CIBSE Technical Seminar on Latest Development of Lift Engineering

Overview of the Latest Development of Building Energy Code for Lift and Escalator Installations in Hong Kong

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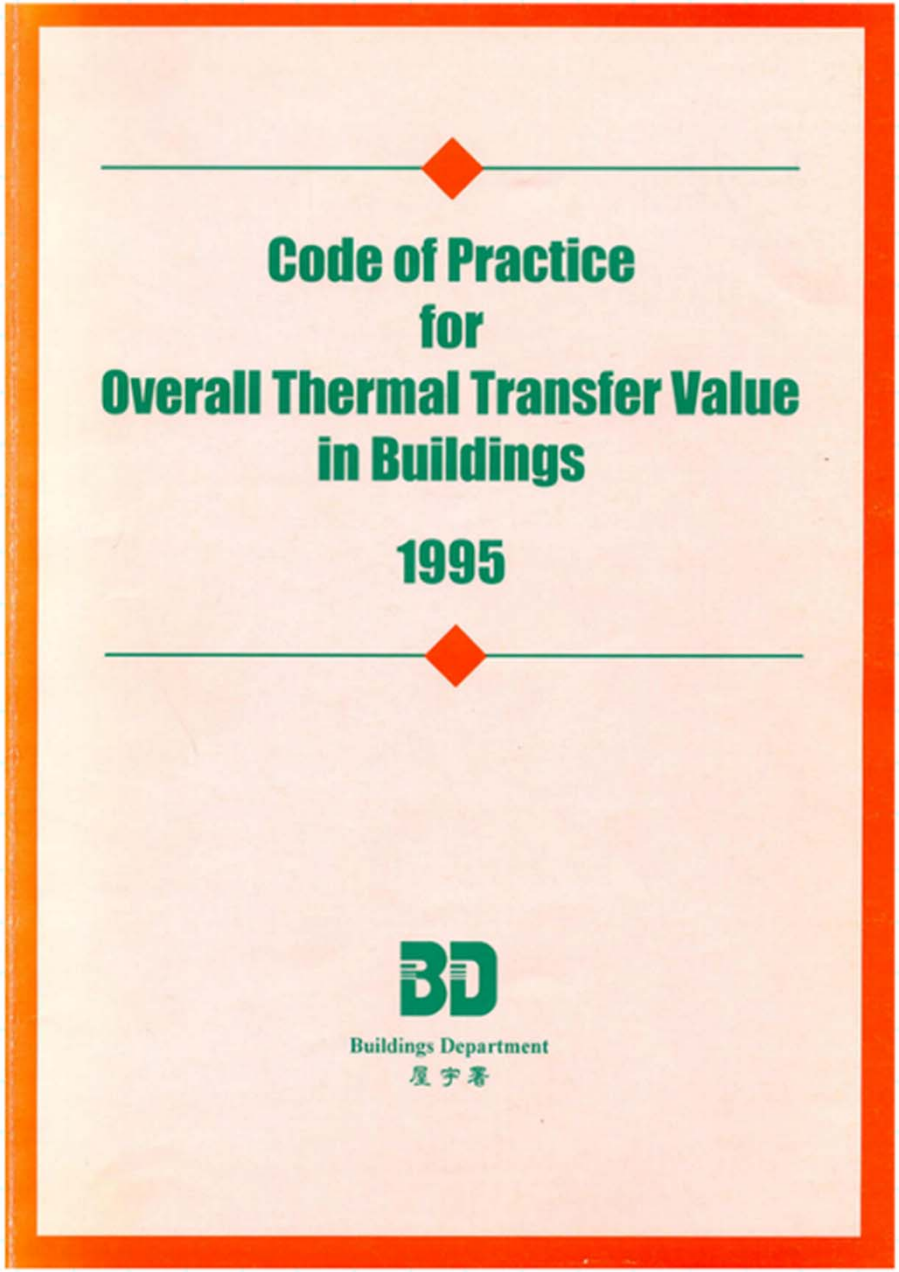
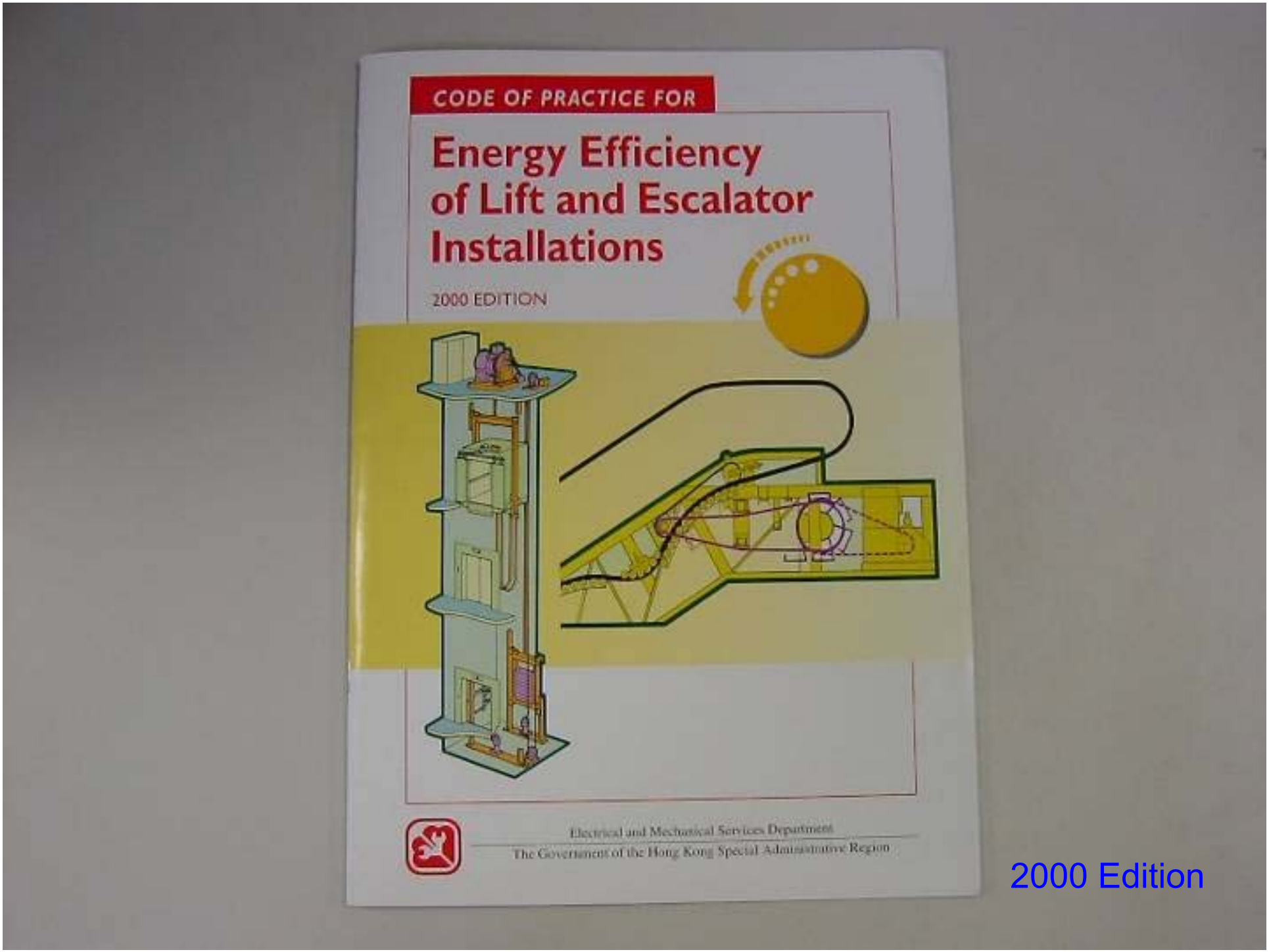
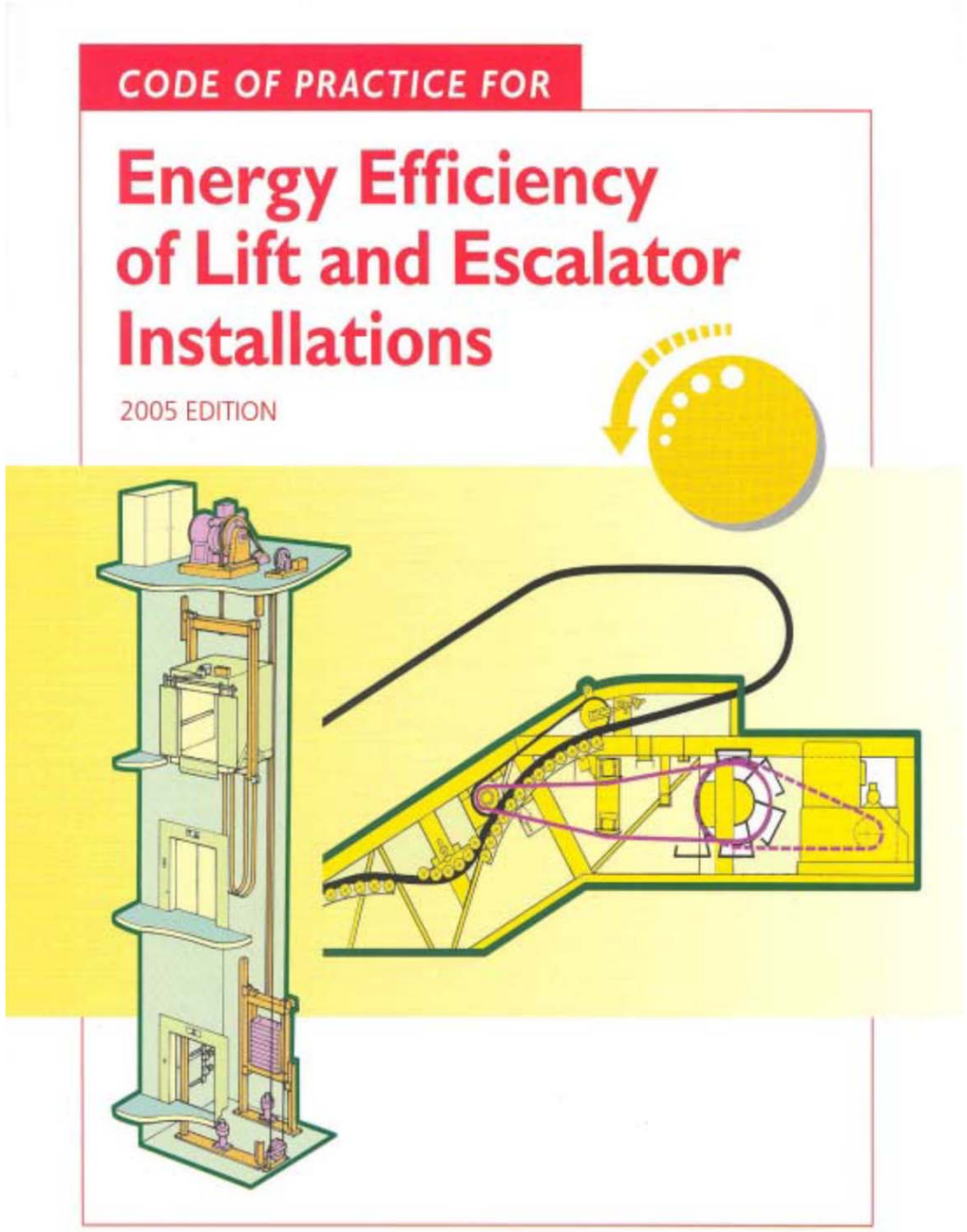
1 February 2018



