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QCVN 09:2017/BXD

NATIONAL TECHNICAL REGULATION ON ENERGY EFFICIENCY BUILDINGS

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CONTENTS

INTRODUCTION

QCVN 09:2017/BXD - "National Technical Regulation on Energy Efficiency Buildings" was reviewed by the Construction Technique Institute (Vietnam Association of Structural Engineering and Construction Technology) based on the QCVN 09:2013/BXD, submitted by the Department of Science, Technology and Environment, and enacted by the Ministry of Construction under Circular 15/2017/TT-BXD, dated on December 28, 2017.

QCVN 09:2017/BXD shall replace the QCVN 09:2013/BXD - "National Technical Regulation on Energy Efficiency Buildings", which was enacted by the Minister of Construction in Circular 15 /2013/TT-BXD dated September 26, 2013.

The National Technical Regulation on Energy Efficiency Buildings was developed thanks to the support of the Government of Denmark and the contribution of experts from the Vietnam Association of Civil Engineering Environment, the International Finance Corporation (IFC), and the Pacific Northwest National Laboratory (PNNL) of the United States Department of Energy.

National Technical Regulation on Energy Efficiency Buildings

1. GENERAL REQUIREMENTS

1.1. Scope

1.1.1 The National Technical Regulation on Energy Efficiency Buildings provides mandatory technical standards in design, construction or retrofit of buildings with a gross floor area of 2,500 m^2 or larger of the following types:

1) Offices;
2) Hotels;
3) Hospitals;
4) Schools;
5) Commercials, services,
6) Residential.

1.1.2 The requirements of this Regulation apply to:

1) Building envelope;
2) Ventilation and air conditioning systems;
3) Lighting systems;
4) Other electrical equipment (electric motors, water heating systems).

NOTE: For retrofit projects of building types within the scope of this Regulation, the mandatory requirements for building envelope, ventilation and air conditioning systems, lighting systems and other electrical equipment shall apply to the corresponding systems to be retrofitted.

1.2. Coverage

This Regulation shall apply to all organizations and individuals involved in activities pertaining to construction of buildings within the scope of this Regulation.

1.3. References

QCXDVN 05:2008/BXD	Vietnam Building Code: Dwellings and Public Buildings - Occupational Health and Safety;
QCVN 12:2014/BXD	National Technical Regulation on Electrical Installations of Dwelling and Public Buildings;
AMCA 205	Energy efficiency classification for fans;
ANSI Z21.10.3	Gas Water Heater, Volume 3, Storage, with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous Water Heaters;
ARI 210/240	Performance rating of unitary air-conditioning and air-source heat pump equipment;
ARI 340/360	Performance rating of commercial and industrial unitary air-conditioning and heat pump equipment;
ARI 365	Commercial and industrial unitary air-conditioning condensing units;
ARI 550/590	Performance rating of water-chilling packages using the vapor compression cycle;
ARI 560-2000	Absorption water chilling and water heating packages;
ASHRAE 90.1-2016	Energy standard for buildings except low-rise residential buildings;
NEMA MG 1-2016	Motors and generators;

NFRC 200-2017	Procedure for determining fenestration product Solar Heat Gain Coefficients and Visible Transmittance at normal incidence;
ISO 6946-2017	Building components and building elements: Thermal resistance and thermal transmittance - Calculation method;
ISO 10456-2007	Building materials and products – Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values
ISO 12759:2010	Fans - Efficiency classification for fans
TCVN 4605:1988	Heating techniques - Insulating components - Design standard
TCVN 5687:2010	Ventilation, Air-conditioning - Design standard;
TCVN 6307:1997 (ISO 916:1968)	Testing of refrigerating systems;
TCVN 6576:2013 (ISO 5151:2010)	Non-ducted air conditioners and heat pumps - Testing and rating for performance;
TCVN 7540:2013	Three-phase asynchronous squirrel cage electrical motors:
	Part 1: Energy efficiency (TCVN 7540-1:2013); Part 2: Methods for determination of energy efficiency (TCVN 7540-2:2013);
TCVN 7830:2015	Non-ducted Air Conditioners - Energy Efficiency;
TCVN 9258:2012	Heat protection for residential buildings - Design guide;
TCVN 10273-1:2013 (ISO 16358-1:2013)	Air-cooled air conditioners and air-to-air heat pumps - Testing and calculating methods for seasonal performance factors - Part 1: Cooling seasonal performance factor;

1.4. Terms, definitions and symbols

1.4.1. Terms and definitions

1) *Fan Efficiency Grade (FEG):* The numerical rating that indicates the aerodynamic quality of a fan. It is defined as the air power divided by the fan input power;

2) *Coefficient of Performance (COP, kW/kW):* The ratio of the rate of heat removal to the rate of energy input, in consistent units, to be verified in accordance with existing national standards or designated operating conditions. COP is used to rate the efficiency of electricity-powered condenser air conditioner, including the compressor, evaporator coil and condenser coil. COP can also be used to rate the efficiency of water-cooled chiller (not including chiller pumps, condensed cooling water and cooling tower fans);

