HKIE-BSD, CIBSE-HKB & ASHRAE-HKC Joint Symposium 12 Nov 2013
"Innovation and Technology for Built Environment"

Technical Guidelines on Code of Practice for Energy Efficiency of Building Services Installation

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ABSTRACT

Densely populated cities full of high rise buildings create unique challenges for sustainable development and building operation, and in the combat of climate change the energy consumption of buildings amidst their dense environment is undoubtedly a key concern. To improve the energy efficiency in buildings in Hong Kong, the Buildings Energy Efficiency Ordinance, Cap 610 (BEEO) was enacted and put into full operation on 21 Sep 2012. The BEEO applies to four key types of building services installations namely lighting installations, air-conditioning installations, electrical installations and lift and escalator installations in prescribed buildings, which are required to comply with the "Code of Practice for Energy Efficiency of Building Services Installation", hereinafter referred as the "Building Energy Code (BEC)", issued in Feb 2012 by the Electrical and Mechanical Services Department (EMSD), Government of Hong Kong Special Administrative Region (HKSAR). The BEC sets out the technical details in respect of the minimum energy efficiency requirements governing the building services installations. To assist in the understanding of the BEC, EMSD issues the "**Technical Guidelines on Code of Practice for Energy Efficiency of Building Services Installation**", in short the **TG**, in early September 2013. The TG provides an overview of the legislative requirements of the BEEO and the engineering requirements of the BEC, with detailed descriptions of lodging of declarations and forms for the demonstration of compliance with the BEC. The TG also provides good engineering practices for enhanced energy efficiency. This paper describes the major contents of the TG.

Keywords: technical guidelines, building energy code, energy efficiency ordinance

1. INTRODUCTION

The TG consists of ten sections: the overview with certain explanations of the BEEO compliance process are given in sections 1 to 4, and the technical energy efficiency

requirements of the BEC are explained in TG sections 5 to 10.

2. BEEO LEGISLATIVE REQUIREMENTS

The following briefly summarizes the contents of TG sections 1 to 4 (in which the scope of coverage and compliance hierarchy are, for purpose of easy understanding, shown in tabulated format in TG Tables 4.1.1, 4.2.2 & 4.2.3).

2.1 Scope of Coverage

2.1.1 Building services installations and types of buildings

The BEEO governs the energy efficiency standard in respect of the design of building services installations (hereinafter denoted as BSIs) in prescribed types of buildings, requiring the compliance with the BEC for newly constructed buildings and for major retrofitting works in existing buildings. (TG clause 3.1)

BSIs governed under the BEEO include lighting installation, air-conditioning installation, electrical installation, and lift and escalator installation, but exclude fire services, security installation etc. (TG clauses 1.1 & 3.2.5).

The prescribed types of buildings governed by the BEEO cover most types of buildings of both government and private sector, including buildings for usage of commercial (office, shopping complex etc.), hotel, municipal, community, etc. and the common areas of both residential buildings and industrial buildings (TG clause 3.1). The BEEO does not govern historical buildings, small buildings and BSIs solely for purpose of life safety or specific technical nature (scope for latter two e.g. fire suppression, surgical operation etc.) prescribed in the BEEO) (TG clause 3.2.4).

2.1.2 Newly constructed buildings and existing buildings (TG clause 4.1)

The BSIs in a newly constructed building, i.e. a building with the consent for superstructure construction works given after 21 Sep 2012 (the BEEO's full implementation date) should comply with the requirements in the BEC, and the compliance is applicable to all subsequent retrofitting works irrespective of whether the works are regarded as major retrofitting works or not. As for an existing building, i.e. a building with the consent given on or before 21 Sep 2012, the BEC requirements have to be complied with only for major retrofitting works so defined in the BEEO.

2.1.3 Major retrofitting works (TG clause 4.2.5)

Major retrofitting works (hereinafter referred to as MRW) refer to the addition or replacement of BSI covering a works floor area aggregated to 500 m^2 or above (under the same series of works within 12 months), or the addition or replacement of a central BSI's main component that is an electrical circuit at rating 400A or above, a chiller/air-conditioner at 350 kW cool/heat capacity or above, or a motor drive plus mechanical drive of a lift or escalator**.**

2.2 Compliance Hierarchy (TG clause 4.2)

The BEEO prescribes the responsibilities of the developer, owner and responsible person of a building or a unit of the building, and the Registered Energy Assessor (REA) registered under the BEEO, involving the submissions and certifications to demonstrate the compliance with the BEEO, for newly constructed buildings at occupation approval and when MRW are carried out, and for existing buildings when MRW are carried out.

