



BEC 2018 & EAC 2018

Summary of Changes



17 December 2018



1. BEC2018 & EAC2018 Review Process
2. Changes in the BEC 2018
3. Anticipated Energy Saving
4. Changes in the EAC 2018
5. Grace Period
6. Q&A



Review on the BEC 2018 & EAC 2018

- Technical Taskforce and **6** Working Groups : **34** representative organizations

✓ **13** Professional Institutions

✓ **14** Trade, consultant/contractor associations

✓ **3** University Academia

✓ **2** Utility Companies

✓ **2** Government departments

Air-conditioning
20 members

Lighting
15 members

Electrical
15 members

Lift/Escalator
10 members

Energy Audit
21 members

Performance Based
15 members

Review on the BEC 2018 & EAC 2018

- Review in a **3-year** interval
- Making reference to:
 - a) **Maturity of latest technology** development;
 - b) Recognized **international standards** from other countries
 - c) *Data analysis from statutory submission*
 - d) *Aspiration from the public and stakeholders*



1) Addition of new requirements
(e.g. COP of Heat Pump, LPD in new spaces)

2) Upgrade on prevailing parameters
(e.g. Tighten the COP, LPD, motor efficiency)



Changes - BEC 2018

1. Lighting Installation
2. Air Conditioning Installation
3. Electrical Installation
4. Lift & Escalator Installation
5. Performance-based Approach





BEC 2018

Section 5

Lighting Installation





Summary

LPD requirement covers new spaces

LPD requirement of certain spaces tightened

Lighting control point (introducing exception)

Automatic lighting control (No Change)

Daylight responsive control (No Change)





Table 5.4 LPD Requirement Covers New Spaces

Type of spaces	BEC 2018 LPD (W/m ²)
Common room/ Break Room	8
Copy/ Printing Room, Photocopy Machine room/ Changing room/ Locker room	10
Covered playground/ Sky Garden/ Confinement Cell/ Pantry	12
Fast food/ Food court	14
Indoor swimming pool, for recreational or leisure purposes	15
Long stay ward for elderly/ Porte Cochere (>5m headroom)	15
Nurse station/ Porte Cochere	13

Includes Underwater Lighting





Table 5.4
LPD Requirement of Certain Spaces Tightened



Type of Space	BEC 2015 (W/m ²)	BEC 2018 (W/m ²)	% of Change
Bar / Lounge	14	13	7
Banquet Room/ Function Room/ Ball Room	20	17	15
Entrance Lobby	14	13	7
Exhibition Hall/ Gallery	17	15	12
Gymnasium/ Exercise Room	13	11	15
Library – reading area or Audio Visual Centre	15	12	20
Lift Lobby	11	10	9
Patient Ward/ Day Care	15	13	13
Retail	17	16	6



Office – LPD Tightening



Internal Floor Area (m ²)	BEC 2015 (W/m ²)	BEC 2018 (W/m ²)
	Demarcation: 15m ²	Demarcations: 15m ² & 200m ²
A ≤ 15	13	12
A > 15	12	-
15 < A ≤ 200	-	10
A > 200	-	9