3) *Coefficient of performance (COP) - heat pump*: the ratio of the rate of heat output to the rate of energy input, in consistent units, for a complete heat pump system under designated operating conditions;

4) *Overall thermal transfer value (OTTV)*: The total heat gain through the entire surface area of the building envelope, including opaque walls and glazing by every square meter of the building exterior surface area, W/m^2;

5) *Thermal Transmittance (U_0)*: The intensity of a time-constant heat flux going through a surface area unit of the enclosing structure when the temperature difference of the air on both sides of the structure is 1 K, measured in $W/m^2.K$;

6) *Thermal Resistance:* The inverse of overall heat transfer coefficient U_0: $R_0 = 1/U_o$, measured in m^2.K/W;

7) *Lamp efficiency*: The ratio of rated light output to power consumption, measured in lumen/W;

8) *Efficiency of the ventilation & air-conditioning systems*: The ratio of output energy (useful energy at the time of use) to input energy, in consistent unit, for a specific length of time, measured in %;

9) *Lighting power density (LPD)*: The ratio of electric lighting output to the illuminated area, measured in W/m^2;

10) *Building envelope*: Building envelope or building enclosure consists of opaque or transparent walls, windows, doors, skylights, among others, that form enclosed spaces within a building.

1.4.2. Symbols, measurement units and acronyms

1) Symbols and measurement units

SHGC	Heat gain coefficient (Solar Heat Gain Coefficient) of glazing, published by manufacturers or determined in accordance with prevailing standards, dimensionless. In case manufacturers avails of the shading coefficient SC, SHGC = SC x 0.86;
SC	Shading Coefficient
R_0	Thermal resistance of enclosing assembly, measured in m^2.K/W.
	Thermal Transmittance $U_0 = 1/R_0$, $W/(m^2.K)$;
$OTTV_T$	Overall thermal transfer value for walls – the mean intensity of the heat flux transferred through 1 m^2 of exterior walls, W/m^2;
$OTTV_M$	Overall thermal transfer value for roofs – the mean intensity of the heat flux transferred through 1 m^2 of roofing, W/m^2;
WWR	Window to Wall Ratio, measured in %;

2) Acronyms

AHU	Air Handling Unit;
AMCA	Air Movement and Control Association International, Inc.;
ANSI	American National Standards Institute;
ARI	Air Conditioning and Refrigeration Institute;
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers;
ASME	American Society of Mechanical Engineers;
HVAC	Heating, Ventilation and Air Conditioning
NEMA	National Electric Manufacturers Association
NFRC	National Fenestration Rating Council, Inc.
ISO	International Organization for Standardization
QCVN	National Technical Regulation;
TCVN	National Standard

2. TECHNICAL REQUIREMENTS

2.1. Building envelope

2.1.1 Technical requirements for building envelope shall only apply to air-conditioned spaces.

2.1.2 Requirements for building exterior walls and roofs

1) Thermal Resistance R_0 of the opaque parts:

- Exterior walls above the ground surface (opaque parts of the walls) of the air-conditioned spaces shall maintain a minimum overall thermal resistance value $R_{0.min}$ no smaller than 0.56 m^2.K/W;
- Flat roofs and roofs with gradient of less than 15 degrees placed directly above the air-conditioned spaces shall maintain a minimum overall thermal resistance value $R_{0.min}$ no smaller than 1.00 m^2.K/W.

NOTES*:*

- Flat roofs with reflective materials: Thermal resistance value $R_{0.min}$ may be multiplied by a coefficient of 0.80 for roofs designed with reflective materials that have a solar reflectivity within a range of 0.70÷0.75[(1)] to increase heat reflectivity for the exterior roof surface (Annex 5);
- Roofs with gradient of 15 degrees or above: The minimum total thermal resistance value for roofs may be identified by multiplying $R_{0.min}$ with a coefficient of 0.85;
- Roofs which are not obliged to follow Item 2.1.2: More than 90% of the roof is covered with a permanent sunshade with ventilation. The sunshade must be installed at a minimum clearance of 0.3 m from the roof surface to be recognized as having ventilation between the roof and sunshade (double-layer roof with an air cushion in between).

2) Requirements for the transparent parts (glazing)

- Maximum SHGC values for glazing shall be respectively determined for the North facing façade, the South facing façade (North facing façade is defined as the façade oriented within the range of 22.5 degrees West of North and 22.5 degrees East of North; South facing façade is defined similarly) and the other orientations. Maximum SHGC values must comply with the values specified in Table 2.1.

