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SINGAPORE STANDARD

Code of practice for energy efficiency standard for building services and equipment



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Singapore Green Building Council
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Foreword

This code of practice was prepared by a Working Group appointed by the Technical Committee on Building Maintenance and Management which is under the purview of the Building and Construction Standards Committee.

The Inter-Ministerial Committee on Sustainable Development (IMCSD) has set a long term goal to have "at least 80% of the buildings in Singapore to be green by 2030". In Singapore's densely built-up urban development, with limited land and few natural resources, making buildings green and energy efficient underpin our efforts to reduce our energy and carbon footprint and contribute to the global fight against climate change. Having higher minimum requirements for energy efficient building services and equipment push the boundaries of building performance to create a better and greener built environment for all.

This is a revision of SS 530 : 2006 – 'Code of practice for energy efficiency standard for building services and equipment'. The purpose of this revision is to keep abreast of international standards in energy efficiency for building services and equipment.

The changes include:

(a) raising the energy efficiency requirements in accordance with international standards for air-conditioning equipment, water heaters, electric motors and lighting power density stated in this Code.

(b) new methods to determine efficiency for water chilling packages and lighting power density.

(c) new inclusion of efficiency standards for buildings with high-capacity service water-heating systems, distribution transformers and lifts and escalators.

In preparing this specification, reference was made to the following overseas publications:

(1) ANSI/ASHRAE/IES Standard 90.1 : 2013 Energy standard for buildings except low-rise residential buildings

(2) IEC 60034-30-1 : 2014 Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)

Acknowledgement is made for the use of the information from the above references.

At the time of publication of this Code, it continued to serve as a reference for the Building and Construction Authority's Building Control Regulations.

Attention is drawn to the possibility that some of the elements of this Singapore Standard may be the subject of patent rights. SPRING Singapore shall not be held responsible for identifying any or all of such patent rights.

NOTE

1. *Singapore Standards are subject to periodic review to keep abreast of technological changes and new technical developments. The revisions of Singapore Standards are announced through the issue of either amendments or revised editions.*

2. *Compliance with a Singapore Standard does not exempt users from legal obligations.*

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Code of practice for energy efficiency standard for building services and equipment

1 Scope

1.1 This code provides:

(a) minimum energy-efficiency requirements for:

(i) new installation of systems and equipment in buildings;

(ii) replacement of systems and equipment in buildings; and

(iii) replacement of components of systems and equipment in buildings.

(b) criteria for determining compliance with these requirements.

1.2 The provisions of this code apply to the following systems and equipment used in conjunction with buildings:

(i) air-conditioning equipment ; [1]

(ii) heat rejection equipment;

(iii) water heaters;

(iv) motor drives, and

(v) high efficiency lighting. [2]

(vi) distribution transformers

(vii) lifts and escalators

1.3 This code shall not prevail over any safety, health or environmental requirements.

NOTE 1 – For related matters on energy conservation in air-conditioning systems, reference is to be made to Singapore Standard SS 553 'Code of practice for air-conditioning and mechanical ventilation in buildings'.

NOTE 2 – For guidance on the illuminances recommended for different applications, reference is to be made to Singapore Standard SS 531 'Code of practice for lighting of work places'.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI Z21.10.3	Gas-fired water heaters, volume III, storage water heaters with input ratings above 75,000 Btu per hour, circulating and instantaneous
ANSI/AHRI 210/240	Unitary air-conditioning and air-source heat pump equipment

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ANSI/AHRI 340/360	Commercial and industrial unitary air-conditioning and heat pump equipment
ANSI/AHRI 365	Commercial and industrial unitary air-conditioning condensing units
ANSI/AHRI 560	Absorption water chilling and water heating packages
ANSI/AHRI 1230	Performance rating of variable refrigerant flow (VRF) multi-split air-conditioning and heat pump equipment
ANSI/AHRI 551/591	Performance rating of water-chilling and heat pump water-heating packages using the vapor compression cycle
CTI ATC-105	Acceptance test code for water cooling towers
10 CFR Part 430	Energy conservation program for consumer products
10 CFR Part 431	Energy efficiency program for certain commercial and industrial equipment
IEC 60034-2-1	Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IEC 60034-30-1	Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)
ISO 5151	Non-ducted air-conditioners and heat pumps – Testing and rating for performance
JIS B 8615-1	Non-ducted air-conditioners and heat pumps – Testing and rating for performance
JIS B 8615-2	Ducted air-conditioners and air-to-air heat pumps – Testing And rating For performance
SS 531 standard series	Code of practice for lighting of work places

3 Definitions, abbreviations and acronyms

For the purpose of this Code, the following definitions apply. Terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used.

3.1 Air-conditioning

The process of treating air to control simultaneously its temperature, humidity, cleanliness and distribution to meet the comfort requirements of the occupants of the conditioned space.

3.2 Annual fuel utilisation efficiency (AFUE)

The ratio of annual output energy to annual input energy, which includes any off-cycle pilot input loss and cycling effects.

3.3 Boiler

A low-pressure, self-contained appliance intended for use in heating water or producing steam.

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3.4 Check metering

Measurement instrumentation for the supplementary monitoring of equipment and tenant energy use (electric, gas, oil, etc.), in addition to the revenue metering furnished by the utility.

3.5 Coefficient of performance (COP) – Cooling

The ratio of the rate of heat removal to the rate of energy input in consistent units for a complete refrigerating system or some specific portion of that system under designated operating conditions.

3.6 Control

To regulate the operation of equipment.

3.7 Control device

A specialised device used to regulate the operation of equipment.

3.8 Electric meter

A mechanical/electrical device that can measure consumed electricity.

3.9 Energy

The capacity for doing work; taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical and chemical; in SI units, measured in joules (J), where 1 joule = 1 Watt-second; in customary units, measured in kilowatt-hours (kWh).

3.10 Energy factor (EF)

A measure of water heater overall efficiency (as specified in 10 CFR Part 430).

3.11 Equipment

Devices for comfort conditioning, electric power, lighting, transportation, or service water-heating, including but not limited to: furnaces, boilers, air-conditioners, heat pumps, chillers, water heaters, lamps, luminaires, ballasts, elevators, escalators, or other devices or installations.