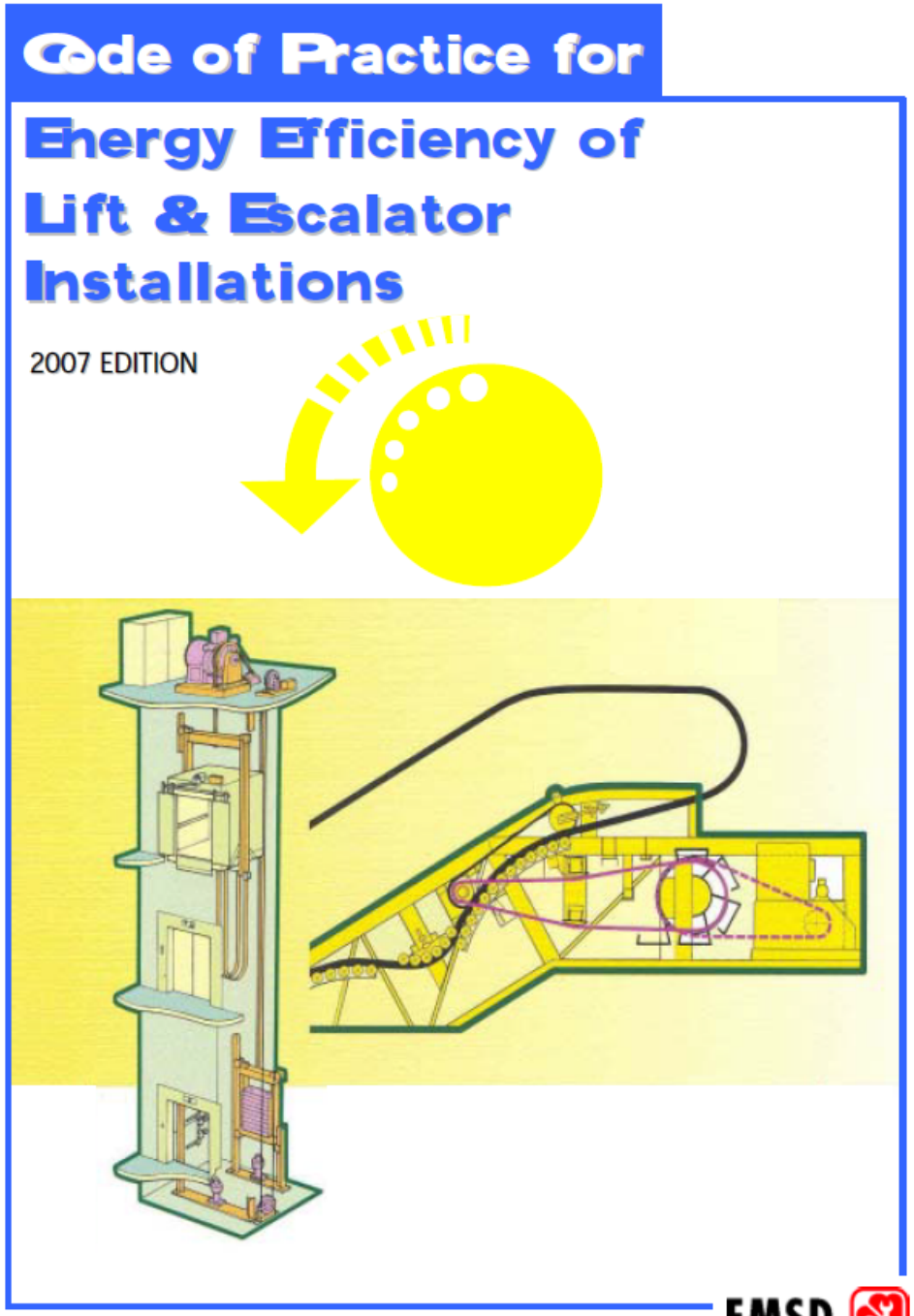
Some Historical Review

The First BEC in Hong Kong

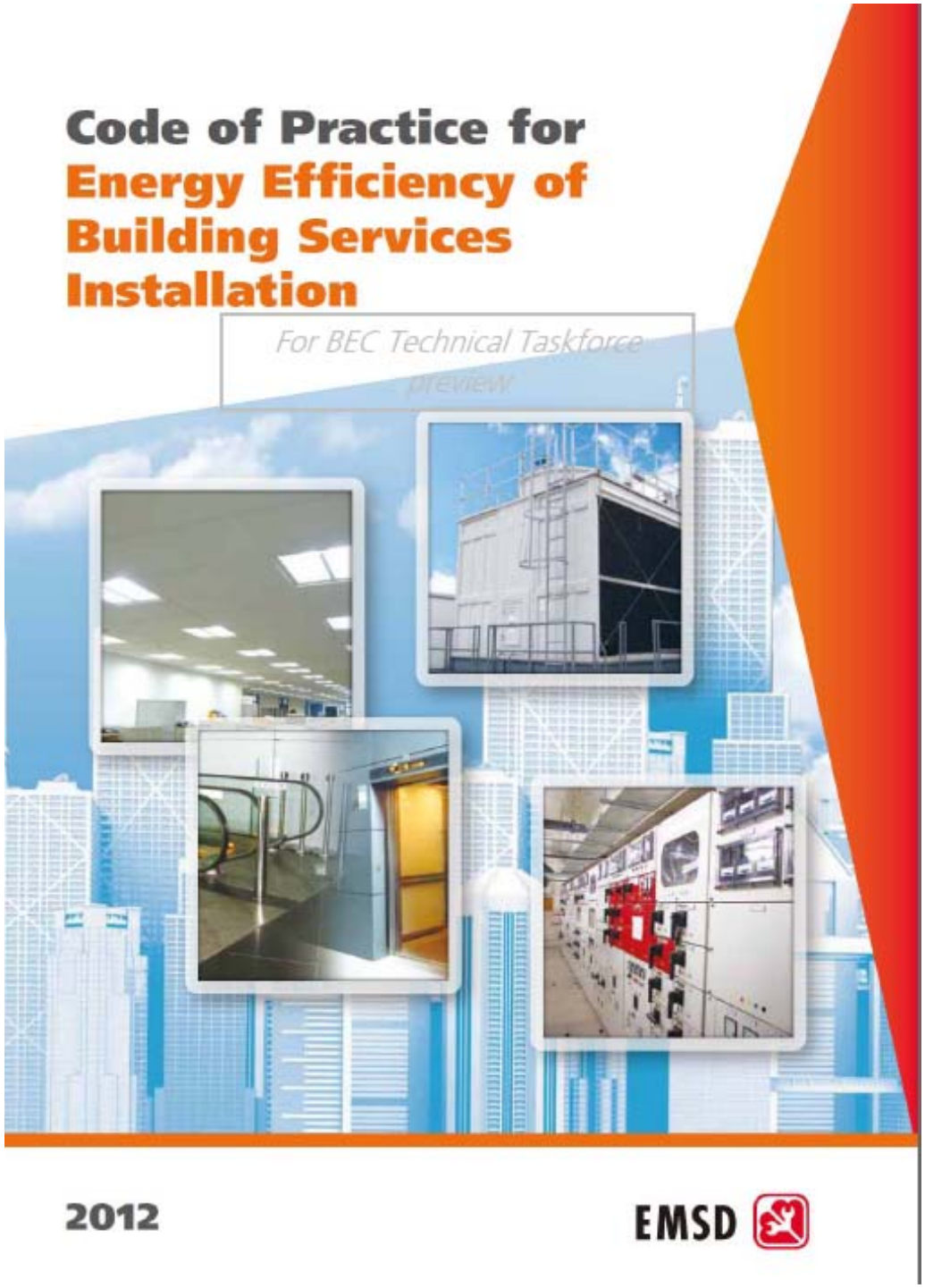

CODE OF PRACTICE FOR
Energy Efficiency of Lift and Escalator Installations
2000 EDITION
Electrical and Mechanical Services Department
The Government of the Hong Kong Special Administrative Region
2000 Edition



