

## Category I Standard

# S1068

# Mechanical Building Services, Utility Provision and Energy Management in London Underground

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## Contents

|      |                                                              |    |
|------|--------------------------------------------------------------|----|
| 1    | Purpose                                                      | 3  |
| 2    | Scope                                                        | 3  |
| 2.1  | This standard covers the following:                          | 3  |
| 3    | Requirements                                                 | 4  |
| 3.1  | General                                                      | 4  |
| 3.2  | Hot and Cold Water Systems                                   | 4  |
| 3.3  | Condensate Pipework                                          | 8  |
| 3.4  | Water System Redundant and Infrequently Used Outlets         | 8  |
| 3.5  | Water Economisers                                            | 8  |
| 3.6  | Grey Water Harvesting                                        | 8  |
| 3.7  | Gas Systems - general                                        | 9  |
| 3.8  | Existing Gas, Oil and Solid Fuel Systems                     | 9  |
| 3.9  | New Gas, Oil and Solid Fuel Systems                          | 9  |
| 3.10 | Heating & Cooling General                                    | 10 |
| 3.11 | Boilers and Low Temperature Hot Water (LTHW) Heating         | 13 |
| 3.12 | Depot Heating                                                | 15 |
| 3.13 | Ventilation                                                  | 15 |
| 3.14 | Escalator Machine Chamber - Cooling                          | 19 |
| 3.15 | Escalator Machine Chamber – Smoke Exhaust Ventilation        | 20 |
| 3.16 | Hydraulic Lift Pump Rooms                                    | 21 |
| 3.17 | UPS/OLBI rooms and cupboards                                 | 22 |
| 3.18 | Air Conditioning and Comfort Cooling                         | 22 |
| 3.19 | Inspection and Record Keeping for Refrigerant Systems        | 25 |
| 3.20 | Electrical Requirements                                      | 25 |
| 3.21 | Control Panels                                               | 26 |
| 3.22 | Labelling                                                    | 27 |
| 3.23 | Energy Management                                            | 28 |
| 3.24 | Thermal Insulation                                           | 28 |
| 3.25 | Controls                                                     | 29 |
| 3.26 | Environment                                                  | 30 |
| 3.27 | Reliability, Availability, Maintainability and Safety (RAMS) | 31 |
| 3.28 | Whole Life Cost/Benefit Analysis                             | 31 |
| 4    | Responsibilities & Compliance                                | 32 |
| 5    | Supporting information                                       | 33 |
| 6    | References                                                   | 39 |
| 6.1  | Statutory Documents and Standards                            | 39 |
| 6.2  | Abbreviations                                                | 42 |
| 6.3  | Definitions                                                  | 43 |
| 6.4  | Person accountable for the document                          | 43 |
| 6.5  | Document history                                             | 44 |

## 1 Purpose

The purpose of this standard is to define the mechanical requirements for all LU property building services systems serving non-public areas only, the provision of gas and water utility connections and building services energy management.

## 2 Scope

### 2.1 This standard covers the following:

- a) General Requirements
- b) Hot and Cold Water Systems
- c) Condensate Pipework
- d) Water System Redundant and Infrequently Used Outlets Economisers
- e) Grey Water Harvesting
- f) Existing Gas, Oil and Solid Fuel Systems
- g) New Gas, Oil and Solid Fuel Systems
- h) Heating & Cooling General
- i) Boilers and LTHW Heating
- j) Electric Space Heating
- k) Depot Heating
- l) Ventilation
- m) Escalator Machine Chamber – Cooling
- n) Escalator Machine Chamber – Smoke Exhaust Ventilation
- o) Hydraulic Lift Pump Rooms
- p) UPS/OLBI rooms and cupboards
- q) Air Conditioning and Comfort Cooling
- r) Inspection and Record Keeping for Refrigerant Systems
- s) Electrical Requirements
- t) Control Panels
- u) Labelling
- v) Energy Management
- w) Thermal Insulation
- x) Controls

- y) Environment
- z) Reliability, Availability, Maintainability and Safety (RAMS)
- aa) Whole Life Cost/Benefit Analysis

- 2.2 Tunnel and public area cooling and ventilation systems are covered under LU category 1 standard S1067.
- 2.3 This standard incorporates the stand-alone supporting mechanical guidance document G-074 which is withdrawn.