The developer of a building, is required at design stage to submit to EMSD a "stage one declaration" to undertake BEC compliance of the building's BSIs, and the declaration has to be certified by an REA. Subsequently at occupation approval, the developer is further required to submit to EMSD a "stage two declaration" certified by an REA to declare the BSI's compliance with the BEC, and apply from EMSD a Certificate of Compliance Registration (COCR) for the building. During routine operation of the building, the owner of the central BSI (usually the owner of the building) and the responsible persons (usually the owners or tenants) of units in the building are required to ensure that when a BSI (irrespective of falling under the scope of MRW or not) is replaced or added, it complies with the BEC (TG Table 4.2.2).

When MRW are involved, irrespective of newly constructed buildings or existing buildings, the owner / responsible person are required to obtain from an REA a Form of Compliance certifying the MRW's compliance with the BEC (TG Table 4.2.3).

3. BEC ENERGY EFFICIENCY REQUIREMENTS

The following extract the TG's noteworthy descriptions, which serve to assist the reader to develop a good appreciation of the BEEO and BEC's intents (with minimal reading of the BEEO and BEC contents).

3.1 BEEO Legislative Interpretation (TG sections 1 to 4)

- The BEC is the minimal requirement. Building owners and designers are encouraged to pursue beyond the BEC standard (TG clause 1.5).
- The rating of an installation in the determination of application threshold is the rating at works completion, such as the MRW chiller rating refers to the replacing and not the replaced chiller (TG clause 3.4).
- The MRW are regarded as completed when all the involved works are ready to be used for the involved area's principal function. For example, if lighting installation, electrical installation and air-conditioning installation are involved in the works and the air-conditioning installation is the last completed, the works are regarded as completed when the air-conditioning installation is also ready to be put into normal operation. A certificate of completion issued by the works consultant or contractor may be regarded as documentary evidence illustrating the completion date of the works (TG clause 4.2.3.3).
- A building with common area typically has a deed of mutual covenant (DMC) (interpreted in Building Management Ordinance, Cap 344) (TG clause 4.2.4(a)).
- Examples of non-CBSI in commercial buildings with common area (i.e. with DMC) : luminaires in a unit that is leased or separately owned, AHUs solely serving a unit that is leased or separately owned etc. (TG Table 4.2.4(a))
- Examples of non-CBSI in commercial buildings without common area (i.e. without DMC) and having units leased to tenants : luminaires in a unit leased to a tenant who owns the luminaires, AHUs solely serving a unit leased to a tenant who owns the AHUs etc. (TG Table 4.2.4(b))
- Commercial buildings without common area and having no areas leased to tenants : all BSIs regarded as CBSI (TG clause 4.2.4(b)ii)).
- The works area (e.g. in an AHU room) counting towards the MRW 500 m^2 criterion may not necessary be the area served by the BSI in question (e.g. AHU), example given in TG clause 4.2.5.1.
- Certain guidelines are given on the composition of an building entity (e.g. a complex, a podium plus tower pair, an individual block) for making of a declaration and obtaining of the COCR (TG clause 4.2.7).
- The energy efficiency requirements in the BEC refer to the performance standards at the corresponding design conditions, and not the operating conditions, which may deviate from time to time from the design conditions (TG clause 4.3).
- The BEEO's requirement on maintaining of design standard refers to the standard of the applicable BEC version and not the maintaining of operating conditions such as optimizing room temperature or chilled water temperature etc. which are nevertheless the

good engineering practices. An illustrative example is given in the TG in respect of the applicable BEC version (TG clauses 4.4.2 to 4.4.4).

- A change of use of a BSI (newly constructed building or MRW) may trigger the non-compliance of BEC, e.g. a space changing from office (allowable LPD 15 W/m^2) to store room (allowable LPD 11 W/m^2) (TG clause 4.4.5).
- Meanings of "responsible person" and "unit" are elaborated (TG clauses 4.6.1 & 4.6.2).
- BEEO's interpretation of an occupants' clubhouse or a car park being regarded as a separate common area is elaborated (TG clause 4.6.3).

