CACHE: memory, locality of reference principle, hit ratio; mapping techniques – associative, direct, set-associative; write-through, write-back

RISC Machines: RISC versus CISC; instruction set, register sets

Engineering mathematics.

Matrices: the operations – addition (subtraction), scalar multiplication, matrix multiplication up to 3x3 matrices; identity matrix, inverse matrix; elementary algebraic manipulation of matrices; solving linear equations using inverse matrices and determinants

Quadratic functions: graphs of quadratic functions represented by parabolas and significance of the leading coefficient; zeros represented graphically; solve quadratic equations by factoring and quadratic formula; solve simultaneously linear and quadratic equations algebraically and geometrically

Exponential and logarithmic functions: laws of indices; graph of $f(x) = ka^{bx}$, emphasising $a = 10, e$; definition of the logarithm to any base; graph of $f(x) = k \log_a bx$, emphasising $a = 10, e$; solve exponential and simple log equations using indices, logs, calculator, graphically; change of log base, emphasising 10 and e; growth and decay

Trigonometric functions: the ratios – sin, cos, tan, cosec, sec, cot; degrees, radians; graphs of $k f(ax + b)$ where $f(x) = \sin x, \cos x, \tan x$, and significance of k, a, b ; trigonometric identities; solving trigonometric equations

Writing technical documents.

Preparing an outline of a technical document relevant to a specified industry

Writing a technical document

Technical writing skills and strategies

Meetings.

Convener skills; interpersonal skills; organising skills; reading and writing skills; meeting and convention processes; handling conflict

Category: Electrical (B)

Common

Applications of transducers.

Light and radioactivity detection: light sensors; units of light; light measurement terms; photoemissive light sensors; photoconductive light sensors; photovoltaic light sensors; x-ray sensors; nuclear radiation sensors; units of radiation measurement; units of radiation measurement; radiation sensors – photoelectric, ionisation

Temperature detection: temperature-sensing basics; units and terms used; bimetallic, fluid-pressure, resistive, semi-conductor, thermocouple, radiation pyrometer, oscillating-crystal

Fluid flow and pressure detection: fluid flow sensing; units of flow measurement, terminology; rate of flow sensors; quantity of flow sensors; fluid pressure sensing basics; units of pressure measurement; Bellows, Bourdon-tube, diaphragm, and capsule pressure sensors; pressure cell, differential-pressure sensors

Motion and force detection: motion and force sensing; sensors for linear motion; angular motion; speed of rotation; compression; tension, torque; acceleration, vibration; altitude

Moisture and humidity sensors: moisture and humidity measurements basics; moisture and humidity measurement units and terms; hygrometer-type sensors, resistive, dielectric-film, mechanical displacement, oscillating-crystal, aluminium-oxide; psychrometer-type sensors; dew point sensors, temperature-sensing, instant-of-condensation

Writing technical documents.

Preparing an outline of a technical document relevant to a specified industry

Writing a technical document

Technical writing skills and strategies

Electrical calculations.

Algebra, exponentials and logarithms; solution of equations; functions and graphing; vectors and complex numbers; Boolean algebra; impedance calculations; elementary circuit analysis

Advanced PLCs.

Medium to high level PLC hardware and software: hardware configuration; addressing; memory map; programming instruction syntax; file manipulation; documentation; saving/restoring programs

Number systems and codes: common number formats (binary, octal, integer, hexadecimal); conversions between formats; codes (BCD, grey, ASCII)

Diagnostics: flags/status words (file); fault locations; scan considerations (fixed, variable, immediate update)

Data manipulation (word): binary word structure; single and double words; word devices; arithmetic instructions; word logical instructions; conversions (BCD to binary, binary to BCD); indirect addressing (image register to word, word to IR, word to word, word to table, table to table); word shift registers (LIFO, FIFO); masking; bit manipulation (bit set, bit clear, bit test); entering data constants; multiplexing

Analogue I/O: common signal types; module resolution; scaling; unscaling; signal offset

Sequencers/drum controllers

Specialisation: Power systems

Power systems analysis.