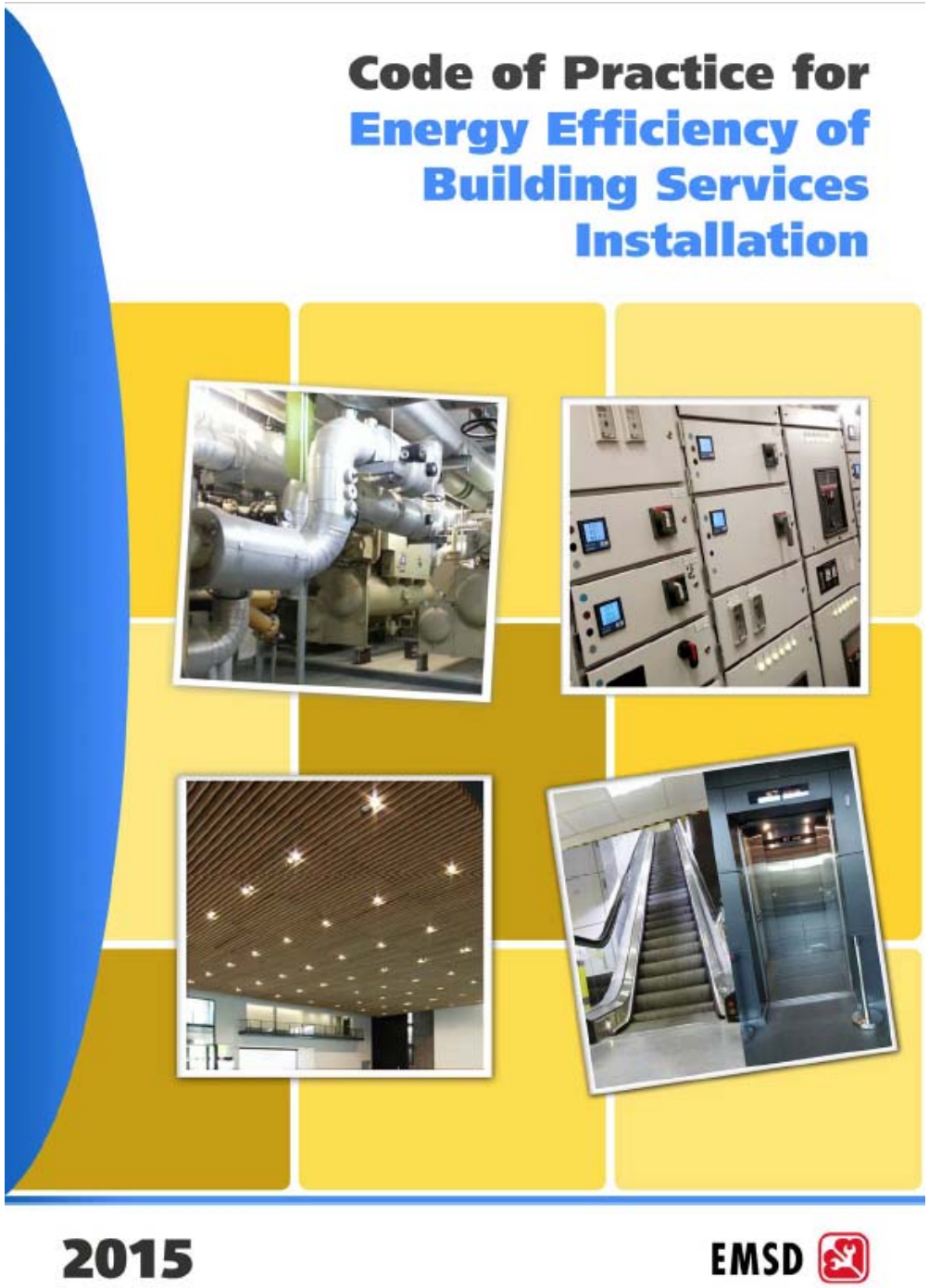
2005 Edition



2007 Edition



2012 Edition



2015 Edition

BEC 2015 (Lift & Escalator Installations) applicable to ALL, except:

- Mechanized vehicle parking system
- Service lift
- Stairlift
- Industrial truck loaded freight lift
- Lift in a performance stage
- Powered lifting platform for wheelchair
- Lift not operated on traction drive or by hydraulic piston (e.g. scissor lift, rack & pinion lift)
- Lifts and escalators specified in Schedule 2 of Chapter 610

What is ALL?

- Passenger lifts
- Bed passenger lifts
- Freight lifts
- Vehicle lifts
- Escalators
- Passenger conveyors
- Fireman's lifts that operate under normal condition
- Lifts and escalators attached to the façade of a building and owned by the building owner

Even lifts and escalators owned by the HKSAR Government are under control

General Approach

Requirements for energy efficient design of lift and escalator installations are for the purposes of:

- Reducing power consumption through
  - imposing maximum allowable electrical power of motor drive
  - provisioning of lift regenerative braking
- Reducing losses in utilization of power through imposing requirements of
  - minimum allowable total power factor
  - limit on lift decoration load
  - lift parking mode

General Approach

Requirements for energy efficient design of lift and escalator installations are for the purposes of:

- Reducing losses due to associated power quality problems
- Provide appropriate metering and energy monitoring facilities for better energy efficiency management

Electrical Power of Traction Lifts

- Rated load at its rated speed in upward direction
- N.A. to 9 m/s or higher and over 50-storey or 175 m between top/bottom-most landing
- N.A. applicable to fireman's lift or sky lobby shuttle serving 2 principal stops
- N.A. to rated load ≥ 5,000 kg and rated speed ≥ 3 m/s