3.12 Fan system energy demand (or fan system power)

The sum of the nominal power demand (nameplate horsepower at nominal motor efficiency) of motors of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the conditioned space(s) and return it to the source or exhaust it to the outdoors.

3.13 Heat

The form of energy that is transferred by means of conduction, convection or radiation, and may or may not be accompanied by a temperature difference.

3.14 Hot water supply boiler

Closed vessel (boiler) completely filled with water that furnishes hot water to be used externally to it at pressure not exceeding 1103 kPa (160 psig) or at a temperature not exceeding 121 °C (250 °F) at or near the boiler outlet.

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3.15 Illuminance

The luminous flux density at a surface, i.e. the luminous flux incident per unit area (lux or lx). Lux = Lumens per square metre.

3.16 Kilowatt (kW)

The basic unit of electric power. Equal to 1000 W.

3.17 Kilowatt-hour (kWh)

The basic unit of electric energy. Equal to 1000 Wh.

3.18 Labelled

Equipment or materials to which a symbol or other identifying mark has been attached by the manufacturer indicating compliance with specified standards or performance in a specified manner.

3.19 Light output ratio

The ratio of the total light output of a luminaire under stated practical conditions to that of the luminaire or luminaires under reference conditions measured at 25 °C ambient temperature.

3.20 Lighting power budget

The maximum lighting power per unit floor area of a building, based on the type of usage.

3.21 Lumen

The SI unit (lm) of luminous flux, used to describe the quantity of light emitted by a source or received by a surface. A source which has a uniform luminous intensity of one candela emits a total of 12.566 lumens in all directions and emits one lumen in one solid angle.

3.22 Luminaire

An apparatus which controls the distribution of light given by a lamp or lamps and which includes all the components necessary for fixing and protecting the lamps and for connecting them to the supply circuit.

3.23 Luminous efficacy

The ratio (lm/control W) of the luminous flux emitted by a lamp to the power consumed by the lamp and its gear. It is also sometimes known as circuit efficacy.

3.24 Manufacturer

The company engaged in the original production and assembly of products or equipment or a company that purchases such products and equipment manufactured in accordance with company specifications.

3.25 Marked (nameplate) rating

The design load operating conditions of a device as shown by the manufacturer on the nameplate or otherwise marked on the device.

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3.26 Metering

Instruments that measure electric voltage, current, power, etc.

3.27 Power

In connection with machines, power is the time rate of doing work. In connection with the transmission of energy of all types, power refers to the rate at which energy is transmitted. In SI units it is measured in joules per second (J/s) or in Watts (W); in customary units, it is measured in Watts (W).

3.28 Primary system

The central air moving, heating and cooling equipment including chilled-water and hot-water equipment, that serves multiple zones through mixing boxes, VAV boxes, or reheat coils.

3.29 Recovered energy

Energy utilised which would otherwise be wasted (i.e. would not contribute to a desired end use) from an energy utilisation system.

3.30 Room air-conditioner

An encased assembly designed as a unit to be mounted in a window or through a wall, or as a console. It is designed primarily to provide direct delivery of conditioned air to an enclosed space, room, or zone. It includes a prime source of refrigeration, for cooling and dehumidification and a means for circulating and cleaning air. It may also include a means for ventilating and heating.

3.31 Service water-heating

Heating water for domestic or commercial purposes other than space heating and process requirements.

3.32 Shall

Indicates that the requirement is strictly to be followed in order to conform to the standard and from which no deviation is permitted.

3.33 Should

Indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.

3.34 Solar energy source

Source of natural daylighting, and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

3.35 System

A combination of equipment and auxiliary devices (e.g. controls, accessories, interconnecting means, and terminal elements) by which energy is transformed so that it performs a specific function such as VAC, service water-heating, or lighting.

3.36 Terminal

A device by which energy from a system is finally delivered, e.g. registers, diffusers, lighting fixtures, faucets, etc.

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3.37 Thermal resistance (R-value)

The reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. Unit of R is m^2K/W.

3.38 Unitary cooling equipment

One or more factory-made assemblies that normally include an evaporator or cooling coil and a compressor combination. Units that perform a heating function are also included.

3.39 Variable air volume (VAV) system

ACMV system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled supply air to the space.

3.40 Variable refrigerant flow (VRF) air-conditioning system

VRF air-conditioning system is classified under unitary system as the complete system that includes outdoor condensing unit, indoor fan coil units and control system is factory-made by a single manufacturer. The compressor(s) of the system is/are inverter controlled to allow for variable compression speeds that match with different cooling requirements.

3.41 Ventilating, air-conditioning system

The equipment, distribution systems, and terminals that provide, either collectively or individually the processes of ventilating or air-conditioning to a building.

3.42 Ventilation

The process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.

3.43 Water chilling package, absorption

A factory-designed and prefabricated assembly (not necessarily shipped as one package) of one or more condensers, water coolers (evaporators), absorbers and generators, with interconnections and accessories, used for chilling water.

3.44 Water chilling package, centrifugal, screw or rotary

A factory-designed and prefabricated assembly (not necessarily shipped as one package) of one or more centrifugal, screw or rotary compressors, condensers, and water coolers (evaporators) with interconnections and accessories, used for chilling water.

3.45 Water chilling package, reciprocating

A factory-designed and prefabricated assembly, self-contained or condenserless, of one or more reciprocating compressors, condensers (self-contained only), and water coolers (evaporators) with interconnections and accessories, used for chilling water.

3.46 Water heater

Closed vessel in which water is heated by the combustion of fuels, electricity, or any other source, and is withdrawn for use external to the system at pressures not exceeding 1103 kPa gauge (160 psig), including the apparatus by which the heat is generated and all controls and devices necessary to prevent water temperatures from exceeding 99 °C (210 °F).

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4 Air-conditioning equipment

4.1 General

All mechanical equipment and systems serving the building's cooling needs shall meet the requirements of this clause. All mechanical equipment shall be supplied with the information necessary to determine compliance.