Impedance of three-phase load: complex analysis; measurement of impedance; conversion of impedance between star and delta

Analysis of mixed load three-phase circuits: star and delta systems; mixed single and three-phase loads; balanced and unbalanced loads; calculation of line and phase currents in both star and delta loads; total line current for mixed loads; power in three-phase systems, including the use of current transformers; power factor; prediction of current and voltage on the loss of the neutral

Measurement in three-phase circuits: measurement of voltage, current, power and power factor in mixed circuits; sources of error

Line voltage drops: cable losses; voltage drop; heat dissipation; Australian Standards and limitations of losses; methods to minimise line losses

Power factor (P.F.) correction: requirement; calculation of reactive element to correct P.F.; synchronous machines for correction of P.F.

Electrical distribution.

Distribution system: systems of distribution used – primary and secondary; voltage levels; supply quality; load curve profiles – residential, industrial, commercial; types of feeders; distribution systems – urban, rural single phase systems – SWER

Overhead lines and installation: industry and safety regulations; overhead conductors – conductor material, current rating factors – heating, voltage drops, power losses, aerial bundled cables – HV and LV, covered conductors; overhead lines poles – types – wood, concrete and steel, installation of poles – tooling, rake, life, labelling, sinking, maintenance of poles – above and below ground, pole strength and loads; crossarms – types and standard sizes; insulators – insulation types, types – pin, suspension or disc, shackle, creepage – necessary clearances, acing horns – insulator mounting; structure types – mechanical properties – working strength, maximum tension, limiting size; stringing charts (use of) – sag – calculations, measurement and tension measurement, sight and wave sagging, sag correction; stays – components, anchorage; use of design

schedules – design problems – examples of common design practice line, voltage, structure types used, line deviation, span sag, crossarms, insulators and stays wind loading and line deviation loading basic surveying, measurement of levels, deviation angle and compass bearings, perform survey of short distribution line extension of produce filed notes

Underground cables: cables types – ratings, core material, design considerations, cable dielectrics, insulating materials and abbreviations, electric stress, cable volt drop and volt drop calculations, cable termination, joints and installation; induction and eddy currents; cable testing - cable fault location; cable drawing

Voltage regulations of feeders and associated equipment: terminology used – distribution system, service line, customer's terminals, customer voltage, utilisation voltage, base voltage, voltage variation and bandwidth; voltage limits and effects for voltage variation; causes of variation – inductance, capacitance and reactance of distribution lines, transformers; methods of voltage control – off-load, on-load tap changers, voltage regulating relays, line drop compensation, different types of voltage regulators; voltage profiles – principles, effect on voltage profiles, limits of voltage, voltage drops due to LV mains transformers, tapsettings feeder and service lines

Specialisation: Control systems

SCADA systems.

System requirements

Use, features and facilities of different SCADA packages

Hardware requirements

PLC interface requirements

Networking requirements of the system

Mimics and animated graphics: graphics designs; balance of layout

Trending: analysis of process to select data; sampling of the process in terms of temperatures, time, weight; viewing data and graphical representation of selected information; trend graphs and data matching

Alarm logging: analysing select data, applying limits and specification applied to processes; corrective action of alarm status

Recipes and scheduling: methods of producing libraries for different process conditions, required for varied production runs; analysis of different production runs; alarm limits/material specifications; scheduling, setting limits and evoking program changes

Data collection and databasing: producing a database of variables; conversion of raw data into appropriate databasing software package

Reports: types and layout of reports; analysis of data

Programming language: automation of tasks within the software package

Implementation and applications: networking; types of networks; co-ordination and access of networking by linking to mainframe or factory network

Transmitters and converters.