Electrical Power of Escalators / Passenger Conveyors

- No load at rated speed
- Limit to 6^{o} inclination for passenger conveyors

Table 8.4.1a : Maximum Electrical Power (kW) of Traction Drive Lift at Rated Load for Various Ranges of Rated Speed (applicable to new building)

Rated Load L (kg)	Rated Speed Vc (m/s)				
	Vc < 1	1 ≤ Vc < 1.5	1.5 ≤ Vc < 2	2 ≤ Vc < 2.5	2.5 ≤ Vc < 3
L < 750	6.5	9.2	11.1	14.7	16.6
750 ≤ L < 1000	9.2	11.1	15.7	19.4	22.1
1000 ≤ L < 1350	11.1	15.7	20.3	24.9	29.5
1350 ≤ L < 1600	13.9	18.4	24.9	29.5	35
1600 ≤ L < 2000	15.4	22.6	28.9	35.2	41.5
2000 ≤ L < 3000	22.6	33.4	42.5	53.3	63.2
3000 ≤ L < 4000	29.8	43.3	56.9	70.4	83
4000 ≤ L < 5000	37.9	54.2	70.4	87.6	103.8
L ≥ 5000	0.0075L + 0.451	0.0106L + 0.903	0.0141L + 0.456	0.0171L + 1.805	0.0206L + 0.451
Rated Load L (kg)	3 ≤ Vc < 3.5	3.5 ≤ Vc < 4	4 ≤ Vc < 5	5 ≤ Vc < 6	6 ≤ Vc < 7
L < 750	19.4	20.8	22.6	27.1	30.7
750 ≤ L < 1000	24.9	28	28.9	35.2	41.5
1000 ≤ L < 1350	33.2	36.1	40.7	46.9	54.2
1350 ≤ L < 1600	39.7	44.3	46.9	56	65
1600 ≤ L < 2000	47.9	54.2	58.7	67.7	79.4
2000 ≤ L < 3000	71.3	81.2	85.8	103.8	119.1
3000 ≤ L < 4000	93.9	108.3	117.3	135.4	158
4000 ≤ L < 5000	117.3	135.4	144.4	171.5	198.6

Extracted from BEC 2015

Rated Load L (kg)	7 ≤ Vc < 8	8 ≤ Vc < 9	Vc ≥ 9
L < 750	35.2	40.7	$4.411Vc + 0.0012Vc^3$
750 ≤ L < 1000	46.9	54.2	$5.882Vc + 0.0019Vc^3$
1000 ≤ L < 1350	63.2	72.2	$7.939Vc + 0.0019Vc^3$
1350 ≤ L < 1600	75	85.8	$9.41Vc + 0.0024Vc^3$
1600 ≤ L < 2000	94.8	108.3	$11.762Vc + 0.0012Vc^3$
2000 ≤ L < 3000	139.9	158	$17.643Vc + 0.0028Vc^3$
3000 ≤ L < 4000	185.1	212.1	$23.524Vc + 0.0034Vc^3$
4000 ≤ L < 5000	230.2	261.7	$29.405Vc + 0.0044Vc^3$

Maximum electrical power versus speed and load Tightened!

Table 8.4.2 : Maximum Electrical Power (kW) of Hydraulic Lift at Rated Load	
Rated Load L (kg)	Power (kW)
L < 1000 kg	25.3 (26.2)
1000 kg ≤ L < 2000 kg	47.9 (50.4)
2000 kg ≤ L < 3000 kg	67.7 (71.3)
3000 kg ≤ L < 4000 kg	87.6 (92.2)
4000 kg ≤ L < 5000 kg	109.3 (115)
L ≥ 5000 kg	0.022L (0.023L)

Extracted from BEC 2015

Tightened!

Table 8.4.3 : Maximum Electrical Power of Escalator at Designated Width and Rise for Various Ranges of Rated Speed Operating under No Load

Nominal Width W (mm)	Rise R (m)	Electrical Power (W) at Rated Speed Vr (m/s)					
		Non-Public Service Escalator			Public Service Escalator		
		Vr < 0.5	0.5 ≤ Vr < 0.6	0.6 ≤ Vr < 0.75	Vr < 0.5	0.5 ≤ Vr < 0.6	0.6 ≤ Vr < 0.75
600	R < 3.5	1257	1444	1816	Not Applicable		
	3.5 ≤ R < 5	1490	1769	2188			
	5 ≤ R < 6.5	1723	2095	2561			
	R ≥ 6.5	205R + 423	242R + 519	296R + 639			
800	R < 3.5	1397	1583	1909	1955	2328	2886
	3.5 ≤ R < 5	1676	1955	2375	2328	2793	3445
	5 ≤ R < 6.5	1955	2328	2840	2700	3212	4003
	6.5 ≤ R < 8	2281	2700	3306	3072	3631	4516
	R ≥ 8	225.4R + 576	248.5R + 680	306.3R + 836	285.8R + 779	340.7R + 933	424.3R + 1159
1000	R < 3.5	1490	1769	2141	2095	2468	3072
	3.5 ≤ R < 5	1862	2141	2654	2468	3165	3631
	5 ≤ R < 6.5	2170	2607	3165	2840	3399	4190
	6.5 ≤ R < 8	2561	2979	3678	3212	3817	4795
	R ≥ 8	262.6R + 640	342.6R + 756	339.8R + 977	299.5R + 820	339.8R + 1087	447.8R + 1226

1000	Rise R (m)	Heavy Duty Escalator @		
		Vr = 0.5	0.5 < Vr ≤ 0.65	0.65 < Vr ≤ 0.75
	R ≤ 5	3746	4044	4241
	5 < R ≤ 6.5	4651	4973	5186
	6.5 < R ≤ 10	6893	7305	7587
	10 < R ≤ 13	8814	9312	9643
	13 < R ≤ 16	10647	11197	11565
	16 < R ≤ 17.5	11561	12140	12524
	17.5 < R ≤ 20	13088	13711	14137
	R > 20	610.4R + 878	628.5R + 1142	640.9R + 1318

Remarks:

@ escalator with the following characteristics can be regarded as heavy duty escalator :

- designed to operate continuously for a period of not less than 20 hours per day, seven days per week, with an alternating passenger load of 100% brake load for one hour and 50% brake load for the following hour;
- not less than 4 no. of flat steps at each landing;
- maximum calculated or measured deflection of supporting structure of escalator not exceeding 1/1500 of the distance between supports;
- brake load given by multiplying the number of visible steps by 120 kg; and
- diameter of chain wheel not less than 100 mm.

