

### Overview

This Unit covers the competences required to inspect complex/central air conditioning systems as defined by the CIBSE TM 44 Figure 1.1: Summary of system types and their component parts. The air conditioning systems are more extensive and complex and are generally characterised by the use of water, air or other distribution systems to deliver cooling to conditioned spaces using a variety of active (i.e. that contain air moving fans) or passive terminal devices. They generally include more complex controls that may break down the conditioned spaces into zones where different control parameters can be applied, and that could be located remotely from the equipment, or incorporated into a building management system (BMS).

Such systems would include:

1. Centralised cooled air systems
2. Centralised cooled water systems
3. Water loop/reversible heat pump systems
4. Additional systems i.e. where areas are served by packaged, split and multi-split packaged comfort cooling equipment, including variable refrigerant flow (VRF) equipment.

The aim of the inspection is to assess the efficiency and sizing of the system compared to the cooling requirements of the building. In turn, this will enable the production of a report, which advises clients on issues that affect energy efficiency and the use of installed air conditioning systems, and suggest potential improvements.

The unit is about reviewing existing information relating to the air conditioning system, its maintenance and energy consumption. It is also about ensuring that the client understands that which is 'essential', that which is 'desirable' and that which is 'optional', and taking appropriate action where information is not forthcoming, is incomplete or inaccurate. You are expected to use existing information to identify any significant factors that may influence the conduct of the inspection e.g. access issues, the need to inspect a sample of system components, the need to start up or shut-down the system.

The unit also covers the competences required to conduct a thorough inspection of complex/ central air conditioning systems including the visual inspection of all relevant aspects of the air conditioning system in accordance with the requirements set out within 'CIBSE TM44: Inspection of air conditioning systems' which is consistent with the principles for the inspection of air conditioning systems set out in BS EN 15240: 'Ventilation for buildings. Energy performance of buildings. Guidelines for inspection of air conditioning systems', and EN 15240: 'Inspection of air conditioning systems'.

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You must carry out any specific, non-hazardous techniques that have been included within the agreed scope of works e.g. the use of a smoke pencil to observe air flow, and the collect information required to determine the energy performance of the system.

This element also requires extensive knowledge and understanding of, for example the design intent of the installed air conditioning system, the definitions and conventions embodies in 'CIBSE TM 44: Inspection of air conditioning systems', and the factors relevant to determining the energy performance of air conditioning systems. The unit also covers the production of complete and accurate records of findings using appropriate methods and ensuring that records are legible and complete.

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### Performance criteria

### Review and record information relating to the energy performance of complex/central air conditioning systems

*You must be able to:*

- P1 identify essential, desirable and optional information
- P2 review available information and identify that which is relevant to the energy performance of the air conditioning system
- P3 review the installed equipment, controls, building fabric and layout
- P4 identify variations from any drawings, documents and records and evaluate any impact they may have on energy performance
- P5 review the relevant site information and identify any significant factors that may influence the conduct of the energy assessment
- P6 locate the equipment and assemble a minimum portfolio of relevant documentation if documentation is insufficient
- P7 record where there is evidence of regular inspection and maintenance
- P8 record and comment on the frequencies and scope of maintenance to the air conditioning equipment and systems
- P9 compare system sizes with likely loads
- P10 inform the client(s) promptly in cases where your investigations reveal problems that prevent you from assessing the energy performance of the air conditioning system
- P11 estimate the specific fan power of air movement systems, compressors and pumps

### Locate and inspect refrigeration equipment

*You must be able to:*

- P12 locate relevant refrigerant compressors and confirm that these can be brought into operation
- P13 note the general state of the refrigerant equipment and the space immediately around it checking particularly for signs of oil/refrigerant leakage
- P14 observe the temperature difference across the refrigeration compressor using surface temperature probes
- P15 observe any visible liquid sight glass on liquid line and on flooded evaporators during plan operation to record condition of refrigerant or symptoms of other plant problems
- P16 compare refrigerant temperature and/or pressure gauge readings with expected temperature and pressures for the current indoor and outdoor temperatures to check for condenser blockage or undersize and sufficiency of refrigerant
- P17 check water chillers to ensure that adequate water flow rates are available through the condensers and evaporators according to design or commissioning data
- P18 check that water pressure drops across the condensers and evaporators are in accordance with the design or commissioning data

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### Locate and inspect heat rejection equipment

- You must be able to:*
- P19 check that any enclosure around heat rejection equipment does not obstruct air flow to and from the equipment and there is free passage of air into and out of the enclosure
  - P20 check that the heat exchanger surfaces are free from debris and are reasonably undamaged
  - P21 check for the possibility of air short-circuiting
  - P22 check for signs of leakage on direct expansion heat exchanger surface
  - P23 check the rotation and control of heat rejection fans to ensure that fan operation varies with the heat rejection loads
  - P24 check that water distribution is even across cooling tower or evaporative cooler surfaces and that sprays and nozzles are free flowing and evenly distributed
  - P25 check that there is no restriction to water flow from any cooling tower bund or enclosure and that outlet pipes and strainers appear clear
  - P26 check the route and condition of any cooling water system linking the refrigeration plant with the heat rejection units
  - P27 observe and record indications of elevated Legionella risk and notify the client