Pneumatics: principles of flapper nozzles, pneumatic transmitters

Supplementary pneumatic loop equipment: computing relays, lead/lag units, high and low selectors, air to current and high and low selectors, air to current and current to air converters, square root extractors, integrators, regulators, multipliers and dividers

Electronics: electronic transmitters, analogue computing, integrators, high and low signal selector, signal converters

Transducers I to P, P to I converters, analogue to digital and digital to analogue converters, RTD/I, mV/mA, frequency to I, square root extractors and integrators

Linear variable differential transformers

Intrinsic safety

Zener barriers

Explosion/flame proof enclosure

Specialisation: Drive systems

Variable speed drives.

Introduction to variable speed drives: advantages of variable speed drives – speed and direction control, acceleration control, torque control, energy savings; terminology used with variable speed drives – direction – forward and reverse, speed - ⁺ve and ⁻ve, torque - ⁺ve and ⁻ve, 4 quadrants of torque/speed operation, acceleration - ⁺ve and ⁻ve, load power – supply power, efficiency; power electronic converters – common electronic power control circuits for – AC/DC rectifier, un-controlled and controlled, DC/AC inverter, PWM and quasi-square wave AC/AC converters, rectifier linked to inverter and a matrix converter, DC/DC converters, PWM; input and output waveforms for power electronic converters – interference generated by circuits, electrical and audio; electromagnetic compatibility (EMC), introduction to harmonic distortion analysis using microprocessor based test equipment (not mathematical analysis), filtering techniques employed to optimise EMC switching frequency and effects on motor performance and EMC; control system for variable speed drives PWM (Pulse width modulated), VVVF drive (variable voltage variable frequency) – inverter control system, speed feedback and control system, current feedback and control system, external interface, selection of, and applications for PWM, VVVF drives; flux vector control drive – inverter control system, speed feedback and control system, current feedback and control system, select of, and applications for slip recovery drives; control system for soft starter – overview of operation of soft starter selection of, and application for soft starters; new development in AC variable speed drive technology – e.g. switched reluctance drive/motor

Protection of AC variable speed drives and motors: sources of failure – loss of cooling, overloading, frequent starting, supply problems, high ambient temperature; methods of protecting against sources of failure; protecting the frequency converter – current limit, over current trim; protecting the AC motor – motor thermal model

Commissioning: purpose; setting parameters; testing

Differentiation of common faults in systems: source of faults; methods to determine nature of fault; includes communications and external interface

Adjust settings: manufacturers specifications; load testing

Identify drive faults: source of faults; fault-finding methods

Selection, installation and fault-finding techniques: choosing size of frequency converter; motor loading and cooling; checking motor loading; over synchronous speed – advantages; mounting position and enclosures; supply and control cable selection and installation; environmental conditions; earthing

Category: Electronics (C)

Common

Writing technical documents.

Preparing an outline of a technical document relevant to a specified industry

Writing a technical document

Technical writing skills and strategies

Engineering mathematics.

Matrices: the operations – addition (subtraction), scalar multiplication, matrix multiplication up to 3x3 matrices; identity matrix, inverse matrix; elementary algebraic manipulation of matrices; solving linear equations using inverse matrices and determinants

Quadratic functions: graphs of quadratic functions represented by parabolas and significance of the leading coefficient; zeros represented graphically; solve quadratic equations by factoring and quadratic formula; solve simultaneously linear and quadratic equations algebraically and geometrically

Exponential and logarithmic functions: laws of indices; graph of $f(x) = ka^{bx}$, emphasising $a = 10, e$; definition of the logarithm to any base; graph of $f(x) = k \log_a bx$, emphasising $a = 10, e$; solve exponential and simple log equations using indices, logs, calculator, graphically; change of log base, emphasising 10 and e ; growth and decay

Trigonometric functions: the ratios – sin, cos, tan, cosec, sec, cot; degrees, radians; graphs of $k f(ax + b)$ where $f(x) = \sin x, \cos x, \tan x$, and significance of k, a, b ; trigonometric identities; solving trigonometric equations

Basic determinants and solution of 2/3 simultaneous linear equ by determinants
exponents and logs

Time dependent trig functions - $\sin(\omega t + \theta)$

Trig of oblique triangles

Introduction to vectors

Complex numbers

Circuit analysis.