Extracted from BEC 2015

Tightened!

Table 8.4.4 : Maximum Electrical Power of Passenger Conveyor at Designated Width and Length at Inclination up to 6^0 from Horizontal for Various Ranges of Rated Speed Operating under No Load

Nominal Width (mm)	Length L (m)	Electrical Power (W) at Rated Speed Vr (m/s)							
		Non-Public Service Passenger Conveyor				Public Service Passenger Conveyor			
		Vr < 0.5	0.5 ≤ Vr < 0.6	0.6 ≤ Vr < 0.75	0.75 ≤ Vr < 0.90	Vr < 0.5	0.5 ≤ Vr < 0.6	0.6 ≤ Vr < 0.75	0.75 ≤ Vr < 0.90
800	L < 8	1071	1350	1769	2095	1257	1630	1862	2188
	8 ≤ L < 12	1537	1955	2560	3026	1537	1955	2560	3026
	12 ≤ L < 16	2002	2561	3259	4003	2002	2561	3259	4003
	16 ≤ L < 20	2468	3631	4096	4934	2468	3631	4096	4934
	L ≥ 20	118.2L + 94	173.2L + 138	196.4L + 157	235.5L + 188	118.2L + 94	173.2L + 138	196.4L + 157	235.5L + 188
1000	L < 8	1210	1537	1769	2095	1350	1723	1955	2281
	8 ≤ L < 12	1955	2514	2840	3399	1955	2514	2840	3399
	12 ≤ L < 16	2607	3306	3724	4469	2607	3306	3724	4469
	16 ≤ L < 20	3212	4096	4609	5540	3212	4096	4609	5540
	L ≥ 20	152.7L + 122	194.5L + 156	220.5L + 176	265.3L + 212	152.7L + 122	194.5L + 156	220.5L + 176	265.3L + 212
1400 & above	L < 8	1513	1921	2211	2620	1689	2154	2444	2852
	8 ≤ L < 12	2444	3142	3551	4248	2444	3142	3551	4248
	12 ≤ L < 16	3259	4132	4655	5586	3259	4132	4655	5586
	16 ≤ L < 20	4016	5121	5761	6925	4016	5121	5761	6925
	L ≥ 20	191L + 152	243L + 195	275L + 221	331L + 265	191L + 152	243L + 195	275L + 221	331L + 265

Remarks:

The maximum allowable electrical power for a passenger conveyor with Nominal Width above 1000 mm and below 1400 mm is given by interpolation of the control value for equipment at Nominal Width 1000 mm and the control value for equipment at Nominal Width 1400 mm.

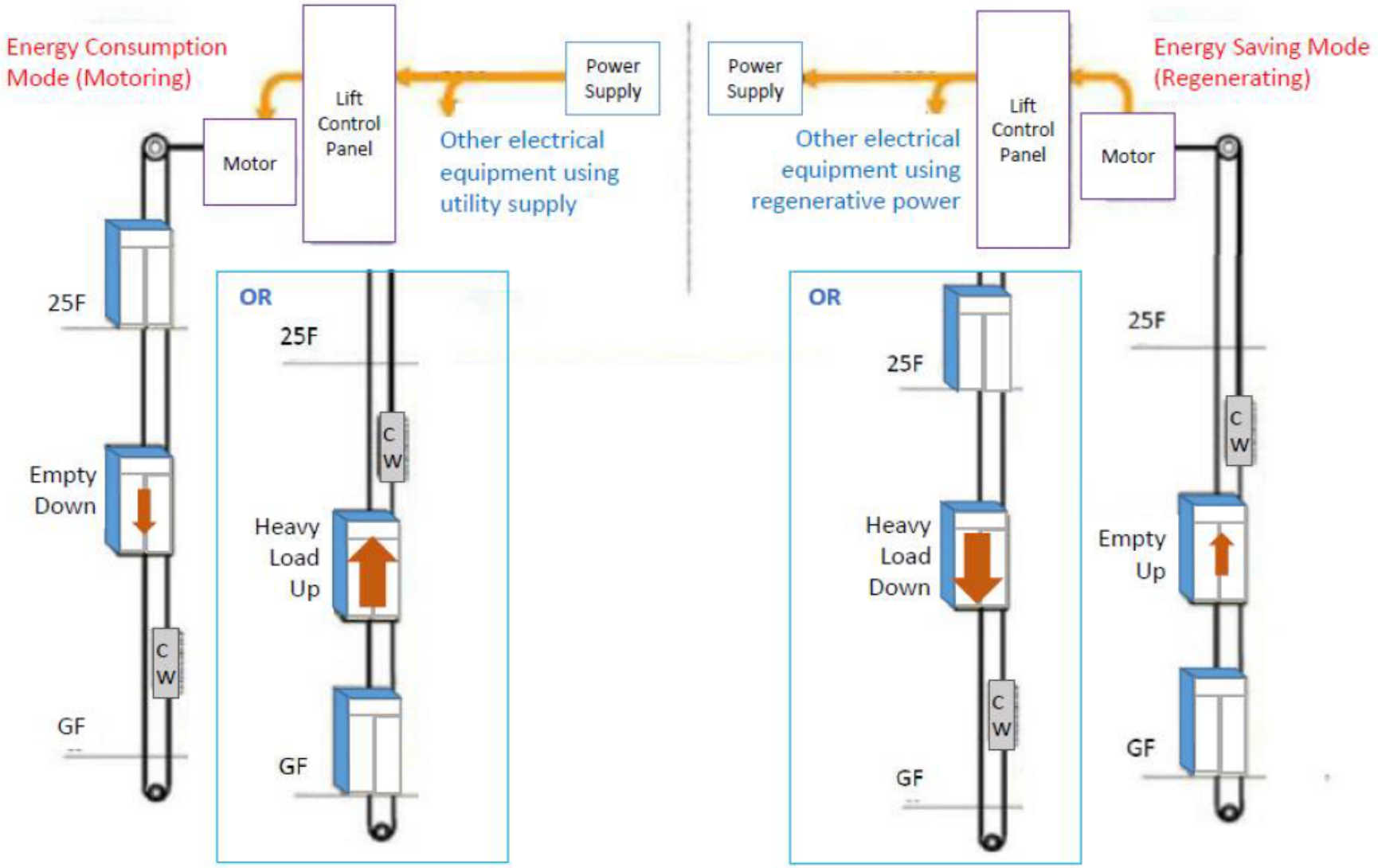
Extracted from BEC 2015

Tightened!