### 3 Requirements

#### 3.1 General

- 3.1.1 In all cases for non-public areas a heat strain risk assessment shall be carried out where;
  - a) The internal temperature of areas normally occupied for work exceeds 30°C.
  - b) The internal temperatures of areas which are required to be occupied for maintenance purposes exceed 35°C.
  - c) The HSE website example format heat strain risk assessment shall be used.
- 3.1.2 Mitigation measures shall be implemented to ensure that internal temperatures are maintained below the 30°C for non public areas normally occupied for work.
- 3.1.3 Mitigation measures shall be implemented to ensure that internal temperatures are maintained below the 35°C for non public areas which are required to be occupied for maintenance purposes.
- 3.1.4 System selection choice between alternatives shall be based on a feasibility analysis.
- 3.1.5 System selection choice between alternatives shall be based on a whole-life cost analysis.
- 3.1.6 Equipment shall meet the performance criteria specified by Department of Energy and Climate Change in the 'Enhanced Capital Allowance (ECA) Scheme for Energy Efficient Technologies - Energy Technology Criteria List'.
- 3.1.7 Before use Suppliers shall arrange listing of qualifying equipment that is not on the Energy Technology List.
- 3.1.8 Safe and adequate maintenance access shall be provided to all equipment.

#### 3.2 Hot and Cold Water Systems

- 3.2.1 Water services installations shall comply with Water Supply (Water Fittings) Regulations.
- 3.2.2 Water services installations shall meet the recommendations of Chartered Institute of Building Services Engineers (CIBSE) Guide G.

- 3.2.3 Water services installations shall comply with BS EN 806. For guidance on compliance with this standard refer to complimentary guidance BS 8558: 2011.
- 3.2.4 Water fittings shall be selected from Water Regulatory Advisory Service (WRAS) approved list.
- 3.2.5 New and existing water systems shall comply with recommendations within HSE approved code of practice L8.
- 3.2.6 The risks associated with Legionella within new and existing water systems shall be mitigated to ALARP status and eliminated where practicable.
- 3.2.7 Records associated with the management and control of Legionella shall be stored and archived in a central business electronic file storage system for audit purposes, i.e. Live Link.
- 3.2.8 When there is an operational change of use of water systems created by organisational change or any other change, the landlord and maintainer shall be informed.
- 3.2.9 When there is an operational change of use of water systems created by organisational change or any other change, a review of the Legionella risk assessment shall be undertaken.
- 3.2.10 When there is an operational change of use of water systems created by organisational change or any other change which results in an infrequently used outlet, it shall be removed in compliance with the requirements in section 3.4.
- 3.2.11 Solar water heating systems shall be prioritised to be selected for use for all above ground LU operational buildings, based on a whole life cost analysis.
- 3.2.12 Lead pipework shall not be used.
- 3.2.13 Existing lead pipework associated with an active water distribution system which is being affected by project works shall be removed from the water system as part of those works.
- 3.2.14 Water mains pipe work shall be sized to meet the required capacity at a location.
- 3.2.15 Water system capacity sizing shall be optimised based on demand unit calculations. For guidance on demand unit calculations refer to CIBSE Guide G.
- 3.2.16 All new mains water supplies shall be metered at the point of entry to LU premises.
- 3.2.17 Tenant's supplies shall be fed from an independent mains water supply separate from the LU mains water supply.
- 3.2.18 Hot water outlets provided for hand or body washing shall in all cases be limited to a maximum hot water discharge temperature of 43°C.
- 3.2.19 Showers shall provide thermostatic control of the hot water so that it is limited to a maximum hot water discharge temperature of 43°C.
- 3.2.20 Dedicated hot water taps (non mixers) for purpose of hand or body washing shall be limited to a maximum hot water discharge temperature of 38°C.