Table 2.1 - WWR-related SHGC for glazing

WWR (%)	SHGC		
	North	South	Other orientations
20	0.90	0.90	0.80
30	0.64	0.70	0.58
40	0.50	0.56	0.46
50	0.40	0.45	0.38
60	0.33	0.39	0.32
70	0.27	0.33	0.27
80	0.23	0.28	0.23
90	0.20	0.25	0.20
100	0.17	0.22	0.17

NOTES:

- WWR shall be calculated for each of the façades then averaged for the entire building[(2)];
- If WWR does not match with the values in the table, SHGC values shall be determined through linear interpolation using the nearest higher and lower WWR values;

[1] *VGBC's comment: It should be materials that have a solar reflectivity higher than 0.70.*

[2] *VGBC's comment: Actually there is no need to calculate the average WWR of the building as SHGC requirements are given for different orientations.*

- SHGC of each façade or the entire building can be determined through the area-weighted average value of the transparent parts on building façades:

$$\mathbf{SHGC} = \frac{\sum_{i=1}^{n}(\mathbf{SHGC_i} \times \mathbf{A_i})}{\mathbf{A_1} + \mathbf{A_2} + \ldots + \mathbf{A_n}}$$

$SHGC_i$, A_i – respectively, SHGC value and area of the transparent part i (i=1, n).

- Maximum SHGC value of glazed roofs is set at 0.3. For attic spaces designed with daylighting, maximum SHGC value of skylight is 0.6.
- In case of building facades being installed with permanent vertical or horizontal sunshades, SHGC values in Table 2.1 may be adjusted by multiplying them with the A coefficients in Table 2.2a and Table 2.2b.

Table 2.2a - Coefficient A for permanent horizontal sunshades

Projection Factor PF=b/H	Coefficient A		
	North	South	Other orientations
0.10	1.23	1.20	1.09
0.20	1.43	1.39	1.19
0.30	1.56	1.39	1.30
0.40	1.64	1.39	1.41
0.50	1.69	1.39	1.54
0.60	1.75	1.39	1.64
0.70	1.79	1.39	1.75
0.80	1.82	1.39	1.85
0.90	1.85	1.39	1.96
1.00	1.85	1.39	2.08

NOTES:

- PF (Projection Factor) = b/H; b – projection of sunshade from the window surface; H – distance from the window-sill to the bottom of the sunshade; b and H share the same dimension for length.
- Applicable for continuous horizontal sunshades placed above the upper window edge by a distance d, with $d/H \leq 0.1$ (tolerance of less than 10%).

Table 2.2b - Coefficient A for permanent vertical sunshades

Projection Factor PF=b/B	Coefficient A		
	North	South	Other orientations
0.10	1.25	1.11	1.01
0.20	1.52	1.19	1.03
0.30	1.75	1.22	1.05
0.40	1.82	1.25	1.06
0.50	1.85	1.28	1.09
0.60	1.85	1.30	1.10
0.70	1.89	1.30	1.12
0.80	1.89	1.30	1.14
0.90	1.89	1.30	1.16
1.00	1.89	1.30	1.18

NOTES:

- PF (Projection Factor) = b/B; b – projection of the vertical sunshade from the surface of fenestration; B – window width from its side edge to the inner contact of vertical sunshade structure; b and B share the same dimension for length.
- Applicable for continuous vertical sunshades placed by a clearance e from to the window edge, with $e/B \leq 0.1$ (tolerance of less than 10%).

- For buildings adjacent to the street, ground floor spaces, if designed for product and service promotion purposes, shall not have to comply with the SHGC requirements when meeting all of the following requirements: (a) Ground floor height is no greater than 6m; (b) Continuous sunshades with b/H > 0.5; (c) The area of glazing is smaller than 75% of the gross wall area of the ground floor at the side adjacent to street.

3) If the aforementioned requirements for R_0 and SHGC are not applicable, the overall thermal transfer value (OTTV) of the opaque and transparent parts of building envelope shall be applied; and required as follow:

- $OTTV_T$ for walls is no greater than 60 W/m^2;
- $OTTV_M$ for roofs is no greater than 25 W/m^2.

NOTE: $OTTV_T$ for walls and $OTTV_M$ for roofs are determined using prevailing standards and technical guidelines.

2.1.3 Requirements for building components and elements of the walls and roofs

1) Thermal conductivity coefficient λ of materials and Overall thermal resistance value R_0 of walls and roofs are determined in accordance with ISO 6946:2017, or following the instructions in Annex 1, 2, 3, 4 and 6 of this Regulation;

NOTES: Thermal conductivity coefficient λ of a material can be determined based on manufacturer's published data, or according to TCVN 4605:1988, TCVN 9258:2012.

2) SHGC Certification of glazing must be provided by manufacturers. SHGC values of glazing shall be determined in accordance with NFRC 200-2017 standards and conducted by an independent laboratory.

2.2. Ventilation and air conditioning

2.2.1 Natural ventilation

1) Area of vent holes and operable windows on walls and roofs is no less than 5% of the floor area of the space adjacent to the outdoor space.