Phasors: time domain; frequency domain; frequency, angular frequency and units of measurement

Complex impedance: impedance diagram; resistance; reactance; admittance; conductance; susceptance; equivalent series circuit; equivalent parallel circuit

AC series/parallel circuits: Kirchhoff's laws; series equivalent impedance; parallel equivalent impedance; voltage divider rule; current divider rule; phasor diagrams

Complex power: true power; reactive power and apparent power; units of measurement – watt, volt-amp; reactive, volt amp; power triangle; power factor

Superposition theorem: power considerations

Thevenin and Norton theorems: voltage source models; current source models; practical sources; open circuit voltage; equivalent impedance; short circuit current; source conversion

Star/delta conversions: equivalent circuits; star/delta transformation formulae; selection of appropriate conversion

Specialisation: Communications

Communication fundamentals.

Basic communication system: radio wave as a T.E.M. wave; radio wave frequency band identification; relationship between frequency – wavelength and velocity of propagation for radio wave

Transmission media: metal cable; waveguide; optical fibre; radio wave paths

Noise: definition; categories; effect on communication systems; communication signals in both the time and frequency domain; fourier analysis of periodic complex waveforms; baseband signals; modulation signals

Modulation techniques: AM full carrier; double sideband; single sideband; vestigial sideband; frequency modulation; phase modulation

Demodulation techniques: AM full carrier; single sideband; frequency modulation; frequency division multiplexing (FDM) F.D.M hierarchy; F.D.M in stereo FM; time division multiplexing (TDM); TDM hierarchy; basic crystal set receiver; TRF receiver

Superheterodyne receiver: block diagram; advantages

Transmitters: AM full carrier; single sideband; FM; digital signals; sampled analogue signals; sampling theorem; pulse code modulation (PCM) – quantisation, quantisation noise, compounding, encoding; digital signal transmission compared to analogue signal transmission; noise in communication systems; signal-to-noise ratio; noise figure; noise factor; noise temperature signal-to-noise bit error rate in digital

Receiver and transmitter circuits.

Receiver block diagrams: principles of dual conversion; DSBFC dual conversion receiver

RF amplifiers: intermodulation; cross modulation; RF amplifier performance

Intermediate frequency (IF) amplifiers: IF amplifier alignment; neutralisation; IF amplifier performance

Demodulation: SSBSC

AGC systems: SSBSC receivers

Phase locked loops (PLL): PLL noise; frequency synthesis using PLLs

Receiver performance criteria: sensitivity test - FM quieting, S/N ratio, SINAD measurements; spurious signal responses; receiver noise figure

NBFM transmitters: operation; tuning and adjustment; testing

Digital transmitters

Specialisation: Analogue and digital

Microprocessor system assembly language programming.

Operation of a microprocessor based computer system: ROM, RAM, IO and major system components

CPU architecture: registers; instruction set considerations – common and advanced instructions; addressing modes supported – direct, indirect, indexed; software interrupts and system calls

Processor and system support: instruction pre-fetch pipeline; system timer chip – function and programming; hardware interrupt programming considerations; DMA devices and support; co-processors and bus interface

Modular programming: separately compiled and linked assembly language modules; library modules; macros

Documentation and debugging: system specification and documentation; debugging and tracing program execution

Electronic instruments.

Loading and matching; connectors; decibels; storage and delay CROs; frequency synthesisers; frequency counters; spectrum analysers; noise and distortion meters; RF communications service monitor

Category: Instrumentation (D)

Common

Control programming style.

