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Code of Practice for Energy Audit in Buildings

NOTE: This version of the Code is for reference only and not the official version to be gazetted by the Director of Electrical and Mechanical Services under section 40(3) of the Ordinance

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Electrical & Mechanical Services Department

Code of Practice for Energy Audit in Buildings

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1. Introduction

- 1.1 This Code of Practice should be titled "Code of Practice for Energy Audit in Buildings", hereinafter referred as the "Energy Audit Code" or "EAC", is approved and issued under the Building Energy Efficiency Ordinance, Chapter xxx (hereinafter referred as "the Ordinance").
- 1.2 This EAC sets out the technical guidance and details in respect of the energy audit requirements under the Ordinance. Energy audits conducted in accordance with this EAC are deemed to have satisfied the relevant requirements of the Ordinance in the technical aspects.
- 1.3 This EAC is developed by the Electrical & Mechanical Services Department (EMSD) in conjunction with various professional institutions, trade associations, academia and government departments.
- 1.4 This EAC may be updated from time to time by appropriate notices to cope with technological advancement and prevalent trade practices, and the update will be publicized and given in EMSD's web-site (<http://www.emsd.gov.hk>).

2. Interpretations

'air-conditioning' means the process of cooling, heating, dehumidification, humidification, air distribution or air purification.

'air-conditioning system' means the fixed equipment, distribution network and terminals that provide either collectively or individually the processes of cooling, dehumidification, heating, humidification, air distribution or air purification or any other associated processes to a conditioned space.

'air handling unit (AHU)' means an equipment that includes a fan or blower, cooling and/or heating coils, and provisions for air filtering and condensate drain etc.

'building services installation' has the same meaning in the Ordinance, which means - (a) an air-conditioning installation; (b) an electrical installation; (c) a lift and escalator installation; or (d) a lighting installation.

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'**central building services installation**' has the same meaning in the Ordinance, which means –

- (a) a building services installation in a prescribed building that does not solely serve a unit of that building; or
- (b) a building services installation in a prescribed building that has no common area except an installation that –
 - (i) solely serves a unit of that building; and
 - (ii) is owned by a person who is not the owner of that building.

The technical elaboration of **central building services installation** for corresponding individual installations is -

<u>Individual installation</u>	<u>Technical elaboration of central building services installation serving the common area</u>
Lighting installation	located in the common area
Air-conditioning installation	not separately owned by the responsible person of an individual unit
Electrical installation	not on the customer's side of an electricity supplier's electricity meter for an individual unit
Lift & escalator installation	located in the common area, unless solely serving an individual unit

'**chilled/heated water plant**' means a system of chillers/heat pumps, with corresponding matching chilled/heated water pumps and as appropriate condenser water pumps, cooling towers and radiators.

'**chiller**' means an air conditioning equipment that includes evaporator, compressor, condenser, and regulator controls, which serves to supply chilled water.

'**common area**' has the same meaning in the Ordinance, which, in relation to a prescribed building –

- (a) means any area of the building other than the parts that have been specified in an instrument registered in the Land Registry as being for the exclusive use, occupation or enjoyment of an owner; and
- (b) without limiting paragraph (a), includes car parks, entrance lobbies, lift lobbies, corridors, staircases, common toilets, common store rooms, plant rooms, switch rooms, pipe ducts, cable ducts, refuse rooms, material recovery chambers, covered podia, covered playgrounds, occupants' clubhouses and building management offices.

'**conditioned floor area**' means the floor area of conditioned space, as measured at the floor level within the interior surfaces of walls enclosing the conditioned space.

'**conditioned space**' means a space within boundaries maintained to operate at desired temperature through cooling, heating, dehumidification or humidification, using means other than only natural or forced fan ventilation.

'**energy consuming equipment**' means the equipment which consumes energy of all forms including electricity, town gas, LPG, industrial diesel fuel, petrol, kerosene and fuel oil etc.