3.2 BEC Requirements – Lighting Installation (TG section 5)

TG diagrammatic illustration showing BEC non-applicable outdoor lighting

- Examples (illustrating with photo images) of various BEC non-applicable installations are given (TG clause 5.1), a sample illustration is shown alongside.
- Should a lighting installation for the purpose of exhibit, decoration or visual production also serves as general lighting that provides a substantially uniform level of illumination, the BEC requirements (allowable LPD) apply also to the installation (TG clause 5.1.3).
- To classify a space in a design as one of the types of space in BEC Table 5.4 on maximum allowable LPD (TG clause 5.4.1(a)).
- LPD calculation for multi-functional space is elaborated (TG clause 5.4.4).
- The quantity of control points (for office space) calculated based on equations given in the BEC is tabulated (TG Table 5.5.1).
- An example illustrating the calculation of LPD is given (TG clause 5.6).

3.3 BEC Requirements – Air-conditioning Installation (TG section 6)

- Examples of BEC applicable installations (TG Table 6.1.2) and BEC non-applicable installations (TG Table 6.1.3) are given.
- Sample calculations are given to illustrate the allowable CAV 1.6 W per L/s and VAV 2.1 W per L/s requirements and the allowable pressure drop for air treatment/filtering (TG clauses 6.7(a) & (b)).
- The exemption from allowable system fan motor power requirement is elaborated (TG clause 6.7(c)).
- The requirements for both the VAV fan motor and the variable speed pump, essentially the adoption of a frequency inverter type variable speed drive, are elaborated (respectively TG clauses 6.7(d) and 6.8.2).
- The requirements on control are elaborated (TG clause 6.10), including for temperature,

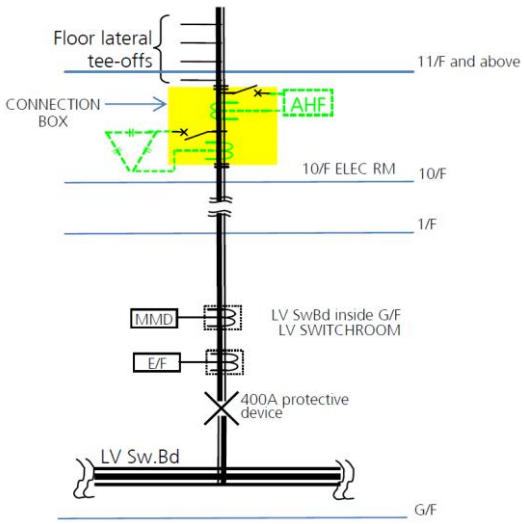
for humidity, for zone, for simultaneous heating & cooling, for off-hours general approach, and for off-hours in guest rooms in hotel/guest house/hostel.

- The requirements on thermal insulation are elaborated (TG clause 6.11), with the heat transfer equations (leading to the BEC Tables 6.11a to 6.11c tabulated values) provided. For an insulation material with different thermal conductivity or surface coefficient, and for a different line temperature from the tabulated values, the equations may be used to calculate the required thickness (TG clause 6.11.1(a)iv). Also, the calculated thickness values for ductwork for a 10^0C temperature difference are listed in TG Table 6.11.1(a) which may be deemed as a supplement to BEC Table 6.11c (TG clause 6.11.1(a)vii).
- A false ceiling void is normally regarded as an unconditioned space, unless it also serves as a return air plenum or has a perforated segregation (TG clause 6.11.1(d)).
- Examples of water vapor retardant type insulation are given – closed cell type, fibreglass with multi-layer double-side reinforced aluminium foil, insulation coated with heavy duty mastic etc. (TG clause 6.11.2). Application of metal cladding would be a good practice.

3.4 BEC Requirements – Electrical Installation (TG section 7)

- Examples of BEC applicable installations (TG Table 7.1.2) and BEC non-applicable installations (TG Table 7.1.3) are given.
- A sub-circuit may consist of a common portion with branch-offs from an intermediate distribution board. The approach in calculating the percentage of copper loss for this sub-circuit is given TG Table 7.4(b)iii). The need to include the losses in the common portion as well as in each and every branch-offs and to apply the diversity factor to each branch is emphasized.
- Theory behind harmonics and power factor and their characteristics is described (TG clause 7.6(b)).
- The constitution of a connection point for a correction device is elaborated (TG clause 7.6(c)), with the use of diagrammatic figures. An illustration of an electrical schematic for connection points at rising mains (TG Figure 7.6(c)iii)) in the TG is shown alongside.