Control applications of software; software terminology; relevant programming languages currently available; flowcharts; pseudocode; nassi sniedeman charts; developing algorithms; programming style; programming structure; documentation

Installing a language compiler; using a text editor; compiling source code; generating executable files

Scalar and structured data types; constants and variables; reading from keyboard and writing to screen; arithmetic, relational and logical operations; making decisions using if/then, if/then/else, nested if/then and case; looping operations using while/go, repeat/until and for/do; subprograms; functions; procedures

Installation of computer interface circuit boards; programming to access external devices via I/O boards

Electrical control 'C' programming.

'C' language: uses; advantages and disadvantages

'C' development package: editor commands; the edit-compile-run cycle; compiler and linker options; header files

Language syntax: data types; arithmetic and logical operations; program structure

Control structure: sequential; repetition; selection

Functions: macros; global and local variables; intrinsic functions used in control; writing functions, linking in external functions to control hardware; numerical and character arrays; sequential file reading and writing

Control electrical calculations.

Algebra, exponentials and logarithms; solution of equations; functions and graphing; vectors and complex numbers; Boolean algebra; impedance calculations; elementary circuit analysis

On-stream analysis.

On-stream analysis: chromatography; spectroscopic methods; electrical methods; sampling systems

SCADA systems.

System requirements

Use, features and facilities of different SCADA packages

Hardware requirements

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Mimics and animated graphics: graphics designs; balance of layout

Trending: analysis of process to select data; sampling of the process in terms of temperatures, time, weight; viewing data and graphical representation of selected information; trend graphs and data matching

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Data collection and databasing: producing a database of variables; conversion of raw data into appropriate databasing software package

Reports: types and layout of reports; analysis of data

Programming language: automation of tasks within the software package

Implementation and applications: networking; types of networks; co-ordination and access of networking by linking to mainframe or factory network

Writing technical documents.

Preparing an outline of a technical document relevant to a specified industry

Writing a technical document

Technical writing skills and strategies

Final control elements.

Control valve selection and sizing

Pneumatic controllers and positioners

Pumps and blowers

Variable speed drives

Dampers

Category: Refrigeration and air conditioning (E)

Common

Commissioning - HVAC systems.

General requirements: building codes; local government regulations; human comfort – comfort chart; reporting procedures; pre-commissioning checks

Air systems: air tab instruments (air flow, pressure, temperature); fan testing; air balancing procedures; leakage testing; system capacity calculations

Hydronic systems: hydronic tab instruments (fluid flow, pressure, temperature); pumps; pumps, curves and system curves; pump testing; hydronic (balancing procedures, general, compensation method); balancing valves; capacity calculations

Plant and equipment: controls; heat exchangers; chillers; boilers; cooling towers

Writing technical documents.

Preparing an outline of a technical document relevant to a specified industry

Writing a technical document

Technical writing skills and strategies

Meetings.

Convener skills; interpersonal skills; organising skills; reading and writing skills; meeting and convention processes; handling conflict

Specialisation: Control systems

Advanced HVAC control systems

Control diagrams: electric/electronic control diagrams; electrical installation documents; pneumatic diagrams; DDC diagrams; controls/electrical power circuit interface; nomographs

Evaluate existing automatic control systems: specifications; briefs; descriptions of operation

Control requirements: standard and statutory requirements; economy of operation (energy management)

Building management systems.

Functions of a BMS: autonomous functions; input; output; general I/O; installation management items; energy management; risk management; information processing; objective; building running costs

BMS hardware: system architecture; communication devices; substations; PCs

Input and output functions: digital – input, outputs; digital output with status feedback; analogue input, output; sensors; alarms

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

Information processing functions: computer systems; central system management; programs; system configuration and security; operator – machine interface; data points

Risk and maintenance management: system files; fire – intruder control; access control

Energy management.