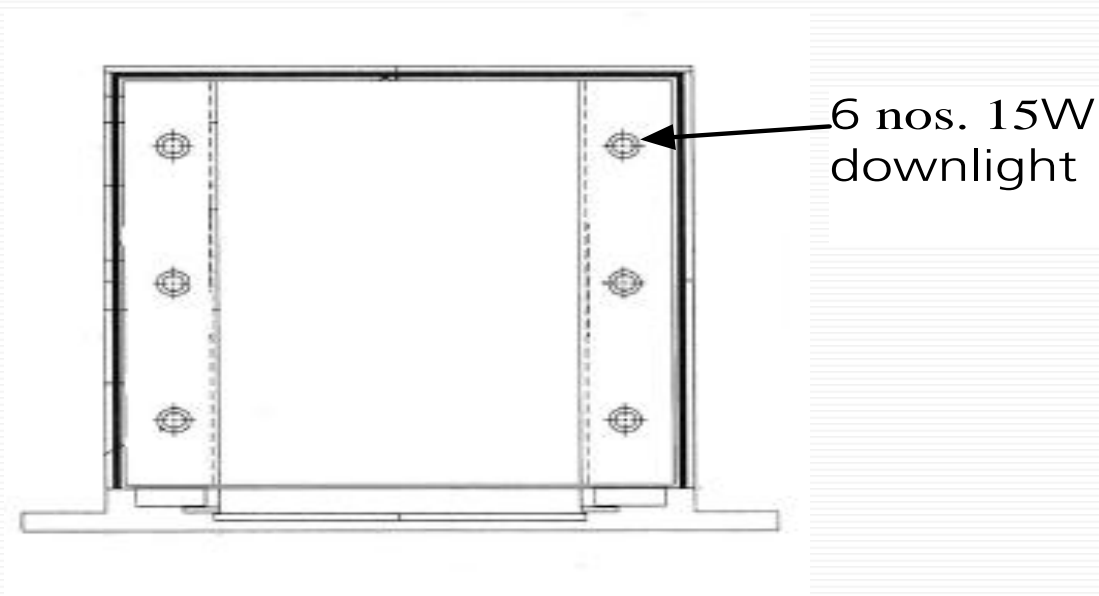
Automatic Lighting Control (ALC) exception

BEC clause 5.5.1

A single lighting control point in any of the spaces that is not classified as an office should control no more than 500m², unless the total electrical power consumed by the complete fixed lighting installations in the space does not exceed 70W. (BEC2018)

BEC clause 5.6.1.7 – lift car exception

The exception on automatic lighting control as given in clause 5.6.1.1 should **not be applicable** to the lighting installation **in lift car.** (BEC2018)



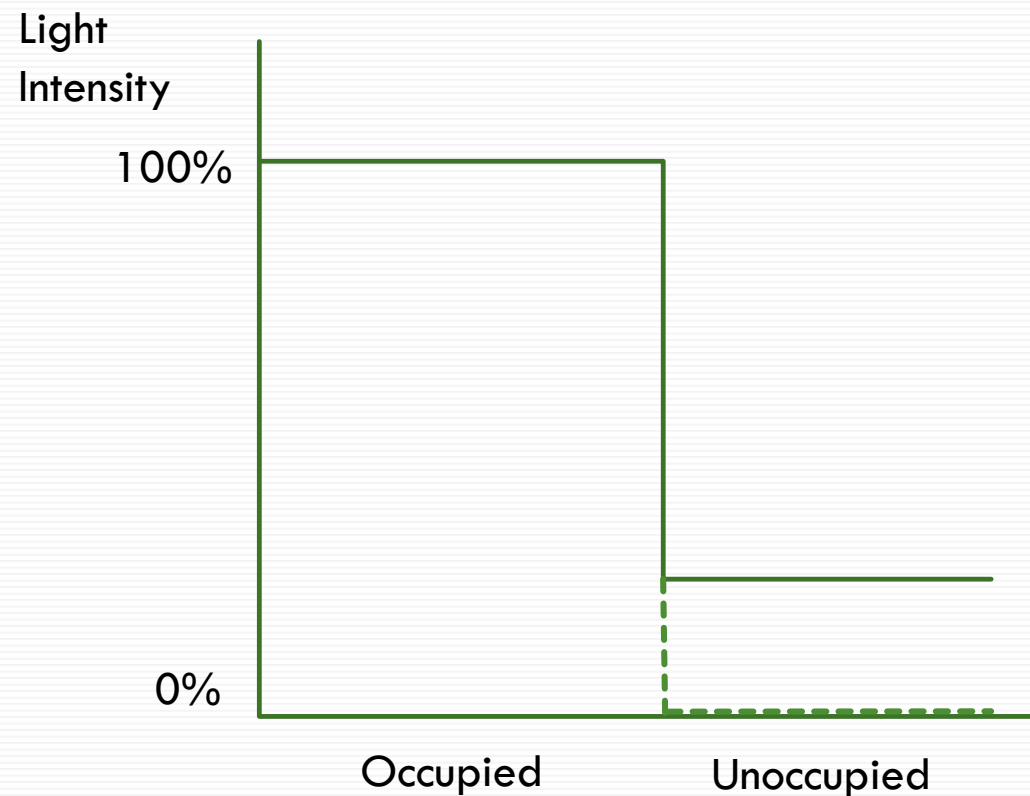


Good Practice – ALC in Toilet

BEC Table 5.4

Occupant sensor for ALC is applicable to toilet.