Lift Regenerative Braking

- Regenerative braking should be provided for lift
  - with rated speed of 3 m/s or above, and
  - rated load at 1000 kg or above
- Power from regenerative braking should be fed towards incoming power supply source

Figure 8.5.5 (a): Example of lift with regenerative function



Extracted from BEC TG 2015

Total Power Factor

- TPF measured at the isolator connecting the lift / escalator / passenger conveyor to the building's electrical supply circuit
- TPF $\geqq$ 0.85 for lift at *rated load*, *rated speed* and travelling in *upward direction*
- TPF $\geqq$ 0.85 for escalator / passenger conveyor at *brake load*, *rated speed* in an *upward movement*

Total Harmonic Distortion

- For lifts: Rated load, rated speed in upward direction

Table 8.6.1 : Maximum Total Harmonic Distortion of Motor Drive for Lift	
Circuit Fundamental Current of Motor Drive, I (A), Moving Up with Rated Load at Rated Speed	Maximum Total Harmonic Distortion (%) in Each Phase
$I < 40A$	40%
$40A \leq I < 80A$	35%
$80A \leq I < 400A$	22.5%
$400A \leq I < 800A$	15%

Total Harmonic Distortion

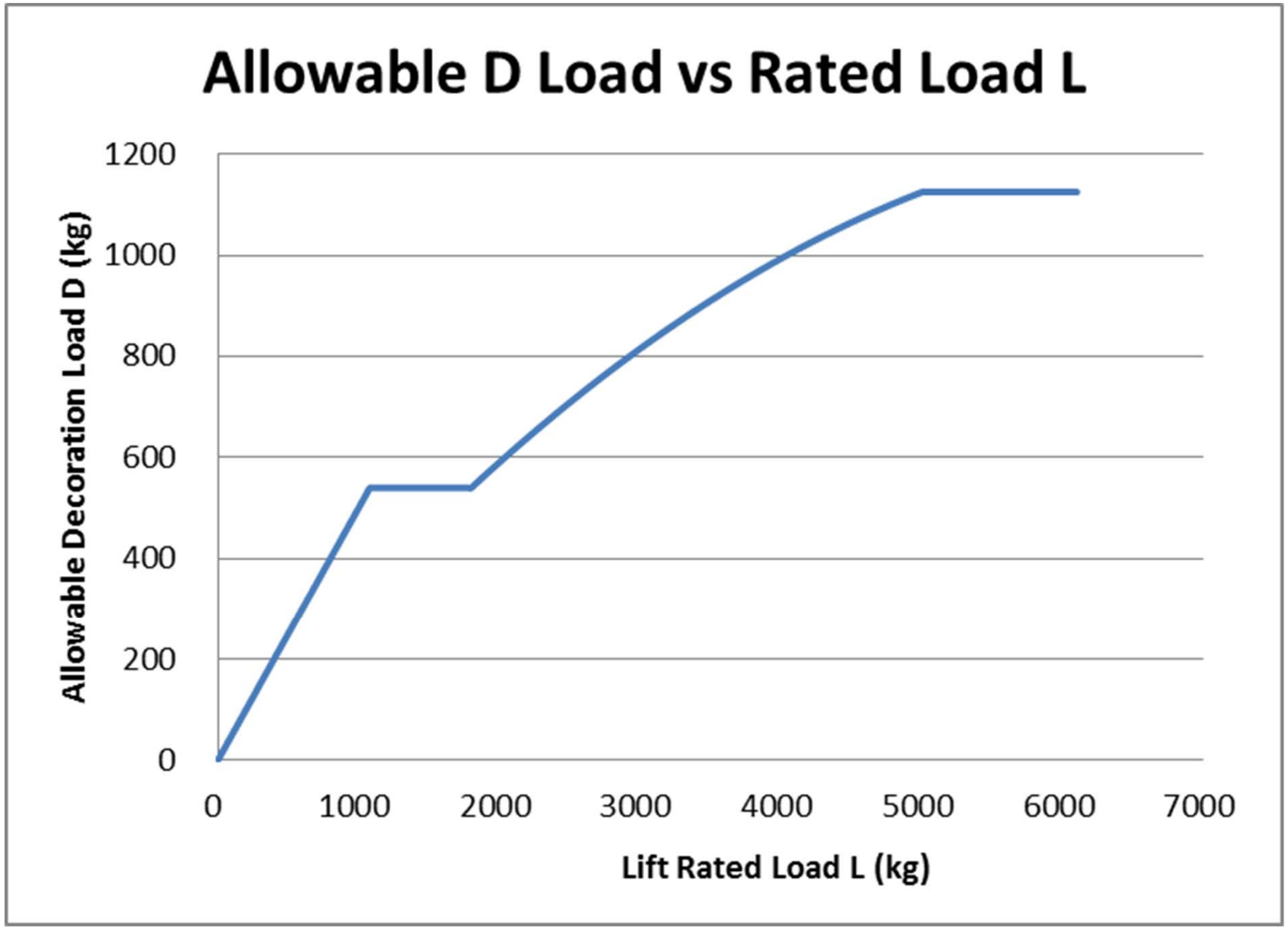
- For escalators / passenger conveyors:
  No load, rated speed

Table 8.6.2 : Maximum Total Harmonic Distortion of Motor Drive for Escalator and Passenger Conveyor		
Circuit Fundamental Current of Motor Drive, I (A), with No Load at Rated Speed	Maximum Total Harmonic Distortion (%) in Each Phase	
I < 40A	35%, for electrical supply direct from building's feeder circuit	40%, for electrical supply not direct from building's feeder circuit
40A ≤ I < 80A	35%	
80A ≤ I < 400A	22.5%	

Lift Decoration Load

Maximum Lift Decoration Load	
Lift Rated Load L (kg)	Allowable Decoration Load D (kg)
$L < 1800$	$D = 0.5L$ or 540 whichever is smaller
$L \geq 1800$	$D=0.3422L-0.00002344L^2$, or 1125 whichever is smaller

For lift with rated load above 1800 kg, allowable decoration load drops gradually from approximately 30% to 22.5% of rated load at a maximum of 5000 kg.