2) Natural ventilation or mixed-mode ventilation (combining natural ventilation with mechanical ventilation) for parking spaces (garages) shall meet the requirements of QCXDVN 05:2008/BXD.

2.2.2 Mechanical ventilation

1) Mechanical ventilation systems shall meet the requirements for ventilation determined in QCXDVN 05:2008/BXD.

2) Fans with motor of higher than 0.56 kW shall be equipped with automatic controls that are able to turn off the fan when not needed.

NOTES: With the exception of fans in continuous-operation HVAC systems.

2.2.3 Air-conditioning systems

1) Air conditioners and chillers shall ensure the minimum coefficients of performance (COP) in standard rating conditions are not lower than the values provided in Table 2.3 and Table 2.4.

Table 2.3. Coefficient of performance (COP) for direct electric air conditioners

Type of equipment	Cooling output, kW	COP_{Min}, kW/kW	Test procedures
Unitary air-conditioner	-	2.80(*)	TCVN 6576:2013 TCVN 7830:2015 TCVN 10273-1:2013
Split air-conditioner	< 4.5	3.10(*)	
	≥ 4.5 and < 7.0	3.00(*)	
	≥ 7.0 and < 12.0	2.80(*)	
Air conditioners, air cooled	≥14.0 and < 19	3.81	TCVN 6307:1997 or ARI 210/240
	≥ 19 and < 40	3.28	ARI 340/360
	≥ 40 and < 70	2.22	
	≥ 70 and < 223	2.93	
	≥ 223	2.84	
Air conditioners, water cooled	< 19	3.54	ARI 210/240
	≥ 19 and < 40	3.54	ARI 340/360
	≥ 40 and < 70	3.66	
	≥ 70 and < 223	3.63	
	≥ 223	3.57	
Air conditioners, evaporatively cooled	< 19	3.54	ARI 210/240
	≥ 19 and < 40	3.54	ARI 340/360
	≥ 40 and < 70	3.51	
	≥ 70 and < 223	3.48	
	≥ 223	3.43	
Condensing units, air cooled	≥ 40	3.07	ARI 365
Condensing units, water and evaporatively cooled	≥ 40	3.95	

NOTES*:*

Coefficient of performance (COP) = Cooling capacity / Power input (kW/kW);

Condenser units include compressor and condenser coils;

(*) Unitary air-conditioner or split air-conditioner: Energy efficiency of the equipment shall be determined by Cooling Seasonal Performance Factor (CSPF) instead of COP. The procedure for testing and reviewing energy efficiency of the equipment shall be conducted as per TCVN 7830:2015, TCVN 6576:2013 and TCVN 10273-1:2013 (ISO 5151:2000).

Table 2.4. Coefficient of Performance for Chillers

Type of equipment	Cooling output (kW)	COP_{Min}, kW/kW
Air-cooled chillers, Attached or separated[3] condenser, electrically operated	All capacities	2.80
Reciprocating water-cooled chillers, electrically operated	Follow the requirements for electric water-cooled rotary screw/scroll chiller	
Rotary screw/scroll water-cooled chillers, electrically operated	< 264	4.51
	≥ 264 and < 528	4.53
	≥ 528 and < 1055	5.17
	≥ 1055	5.67
Centrifugal water-cooled chillers, electrically operated	< 528	5.55
	≥ 528 and < 1055	5.55
	≥ 1055 and < 2110	6.11
	≥ 2110	6.17
Air-cooled absorption, single effect	All capacities	0.60 (*)
Water-cooled absorption, double effect[4]	All capacities	0.70 (*)
Absorption double effect, indirect fired	All capacities	1.00 (*)
Absorption double effect, direct fired	All capacities	1.00 (*)

NOTES:

(*) For absorption chillers, COP = Cooling load / Heat input;
Performance of absorption chillers shall be rated as per ARI Standard 560;
Performance of water-cooled packages shall be rated as per ARI Standard 550 / 590.

2) Each of chillers, hot air systems, cooling tower fans and pumps with capacity equal to or greater than 5 HPs (3.7 kW) must be equipped with an automatic control device to adjust capacity and flow rate according to cooling or heating load and water level.

3) For ventilation and air conditioning system with capacity equal to or greater than 5 HPs (3.7 kW), fan motors must have a Fan Efficiency Grade (FEG) higher than 67 as rated under AMCA Standard 205.

   NOTE: ISO 12759:2010 can also be applied.

4) Buildings with central air conditioning system must be equipped with enthalpy recovery system. Energy recovery efficiency of the equipment shall be no smaller than 50%.

5) Insulation material and thickness of refrigerant conduits, cooled water conduits, air supply and air recovery ducts must be designed, installed and commissioned in accordance with a technical standard, which is selected for the entire building.

   NOTE: The technical standard shall be selected by project owner. Applicable standards may include: TCVN 5687:2010, ASHRAE 90.1 and other equivalent standards.