To reduce the nuisance to user, lighting, dimming or partial switch off is recommended as good practice.





Further notes to ALC at 24-7 occupied area

BEC clause 5.6.1.6

ALC should not be applicable (N/A) for the space occupied in 24-7 (24 hours a day and 7 days a week).

The occupied area defines the space with occupant working/staying in 24-7.

General Plantroom without occupant is not considered as 24-7 occupied area.





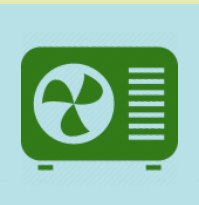
BEC 2018

Section 6

Air-conditioning Installation



<i><u>Tightening Requirement</u></i>	<i><u>Elaborated / New Requirement</u></i>
Chiller COP	Heat Pump COP
VRF System COP	Cooling Tower fan speed control
	Off-hours Control <ul style="list-style-type: none">• Control Setback• Automatic equipment shutdown
	Energy metering (Monitoring Requirements)





System Load Design

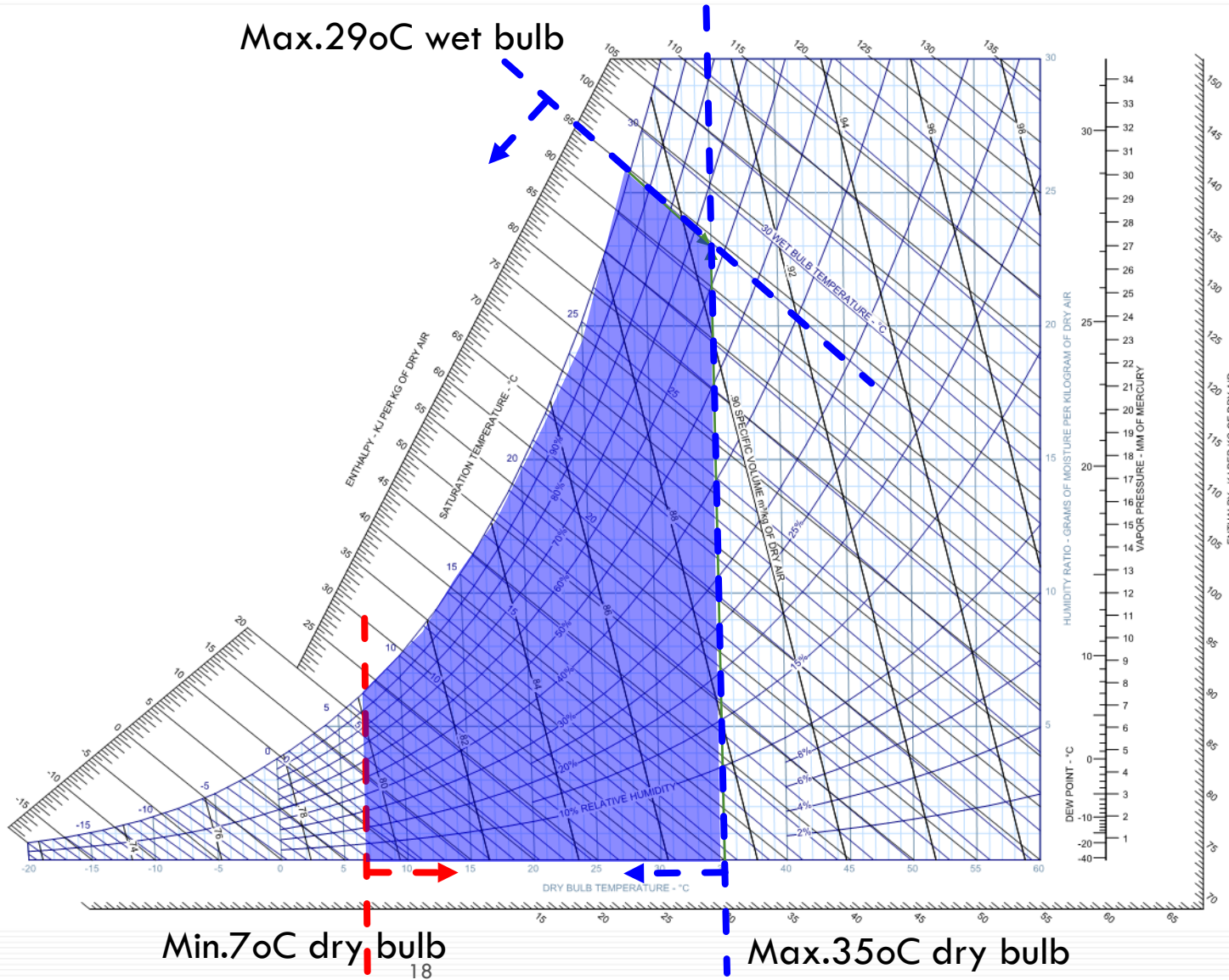
Table 6.4 : Air-conditioning System Load Design Conditions