'**energy consumption data**' means the record of consumption of all forms of energy including electricity, town gas, LPG, industrial diesel fuel, petrol, kerosene and fuel oil etc.

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'**energy management opportunities (EMO)**' means the ways to achieve energy efficiency and conservation.

'**energy utilization index (EUI)**', in relation to the energy consumption of the central building services installation, means dividing energy consumption for a specific period by the total internal floor area of the common area.

'**internal floor area**', in relation to a space or a unit, means the floor area of all enclosed space measured to the internal faces of enclosing external walls, party walls or virtual side planes to distinguish the space or unit in question from adjoining spaces or units.

'**lighting power density (LPD)** (unit : W/m²)' means the electrical power consumed by fixed lighting installations per unit floor area of an illuminated space.

(In equation form, the definition of LPD is given by:

$$LPD = \frac{\text{Total wattage of the fixed lighting installations}}{\text{Internal floor area of that space}})$$

'**luminaire**' means a lighting device, which distributes light from a single lamp or a group of lamps; a luminaire should include controlgears and all necessary components for fixing and mechanical protection of lamps.

'**space**' in the context of lighting installation means a region in a building or unit that is illuminated by artificial lighting and is bounded by a physical floor, a physical ceiling and physical walls or virtual side planes to distinguish the space in question from adjoining spaces.

'**unit**' has the same meaning in the Ordinance, which in relation to a building, means –

- (a) a unit or a part of the building; or
- (b) 2 or more units or parts of the building that are –
 - (i) occupied by the same occupier for the purpose of the same undertaking; and
 - (ii) interconnected by an internal corridor, internal staircase or other internal access;

but does not include a common area of the building.

'**unitary air-conditioner**' means an air conditioning equipment that includes evaporator, compressor, condenser, cooling or heating coil, air re-circulation fan section, and regulator controls, which serves to supply cooled or heated air.

3. Application

3.1 Prescribed Buildings

This EAC is applicable to energy audits for the categories of buildings prescribed in Schedule 4 of the Ordinance.

3.2 Exemption

This EAC is not applicable to –

- (a) the categories of buildings specified in Section 4 of the Ordinance, and
- (b) the categories of building services installations specified in Schedule 2 of the Ordinance.

4. Technical Compliance with the Ordinance

4.1 To satisfy the relevant requirements of the Ordinance, energy audit should be conducted in accordance with this EAC for the central building services installation as a minimum in a prescribed building, save for exemption under the Ordinance.

4.2 In the case of a composite building, the energy audit requirement specified in clause 4.1 should only apply to –

- (a) the building's commercial portions that
 - (i) are explicitly defined in the "occupation approval" (as defined in Section 2 of the Ordinance) as for non-domestic use only and
 - (ii) are used for offices, shops or entertainment facilities, or used for the purpose of any trade, business or profession (but not used for purpose of an industrial building); and
- (b) the central building services installation solely serving the commercial portions (the inclusion of installations serving both commercial and non-commercial portions not a must).

5. Objectives of Energy Audit

5.1 An energy audit involves the systematic review of the energy consuming equipment/systems in a building to identify energy management opportunities (EMO), which provides useful information for the building owner to decide and implement energy saving measures for environmental consideration and economic benefits.

6. Overview of Energy Audit

6.1 An energy audit commences with the collection and analysis of relevant information that may affect the energy consumption of the building, followed with the reviewing of the collected information, the analyzing of the conditions and performances of existing equipment, systems and installations, and the utility bills, and the comparing with

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relevant recognized benchmarks, and finally the identification of areas of energy inefficiency and the means for improvement.

6.2 Energy audit can achieve energy efficiency and conservation through the implementation of EMO identified in the audit. EMO is classified into three categories -

- (a) Category I - involving housekeeping measures which are improvements with practically no cost investment and no disruption to building operation;
- (b) Category II - involving changes in operation measures with relatively low cost investment; and
- (c) Category III – involving relatively higher capital cost investment to attain efficient use of energy.