4.2 Mechanical equipment efficiency

Equipment shown in Tables 1 to 3 shall have a minimum performance at the specified rating conditions when tested in accordance with the specified test procedure. The tables contain the minimum efficiency requirements for equipment covered by this code. The tables are organised to cover the following types of equipment:

Table 1A Electrical operated unitary air-conditioners and condensing units – Minimum efficiency requirements

Table 1B Electrical operated variable refrigerant flow air-conditioning units – Minimum efficiency requirements

Table 2 Water chilling packages – Minimum efficiency requirements

Table 3 Performance requirements for heat rejection equipment

Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Equipment used to provide water-heating functions as part of a combination system shall satisfy all stated requirements for the appropriate space cooling category.

Equipment efficiency shall be supported by data furnished by the manufacturer or shall be certified under a rating procedure acceptable to the relevant authority. Where components such as indoor or outdoor coils from different manufacturers are used, the combined efficiency shall meet the minimum equipment efficiency requirements.

Table 1A – Electrical operated unitary air-conditioners and condensing units – Minimum efficiency requirements

Equipment type	Cooling capacity	Minimum efficiency	Test procedure
Air-conditioners (air-cooled)	≤ 17.6 kW	Reference to MEPS requirements by NEA, Singapore	
	> 17.6 kW and < 40 kW	3.28 COP	ANSI/AHRI 340/360
	≥ 40 kW and < 70 kW	3.22 COP	
	≥ 70 kW and < 223 kW	2.93 COP	
	≥ 223 kW	2.84 COP	
Air-conditioners (water cooled, evaporatively cooled)	< 19 kW	3.54 COP (water cooled) 3.54 COP (evaporatively cooled)	ANSI/AHRI 210/240
	≥ 19 kW and < 40 kW	3.54 COP (water cooled) 3.54 COP (evaporatively cooled)	ANSI/AHRI 340/360

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Equipment type	Cooling capacity	Minimum efficiency	Test procedure
	≥ 40 kW and < 70 kW	3.66 COP (water cooled) 3.51 COP (evaporatively cooled)	
	≥ 70 kW and < 223 kW	3.63 COP (water cooled) 3.48 COP (evaporatively cooled)	
	≥ 223 kW	3.57 COP (water cooled) 3.43 COP (evaporatively cooled)	
Condensing units, air-cooled	≥ 40 kW	3.07 COP	ANSI/AHRI 365
Condensing units, water-cooled	≥ 40 kW	3.95 COP	
Condensing units, evaporatively cooled	≥ 40 kW	3.95 COP	
COP – Coefficient of Performance at full load capacity and is defined as the full load cooling capacity of the unit divided by the effective power input of a unit at the full load outdoor conditions according to the specified testing standards, expressed in W/W.			

Table 1B – Electrical operated variable refrigerant flow air-conditioning units – Minimum efficiency requirements

Equipment type	Cooling capacity	Minimum efficiency[a]	Test procedure
VRF air conditioners (air-cooled)	< 17.6 kW	Reference to MEPS Requirements by NEA, Singapore	
	≥ 17.6 kW and < 40 kW	3.28 COP 3.84 ICOP	AHRI 1230 ISO 5151 JIS B 8615-1 JIS B 8615-2
	≥ 40 kW and < 70 kW	3.22 COP 3.75 ICOP	
	≥ 70 kW	2.93 COP 3.40 ICOP	
VRF air conditioners (water-cooled)	< 19 kW	3.52 COP	AHRI 1230 (Rated condition at 30°C entering water)
	≥ 19 kW and < 40 kW	3.52 COP	
	≥ 40 kW	2.93 COP	
COP – Coefficient of Performance at full load capacity and is defined as the full load cooling capacity of the unit divided by the effective power input of a unit at the full load outdoor conditions according to the specified testing standards, expressed in W/W. ICOP – A single number that is a cooling part load efficiency figure of merit equivalent to IEER calculated per the method described in ANSI/AHRI 340/360, ANSI/AHRI 1230 and ISO 5151. [a] Both COP and ICOP shall be met or exceeded to comply with this standard.			

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Table 2 – Water chilling packages – Minimum efficiency requirements

Equipment type	Size category	Minimum efficiency		Test procedure
		Path A	Path B	
Air-cooled, with condenser, electrically operated	<528 kW	2.985 FL	2.866 FL	AHRI 551/ 591
		4.048 IPLV	4.669 IPLV	
	≥528 kW	2.985 FL	2.866 FL	
		4.137 IPLV	4.758 IPLV	
Air-cooled, without condenser, electrically operated	All capacities	Air cooled chillers without condenser shall be rated with matching condenser and comply with air-cooled chiller efficiency requirements		
Water-cooled, electrically operated, positive displacement (rotary screw and scroll)	<263 kW	4.694 FL	4.513 FL	
		5.867 IPLV	7.041 IPLV	
	≥264 kW and <528 kW	4.889 FL	4.694 FL	
		6.286 IPLV	7.184 IPLV	
	≥528 kW and < 1055 kW	5.334 FL	5.177 FL	
		6.519 IPLV	8.001 IPLV	
	≥1055 kW and <2100 kW	5.771 FL	5.633 FL	
		6.770 IPLV	8.586 IPLV	
	≥2100 kW	6.286 FL	6.018 FL	
		7.041 IPLV	9.264 IPLV	
Water-cooled, electrically operated, centrifugal	<528 kW	5.771 FL	5.065 FL	
		6.401 IPLV	8.001 IPLV	
	≥528 kW and < 1055 kW	5.771 FL	5.544 FL	
		6.401 IPLV	8.801 IPLV	
	≥1055 kW and <1407 kW	6.286 FL	5.917 FL	
		6.770 IPLV	9.027 IPLV	
	≥1407 kW and <2110 kW	6.286 FL	6.018 FL	
		7.041 IPLV	9.264 IPLV	
	≥2110 kW	6.286 FL	6.018 FL	
		7.041 IPLV	9.264 IPLV	
Air-cooled absorption single effect	All capacities	0.600 FL	N.A	AHRI 560
Water-cooled absorption single effect	All capacities	0.700 FL	N.A	
Absorption double effect, indirect-fired	All capacities	1.000 FL	N.A	
		1.050 IPLV		
Absorption double effect, direct-fired	All capacities	1.000 FL	N.A	
		1.000 IPLV		

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NOTE 1 – All minimum efficiency units are in Coefficient of Performance (COP) (W/W).