### Locate and inspect waterborne cooling and air conditioning systems in treated areas

- You must be able to:*
- P28 check the route and condition of any cooling or chilled water system serving local cooling units and that the system is effectively controlled
  - P29 check the condition and operation of the local heat exchange units
  - P30 check that the heat exchanger surfaces are free from debris and reasonably undamaged
  - P31 where present, check the condition of intake filters for compliance with manufacturers' requirements
  - P32 check that inlet and outlet grilles are not obstructed
  - P33 check the correct rotation and control of heat exchange fans
  - P34 check that the controls on fan coils supplied with chilled and hot water are set correctly preventing the unit receiving both simultaneously
  - P35 check the operation of local heat pump unit compressors to ensure adequate charge of refrigerant and the absence of cycling and frosting
  - P36 check for signs of leakage of refrigerant from direct expansion heat exchanger surfaces

### Locate and inspect airborne cooling and air conditioning systems in treated spaces

- You must be able to:*
- P37 check the condition of air delivery and extract openings, grilles and diffusers identifying airflow arrangements
  - P38 check if occupants find the air distribution arrangements unacceptable and the actions they have taken to change the air distribution

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- P39 observe whether building modifications, partitioning, or fitted furniture have affected the performance of the system through obstruction or otherwise
- P40 check that the airflow is apparent through the identified openings, preferably towards the extremity of the system
- P41 conduct checks where individual temperature and volume controls operate in separate spaces to ensure they are functioning satisfactorily and are not in conflict with other forms of heating within the space

### **Locate and inspect airborne cooling systems and air conditioning systems in air handling units and associated ductwork**

*You must be able to:*

- P42 arrange for air handling fans and air distribution systems to be turned off prior to inspection
- P43 note usual filter changing and cleaning frequency and elapsed time since the last change or clean for compliance with manufacturers' requirements
- P44 assess the state of cleanliness, damage or blockage of filters
- P45 measure filter resistance where differential filter gauges are inoperable
- P46 observe the filter condition directly and check the fit and sealing of the filter and housing within the duct
- P47 assess the condition of heat exchangers for damage, blockage and debris
- P48 measure the air path resistance across the coil and compare this with design resistance
- P49 check refrigeration heat exchangers for signs of leakage of refrigerant
- P50 note the fan type and method of control
- P51 check the functioning of any energy conservation facilities such as heat recovery
- P52 check the air handling plant and visible air containment including ductwork, floor or ceiling plenums and builders' work shafts for signs of excessive leakage
- P53 note the setting and functioning of any dampers that modulate the proportions of fresh and recirculated air

### **Locate and check outdoor air inlets**

*You must be able to:*

- P54 note any significant obstructions or blockages to inlet grilles, screens and pre- filters
- P55 note where inlets may be affected by proximity to local sources of heat or to air exhausts

### **Locate and examine system controls responsible for the operation of the air conditioning or comfort cooling system, the heating system controls and their associated temperature sensors**

*You must be able to:*

- P56 determine the individual control zones for heating and cooling

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- P57 assess the appropriateness of zoning in relation to factors such as local levels of internal heat gains, orientation, exposure to radiation and seasonal differences
- P58 observe any control timers and note the current indicated weekday and time of day against the actual time
- P59 note the set times of on and off periods and whether manually overridden
- P60 assess the suitability of the timers and the suitability of the set periods in use
- P61 note the locations of zone heating and cooling emitters
- P62 assess the appropriateness of the type and location of sensors in relation to the heating and cooling emitters, heat flows or likely temperature distributions in the zone and space and the intended function of the sensors
- P63 determine the set temperatures in each zone for heating and cooling
- P64 assess the suitability of the set temperatures in relation to the activities and occupancy of the zones and spaces in relation to the manager's intent and in relation to each other
- P65 review documentation to demonstrate the current values of the timers and temperatures where they are part of a Buildings Management System
- P66 determine the type and age of the refrigeration compressor(s) and method of refrigeration capacity control from rating plate or documentary records
- P67 assess the likely efficiency compared to good current practice based on observations, checking the equipment rating plate(s) and where appropriate making physical measurements of performance to:
  - P67.1 estimate current cooling loads against appropriate optimum cooling loads for a typical building of the type being inspected
  - P67.2 establish the optimum size of the cooling system
  - P67.3 identify special cooling measures for specific areas
  - P67.4 assess cooling capacity using equipment rating plates and performance data available from manufacturers and online databases based on size and likely age of the equipment
  - P67.5 establish the ventilation rate in terms of volume of air being circulated through the building and prescribed ventilation rates in regulatory documentation and professional guidance
  - P67.6 determine airflow rates provided by fans in relation to ventilation requirements of the building and fan duties available from building logbooks, Operational and Maintenance manuals and rating plates and the total power required by supply and extract fans
  - P67.7 establish the specific fan power of the supply and extract installation from available information compared to