7. Energy Audit Requirements

7.1 General

In conducting the energy audit, a checking of practically all and if not possible the major energy consuming equipment/systems should be carried out, followed with an evaluation of their operation characteristics and controlling parameters, leading to the identification of as many EMO as possible and their categorization. The checking should focus on the central building services installation. The following auditing steps should be followed.

7.2 **Step 1** – Collection of Building Information

Information on building operation characteristics and technical characteristics of various energy consuming equipment/systems relevant to the central building services installation should be collected. The essential information should include the following -

- (a) record of EMO already implemented in the last 36-month or to be implemented, and corresponding energy audit report if available;
- (b) inventories of the energy consuming equipment, and manuals or technical brochures indicating their configurations and characteristics;
- (c) drawings and system schematics showing the layouts of the energy consuming equipment and systems, and drawings showing the layout of the building;
- (d) equipment day-to-day operation records, including room temperature settings and corresponding room temperatures, chilled water supply & return temperature settings and corresponding water temperatures, supply & return air temperature settings and corresponding air temperatures, building & equipment operation hours etc.;
- (e) energy consumption data in last 36-month or since operation of the building should such period be less than 36-month;

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- (f) operation & maintenance programmes including timing of major alterations, replacements or retrofits of the building;
- (g) areas of relevant spaces attributing to the internal floor area of the common area; and
- (h) internal floor area of the building.

7.3 Step 2 – Review of Energy Consuming Equipment

7.3.1 Study the information collected and conduct site inspections for an appreciation of the energy consuming equipment and systems relevant to the central building services installation. Based on the findings in the study and inspections, compile records of the characteristics of the energy consuming equipment and systems including -

- (a) types of air conditioning systems and their components;
- (b) types of chillers and/or unitary air-conditioners, their capacity ratings and operating characteristics;
- (c) types of major air handling units (AHU) and fans, their capacity ratings and operating characteristics;
- (d) types of major air conditioning water pumps, their capacity ratings and operating characteristics;
- (e) types of luminaires, their ratings and operating characteristics;
- (f) utilization pattern of the area served by the energy consuming equipment/systems (e.g. hours of operation, occupant density, equipment in operation at different hours of the day and days of the year);
- (g) control mechanisms for various equipment/systems;
- (h) electrical power quality and metering provision;
- (i) types of lift and escalator installation, their capacity ratings, and operating characteristics;
- (j) operating characteristics of other major energy consuming equipment/systems e.g. plumbing & drainage water pumps; and
- (k) characteristics of the building affecting building energy consumption (e.g. external shading, shading coefficient of glazing).

7.3.2 (a) Based on the operation records, identify or calculate the power and energy consumptions of the major energy consuming equipment/systems, including chillers, unitary air-conditioners, major air handling units, fans and pumps, large motors, lifts & escalators etc. The power and energy consumption values can be calculated based on available consumption values shown in technical brochures with adjustments to suit the actual operating conditions such as operation hours reflected in the operation records.

(b) Should the operation records not be sufficient to provide the information, take measurements at representative instants and time intervals of the power inputs

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and/or energy consumptions, or take measurements of parameters such as flow and temperature difference from which the power or energy can be calculated.

- (c) External metering for the measurements should be used in case of an inadequacy of in-situ metering facilities. Notwithstanding, measurements should be conducted based on the available resources.

7.4 **Step 3** – Identification of EMO

7.4.1 Based on the findings in clause 7.3, an appraisal and evaluation should be conducted on the energy consuming equipment/systems, focusing on their energy performances against their corresponding operating conditions, including but not limiting to -

- (a) chiller energy consumption (kWh per annum);
- (b) major air distribution system (e.g. primary air handling unit (PAHU) and typical AHU, carpark ventilation) - fan power consumption (W per litre/s);
- (c) major water distribution system – pump power consumption (W per litre/s);
- (d) lighting power density (W/m²);
- (e) energy performance of other major equipment including fans, boilers, heat pumps, etc.; and
- (f) EUI of the building.