NOTE 2 – One can elect to comply with either Path A or Path B but both FL and IPLV of the selected path shall be complied with.

NOTE 3 – IPLV = 0.01A + 0.42B + 0.45C + 0.12D

Where A = COP at 100% (30 °C) per AHRI STD 551/591 (SI) for water-cooled chillers

B = COP at 75% (24.5 °C)

C = COP at 50% (19 °C)

D = COP at 25% (19 °C)

Where A = COP at 100% (35 °C) per AHRI STD 551/591 (SI) for air-cooled chillers

B = COP at 75% (27 °C)

C = COP at 50% (19 °C)

D = COP at 25% (13 °C)

NOTE 4 – NA means the requirements are not applicable.

NOTE 5 – IPLV was developed by AHRI to create a part load rating index for a single chiller, simulated under 4 distinct operating conditions (average of 29 cities in USA). IPLV provides a measure of relative part load performance comparison of similar technologies. The IPLV value was not intended to be used to predict annualised energy consumption of a chiller in any specific application or operating conditions.

NOTE 6 – Follow AHRI 551/591 rating scope (CHW 2 °C – 16 °C; W/C Condenser: 13 °C – 40 °C entering; A/C Condenser: 13 °C – 52 °C.

NOTE 7 – The requirements for centrifugal chillers at non-standard conditions shall be adjusted using K_{adj} factor per 6.4.1.2.1 of ASHRAE STD 90.1 : 2013.

Table 3 – Performance requirements for heat rejection equipment

Equipment type	Total system heat rejection capacity at rated conditions	Subcategory or rating condition	Performance required[a]	Test procedure
Propeller or axial fan cooling towers	All	35.0 °C entering water 29.4 °C leaving water 23.4 °C wet outdoor air	≥ 3.23 L/s.kW	CTI ATC-105
Centrifugal fan cooling towers	All	35.0 °C entering water 29.4 °C leaving water 23.4 °C wet outdoor air	≥ 1.7 L/s.kW	CTI ATC-105

[a] For the purpose of this table,

- cooling tower performance is defined as the maximum flow rating of the tower divided by the nameplate rated motor power
- air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the nameplate rated motor power

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5 Water heaters

5.1 General

Boilers and water-heating equipment shall meet the requirements of this clause. All boilers and water-heating equipment shall be supplied with the information necessary to determine compliance.

5.2 Equipment efficiency

Boilers and water-heating equipment shall have a minimum performance as listed in Tables 4 and 5 respectively. The performance shall be at the specified rating conditions when tested in accordance with the specified test procedure. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all rated requirements.

Table 4 – Gas and oil-fired boilers – Minimum efficiency requirements

Equipment type[a]	Sub-category or rating condition	Size category (Input)	Minimum efficiency[b]	Test procedure
Boilers, hot water	Gas-fired	< 88 kW[f,g]	82% AFUE	10 CFR Part 430
		≥ 88 kW and ≤ 733 kW	80% E_t	10 CFR Part 431
		> 733 kW[a]	82% E_c	
	Oil-fired[e]	< 88 kW[g]	84% AFUE	10 CFR Part 430
		≥ 88 kW and ≤ 733 kW	82% E_t	10 CFR Part 431
		> 733 kW[a]	84% E_c	
Boilers, steam	Gas-fired	< 88 kW	80% AFUE	10 CFR Part 430
	Gas-fired – all, except natural draft	≥ 88 kW and ≤ 733 kW	79% E_t	10 CFR Part 431
		> 733 kW[a]	79% E_c	
	Gas-fired – natural draft	≥ 88 kW and ≤ 733 kW	77% E_t	
		> 733 kW[a]	77% E_c	
	Oil-fired[e]	< 88 kW	82% AFUE	10 CFR Part 430
		≥ 88 kW and ≤ 733 kW	81% E_t	10 CFR Part 431
		> 733 kW[a]	81% E_c	

a. These requirements apply to boilers with rated input of 2346 kW or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

b. *Ec* = combustion efficiency (100% less flue losses). See reference document for detailed information.

c. *Et* = thermal efficiency. See reference document for detailed information.

d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.

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e. Includes oil-fired (residual).

f. Boilers shall not be equipped with a constant burning pilot light.

g. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

Table 5 – Water-heating equipment – Performance requirements

Equipment type	Size category (input)	Sub-category or rating condition	Performance required [a]	Test procedure [b]
Electric table top water heaters	≤ 12 kW	Resistance ≥ 75.7 *L*	0.93 – 0.00035V EF	10 CFR Part 430
Electric water heaters	≤ 12 kW	Resistance ≥ 75.7 *L*	0.97 – 0.00035V EF	10 CFR Part 430
	> 12 kW	Resistance ≥ 75.7 *L*	0.3 + 27/Vm %/h	G.2 of ANSI Z21.10.3
	≤ 24 A and ≤ 250 V	Heat Pump	0.93 – 0.00035V EF	10 CFR Part 430
Gas storage water heaters	≤ 22.98 kW	≥ 75.7 *L*	0.67 – 0.0005*V* EF	10 CFR Part 430
	> 22.98 kW	< 309.75 W/*L*	80% E_t ($Q/799+16.6\sqrt{V}$) SL, W	G.1 and G.2 of ANSI Z21.10.3
Gas instantaneous water heaters	> 14.66 kW and < 58.62 kW [c]	≥ 309.75 W/*L* and < 7.57 *L*	0.62 – 0.0005*V EF*	10 CFR Part 430
	≥ 58.62 kW	≥ 309.75 W/*L* and < 37.85 *L*	80% E_t	G.1 and G.2 of ANSI Z21.10.3
	≥ 58.62 kW	≥ 309.75 W/*L* and ≥ 37.85 *L*	80% E_t ($Q/799+16.6\sqrt{V}$) SL, W	
Oil storage water heaters	≤ 30.78 kW	≥ 75.7 *L*	0.62 – 0.0005*V* EF	10 CFR Part 430
	> 30.78 kW	< 309.75 W/*L*	80% E_t ($Q/799+16.6\sqrt{V}$) SL, W	G.1 and G.2 of ANSI Z21.10.3
Oil instantaneous water heaters	≤ 61.55 kW	≥ 309.75 W/*L* and < 7.57 *L*	0.59 – 0.0005*V* EF	10 CFR Part 430
	> 61.55 kW	≥ 309.75 W/*L* and < 37.85 *L*	80% E_t	G.1 and G.2 of ANSI Z21.10.3
	> 61.55 kW	≥ 309.75 W/*L* and ≥ 37.85 *L*	78% E_t ($Q/799+16.6\sqrt{V}$) SL, W	
Hot water supply boilers, gas and oil	≥ 61.55 kW and < 3663.8 kW	≥ 309.75 W/*L* and < 37.85 *L*	80% E_t	G.1 and G.2 of ANSI Z21.10.3