- 3.2.21 Where hot water outlets are required to supply hot water at a temperature above 43°C (i.e. kitchens), a prominent warning sign shall be installed adjacent to the outlet.
- 3.2.22 Where hot water outlets are required to supply hot water at a temperature above 43°C (i.e. kitchens), a hand wash tap shall also be provided which is limited to 38°C.
- 3.2.23 Isolation valves shall be provided at, but not limited to, the following listed locations;
  - a) either side of water meters;
  - b) either side of system elements i.e. strainer, non-return valves, pumps etc;
  - c) as close as practicably possible to each outlet;
  - d) each branch connection;
  - e) at logical points in long runs of pipe for zone isolation;
  - f) at the top and bottom of risers; and
  - g) at the inlets and outlets of cold water storage tanks.
- 3.2.24 Isolation valves shall be ball type valves.
- 3.2.25 Isolation valves shall be lever operated in all cases except immediately before outlets which can be either lever or Allen key operated.
- 3.2.26 Each valve shall be fitted with a securely fitted label which identifies it with reference to the buildings water system schematic and details the valves function, i.e. what it isolates. I.e. IV21 – MCWS.
- 3.2.27 For all water distribution systems, both new and existing, an accurate system schematic shall be provided following any works on the system.
- 3.2.28 An appropriately sized copy of the water schematic shall be framed (metal and glass) and wall mounted as close to the mains water supply point as feasible or within a plant room where more practical.
- 3.2.29 An equipment schedule, i.e. valves and all other system components shall be provided.
- 3.2.30 Valves and other system components shall be shown and referenced to the equipment schedule on the schematic.
- 3.2.31 Potable water supplies shall be direct from the incoming mains cold water supply.
- 3.2.32 Potable water supplies shall never be fed from the fire mains.
- 3.2.33 Cold water system tanks shall not be installed for use on stations.
- 3.2.34 Where cold water storage tanks are installed on LU premises they shall be operated such that the complete volume of stored water is replaced every 12 hours.

- 3.2.35 Cold water storage volume shall be adjustable within the range +/- 50% to cater for future changes in capacity requirement.
- 3.2.36 Cold water storage volume shall not be adjustable through the use of water displacement products.
- 3.2.37 The water volume adjustment for tanks is to be via adjustable float on the fill device.
- 3.2.38 All uninsulated pipework exposed in non public areas shall be chrome finished copper.
- 3.2.39 Crimped pipe systems shall be used in preference to compression and solder types.
- 3.2.40 Maintainable items in permanently jointed systems shall be easily removable through the use of flanges, unions or threaded connections into the chosen system component.
- 3.2.41 The use of push fit pipe systems is not permitted.
- 3.2.42 Where solder systems are used the system shall be completely purged of flux internally and external surfaces shall be cleaned before the system is commissioned.
- 3.2.43 Pre-commissioning cleaning of water service pipework shall be carried out in accordance with the latest British Standards, CIBSE code W (Water Distribution Systems) and BSRIA guide Illustrated Guide to Hot and Cold Water Services (BG33/2014).
- 3.2.44 Pipe materials shall be selected to eliminate the risk of electrolytic metal corrosion (i.e. between dissimilar metals).
- 3.2.45 Where dissimilar metals are used within a system suitable inert connector unions shall be used to eliminate the risk of electrolytic metal corrosion.
- 3.2.46 Where pipes pass through elements forming fire compartments pipe sleeves shall be used and a continuous vapour barrier shall be formed.
- 3.2.47 Pipe penetrations and the associated assembly through fire compartments shall maintain the fire rating of the element.
- 3.2.48 Mechanical protection shall be provided to minimise the risk of damage to pipework where potential risk is identified.
- 3.2.49 Polyethylene medium density (blue) pipes are to be used for buried service pipes only in permanent works.
- 3.2.50 Polyethylene pipes can be used for temporary installations providing that it is maintained, thermally insulated and supported correctly and completely removed at the end of works.

### **3.3 Condensate Pipework**

- 3.3.1 All condensate pipework exposed in non-public areas shall be copper.
- 3.3.2 All gravity fed condensate pipework shall have a minimum internal pipe diameter of 15mm.
- 3.3.3 Condensate pipes shall be laid to fall towards drain with a minimum incline of 1 in 100.
- 3.3.4 Suitable rodding access shall be provided at changes of direction and in long straight runs.
- 3.3.5 Discharge from condensate drains in sub-surface areas shall be connected to foul drainage.

### **3.4 Water System Redundant and Infrequently Used Outlets**

- 3.4.1 Redundant outlets and associated branches shall be removed.
- 3.4.2 Infrequently used outlets are defined as outlets with usage less than once every 28 days.
- 3.4.3 Infrequently used outlets shall never be located at the index point of a system.
- 3.4.4 Infrequently used branches shall be fitted with a double check valve and isolator at the point of Connection to the remainder of the water system.
- 3.4.5 In all cases where a water system is installed as new or an existing system is worked upon the thermal insulation of the entire new system and that part of the existing system worked upon shall be brought up to standard.
- 3.4.6 Cold water distribution systems shall be provided with thermal insulation such that water temperature does not exceed 20°C.
- 3.4.7 Hot water distribution systems shall be provided with thermal insulation such that water temperature is maintained above 55°C.