6) Coefficient of Performance – COP (or Cooling Seasonal Performance Factor – CSPF) specified in Table 2.3 and Table 2.4, and Fan Efficiency Grade - FEG must be reviewed by an independent laboratory. Prior to the acquisition and installation of air-conditioning equipment, testing certificates of each technical criteria must be provided by manufactures.

[3] *VGBC's comment: Air-cooled chillers with separated condenser should be rated with matching condensers.*
[4] *VGBC's comment: It should be single-effect chiller according to ASHRAE 90.1-2013.*

2.3. Lighting

2.3.1 Natural lighting

Workrooms, study rooms and reading rooms with daylit zones must be equipped with artificial lighting control systems.

NOTE: Lighting control requirements for daylit zones shall not be applied to hospitals and medical centers, apartments and other building types that have specialized lighting needs.

2.3.2 Artificial lighting

1) The minimum illuminance (lux) in dwelling and public buildings must comply with the requirements of the National Technical Regulation QCVN 12:2014/BXD.

2) Lighting power density (LPD) of interior spaces shall not exceed the maximum allowed limits listed in Table 2.5.

Table 2.5. Lighting power density (LPD)

Type of building	LPD (W/m^2)
Offices	11
Hotels	11
Hospitals	13
Medical and health care centers*	11
Library*	14
Convention centers*	15
Schools	12
Commercial and service buildings	16
Apartments	8
Storage*	9
Indoor parking areas	3

NOTES:

- (*) Applicable to space types within buildings under the scope of this Regulation;
- Lighting power density - LPD is calculated as the ratio of the designed total lighting output to total occupied area;
- For mixed-use buildings with multiple functional areas: LPD shall be determined based on lighting output and occupied area of each function;
- For areas or spaces that have specialized lighting needs such as educational or medical facilities: LPD shall be determined as per applied design standards;
- For apartment buildings: Use lighting fixtures with energy labels specified by prevailing regulations instead of the requirements specified in this Table.

3) Lighting control

a) Lighting control

- Design and install lighting shut-off controls to turn lighting devices off when not needed, independent controls should be provided for areas of no more than 2,500 m^2 but not more than one floor[(5)];

[5] *VGBC's comment: Based on ASHRAE Standard 90.1-2007, the following details can be added:*
Design and install automatic lighting shut-off controls which can function on either:
1. *a scheduled basis using time-of-day operated control device that turns lighting off at specific programmed times. An independent program schedule shall not cover an area of more than 2,500 m2 and shall not cover more than one floor;*
2. *an occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space;*
3. *a signal from another control or alarm system that indicates the area is unoccupied.*

- Each control device shall be designed and installed to cover a maximum occupied area of 250 m^2 for a space area equal to or less than 1,000 m^2; or to cover a maximum occupied area of 1,000 m^2 for a space area greater than 1,000 m^2.
- For areas within a distance of 6 meters to an exterior wall, which is designed with glazing with WWR ≥ 40%, lighting control devices must be installed to enable reducing lighting power.

  NOTE: This requirement is not applicable to spaces with around-the-clock lighting requirement; as well as spaces with special requirement for safety and security.

b) Lighting control for indoor parking areas

- Automatic lighting shutoff (see above);
- Install lighting control devices to reduce lighting power of each light source by at least 30% when there is no activity within the artificially lit area;

  NOTE: This requirement is not applicable to entrance areas adjacent to the outdoor space.

2.4. Other electrical equipment

1) Electric motors

a) All 3-phase (50 Hz) motors, regardless of being manufactured as an independent equipment or as a part of a building equipment, shall have a minimum full-load motor efficiency of no less than the values specified in Table 2.6.

b) The manufacturer's label on motors' housing must provide information of the minimum full-load efficiency. Motor efficiency shall be determined as per NEMA MG-1 standards.

NOTE: TCVN 7540-2:2013 or equivalent standards can be applied.

c) Upon installing, testing and commissioning of electric motors as per prevailing regulations, manufacturers' published information of the minimum motor efficiency affixed on housing must be tested.

Table 2.6. Minimum full-load efficiency for electric motors

Motor output (kW)	Open Motors			Enclosed Motors		
	2 pole	4 pole	6 pole	2 pole	4 pole	6 pole
	Speed (rpm – rounds per minute)					
	3600	1800	1200	3600	1800	1200
0.8	77.0	85.5	82.5	77.0	85.5	82.5
1.1	84.0	86.5	86.5	84.0	86.5	87.5
1.5	85.5	86.5	87.5	85.5	86.5	88.5
2.2	85.5	89.5	88.5	96.5	89.5	89.5
3.7	86.5	89.5	89.5	88.5	89.5	89.5
5.6	88.5	91.0	90.2	89.5	91.7	91.0
7.5	89.5	91.7	91.7	90.2	91.7	91.0
11.1	90.2	93.0	91.7	91.0	92.4	91.7
14.9	91.0	93.0	92.4	91.0	93.0	91.7
18.7	91.7	93.6	93.0	91.7	93.6	93.0
22.4	91.7	94.1	93.6	91.7	93.6	93.0
29.8	92.4	94.1	94.1	92.4	94.1	94.1
37.3	93.0	94.5	94.1	93.0	94.5	94.1
44.8	93.6	95.0	94.5	93.6	95.0	94.5
56.0	93.6	95.0	94.5	93.6	95.4	94.5