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Equipment type	Size category (input)	Sub-category or rating condition	Performance required [a]	Test procedure [b]
Hot water supply boilers, gas		≥ 309.75 W/*L* and ≥ 37.85 *L*	80% E_t ($Q/799+16.6\sqrt{V}$) SL, W	
Hot water supply boilers, oil		≥ 309.75 W/*L* and ≥ 37.85 *L*	78% E_t ($Q/799+16.6\sqrt{V}$) SL, W	
Unfired storage tanks	All		R-2.2	(None)

[a] Energy Factors (EF) and Thermal Efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum W based on a 38.9 °C temperature difference between stored water and ambient requirements. In the EF equation, *V* is the rated volume in Litres. In the SL equation, *V* is the rated volume in Litres and *Q* is the nameplate input rate in W.

[b] Refer to Clause 2 for the titles of the standards.

[c] Instantaneous water heaters with input rates below 58.62 kW shall comply with these requirements if the water heater is designed to heat water to 82.2 °C or higher.

Equipment efficiency shall be supported by data furnished by the manufacturer or shall be certified under a recognised certification programme or rating procedure.

Storage water heaters and hot water storage tanks having more than 530 litres of storage capacity are not required to meet the standby loss (SL) requirements when:

(a) the tank surface is thermally insulated to R-2.2;

(b) a standing pilot light is not installed; and

(c) gas or oil-fired storage water heaters have a flue damper or fan assisted combustion.

5.3 Additional equipment efficiency measures

5.3.1 Vent damper

All gas-fired storage water heaters installed in conditioned spaces shall be equipped with a vent damper listed in accordance with recognised safety standards for vent dampers for use on gas appliances. If the water heater does not have an available electrical supply, the vent damper shall be of a type that does not require an external electrical supply for operation. The vent damper shall be installed in accordance with the manufacturer's instructions.

5.3.2 Exceptions

This requirement shall not apply to:

(a) water heaters equipped with fan-assisted combustion or a power venting device;

(b) water heaters equipped with a flue damper.

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5.4 Buildings with high-capacity service water-heating systems

5.4.1 Gas water-heating equipment

New buildings with gas service hot-water systems with a total installed gas water-heating input capacity of 293 kW or greater, shall have gas service water-heating equipment with a minimum thermal efficiency (Et) of 90%. Multiple units of gas water-heating equipment are allowed to meet this requirement if the water-heating input provided by equipment with thermal efficiency (Et) above and below 90% provides an input capacity-weighted average thermal efficiency of at least 90%.

5.4.2 Exceptions

The exceptions are as follows:

(a) Where 25% of the annual service water-heating requirement is provided by site-solar or site-recovered energy.

(b) Water heaters installed in individual dwelling units.

(c) Individual gas water heaters with input capacity not greater than 29 kW.

6 Electric motors

6.1 General

All permanently wired electric motors shall meet the requirements of this clause.

6.2 Electric motor efficiency

6.2.1 Normal efficiency

All permanently-wired general purpose single-speed polyphase squirrel-cage induction motors shall have a nominal efficiency not less than that shown in Table 6A. These requirements apply to motors of 0.75 to 185 kW.

The nominal efficiencies shall be classified in accordance with IEC 60034-30-1 or other equivalent national standards. The rated efficiency value of a motor by the manufacturer shall be determined in accordance with the testing methods specified in the latest edition of IEC 60034-2-1 or equivalent.

6.2.2 Exceptions

This requirement shall not apply to motors used as an integral component of the equipment meeting the minimum equipment efficiency requirements specified in this code, provided that the motor input is included when determining the equipment efficiency. Examples of an integral component are where the motor is an integral part of a hermetic machine, or where replacing the motor of equipment affects the original equipment design and operation. Motor of a pump or fan set is not considered as an integral component.

6.3 Belts

All belts operated by electric motors shall be V-belts, or synchronous belts.

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Table 6A – General purpose motors – Minimum nominal efficiency

Power (kW)	Minimum nominal full-load efficiency (%)			
	Continuous use [a]		Occasional use [b]	
	2-pole	4-pole	2-pole	4-pole
	IE3 [c]		IE2 [c]	
0.75	80.7	82.5	77.4	79.6
1.1	82.7	84.1	79.6	81.4
1.5	84.2	85.3	81.3	82.8
2.2	85.9	86.7	83.2	84.3
3	87.1	87.7	84.6	85.5
4	88.1	88.6	85.8	86.6
5.5	89.2	89.6	87.0	87.7
7.5	90.1	90.4	88.1	88.7
11	91.2	91.4	89.4	89.8
15	91.9	92.1	90.3	90.6
18.5	92.4	92.6	90.9	91.2
22	92.7	93.0	91.3	91.6
30	93.3	93.6	92.0	92.3
37	93.7	93.9	92.5	92.7
45	94.0	94.2	92.9	93.1
55	94.3	94.6	93.2	93.5
75	94.7	95.0	93.8	94.0
90	95.0	95.2	94.1	94.2
110	95.2	95.4	94.3	94.5
132	95.4	95.6	94.6	94.7
160	95.6	95.8	94.8	94.9
185	95.7	95.9	95.0	95.1

[a] "Continuous use" motors are defined as motors that are used for at least 2900 hours per year

[b] "Occasional use" motors are defined as motors that are used for less than 2900 hours per year.