### **3.5 Water Economisers**

- 3.5.1 Water economisers shall be installed on water supply to flushing urinal systems.
- 3.5.2 Economisers shall be selected and commissioned such that a maximum time between flushes is 12 hours.
- 3.5.3 Flushless urinals are not to be used unless there is an appropriate cleaning regime in place.

### **3.6 Grey Water Harvesting**

- 3.6.1 Grey water harvesting shall not to be used unless there is a proven business case justification and with approval from LU.
- 3.6.2 Grey water systems shall be designed in accordance with the guidance set out in BSRIA guide – Design and Construction of Systems using Grey Water (TN6/2002).

### 3.7 Gas Systems - general

- 3.7.1 Gas installations shall be compliant with The Gas Safety (Installation and Use) Regulations.
- 3.7.2 Gas installations shall meet the recommendations of CIBSE Guide B.
- 3.7.3 Gas appliances shall be compliant with the Gas Appliances (Safety) Regulations.
- 3.7.4 Gas boilers must be installed to the latest applicable BS standards.
- 3.7.5 Gas mains and service pipes shall be designed and installed in accordance with the requirements of the Pipelines Safety Regulations 1996.
- 3.7.6 Gas mains and service pipes shall be designed and installed in accordance with the requirements of the HSE guidance 'A guide to the Pipelines Safety Regulations 1996'.
- 3.7.7 Gas mains and service pipes shall be designed and installed in accordance with the requirements of the Health & Safety Commission (HSC) approved code of practice and guidance 'Design, Construction and Installation of Gas Service Pipes'.

### 3.8 Existing Gas, Oil and Solid Fuel Systems

- 3.8.1 Where there is an existing gas, oil or solid fuel system at sub-surface locations, no appliances shall be added to the existing systems or supply.
- 3.8.2 When an existing gas, oil or solid fuel system is to be removed at a location it shall be capped off at the point of common coupling or entry point to the premises.
- 3.8.3 When an existing gas, oil or solid fuel system is to be removed at a location all dead legs shall be removed.
- 3.8.4 When adding gas appliances to an existing system/supply or when adding a new system to an existing supply the designer must demonstrate that the new appliance(s) and/or system:
  - a) does not affect the operation of existing appliances or systems;
  - b) has main and branch gas pipe sizes sized optimally to all appliances;
  - c) has available gas pressure/flow appropriate to all appliances and;
  - d) has a pressure drop not exceeding 1mb to each index run.
- 3.8.5 Where existing gas boiler equipment is replaced, the new equipment shall be specified in compliance with relevant clauses in section 3.9.
- 3.8.6 Where existing gas boiler equipment is replaced, the gas supply to the boiler shall feature an automatically operated gas safety shut off valve.

### 3.9 New Gas, Oil and Solid Fuel Systems

- 3.9.1 There shall be no new or renewed gas, oil or solid fuel installations at sub-surface locations.

- 3.9.2 Solid fuel systems shall not to be used unless there is a proven business case justification.
- 3.9.3 Installation of solid fuel boilers shall be considered on a case by case basis and only where the business case is demonstrable and the system maintainer has fully endorsed the plans.
- 3.9.4 Gas main sizes shall be optimised based on actual or projected (calculated) consumption.
- 3.9.5 All new gas supplies to surface location tenants' premises shall be directly from the supplier's main with independent metering.
- 3.9.6 Gas and oil pipes shall not be run in the ballast or formation below any tracks or in trackside cable runs except in dedicated concrete or steel service ducts designed for the purpose and permanently ventilated.
- 3.9.7 Where gas point heaters are used, the gas supply pipes shall be surface run and protected.
- 3.9.8 LPG tanks shall be in an enclosure secured from unauthorised access.
- 3.9.9 LPG tanks shall be labelled clearly to identify the nature of the contents and the explosion hazard.
- 3.9.10 Gas, oil and solid fuel heating systems shall use only commercially available fuels having a calorific value suitable for the rated duty of the system concerned.
- 3.9.11 All gas and oil fired appliances shall have fuel shut-off devices fitted adjacent to the appliance but external to it.
- 3.9.12 Fuel shut-off devices shall be labelled clearly to enable identification of the equipment which would be isolated.
- 3.9.13 Gas and oil boilers and heaters shall be fitted with fuel cut-off flame failure devices.
- 3.9.14 Boilers and any associated firing equipment are to be fully automatic in normal operation and use.
- 3.9.15 The use of gas boosters shall be avoided where possible due to the maintenance requirements.
- 3.9.16 Gas pressure boosters shall be provided with isolating valves for ease of maintenance and shall have easily replaceable gas seals.