TG diagrammatic illustration showing electrical schematic for connection points at rising mains



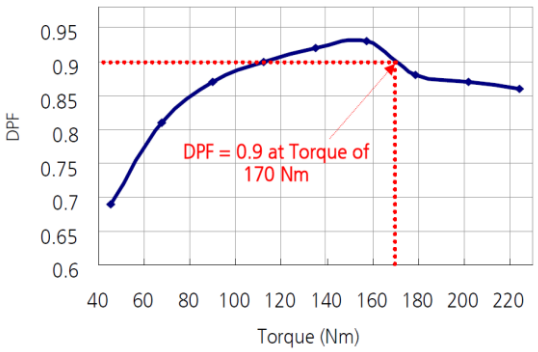
- Metering devices to be capable of measuring the 31st harmonic order (TG Table 7.7).
- Detail guidelines (TG clause 7.8) and an illustrative example (TG clause 7.9) are provided on the calculation of copper loss, in which are described the various design considerations

to be taken into account (TG Tables 7.9.1(a) to (c)).

3.5 BEC Requirements – Lift & Escalator Installation (TG section 8)

- Examples of BEC applicable installations (TG Table 8.1.2) and BEC non-applicable installations (TG Table 8.1.3) are given.
- In respect of escalators or passenger conveyors, the approach to identify the displacement power factor (DPF) of the driving motor is introduced, which is to draw reference to the manufacturer's motor data sheet that gives a range of DPF values versus load or torque values from which the DPF that corresponds to the equipment's brake load can be read off. Based on this DPF, the equipment supplier can after accounting for the driving controller's harmonic distortion assess the motor drive's total power factor (TPF) (TG clause 8.5.1(b)). An illustration in the TG showing the DPF versus torque relationship (TG Figure 8.5.1(b)) is shown alongside.

TG diagrammatic illustration showing DPF versus torque relationship



- Highlighted that a low lift traffic period may be identified by the passengers incoming rate falling to below say 20% of that at peak load (TG clause 8.5.3).
- Exemptions from automatic shut-off of lift ventilation & air-conditioning are explained (TG clause 8.5.4) using a diagrammatic illustration (TG Figure 8.5.4).
- The textual descriptions on the provision for measurement in the BEC are diagrammatically shown (TG Figure 8.7(a)).
- The metering device should be able to account for harmonic contents up to the 31st order. In measuring the TPF, the total kVA attributing to the TPF can be based on the average line voltage and the average line current of all three phases (TG clause 8.7(b)).
- The emerging good practice for normalization & monitoring of lift energy consumption based on its energy consumed per unit load per unit distance travelled is introduced (TG clause 8.8).

3.6 BEC Requirements – Performance-based Approach (TG section 9)

- With the focus on requiring the calculation of the annual total energy consumption of the building under design, the designer can tell and thus the building owner can be informed at the design stage of the energy performance of the designed building, and the choice of the final design can be based on an evaluation of the energy performances of the different

design options (TG clause 9.2).

- The performance-based approach serves to provide certain design flexibility to encourage energy efficient innovative features, example being a lighting installation that has a higher installed LPD but a lower actual energy consumption as a result of its energy efficient control (TG clause 9.4).
- Commonly used building energy simulation programs are highlighted (TG Table 9.6).

3.7 BEC Requirements – Major Retrofitting Works (MRW) (TG section 10)

- Gives detail explanations with charts & tables of the approach to identify if a retrofit falls within the scope of MRW and supplements the explanations with various examples.

4. CONCLUDING REMARKS

With the supplementary explanations in the TG of the requirements of the BEEO and the BEC, it is hoped that the requirements can be more effectively promulgated and interpreted by the building designers and stakeholders, strengthening the roothold of the BEEO and BEC's contribution to building energy efficiency. Fleshing out this roothold, the HKSAR government can set forth to further enhance the energy efficiency of the various types of buildings in Hong Kong.

5. ACKNOWLEDGEMENT

Sincere thanks are extended to member organizations (including HKIE-BSD, CIBSE-HKB & ASHRAE-HKC) of the Technical Taskforce on Mandatory Implementation of the BEC (under the purview of EMSD), in offering their expertise advice and support in the development of the BEC and its technical guidelines.

6. REFERENCES

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