[c] "IE2" and "IE3" are efficiency classes of single-speed, induction motors according to IEC 60034-30-1.

NOTE 1 – For intermediate vales of rated motor output, the efficiency shall be determined by using formula shown in Table 6B.

NOTE 2 – For motors not shown in Table 6A, the nominal limits of respective efficiency classes in IEC 60034-30-1 shall be referred.

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Table 6B – Formula for determining motor minimum efficiency

Efficiency class	Number of poles	Formula
IE2	2	$\eta_n = 0.2972\,[log_{10}(P_n)]^3 - 3.3453\,[log_{10}(P_n)]^2 + 13.0651[log_{10}(P_n)] + 79.077$
IE2	4	$\eta_n = 0.0278\,[log_{10}(P_n)]^3 - 1.9247\,[log_{10}(P_n)]^2 + 10.4395[log_{10}(P_n)] + 80.9761$
IE3	2	$\eta_n = 0.3569\,[log_{10}(P_n)]^3 - 3.3076\,[log_{10}(P_n)]^2 + 11.6108[log_{10}(P_n)] + 82.2503$
IE3	4	$\eta_n = 0.0773\,[log_{10}(P_n)]^3 - 1.8951\,[log_{10}(P_n)]^2 + 9.2984[log_{10}(P_n)] + 83.7025$
Where η_n is the minimum motor efficiency (%) for motor with power output rating P_n in kW		

7 Lighting power density and control

7.1 General and exceptions

7.1.1 General

The designed building interior and exterior lighting power shall not exceed the maximal power described in 7.2 and 7.3 respectively. For lighting control, there are a few basic requirements while the rest control strategies listed here serve as allowance for adjusting the design lighting power. In addition, design service illuminance shall be in accordance with Singapore Standard SS 531. Lamp efficacies and ballast energy performance shall meet the latest Minimal Energy Performance Standard (MEPS).

7.1.2 Exceptions

The exceptions are as follows:

(a) Emergency lighting that is automatically off during normal building operation.

(b) Spaces in individual residences and apartments.

(c) Non-permanent lighting such as portable lighting for offices and temporary outdoor lighting.

(d) Lighting that is specifically designated as required by a health or life safety statute, ordinance, standard, or regulation.

(e) Lighting design with health, security, or safety concern may be exempted in case-by-case basis even if there is no specific statute or regulation for exemption under point (d).

7.2 Building interior lighting

7.2.1 The maximum designed lighting power (including ballast loss) for a building's interior lighting shall not exceed the sum of maximal power for various areas calculated in accordance with Table 7A (space-by-space method). The maximal power density requirements between spaces are tradable and additional control allowance can be claimed (details in Table 7B), as expressed in the equation below.

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Designed building interior lighting power (W)
= Designed building interior fully-ON lighting power (W) – Lighting control allowance power (W)
≤ (maximal W/m^2 for space A x m^2 of space A) + (maximal W/m^2 for space B x m^2 of space B)

7.2.2 In addition, Table 7C (building area method) is a reference for designer to estimate maximal building lighting power consumption at early stage of design, and should not be taken as compliance requirement.

7.3 Building exterior and outdoor lighting

7.3.1 The allowed building exterior and outdoor (uncovered area) lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Table 7D, and the sum of the additional lighting power allowance for specific applications determined in accordance with Table 7E. The maximal power density requirements specified in Table 7D are tradable but those specified in Table 7E are not (unless stated otherwise). The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s), and other improved area(s) that are illuminated.

7.3.2 Exterior lighting shall be controlled by time switches, photo-cells or other devices to turn it off during hours when such lighting is unnecessary, such as the following scenarios:

(a) Where there is sufficient daylight; and

(b) During non-business hours after 12 am for building facade and landscape lighting. All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least ten hours.

Table 7A – Maximum building interior lighting power density for compliance

Interior spaces – Type of usage		LPD (W/m^2)
Space-by-space method		
Office work and study		
Offices, meeting rooms, copy/print rooms, class rooms, lecture theatres, computer rooms, reading areas		12
Laboratories		16
Atriums, halls and retail		
Entrance halls, atriums, concourses, lobbies, auditoriums and concert halls		10
Multi-purpose halls, conference halls		16
Retail general lighting and (accent, display, decorative)	jewelry and crystal	15 (+ 20)
	furniture, clothing and accessories, cosmetics, artwork	15 (+ 10)
	others, e.g. supermarket, vehicles, sporting goods, hardware and stationery, pharmacy, and undetermined usage during early design	15 (+ 5)
Food and relax		
Food courts, canteens, hawker centres (including dining area and food preparation)		10
Restaurants, lounges, bars (including dining area and food preparation, accent, display, decorative)		12
Transport and goods		
Circulation areas, corridors		7
Stairs, escalators, travelators		6
Lift lobbies		7
Carparks		3
Loading docks		5
Warehouses		7
Storage areas		10

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Interior spaces – Type of usage	LPD (W/m^2)
Rest, clean, exercise, play areas	
Hotel guest rooms (including accent, decorative lighting, and spaces within the guest room such as toilets)	12
Toilets, changing rooms, laundries, washing areas	10
Gymnasiums and physical exercise areas	11
Manufacturing and maintenance	
Mechanical and electrical rooms	10.0
Manufacturing – (low to extra-high bays)	13.0
Manufacturing – electronic manufacturing and fine detail / Assembly industries	14.0
Maximal general and task lighting W/m^2 for above and other areas can also be determined by required lux level (in accordance to SS 531) and room cavity ratio (RCR) calculated with one of equations below	
For rectangular rooms, RCR = 5H(L+W)/(L×W); For irregular-shaped rooms, RCR = 2.5H×P/A Where: L =Length of room; W = Width of room; H =Vertical distance from the work plane to the centreline of the lighting fixture; P = Perimeter of room, and A = Area of room	