### **3.10 Heating & Cooling General**

- 3.10.1 Centralised systems that have the functionality to provide simultaneous heating and cooling shall be provided where practicable.
- 3.10.2 A practicability assessment report for each centralised cooling/ heating systems shall be produced and issued to LU.

- 3.10.3 At new buildings and where heating and cooling systems in existing buildings are being replaced the designer shall introduce centralised systems which feature waste heat recovery.
- 3.10.4 The use of new multiple individual heating or cooling systems such as split system heat pumps and direct electric heaters shall only be installed if the output of the practicability assessment deems that the installation of a centralised cooling / heating systems is not practicable.
- 3.10.5 Waste heat shall be discharged to atmosphere where practicable.
- 3.10.6 A practicability assessment report for all cooling systems (i.e. condensers, exhaust ventilation, etc) to discharge waste heat to atmosphere shall be produced and issued to LU.
- 3.10.7 For new buildings including new staff accommodation provided at new or existing above ground stations and depots a simplified building energy model (SBEM) calculation shall be carried out and issued to LU.
- 3.10.8 SBEM calculations shall clearly state the outcome of the analysis and include a signed declaration by the Designer to show compliance with the building regulations and the energy performance of buildings directive.
- 3.10.9 Heating systems shall meet the recommendations given in CIBSE Guide B1.
- 3.10.10 The use of direct electric heating shall be not be used if there are other more energy efficient methods of heating.
- 3.10.11 Direct electric heaters are permitted for use for the purpose of frost protection only.
- 3.10.12 Direct electric heaters used for the purpose of frost protection shall be limited to an upper temperature of +5°C.
- 3.10.13 Operation of frost protection heating shall be automatic and thermostats shall be tamperproof.
- 3.10.14 The Designer shall be required to demonstrate that all other more energy efficient methods of heating options are not practicable or desirable based on a whole life cost basis.
- 3.10.15 Water circulation systems for purpose of heating and/or cooling shall comply with industry best practice as well the following LU specific criteria:
  - a) Strainers are to be fitted to protect heat exchangers, automatic control valves, pumps and other sensitive areas of the system. A single appropriately positioned strainer is acceptable.
  - b) Full bore flap type non-return-valves shall be fitted at each pump discharge to prevent back flow or short circuiting in multi pump systems.
  - c) Isolation valves shall be placed either side of maintainable components, at logical points throughout the system including terminal units such as fan coil units, chilled beams, radiators etc. Isolation valves shall be of an appropriate type for the use as governed by industry best practice.

- d) Provision shall be made for venting of air from all system high points. Automatic air vents are permissible when accompanied by a ¼ turn ball type isolation valve to enable replacement as required.
- e) Pressure gauges in an appropriate scale shall be fitted (not immediately) either side of pumps.
- f) An isolation valve shall be installed between gauge and pipe.
- g) Where significant pressure fluctuations are expected a snubber device shall be considered.
- h) The flow and return pipes shall be connected via a bypass circuit at each index point of the system complete with an isolation valve to enable flushing and cleaning.
- i) A bypass with manual isolation shall be provided to enable sensitive items of equipment to be removed from the system for purpose of flushing or cleaning.
- j) Pumps shall be specified at 120% system flowrate (m³/s) @ 120% total system pressure (kPa).
- k) Pumps shall be of a variable speed type.
- l) Variable speed pumps shall be commissioned to a speed which satisfies the required flow in a constant flow system.
- m) Variable speed pumps shall be commissioned and speed controlled to meet the maximum system demand in a variable flow system.
- n) In variable flow systems pump speed must not fall below the manufacturer's recommended minimum speed.
- o) In variable flow systems pressure independent valves shall be used for both balancing and control.
- p) Biocides and inhibitors shall be specified for use to achieve corrosion protection and maintain performance and system integrity.
- q) Biocides and inhibitors shall be appropriate to be used simultaneously.
- r) Biocides and inhibitors shall be appropriate to be used with all wetted materials within the system.
- s) Systems which provide non-chemical based corrosion inhibition through PH control and filtering are preferred.
- t) Trace heating systems shall be used to provide freeze protection in systems with external pipe runs or plant.
- u) Freeze protection in free cooling chilled water systems with external pipe runs or plant shall use up to 20% glycol concentration within the system water content.