Condition	Season	Applications	Temperature / Relative Humidity	
Indoor, for human comfort applications	Summer	Office and Classroom	Minimum dry bulb temperature	23°C
			Minimum relative humidity	50%
	Other applications	Minimum dry bulb temperature	22°C	
		Minimum relative humidity	50%	
	Winter	Hotel	Maximum dry bulb temperature	24°C
			Maximum relative humidity	50%
Other applications	Maximum dry bulb temperature	22°C		
	Maximum relative humidity	50%		
Outdoor	Summer	All applications	Maximum dry bulb temperature of 35°C with wet bulb temperature lower than 29°C, or Maximum wet bulb temperature of 29°C with dry bulb temperature lower than 35°C	
	Winter	All applications	Minimum dry bulb temperature	7°C





System Load Design



Dry bulb temperature 35°C and Wet bulb temperature 29°C for summer condition & Dry bulb temperature 7°C for winter condition are only boundary conditions.

In order to not oversize the system, any point within the shaded region can be used for system load sizing.





Air-Cooled Chiller		BEC 2015	BEC 2018
Screw	Below 500 kW	2.9	3.0
	At & Above 500 kW	3.0	3.1
VSD Screw	Below 500 kW	2.8 (3.6 at 75% load)	3.0 (3.8 at 75% load)
	At & Above 500 kW	2.9 (3.7 at 75% load)	3.1 (3.9 at 75% load)
VSD Centrifugal	All Ratings	3.1 (4.0 at 75% load)	3.2 (4.2 at 75% load)





<u>Water-Cooled Chiller</u>		<u>BEC 2015</u>	<u>BEC 2018</u>
VSD Screw	< 500 kW	6.1 at 75% load	6.4 at 75% load
	500 to 1000 kW	6.3 at 75% load	6.7 at 75% load
	> 1000 kW	5.2 (6.7 at 75% load)	5.3 (7.0 at 75% load)
Centrifugal	1000 to 3000 kW	5.7	5.8
VSD Centrifugal	< 1000 kW	5.1 (6.6 at 75% load)	5.3 (7.0 at 75% load)
	1000 to 3000 kW	5.5 (7.1 at 75% load)	5.6 (7.5 at 75% load)
	> 3000 kW	5.6 (7.2 at 75% load)	5.8 (7.6 at 75% load)





Minimum COP of VRF System	BEC 2015	BEC 2018
<u>Air-cooled (cooling mode)</u>	3.3 (7.5kW & Below 40kW)	3.6 (20 kW or below)
		3.6 (Above 20 kW to 40 kW)
	3.3 (40 to 200kW)	3.45 (Above 40 kW to 200 kW)
<u>Air-cooled (heating mode)</u>	3.8 (7.5kW & Below 40kW)	4.0 (20 kW or below)
		3.8 (Above 20 kW to 40 kW)
	3.6 (40 to 200kW)	3.8 (Above 40 kW to 200 kW)
<u>Water-cooled (cooling mode)</u>	4.3 (All Ratings)	4.5 (All Ratings)