Illuminance level (Lux)	**RCR ≤ 2.0**	**2.0 < RCR ≤ 3.5**	**3.5 < RCR ≤ 7.0**	**RCR > 7.0**
50	2	3	4	6
100	4	6	7	11
200	6	8	12	18
300	8	10	14	21
400	9	11	15	23
500	10	12	16	25
600	12	14	18	28
700	14	16	21	31
800	16	19	25	35
900	18	22	29	40
1000	20	24	32	45

Table 7B – Building interior lighting control

Essential requirements	
Area control	The lighting control shall be readily accessible. For centralised control, the system shall either allow easy monitoring of lightings or the controlled area for person using the control, or be automated with proper control strategy. Each control device shall control an area i) no larger than 250 m^2 if the enclosed space is < 1000 m^2 and ii) no larger than 1000 m^2 otherwise. General, display, and ornamental lighting shall be separately controlled.
Independent control for day-lighted zone and mandatory daylight control	• All luminaires providing general lighting in or partially in day-lighted zone shall be controlled independently from other luminaires not in the same zone. • For common area (e.g. entrance halls, corridors) receiving more than >150% of designed illuminance in typical rainy days, automatic daylight control is mandatory either by photo-sensor or by schedule, with following exception i) the daylighted area is less than 20 m^2, ii) the general lighting power for the daylighted area is less than 120 W even when the lights are fully on.

Optional lighting control allowance (W) = Sum of [Watts of luminaries fulfilling below control requirements x Power adjustment factor (PAF)]		
Control type	Description of requirement for eligible control allowance	PAF*
Shut-Off control	Automatic control to shut OFF all of the lighting when the space is unoccupied, determined by occupant sensor, schedule, or other signals	0.01

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Essential requirements			
Manual On control	Manual on control with no more than 50% of the lighting power to be automatically turned on		0.01
Multi-level lighting control	At least one intermediate control step (between 30% – 70% of full lighting power) or continuous dimming in addition to full ON and full OFF		0.01
Basic demand-response control	Automatic control to reduce lighting power in response to an occupant sensor-control to a level ≤ 50% (≤ 70% for carpark) of designed power within 20 min of all occupants leaving the sensor-detectable space. Each control device shall control no more than 450 m^2.		0.02
Automatic daylight responsive control	Automatic photo-control to reduce lighting power in response to available daylight using continuous dimming or with at least two intermediate control points in addition to full ON and full OFF: i) between 50% – 70% of full lighting power; ii) between 20% – 40% of full lighting power.		0.03
Partial-On occupant sensing control	• Applicable to any area ≤ 25 m^2 enclosed by floor-to-ceiling partitions; any size enclosed (non-day-lighted) classroom, conference or waiting room. • Automatically deactivate all of the lighting power in the area within 30 min after the room has been vacated • Partial-on to 30% – 70% of the lighting power in the area when occupant is detected; • Manual activation required for further increase in lighting power		0.15
Occupant sensing controls in open plan office	In open plan offices (containing workstations) > 25 m^2, each sensor control device shall control the general lighting between a full ON and full OFF status for an area (defined in the right)	≤12 m^2	0.30
		12 – 25 m^2	0.20
		25 – 50 m^2	0.15
Manually operated dimming System	For hotels/motels, restaurants, auditoriums, theatres only		0.10
Combination of partial-on occupant sensing and manually operated dimming	• Applicable to any area ≤ 25 m^2 enclosed by floor-to-ceiling partitions; any size enclosed (non-day-lighted) classroom, conference or waiting room. • Other requirements stated for partial-on occupant sensing control • Manually operated dimming control		0.20
* For each control device, only a single value of PAF can be chosen. Summation of PAF is not allowed. Areas classified for mandatory daylight control shall not be qualified for lighting control allowance.			
Notes for designer: • Through a well designed demand-response control, the building's total lighting power could be lowered by more than 15% below the total installed lighting power. • For air-conditioned area, excess daylight e.g. from skylight, may result more energy consumption due to higher cooling load, instead of saving energy from lighting.			

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Table 7C – Maximum building interior lighting power density for reference (building area method)

Building area method (including general, display and accent) W/m^2 gross lighted floor area	
Automotive facility	8.5
Convention centre	11.0
Courthouse	11.0
Dormitory	6.5
Exercise centre / sports arena / gym	9.5
Fire station	7.5
Health-care clinic	9.5
Hospital	11.5
Hotel and motel	9.0
Library	12.0
Manufacturing facility	12.5
Motion picture theater	8.0
Museum (300 lux general lighting)	11.0
Office	9.0
Penitentiary	9.0
Performing arts theater	15.0
Police station	9.0
Post office	9.0
Religious building (100 – 300 lux)	9.0
Retail	14.0
School / university	9.5
Warehouse	7.0

Table 7D – Maximum building exterior lighting power density for compliance (general hardscape lighting for uncovered areas)

	zone 1	**zone 2**	**zone 3**	**zone 4**
Linear (<3 m width) wattage allowance (W/m), e.g. walkways	1.5	2.0	2.5	3.0
Area wattage allowance (W/m^2) for plaza areas, pedestrian tunnels, special feature areas	1.5	1.6	1.8	2.2
Area wattage allowance (W/m^2) for other areas e.g. uncovered parking, walkways, bicycle tracks, stairways	0.5	0.7	1.2	1.5
Initial wattage allowance per site (W)	350 W	550 W	750 W	1100 W
Zone 1: Developed areas of National parks, state parks, forest land, rural areas Zone 2: Areas predominantly consisting of residential zoning, neighbourhood business districts, light industrial with limited nighttime use and residential mixed use area Zone 3: All other areas Zone 4: High activity commercial central business district area				

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Table 7E – Maximum building exterior lighting power density for compliance (additional lighting power allowance for specific applications)