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recommended levels in guidance documents

- P68 determine the method used to set, modulate or control airflow rate through air supply and exhaust ducts
- P69 record hours run where appropriate and number of starts for each compressor to determine control of compressors

### **Conduct the inspection following best practice**

*You must be able to:*

- P70 identify yourself to those present at the property before commencing the inspection
- P71 ensure that you have the equipment and resources needed for the inspection
- P72 use test equipment according to manufacturers' instructions
- P73 identify any circumstances when at the property that prevent you continuing with the inspection and explain the reasons to the client
- P74 carry out any specific, non-invasive and non-hazardous techniques that have been included within the agreed scope of works
- P75 make accurate observations and measurements which are necessary to provide data for assessment of the energy performance of the air conditioning system
- P76 make further investigations where observations are inconsistent with existing evidence and expected findings
- P77 draw the client's attention to obvious instances of inadequate maintenance or neglect, particularly where these might have implications for the health and safety of occupants or the public

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### Knowledge and understanding

*You need to know and understand:*

- K1 the principles and theory of how an air conditioning system works
- K2 the components and controls of complex/centralised air conditioning systems and their interrelationship
- K3 the design intent of the specific installed air conditioning system, and the impact of any changes in building usage over time on the air conditioning system installed
- K4 how to identify the type, features and location of the air conditioning system(s) present at the property
- K5 the design and operation of:
  - K5.1 centralised cooled air systems
  - K5.2 centralised cooled water systems including absorption water chillers
  - K5.3 water loop/reversible heat pump systems
  - K5.4 additional systems i.e. where areas are served by packaged, split and multi-split packaged comfort cooling equipment, including variable refrigerant flow (VRF) equipment linked into Building Management Systems (BMS)
- K6 how to check that the system settings are within appropriate limits set by manufacturers' data or design intent
- K7 how to read and interpret building drawings
- K8 factors affecting air conditioning systems efficiency in terms of:
  - K8.1 the inherent inefficiency of the system
  - K8.2 its state of maintenance
  - K8.3 its effective control
- K9 the potential impact of the phasing out of ozone depleting refrigerants including the types of refrigerants and their global warming potential (GWP) and total equivalent warming impact (TEWI)
- K10 the range of information that may be available relating to the air conditioning system installed, its maintenance and energy consumption including:
  - K10.1 the design intent of the system installed
  - K10.2 the type, features, including refrigerant type and location of the system installed
  - K10.3 the size of the area served by the system
  - K10.4 method of controlling temperature
  - K10.5 method of controlling periods of operation
  - K10.6 maintenance records relating to the system
  - K10.7 energy consumption of the system where available
- K11 what information is 'essential', 'desirable' and 'optional' to the pre-inspection review
- K12 the action to take in cases where information is not forthcoming, is incomplete or is inaccurate including:



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- K12.1 explaining to the client the consequences of inadequate information
- K12.2 requesting information from other sources
- K12.3 preparing 'essential' information as part of the inspection procedure
- K13 how to review available information in order to identify that which is relevant to the energy performance of the air conditioning system
- K14 how to review available information in order to identify any significant factors that may influence the energy assessment including:
  - K14.1 concerns about information (e.g. missing, incomplete, out of date, inaccurate)
  - K14.2 health and safety considerations
  - K14.3 access issues
  - K14.4 the need to inspect a sample of system components (e.g. fan-coil units)
  - K14.5 the need to shut-down the system
- K15 how to identify circumstances that prevent you from assessing the energy performance of the air conditioning system including:
  - K15.1 the discovery of unexpected or hazardous conditions or materials
  - K15.2 other potential threats to health and safety
- K16 how to identify refrigerant leakage in positive and negative pressure systems and the requirement to notify the responsible person immediately
- K17 the definition of non-invasive techniques and associated safety precautions including risk assessment
- K18 what equipment and resources are needed for the inspection
- K19 how to carry out any specific, non-invasive and non-hazardous techniques included within the agreed scope of works
- K20 how to make further investigations where observations are inconsistent with existing evidence and expected findings, and how to identify the causes of these inconsistencies
- K21 the requirements and application of relevant regulations, standards and guidance that apply to the assessment of the energy performance of air conditioning systems
- K22 how to identify potential risk areas in waterborne cooling systems where Legionella may be present and how to take precautionary action to protect self and others
- K23 how to collate information required to assess the energy performance of air conditioning systems
- K24 the types of advice that can be provided to clients during inspection
- K25 the sources of information and advice about energy performance to which clients can be referred

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