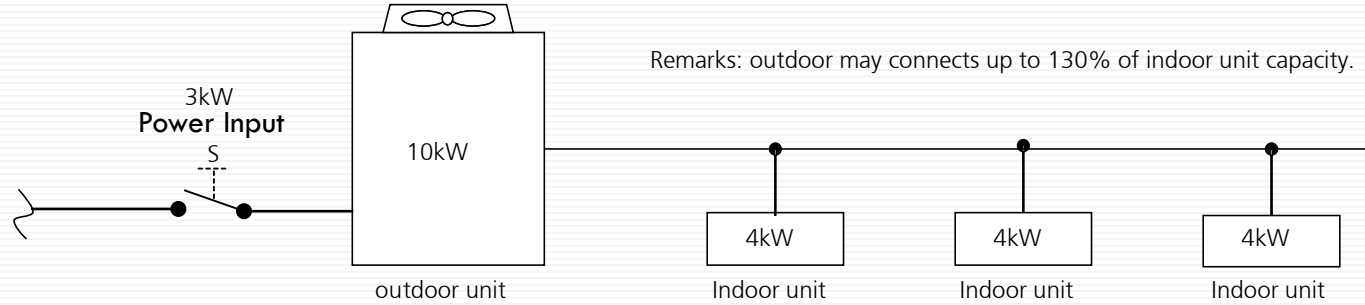




VRF System, U-AC COP Determination



Typical VRF system



Sample calculation:

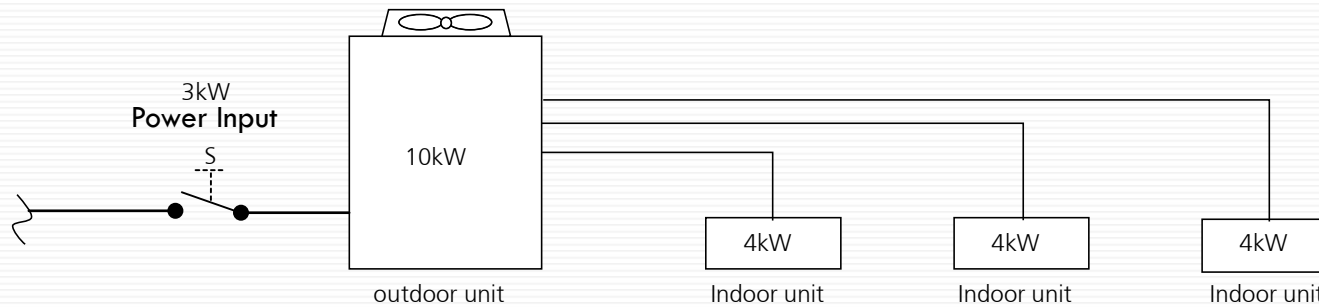
$$\text{VRF COP} = 10\text{kW} / 3\text{kW} = 3.33$$

$$\text{VRF COP} = (4\text{kW} + 4\text{kW} + 4\text{kW}) / (3 + 3 \times 0.1) = 3.63$$

?

x

Multi-split VRF system



Sample calculation:

$$\text{VRF COP} = 10\text{kW} / 3\text{kW} = 3.33$$





Minimum COP of Heat Pump

<i>Heat Extract</i>	<i>Capacity: 500 kW & Below</i>	<i>Capacity: Above 500 kW</i>
Air to Water	2.8	3.1
Water to Water	4.4	4.5