Lighting application	Zone 1	Zone 2	Zone 3	Zone 4
*Wattage allowance per application (**W**). Use all that apply as appropriate.*				
Building entrance or exits. Allowance per door only for luminaires within 7 m of the door	30	60	90	90
Primary entrances to senior care facilities, police stations, hospitals, fire stations and emergency vehicle facilities. Allowance per primary entrance(s) only. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 30 m of the primary entrance.	45	80	120	130
Drive up windows. Allowance per customer service location.	40	75	125	200
Vehicle service station uncovered fuel dispenser. Allowance per fueling dispenser.	120	175	185	330
ATM and night depositories	270 / location + 90/ATM	270 / location + 90/ATM	270 / location + 90/ATM	270 / location + 90/ATM
*Wattage allowance per unit length (**W / linear m**). May be used for one or two frontage side(s) per site.*				
Outdoor sales frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length.	NA	75	120	150
*Wattage allowance per hardscape area (**W/m²**). May be used for any illuminated hardscape area on the site.*				
Hardscape ornamental lighting / Landscape lighting	NA	0.2	0.4	0.6
*Wattage allowance per hardscape area (**W/m²**). Use as appropriate provided that none of the following specific applications shall be used for the same area.*				
Building facades Total façade lighting power shall be <5% total interior lighting power	NA	1.1	1.6	2.2
Outdoor uncovered sales lots. exclusively for the display of vehicles or other merchandise for sale. Hardscape areas should not be included even they are surrounded by sales lot.	2	6	8	13
Vehicle service station hardscape. Allowance for the total illuminated hardscape area excluding area of buildings, under canopies, off property or obstructed by signs or structures.	0.3	2	3	5
Vehicle service station canopies. Allowance for the total area within the drip line of the canopy.	5.5	11	14	23
Loading docks	5.4	5.4	5.4	5.4
Sales canopies. Allowance for the total area within the drip line of the canopy.	NA	7	9	11
Non-sales canopies. Allowance for the total area within the drip line of the canopy.	1.0	2.2	4.3	6.3
Guard stations. Allowance up to 100 m^2 per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants.	2	4	8	10
Student pick-up/drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 8 m, times the smaller of the actual length or 75 m.	NA	1.3	5	5
Outdoor dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages.	0.3	2	3	5

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8 Distribution transformers

8.1 General

To reduce energy losses associated with transformer operation in the electricity distribution system, both liquid immersed transformer and dry type transformer shall meet the requirements of this clause.

8.2 Transformer efficiency

Liquid immersed and dry type transformer shall have an efficiency level at 50 % nameplate-rated load not less than that shown in Table 8. These requirements apply to single-phase transformers > 10 kVA and three-phase transformers > 25 kVA.

The rated efficiency value of a transformer by the manufacturer shall be determined in accordance with the latest IEC or equivalent standards. For both liquid-immersed and dry-type transformers the no-load losses shall be determined at a temperature of 75°C. For the load losses used in the efficiency calculation, the specified reference temperatures to be used are 55°C for liquid-immersed transformers and 75°C for dry-type transformers. Temperature correlation for the load losses should be applied according to the latest IEC standard, if the testing temperature is different from the specified reference temperature.

Table 8 – **Minimal efficiency requirement for distribution transformers**

Transformer type	Rating (kVA)	Liquid-immersed	Dry-type		
		Efficiency (%) at 50 % load	Efficiency (%) at 50% load Um = 12 kV	Efficiency (%) at 50% load Um = 24 kV	Efficiency (%) at 50% load Um =36 kV
Single phase (and SWER*)	10	98.42	97.53	97.32	96.87
	16	98.64	97.83	97.55	97.11
	25	98.80	98.11	97.78	97.37
	50	99.00	98.50	98.10	97.74
Three phase	25	98.50	97.42	97.42	96.92
	63	98.82	98.01	98.01	97.30
	100	99.00	98.28	98.28	97.58
	200	99.11	98.64	98.60	98.26
	315	99.19	98.82	98.74	98.44
	500	99.26	98.97	98.87	98.62
	750	99.32	99.08	98.98	98.77
	1000	99.37	99.14	99.04	98.87
	1500	99.40	99.21	99.12	98.99
	2000	99.40	99.24	99.17	99.00
	2500	99.40	99.27	99.20	99.00
	3150	99.40	99.27	99.20	99.00

* SWER: single wire earth return transformer

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9 Lifts and escalators

Energy efficiency of lifts and escalators may take direct reference to VDI 4707 (Energy efficiency of lifts) for planning. For measurements of energy consumption on installed equipment, ISO 25745 (Energy performance of lifts, escalators and moving walks) could be applied. Other equivalent of VDI 4707 and ISO 25745 may also be used.

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Under the national standardisation programme, SPRING Singapore helps companies and industry to meet international standards and conformity requirements by creating awareness of the importance of standardisation to enhance competitiveness and improve productivity, co-ordinating the development and use of Singapore Standards and setting up an information infrastructure to educate companies and industry on the latest developments.

SPRING Singapore is vested with the authority to appoint a Standards Council to advise on the preparation, publication and promulgation of Singapore Standards and Technical References and their implementation.

Singapore Standards are in the form of specifications for materials and products, codes of practice, methods of test, nomenclature, services, etc. The respective committee or working group will draw up the standards before seeking final approval from the Standards Council or the relevant Standards Committee. To ensure adequate representation of all viewpoints in the preparation of Singapore Standards, all committees appointed consist of representatives from various interest groups which include government agencies, professional bodies, tertiary institutions and consumer, trade and manufacturing organisations.

Technical References are transition documents developed to help meet urgent industry demand for specifications or requirements on a particular product, process or service in an area where there is an absence of reference standards. Unlike Singapore Standards, they are issued for comments over a period of two years before assessment on their suitability for approval as Singapore Standards. All comments are considered when a technical reference is reviewed at the end of two years to determine the feasibility of its transition to a Singapore Standard. Technical References can therefore become Singapore Standards after two years, continue as Technical References for further comments or be withdrawn.

In the international arena, SPRING Singapore represents Singapore in the International Organization of Standardization (ISO), the Asia-Pacific Economic Co-operation (APEC) Sub-committee for Standards and Conformance (SCSC) and in the ASEAN Consultative Committee on Standards and Quality (ACCSQ). The Singapore National Committee of the International Electrotechnical Commission which is supported by SPRING Singapore, represents Singapore in the IEC.

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