- v) For all system dosing required, a fixed dosing facility shall be provided, complete with the specified products, concentrations and testing process.
- w) Pumps shall be securely mounted on either builders work plinths, walls or on frames (which are fixed secured to the structure).
- x) Anti-vibration mountings and flexible connections shall be provided to pumps.
- y) Condensation forming on chilled water pumps shall be channelled to drain.

3.10.16 Water based heating and cooling systems shall be internally cleaned prior to commissioning in accordance with the guidance set out in BSRIA guide – Pre-Commission Cleaning of Pipework Systems (BG29/2012) and also CIBSE code W (Water Distribution Systems).

3.10.17 Water based heating and cooling systems shall be chemically treated in accordance with the guidance set out in BSRIA guide – Water Treatment for Closed Heating and Cooling Systems (BG50/2013).

3.10.18 All components of a system shall be assigned a unique ID code.

3.10.19 All components of a system shall feature permanently fixed labels which shall identify the device/component's unique ID code.

3.10.20 This ID code shall correspond to those on the 'as installed' system schematic.

3.10.21 Water system schematics shall be updated following system modification.

3.10.22 Water system schematics shall be framed and mounted on site located adjacent to the equipment.

3.10.23 Mechanical comfort cooling shall not be provided to rooms with openable windows.

### **3.11 Boilers and Low Temperature Hot Water (LTHW) Heating**

3.11.1 All radiators shall be fitted with thermostatic valves (TRVs) with an allen key operated ball type isolation valve installed on the upstream side.

3.11.2 The TRV shall not be used for purpose of isolation.

3.11.3 Where radiators are installed within an enclosure, TRV's with remote thermostatic elements shall be specified such that the element is outside of the enclosure and hence is sampling room temperature and not the elevated temperature within the enclosure.

3.11.4 Where a radiator circuit with TRVs is served by a gas boiler the designer shall ensure that the boiler can provide the required minimum water volume flowrate.

3.11.5 Where new boilers serve space heating they shall be;

- a) condensing type;
- b) capable of weather compensated flow temperature control; and
- c) specified with appropriate controls and sensors to achieve automatic variable flow temperature.

- 3.11.6 Where boilers are required to serve domestic hot water storage, the control system shall enable the boiler to revert to a fixed (higher) temperature output for purpose of charging the hot water store.
- 3.11.7 New LTHW heating systems shall be designed such that peak heating load is delivered at flow temperatures which are within the boilers peak efficiency range (condensing range).
- 3.11.8 Central boilers are to be installed in a separate boiler plant room designated for that plant only.
- 3.11.9 The central boilers shall be controlled by a purpose built control panel which includes the following:
- a) LED run and failure lights for all plant items i.e. pumps, boilers, pressurisation units, flue fans etc;
  - b) lamp test button;
  - c) run hours meters;
  - d) on/off/auto switches;
  - e) main isolator with LED indication light;
  - f) external building management system interface (whether or not a BMS is installed at the time);
  - g) interface and indicators associated with installed safety devices;
  - h) appropriate fixed permanent labelling detailing the purpose of the panel and what equipment it serves;
  - i) third party boiler controls i.e. the manufacturers own controller (where fitted); and
  - j) electric space heating.
- 3.11.10 Where gas heating is not available or not permitted an electrical solution shall be required.
- 3.11.11 Where electric heating systems are used, the system selection shall be prioritised as follows (preferred (a) to least preferred solution (d)):
- a) recovered heat (from an on-site cooling system or process);
  - b) output from a centralised system, i.e. VRF/VRV;
  - c) using a single or multi split system which meets the performance criteria of the ECA scheme; and
  - d) direct electrical means.