Clause 6.10.4 – Elaboration on Off-hours Control



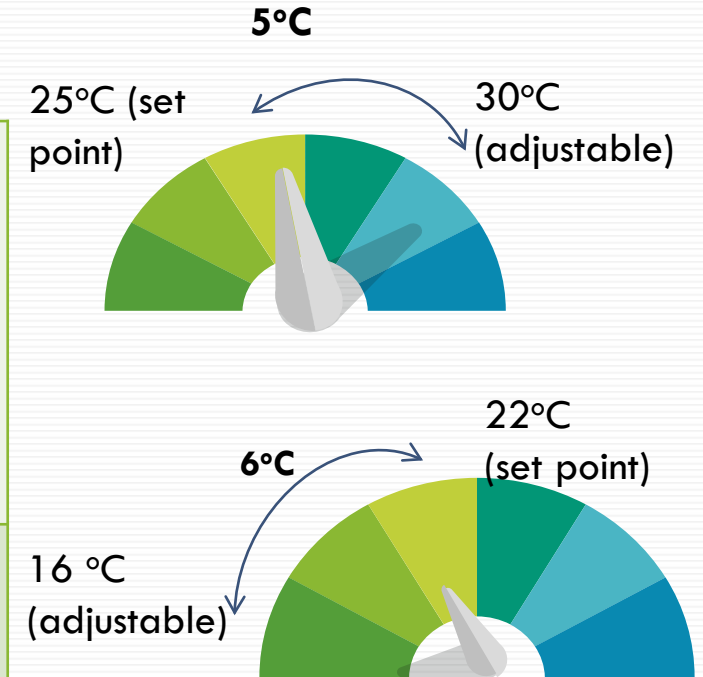
Control setback

Cooling Mode

- Adjustable setback set point at least 5 °C above occupied set point
- Maintain space temp. below the setback set point.

Heating Mode (if provided)

- Adjustable setback set point at least 6 °C below occupied set point
- Maintain space temp. above the setback set point.





Clause 6.10.4 – Elaboration on Off-hours Control



Equipment Shutdown

Time scheduling:

- 7 different day types per week;
- Retain program & time setting – power loss period 10 hours
- Manual overriding control (a/c operation lasting for up to 2 hours)

Occupant sensor:

- Activation time – 30 min. or less

Gravity damper does not fulfil the BEC's requirement as damper for automatic shutoff under clause 6.10.4.4.



Clause 6.13 Energy Metering (Elaboration on Monitoring Facilities)



Clause 6.13.5

- 15-min interval
- Hourly, daily, monthly & annual data
- 36-month data storage

Involved Parameters

- Individual chiller/heat pump (rating $\geq 350\text{kW}$);
 - Power & energy input
 - Cooling/Heating power & energy output;
 - CoP
- Chilled/Heated water plant (rating $\geq 350\text{kW}$);
 - Power & energy input
 - Cooling/Heating power & energy output
 - Determined plant's CoP



BEC 2018

Section 7

Electrical Installation





3-Ph Induction Motor (Single Speed 4-pole)



	<u>BEC 2015</u> <u>(IE2/IE3)</u>	<u>BEC 2018</u> <u>(IE3)</u>	%
0.75 to <5.5 kW	79.6 – 86.6	82.5 – 88.6	2.3
5.5 kW to <7.5 kW	87.7	89.6	2.2
7.5 to <22 kW	90.4 – 92.6	90.4 – 92.6	-
22 to <55 kW	93.0 – 94.2	93.0 – 94.2	-
55 to <90 kW	94.6 – 95.0	94.6 – 95.0	-
90 to >200 kW	95.2 – 96.0	95.2 – 96.0	-





Clause No.	New / Elaborated Requirement	
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7.7.4

Metering device (MD) with THD measurement, including 31st harmonic order

- MD for **main** circuit $\geq 400A$
- MD for **feeder** or **sub-main** circuit $\geq 400A$
- MD for circuit serving CBSI with circuit rating $\geq 400A$ (e.g. Chilled water plant)
- MD for Lift & Escalator Installation
- MD for feeder or sub-main circuit $> 200A$ & $< 400A$ - not mandatory
- MD not mandatory for feeder/sub-main circuit $\leq 200A$





Clause No.	New / Elaborated Requirement	
7.7.5	<p>Trend the measured data:</p> <ul style="list-style-type: none">• 15-min interval;• hourly, daily, monthly and annual data;• Maintain 36-month data storage.	<p>Only for the prescribed MDs under the BEC: i.e. N/A to circuit rated $\leq 200A$, for example, provided with MD</p>





BEC 2018

Section 8

Lift and Escalator Installation





Changes in Lift and Escalator Section

Max. allowable traction lift electrical power ↓ **5 %**
(for new installation)

Max. allowable traction lift electrical power ↓ **5 %**
(for existing installation)

Max. lift decoration load ↓ **10 %**

Max. allowable escalator electrical power – No change





Changes

Regenerative braking (lift):

Rated speed at or above **2.5 m/s**; &

Rated load at or above **1000 kg**



Metering device: with THD measurement, including **31st harmonic order**



Trend the measured data:

15-min interval;

hourly, daily, monthly and annual data;

Maintain 36-month data storage.