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; petrochemical

Energy requirements: office lighting; air conditioning systems; refrigeration systems; security systems; computer systems; waste disposal systems; standby/emergency systems

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; estimating savings potential

System operation for energy efficiency: types of systems; efficiency in building structures; operation of a vehicle fleet; proportioning 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

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; implementation issues; monitoring

Methods of energy conservation: time schedules; lighting control

Maintenance practices: filters, fans, appropriate setpoints, 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; supply water reset; condenser water temperature reset

Electrical load control: power demand control; load limiting; load shedding; set point relaxation; ventilation cycles

Tests and data collection procedures: use of BMS for data collection (trending); use of data recorders (loggers); monitoring building operations generally

Analyse results from test data: compare against standards (BOMA); review current practices against ideal; total consumption Vs peak load; electricity tariffs and implications

Methods of reducing energy usage: plant retrofits; controls; plant – fixed OA to economy boiler to electric reheat, constant volume to VAV; cost/benefit (payback)

Specialisation: HVAC systems

Commercial air conditioning system design.

Design parameters for commercial (single zone) air conditioning applications: e.g. offices, restaurants, hotels, bars; customer and objective; customer concept of environment desired; economics; client brief

Relevant design criteria: building purpose, location, orientation and shape; external environment ambient conditions; internal load diversity; thermal capacity behaviours; thermal load (full and partial)

Zoning and building usage: space and building; occupancies, single purpose, multi-purpose

System selection criteria: economics; environment; control requirements; existing structures; new structures; system components; space for equipment and system; selection of appropriate system, ductwork and components

Systems and applications: design features, engineering, controls and selection procedures for fan direct expansion RAC's, coil units, heat pump, package units, free blow and ducted

HVAC energy conservation techniques: heat recovery systems; night cycle; optimum stop/start; purge cycles; load limiting; load shedding; cost/benefit (payback)

HVAC load estimating.

Building survey: space characteristics; location of equipment; design conditions – outdoor, inside (type of installation); storage of heat in building structures; solar heat – direct and diffuse, glass types and factors, shading devices; film coefficients; heat and water vapour through structures – transmission coefficient; heat and water vapour through structures – transmission coefficient; infiltration; ventilation; internal heat gains; system heat gains

Computer programs: ACAOS; TRANE; CARRIER

Psychrometrics – advanced.

Complex psychrometric processes: sensible cooling and heating and evaporative (adiabatic) cooling; cooling and dehumidification; cooling and dehumidification with high latent load; cooling and dehumidification out door air; cooling and dehumidification all out door with dehumidified air requirements less than supply air; cooling with evaporative humidification; cooling with near isothermal humidification; spray processes to include cooling

and dehumidification with heated spray water – heating and humidification; partial load processes – reheat, by-pass of RA only and, mix of RA and OA; variable air volume; variable coil effective surface temperature; split coil - horizontal, vertical and intertwined

System performance: saturation efficiency of sprayers; system capacity calculated from air quantity and enthalpy change

Required plant capacity and airflow rates: effects of coil by-pass factor and ADP; calculation of dehumidified air quantity – using both TSH and ERSH methods

Psychrometric formulae and charts: properties of air; gas constants; derivation of air constants; combined gas laws; Dalton's law of partial pressures; Carrier's equation; psychrometric property tables; psychrometric charts; air mixing equations; air quantity equations

Commercial refrigeration systems design.

Calculation of capacity in heat exchangers

Evaporators: commercial types and applications; coil bypass factor; effects of evaporator TD on space humidity; effects on air circulation on product conditions; selection criteria and selection tables

Condensers: commercial types and applications; effects of ambient conditions; condenser control; heat rejection factor; condenser TD; selection criteria and selection tables

Compressors: types and applications; capacity; power; effect of operating conditions; actual requirements; post defrost loads; pull down torque requirements, high, medium and low back pressure compressors; selection tables, motor selection

Liquid expansion devices: types, operation and applications; effects from subcooling; distributor types, operation and applications; selection tables