Motor output (kW)	Open Motors			Enclosed Motors		
	2 pole	4 pole	6 pole	2 pole	4 pole	6 pole
	Speed (rpm – rounds per minute)					
	3600	1800	1200	3600	1800	1200
74.6	93.6	95.4	95.0	94.1	95.4	95.0
93.3	94.1	95.4	95.0	95.0	95.4	95.0
111.9	94.1	95.8	95.4	95.0	95.8	95.8
149.2	95.0	95.8	95.4	95.4	96.2	95.8
186.5	95.0	95.8	95.4	95.8	96.2	95.8
223.8	95.4	95.8	95.4	95.8	96.2	95.8
261.1	95.4	95.8	95.4	95.8	96.2	95.8
298.4	95.8	95.8	95.8	95.8	96.2	95.8
357.7	95.8	96.2	96.2	95.8	96.2	95.8
373.0	95.8	96.2	96.2	95.8	96.2	95.8

2) Water heating system

a) Water heating equipment efficiency

- All water heating equipment and boilers of the building shall maintain a minimum efficiency as specified in Table 2.7;
- All heat pump water heaters shall maintain a minimum COP as specified in Table 2.8;
- For solar water heating systems: Solar water heaters shall maintain a minimum efficiency of 60% and a minimum thermal resistance value R_0 of 2.2 m^2.K/W at the back of solar panels.

Table 2.7. Minimum efficiency of water heating equipment

Equipment type	Minimum efficiency E_T, %
Gas-fired storage water heaters	78
Gas-fired instantaneous water heaters	78
Gas-fired hot water supply boilers	77
Fuel oil-fired hot water heaters and supply systems	80
Duel fuel gas/oil-fired hot water supply boilers	80
Firewood/paper-fired boiler with output of 10÷350 kW	60
Brown coal-fired boilers with output of 10÷2000 kW	70
Pitcoal-fired boilers with output of 10÷2000 kW	73
Electric resistance water heaters	$E_{min} = 5.9 + 5.3V^{0.5}$ (W)

NOTES:

- The minimum efficiency of gas/oil-fired water heaters is given in form of Thermal efficiency (E_T), which includes thermal losses from the heater shells.
- The minimum efficiency of electric resistance water heaters shall be determined according to the maximum Standby Loss (SL), where exists a difference of 40^OC between stored water temperature and ambient temperature. In the aforementioned equation, V is volume in liters;
- Test procedure shall be conducted as per ANSI Z21.10.3 or equivalent standards.

Table 2.8. Minimum COP of water heating heat pumps

Equipment type	COP, kW/kW
Air-source heat pump water heaters	≥ 3.0
Water-source heat pump water heaters	≥ 3.5
Heat recovery air conditioners: - Hot water supply mode - Air conditioning and hot water supply mode	 ≥ 3.0 ≥ 5.5

b) Prior to the installation of water heaters, equipment efficiency data provided by manufacturers must be reviewed.

c) Thermal insulation of hot water pipes shall be designed, installed and commissioned in accordance with a design standard, which is selected for the entire building.

d) Control of water heating systems

- Temperature control systems shall be installed to maintain water temperature at a maximum of 49°C when in use;
- Temperature control systems shall be installed to maintain tap water temperature at washbasins and bathtubs in public restrooms at a maximum of 43°C.
- Recirculating pumps used to maintain storage tank water temperature shall be controlled to operate correspondingly with the operation mode of hot water supply system.

e) For apartment buildings designed with centralized water heating systems, a renewable energy source (solar, wind, heat recovery, etc.) shall be used as a supplement to the main energy source for water heating systems.

3. REGULATION ON MANAGEMENT

3.1. Design documentation of new construction or retrofit of buildings within the scope of this Regulation shall include a narrative report demonstrating the compliance with the requirements of this Regulation.

3.2. The review and assessment process of building design, construction and commissioning shall be conducted in accordance with the prevailing regulations, including QCVN 09:2017/BXD.

4. IMPLEMENTATION

4.1. The Science - Technology and Environment Department (Ministry of Construction) is responsible for providing implementation guidelines of QCVN 09:2017/BXD to concerned parties.

4.2. Governmental authorities for construction are responsible for monitoring the compliance with QCVN 09:2017/BXD of construction investment activities within their management duties according to the prevailing regulations.