Lift car lighting:

LPD, LCP and ALC related elaboration





Changes (MRW related)

MRW with lift car replacement: (Table 10.1)

Lift ventilation & air conditioning;
LPD; and
ALC

MRW of escalator: (Table 10.1)

Exception on providing automatic speed reduction for public service & heavy duty escalators

Escalator THD & TPF measurement locations:

At local power isolator; or
Circuit protective device.





Updated calculation method for Total Power Factor



B2.4 The apparent power (S) can be obtained by equation B2.

$$S = |V_1| |I_1| + |V_2| |I_2| + |V_3| |I_3| \quad (B2)$$

Where the hypothesized phase voltages V_1, V_2, V_3 are obtained by equation B3, B4 & B5.

$$|V_1| = |V_{31}| \frac{\sin(\frac{\pi}{3} - \beta)}{\sin(\frac{2\pi}{3})} \quad (B3)$$

$$|V_2| = |V_{12}| \frac{\sin(\alpha)}{\sin(\frac{2\pi}{3})} \quad (B4)$$

$$|V_3| = |V_{31}| \frac{\sin(\beta)}{\sin(\frac{2\pi}{3})} \quad (B5)$$

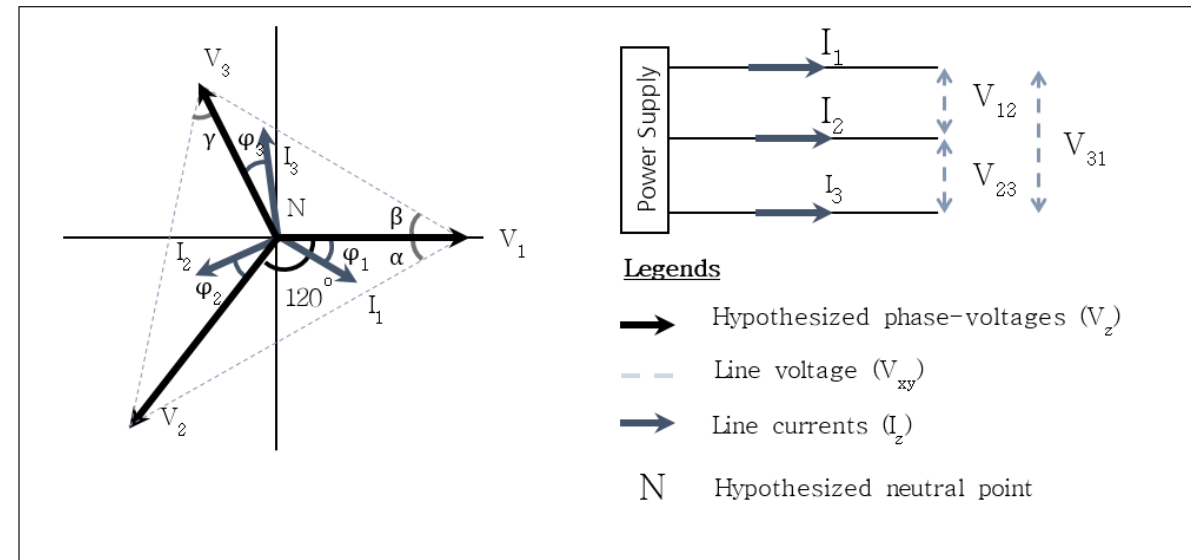
Denotes $\theta = \alpha + \beta$, then

$$\theta = \cos^{-1} \left[\frac{|V_{12}|^2 + |V_{31}|^2 - |V_{23}|^2}{2 |V_{31}| |V_{12}|} \right] \quad (B6)$$

$$\alpha = \tan^{-1} \left[\frac{\sin(\frac{\pi}{3}) - \frac{|V_{31}|}{|V_{12}|} \sin(\frac{\pi}{3} - \theta)}{\cos(\frac{\pi}{3}) + \frac{|V_{31}|}{|V_{12}|} \cos(\frac{\pi}{3} - \theta)} \right] \quad (B7)$$

$$\beta = \theta - \alpha \quad (B8)$$

$$\text{Total Power Factor} = \frac{\text{Active Power (P)}}{\text{Apparent Power (S)}} \quad (B1)$$



The calculation will be incorporated into the form; applicants will only need to input (1) measured line currents and (2) measured line voltages





BEC 2018

Section 9 & Appendix A

Performance-based Approach



BEC 2018

Trade-off items cover all the four BS installations



Lighting installation

3 Items:

Lighting Power Density

Lighting Control Point

Automatic Lighting Control



Electrical installation

3 Items

Motor Efficiency

Copper Loss

Power Quality (power factor, total harmonic distortion)





Air-conditioning installation

6 Items:

Air distribution system fan power

Pumping system variable flow

Pipe Friction Loss etc.