System load balance point

Line sizing and 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

Automatic controls: refrigerant regulating valves; solenoid valves; expansion 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

Specialisation: Refrigeration systems**Industrial refrigeration systems design.**

Standards and codes: AS1677, detailed understanding; AS3666, overview; ozone protection regulations

Operating characteristics: Ph charts; refrigerating effect, relate back to air and fluid coolers; heat of compression, relate back to screw, rotary and reciprocating compressors; heat rejected on high side of the system, relate back to air cooled, evaporative, and water cooled condensers; required mass flow rate of refrigerant and volume; flow rate at various points in system; theoretical compressor power; required condenser capacity

Major system components: refrigerants, including R717 and R22; secondary refrigerants; component lubricant refrigerant compatibility evaporators; condensers, cooling towers; compressors; expansion valves; interconnecting piping and isolating valves; pilot operated valves; defrost system components for air, water, recycled water, hot gas, electric, methods

Moderate and low temperature industrial refrigeration systems: direct – flooded and pumped liquid recirculation systems; evaporators; multistaged compression; direct staging; cascade staging; compound compressors; desuperheaters; liquid injection; direct expansion intercoolers; open and closed intercoolers; basic designs of accumulators/intercooler vessels; oil cooling methods; oil stabilisation – return and oil recovery in flooded systems

Multiple evaporators and multiple compressors: parallel evaporators; multiple temperature systems; evaporator pressure regulators; temperature control methods; parallel compressors; pipework layout; methods of establishing pressure drop in dry and wet suction lines

Indirect refrigeration systems: classification according to AS1677; applications; evaporators; heat exchangers – types, construction, selection; secondary refrigerants; brines; antifreeze solutions

Flooded systems: applications; equipment; accumulators; level controls; liquid recirculation pumps; liquid pressure relief valve

Cryogenic systems: applications and equipment; system components; refrigerants; design safety; economics

Basic control sequences: maintaining evaporator conditions; staging and suction pressure control; maintaining condenser conditions; control of intermediate pressure – methods of industrial refrigeration compressor capacity control

Noise and vibration control.

Fundamentals of sound: frequency; decibels; octave bands; direct sound; velocity; sound pressure level; sound power level; sound meters

Noise and people: physical measurement of sound; weighting networks; NR curves; noise damage to hearing; evaluate daily noise exposures; peak noise levels; attenuation of hearing protectors; excess noise levels permissible; Noise Abatement Act

Identify and analyse problems: one-dimensional sound waves; standing waves; energy in a sound wave; sources; effects of air turbulence; transmitters; amplifiers; absorptivity; reflectivity; room characteristics; acoustic design in buildings; fan and air noise transmission in ducts

Methods of control: natural attenuation; sound absorbing materials, placement; duct lining; lined plenums; lined duct splitters; duct attenuators; white noise; vibration isolators

Acoustic specifications: attenuator ratings

Energy management systems for commercial refrigeration.

Functions of a commercial refrigeration E.M.S: general control function; inputs; outputs; communications; graphing; supervising; data logging; scheduling; alarms; power consumption

E.M.S control components: identify components, pressure sensors, temperature sensors, time clocks, humidity sensors, liquid level sensors, leak detector sensor; state the function and operating parameters of components – pressure sensors, temperature sensors, time clocks, humidity sensors, liquid level sensors, leak detector sensors

Installation requirements and consideration: installation of controller(s); installation of refrigerant leak detector systems; installation accessory boards; installation of pressure transducers and wiring; installation of temperature sensors and wiring; control wiring considerations

System design and applications: select control components to suit given applications – determine system operating parameters, pressure sensors, temperature sensors, time clocks, humidity sensors, liquid level sensors, leak detector sensors, defrost, alarm panel

Programming a control system: display terminal and keypad functions; calibration of sensors; changing original settings; program a given set of parameters to suit an application

Component testing and fault-finding: trouble shooting; testing components