4.3. For any problems that may arise during the adoption of this Regulation, the concerned parties shall contact the Science - Technology and Environment Department (Ministry of Construction) for guidance and support.

Annex 1: Overall thermal resistance value R_0 of building envelope

1) Overall thermal resistance value R0 is given by the following equation:

$$R_0 = \frac{1}{h_N} + \sum_{1}^{n} \frac{b_i}{\lambda_i} + R_a + \frac{1}{h_T} ; \qquad (m2.K/W)$$

where:

h_N, h_T respectively, heat transfer coefficients of outer and inner surfaces of building enclosure (see Annex 3), $W/m^2.K$;

b_i thickness of material layer (i), m;

λ_i thermal conductivity of material layer (i) of the building enclosure, W/m.K;

N number of material layers of the building enclosure;

R_a thermal resistance of the air layer inside the building enclosure, if any, $m^2.K/W$.

2) Physical properties of building materials (Annexes 2, 3 and 4)

Annex 2: Thermal conductivity of building materials (for reference)

Name of Material	**Unit weight, *kg/m³***	**Thermal conductivity λ, *W/(m.K)***
1. Concrete		
Cement wire mesh roof tile	2500	2.04
Reinforced concrete	2400	1.55
Heavy-weight concrete	2200	1.20
Light-weight concrete (cinder concrete)	1500	0.70
	1200	0.52
	1000	0.41
Autoclaved foam concrete	1000	0.40
	800	0.29
	600	0.21
	400	0.15
Autoclaved foam silicate concrete	800	0.29
	600	0.21
	400	0.15
2. Gypsum		
Gypsum drywall board	1000	0.23
Gypsum-slag concrete	1000	0.37
3. Baked materials and mortars		
Baked clay brick	2000	0.93
Baked clay brick	1600	0.70
Baked clay brick, bonded with heavy-weight mortar	1800	0.81
Baked clay brick, bonded with light-weight mortar	1700	0.76

Name of Material	**Unit weight, *kg/m³***	**Thermal conductivity λ, *W/(m.K)***
Hollow brick (1300 kg/m³), bonded with light-weight mortar (1400 kg/m³)	1350	0.58
Multi-hole brick, bonded with heavy-weight mortar	1300	0.52
Cement mortar	1800	0.93
Three-component mortar	1700	0.87
Lime mortar	1600	0.81
4. Non-fired bricks and Autoclaved Aerated Concrete (AAC) blocks		
Cinder block	1400	0.58
Silicate bricks, bonded with heavy-weight mortar	1900	0.87
Autoclaved aerated non-fired brick	400 – 900	0.12 – 0.13
Autoclaved Aerated Concrete (AAC)	400 – 800	0.153
5. Glass materials		
Glass (wall, window)	2500	0.78
Fiberglass	200	0.06
6. Wood materials		
Pine and cedar (across the grain)	550	0.15
Pine and cedar (along the grain)	550	0.17
Plywood board	600	0.17
Fiberboard	600	0.16
	250	0.08
	150	0.06
Corkwood	250	0.07
7. Metals		
Steel, sheet metal	7850	58
Aluminum	2600	220
NOTES: - Thermal conductivity: 1 W/(m.K) = 0.86 kcal/m.h.^{0}C; - Thermal conductivity value of material can be taken from experimental results or ISO 10456:2007 technical standards.		

Annex 3: Surface heat transfer coefficient of building enclosure (for reference)

Quantity	**Direction of heat flow**		
	Horizontal *(for walls)*	**Upwards *(for roofs)***	**Downwards *(for roofs)***
External surface heat transfer coefficient h_N, W/(m².K)	25	25	25
Internal surface heat transfer coefficient h_T, W/(m².K)	7.692	10	5.882
NOTE: Refer to ISO Standard 6946:2007.			

Annex 4[(6)]: Thermal resistance of unventilated air layer Ra (m^2.K/W) (for reference)

Thickness of air layer, *mm*	**Direction of heat flow**		
	Horizontal ***(for vertical air layer)***	**Upwards** ***(for horizontal air layer)***	**Downwards** ***(for horizontal air layer)***
0	0.00	0.00	0.00
5	0.11	0.11	0.11
7	0.13	0.13	0.13
10	0.15	0.15	0.15
15	0.17	0.16	0.17
25	0.18	0.16	0.19
50	0.18	0.16	0.21
100	0.18	0.16	0.22
300	0.18	0.16	0.23
NOTE: Refer to ISO Standard 6946:2007.			