System control

Insulation thickness

Equipment Efficiency (COP)



Lift and escalator installation

3 Items

Electrical power (max. power consumption)

Utilization of Power (lift decoration load, lift car lighting control etc.)

Total Harmonic Distortion





Threshold:

Energy efficiency performance of trade-off item(s) should not be 15% below the prescriptive standard.

The following trade-off items should not be **20%** below the prescriptive standard.

- Lighting Power Density
- Air distribution System Fan Power





New Requirements:

Measurement and monitoring facilities for:

- Recovered energy captured on site; and
- Renewable energy generated on site

Thermal energy/power; &
Electrical energy/ power.

Facilitate evaluation of the system performance and verify the predicted saving etc.





Changes - EAC 2018

- Clause 7.4 – Identification of EMO
- Clause 7.5 – Cost Benefit Analysis of EMO
- Clause 7.6 – Recommendations





EMO Identification



Clause No.	EAC 2015	EAC 2018
7.4.1	Derive energy performance (W per l/s, W/m ² etc.)	Same
7.4.2	Comparison: original design, well known international standard	Same
7.4.3	Involving occupant of building units – behavior change reducing CBSI energy consumption	Same





EMO Identification



Clause No.	EAC 2015	EAC 2018
7.4.4	-	Study viable: <ul style="list-style-type: none">• Replacing or addition of equipment/ system with more efficient models;• energy recovery system;• On-site renewable energy <i>TG-EAC Clause 7.4.4</i>
7.4.5	-	List out obvious EMO(s) during site walk <i>TG-EAC Clause 7.4.1.1</i>





EMO Identification



Clause No.	EAC 2015	EAC 2018
7.4.6	-	<p>Equipment / system utilization patten:</p> <ul style="list-style-type: none">• Automatic control enhancement, improvement of system operating efficiency;• Conduct system balancing;• Matching equipment capacity with load profile <p><i>TG-EAC Clause 7.4.1.1</i></p>





Clause 7.5 – Cost Benefit Analysis of EMO

Clause 7.6 – Recommendations

- Enhancement on M&V related matters
- Robustness of measured or collected energy data
- Facilitate verification work
- Reference: IPMVP (*International Performance Measurement and Verification Protocol*)





Cost Benefit Analysis



Clause No.	EAC 2015	EAC 2018
7.5.1	Estimate energy saving; Cost benefit analysis	Same
7.5.2	-	Elaborate “energy saving”
7.5.3	-	Record of the conditions under which the measured energy use took place
7.5.4	-	EMO’s energy performance degradation over the service life time





Cost Benefit Analysis



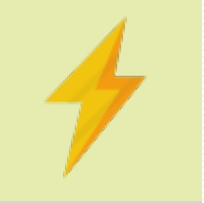
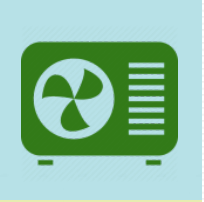
Clause No.	EAC 2015	EAC 2018
7.5.5	-	Energy price
7.5.6	-	Measurement period (preferable of complete operating cycle)
7.5.7	-	Metering details



Recommendation



Clause No.	EAC 2015	EAC 2018
7.6.1	Based on energy saving & cost benefit	Same + robust data for implementation stage evaluation
7.6.2	-	EMO intent/description; Any special requirement to generate expected saving; Functional testing, data trending analysis.
7.6.3	-	Metering point, measurement devices, involved parameter, interval of measurement. (Same basis for comparison)



Grace Period

BEC 2018

COCR - 6 months from gazette (i.e. 16 May 2019)

FOC - 9 months from gazette (i.e. 16 Aug 2019)

EAC 2018

9 months from gazette (i.e. 16 Aug 2019)





Thank You
- End -