Allowable D Load vs Rated Load L
Allowable Decoration Load D (kg)
1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
5000
6000
7000
Lift Rated Load L (kg)

Lift Decoration Load includes:

- Floor tiles
- Additional ceiling panels
- Additional car wall decorative panels and their corresponding materials for backing and/or fixing
- Excluding balancing weights in association with provision of air-conditioning to lift car

Lift Parking Mode

- Under normal operating status, at least one lift of a bank should operate under parking mode during low traffic period
- Parked car not responding to car or landing calls until it returns to normal operation mode

Lift Ventilation & Air-conditioning

- Ventilation of lift car after idling for 2 min. should be shut off automatically until the lift is activated again by passenger call
- Air-conditioning of lift car after idling for 10 min. should
  - be shut off automatically until the lift is activated again by passenger call, and
  - resume operation no earlier than 5 min. after shut-off
- Power consumption of lift car ventilation fan at design air flow condition should not exceed 0.7W per litre per second (L/s)

Lift Car Automatic Lighting Control

- After idling for 15 min., lift car lighting should reduce to 50% or less of total lighting power consumption automatically

Automatic Speed Reduction of Escalator

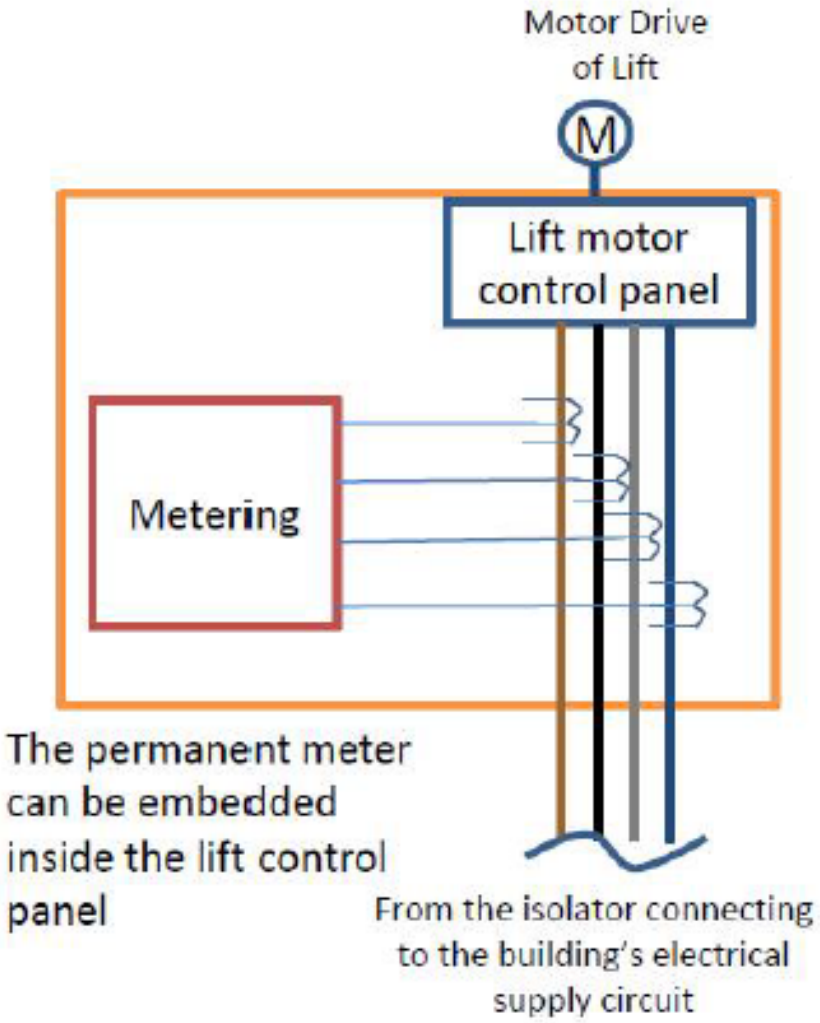
- Switching provision should be made for escalator to operate under automatic speed reduction mode when traffic demand is low
- Safety, operation and riding quality should be considered when deploying automatic stop at low traffic demand period

Extracted from BEC TG 2015

Metering and Monitoring Facilities

- Metering device for each installation
- *Provision for measurement not allowed*
- V (phase-phase, phase-neutral)
- I (3 phases and neutral)
- P (kW)
- TPF
- THD (%)
- Energy consumption (kWh)
- Maximum demand (kVA)

Figure 8.7 (a) : Illustrative diagram of provision of metering device for lift



Extracted from BEC TG 2015

BEC 2012 versus BEC 2015
Lift and Escalator Installations

- Max. allowable traction lift electrical power ⇩ **5 %**
  (for new installation) Table 8.4.1(2012) vs Table 8.4.1a (2015)
- Max. allowable hydraulic lift electrical power ⇩ **5 %**
  (Table 8.4.2)
- Max. allowable escalator electrical power ⇩ **2 %** **(Table 8.4.3)**
- Max. allowable passenger conveyor electrical power ⇩ **2 %**
  (Table 8.4.4)
- Max. lift decoration load ⇩ **10 %** **(Table 8.5.2)**

Emerging good engineering practice to evaluate energy performance of lift

- Unfair to judge that one lift is less ENERGY EFFICIENT only because it consumes more energy than another lift even with same rated load, same rated speed and same height of travel.
- The absolute energy consumption over a period of time MUST NOT BE used.
- Total energy consumption very much depends on the traffic patterns. An idle lift car almost consumes no energy.
- Therefore, the benchmarking parameter must be traffic pattern dependent.

Joule per kg of passengers per meter of car travel should be one appropriate benchmarking parameter, trip by trip basis over a measurement window of say 60 minutes (*i* = 1 to *n* number of trips within 60 minutes), over a day.

$$\text{J/kg - m} = \frac{E_{60}}{\sum_{i=1}^{n} W_i \, D_i}$$

W_i – Car load
D_i – Distance travelled

Such J/kg-m measurement is included in the BEC TG 2012 and 2015 as an emerging good engineering practice.

Trend of considerations in the 2018 review of BEC for Lifts and Escalators (Not yet finalized)

- Further tightening of maximum allowable electrical power under full-loaded up condition of lifts
- Further tightening of lift car lighting control
- Further tightening of lift decoration load
- Further tightening of regenerative braking
- Addition of parameters being metered and monitored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