Annex 5: Solar heat gain coefficient α of material surface (for reference)

No.	**Surface, Material and Color**	**α coefficient**
A. Wall surface		
1	Polished white limestone	0.35
2	Polished dark limestone	0.50
3	Polished white marble	0.30
4	Polished dark marble	0.65
5	Polished light grey granite	0.55
6	polished grey granite	0.60
7	White glazed-brick	0.26
8	bright brown glazed-brick	0.55
9	Dusted common brick	0.77
10	New-red common brick	0.7 – 0.74
11	Bright surface tile	0.45
12	Smooth, even concrete surface	0.54 – 0.65
13	Yellow-white painted mortar surface	0.42
14	Dark painted mortar surface	0.73
15	White painted mortar surface	0.40
16	Light blue painted mortar surface	0.59
17	Grey cement painted mortar surface	0.47
18	White cement painted mortar surface	0.32
19	Plain wood	0.59
20	Dark painted wood	0.77
21	Light yellow painted wood	0.60

[6] *VGBC's comment:*
The values in this table apply when the emissivities of the surfaces bounding the air layer are higher than 0.8. In other configurations, thermal resistance of unventilated air layer should be calculated following ISO 6946.

B. Roof surface		
22	New white fibro-cement board	0.42
23	white fibro-cement board, 6-month used	0.61
24	white fibro-cement board, 12-month used	0.71
25	White corrugated sheet	0.26
26	Black corrugated sheet	0.86
27	Red or brown roof tile	0.65 – 0.72
28	Grey cement roof tile	0.65
29	New galvanized steel sheet	0.30
30	Dusted galvanized steel sheet	0.90
31	Unpolished aluminum	0.52
32	Unpolished aluminum	0.26
C. Painted surface		
33	Pink paint	0.52
34	Blue paint	0.64
35	Bright-blue cobalt paint	0.58
36	Purple cobalt paint	0.83
37	Yellow paint	0.44
38	Red paint	0.63
D. Transparent materials		
39	7 mm-thick glass	0.076
40	4.5 mm-thick glass	0.04
41	6 mm-thick glass with heat absorbing surface	0.306
42	0.1 mm-thick polyclovinil screen	0.096
43	0.08 mm-thick AFF polyamide screen	0.164
44	0.085 mm-thick AFF polyethylene screen	0.109

Annex 6: Total thermal resistance R_0 of common walls and roofs (for reference)

No.	Material layer	Thickness, *m*	Thermal conductivity coefficient λ, *W/(m.K)*	Ro, $m^2.K/W$
A. Solid baked clay brick wall (standard thickness: 110/220 mm)				
1	Exterior cement plaster	0.015	0.93	0.48/0.62
2	Solid baked clay brick[1]	0.105/0.220	0.81	
3	Interior cement plaster	0.015	0.93	
B. Hollow baked clay brick wall (standard thickness: 110/220 mm)				
1	Exterior cement plaster	0.015	0.93	0.55/0.77
2	Hollow baked clay brick	0.105/0.220	0.52	
3	Interior cement plaster	0.015	0.93	

No.	Material layer	Thickness, *m*	Thermal conductivity coefficient λ, *W/(m.K)*	Ro, $m^2.K/W$
C. Autoclaved aerated concrete (AAC) wall (standard thickness: 100/200 mm)				
1	Exterior cement plaster	0.015	0.93	1.00/1.65
2	AAC block (γ = 600 kg/m^3)[3]	0.100/0.200	0.153	
3	Interior cement plaster	0.015	0.93	
D. Concrete brick wall (standard thickness: 110/220 mm)				
1	Exterior cement plaster	0.015	0.93	0.50/0.66
2	Concrete brick (cinder)[4]	0.105/0.220	0.70	
3	Interior cement plaster	0.015	0.93	
E. Non-autoclaved aerated foam concrete brick wall (standard thickness: 110/220 mm)				
1	Exterior cement plaster	0.015	0.93	0.63/0.94
2	Aerated foam concrete brick[5]	0.105/0.220	0.37	
3	Interior cement plaster	0.015	0.93	
F. Silicate brick wall (standard thickness: 110/220 mm)				
1	Exterior cement plaster	0.015	0.93	0.47/0.60
2	Silicate brick	0.105/0.220	0.87	
3	Interior cement plaster	0.015	0.93	
G. 3D construction panel[6] (thickness: 160/180 mm)				
1	Exterior cement plaster	0.015	0.93	1.04/1.54
2	3D wire steel mesh panel	0.05	0.93	
3	Expanded Polystyrene System (EPS)	0.03/0.05	0.04	
4	3D wire steel mesh panel	0.05	0.93	
5	Interior cement plaster	0.015	0.93	
H. Roof with heat insulation layers: Refer to TCVN 9258:2012.				

NOTES:

[1] TCVN 1451:1998 Solid clay bricks

[2] TCVN 1450:2009 Hollow clay bricks

[3] TCVN 7959:2011 Lightweight concrete - Autoclaved aerated concrete bricks (AAC)

[4] TCVN 6477:2011 Concrete brick

[5] TCVN 9029:2011 Lightweight concrete - Non-autoclaved aerated, foam concrete bricks - Specifications

[6] TCVN 7575:2007 3D construction panels