7.4.2 A comparison with original design and relevant benchmarks where available should be conducted to identify any deviations from efficient operation and identify accordingly the potential EMO for improving energy efficiency.

7.4.3 The findings may also identify certain potential EMO contributing to the energy consumption of the central building services installation as a result of behaviours of occupants of units outside the common area, an example being the operating hours of air handling units operated by these occupants. These potential EMO may be recorded and conveyed to the relevant occupants for follow-up or further study.

7.5 **Step 4** - Cost Benefit Analysis of EMO

7.5.1 For each potential EMO identified for the central building services installation, an estimate should be made on the energy saving that can be achieved if the EMO is implemented. For Cat II and Cat III EMO in which capital cost is involved, a cost benefit analysis should be carried out, giving a rough indication of the cost for the EMO against its estimated energy savings over time.

7.6 **Step 5** – Recommendations

- 7.6.1 Recommendations of the EMO to be implemented should be made, with due regard to the energy savings and cost benefits.
- 7.6.2 Recommendations should highlight the known programmed operation & maintenance activities of the building, if carried out in parallel with certain EMO would lower the EMO's implementation cost, such as an EMO of lighting retrofit tying in with a programmed false ceiling renovation.
- 7.6.3 Recommendations may include suggestions for further studies of equipment or components lacking the depth of study at the time of the audit as a result of a limitation of time or financial resources.

7.7 **Step 6** - Compiling Energy Audit Report

The energy audit report should outline the objectives and scope of audit, description of operating characteristics of equipment/systems audited, findings in the audit, potential EMO identified and corresponding energy saving and implementing capital cost with cost benefit analysis, and above all the recommendations on EMO implementation with due regard to the building's influential operation & maintenance programme, and any other follow-up actions.

8. Energy Audit Report

8.1 General

The energy audit report should include an executive summary which should provide a quick overview of the scope of the audit and the recommended EMO with achievable savings and implementing cost investments. EMO of similar nature should be grouped under a common heading with their cumulative savings shown.

8.2 Information for Report

The following information should be included in the report -

- (a) energy audit method statement;
- (b) building characteristics including numbers of floors, internal floor area of the common area, internal floor area of the building, usage, occupancy, hours of operation, year built, etc.;
- (c) general description of equipment/systems audited, including their corresponding capacity ratings, operation hours etc.;

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- (d) energy consumption and performance evaluation of major equipment/systems;
- (e) for the air-conditioning equipment/systems the identification of their –
 - i) types of condenser cooling – air-cooled, evaporative water-cooled, or sea water-cooled;
 - ii) equipment types – unitary air-conditioner, or chilled/heated water plant; and
 - iii) system types – fan coil unit system, constant volume all air system, or variable air volume all air system etc.;
- (f) analysis of historical energy consumption of the building, to be presented graphically as well as with figures -
 - i) current year energy use profile in pie chart form differentiating the consumptions among the major installations, such as air-conditioning, lighting, lift & escalator, plumbing & drainage etc.;
 - ii) annual energy consumption, of the last 36-month or a period since operation of the building should such be less than 36-month, with indication of the monthly EUI; and
 - iii) annual EUI of last 12-month;
- (g) indication as a percentage of the annual EUI of the energy supply from the central building services installation to the units, such as for chilled water supply or cool air supply (excluding the electricity supply via electricity supplier's meters for the individual units);
- (h) findings from the information review and site inspections (in Step 2), with focus on the items leading to identification of potential EMO;
- (i) evaluations of potential EMO, including corresponding justifications, and cost benefit analyses;
- (j) drawing reference of above items to corresponding relevant items in past energy audit report, if available; and
- (k) recommendations with classifications of EMO into categories I, II or III, and their grouping into common headings, and suggestions for further studies.

9. Energy Audit Form

The Energy Audit Form should show the annual EUI of the past 12-month before the date of audit of the building, to reflect its energy usage intensity of the central building services installation, and should be in accordance with the format specified by EMSD.

Energy Efficiency  **EMSD**

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