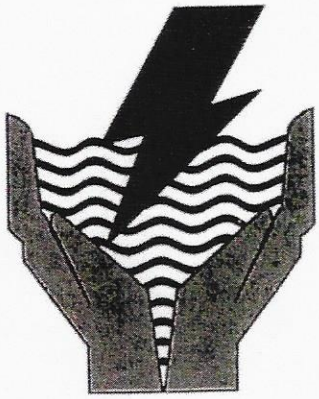


MINISTRY OF
ELECTRICITY AND WATER

ENERGY CONSERVATION CODE
FOR BUILDINGS

MEW/R-6/2018

Foreword

The Energy Conservation Code has always been the main doctrine for practitioners in the buildings' design and air-conditioning fields, as air-conditioning load is attributed to 70% of the peak load in the summer months. Therefore, it is imperative to ensure its up-to-date status and proper implementation. Hence, the ministry is adopting a new strategic approach whereby:

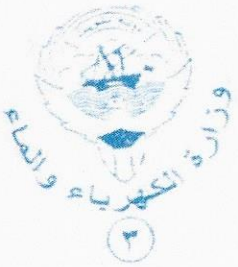
- Updating the Code will be a continuous process to cope up with technological advances, and amendments will be published on a regular basis as deemed necessary.
- The ministry will expand its existing authority to ensure proper implementation of the code not only in the design stage but also during the construction stage.
- The consulting offices are empowered, and held responsible for accurate implementation of the Code during the design and the construction stages.

The ministry, understanding that reform starts at home, has imposed more stringent specifications and standards in this code for all the government buildings in an effort to reduce the buildings peak load as well as energy consumption requirements. Also, realizing that conservation is a community-wise task, MEW urges the assistance of all parties to play their effective role to help cut down the escalating demand of energy and water consumption.

Dr. Meshan M. Al-Otaibi

Assistant Undersecretary for consumer affairs,

Chairman of the Energy Conservation Code Approval Committee



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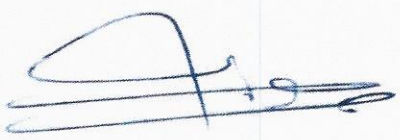

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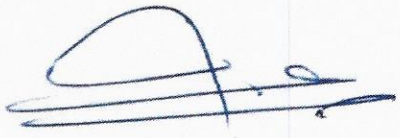


Abbreviations and Acronyms

A/C	Air conditioning
AC	Air-cooled
BAS	Building Automation System
CHIL	Chiller
DBT	Dry-bulb temperature
DX	Direct expansion
FOM	Figure of Merit
HP	Horse power
NDT	Non-Destructive testing
NFRC	National Fenestration Rating Council
PAHW	Public Authority for Housing Welfare
PF	Power factor
PR	Power rating
RT	Refrigeration ton
SHGC	Solar heat gain coefficient
TES	Thermal energy storage
TMY	Typical Meteorological Year
VFD	Variable frequency drive
VRF	Variable refrigerant flow
WBT	Wet-bulb temperature
WC	Water-cooled

1 GENERAL

1.1 Purpose

The purpose of this code is to provide minimum requirements for the energy-efficient design of governmental, commercial and residential buildings in Kuwait.

1.2 Scope

This revised code provides the minimum energy requirements for the design and construction of energy-efficient buildings; both entirely new buildings and new portions of existing buildings. It includes, but not limited to, insulation of building envelope, lighting systems, fenestration, heating, ventilation and air-conditioning (HVAC) systems.

In addition, criteria are provided for determining compliance with these requirements. The provisions of this revised code apply to 1) residential buildings built by the owner or by the Public Authority for Housing Welfare (PAHW), 2) governmental buildings including buildings for the Oil and Military Sectors, and 3) commercial buildings. In the event the requirements for any case are not stated in this document, the latest version of the ASHRAE 90.1 Standard shall be used. The code shall not be used to circumvent any safety, health or environmental requirements.

1.3 Definitions

A/C System: A term commonly used that refers to the HVAC system as a whole, and will be used interchangeably with the term "HVAC system".

Air film: Interior and exterior air surface film coefficients for summer and winter design conditions.

***Air-Conditioners (A/C)*:** All active mechanical and electrical systems employed to provide thermal control of the indoor environment.

***Air-cooled A/C system*:** A system where heat is rejected to the outside environment through air, i.e., air-cooled condenser. The cooling transport medium to the place of use may be either air (in a direct expansion (DX) system) or chilled water (in a chilled water system).

Area, door: total area of the door measured using the rough opening and including the door slab and the frame, (See Fenestration area).

Area of all exterior walls (gross): Exterior surface area of the following assemblies that enclose conditioned space: opaque wall assemblies, including between-floor spandrels and peripheral edges of flooring; fenestration assemblies, including all glazed surfaces and sash and framing elements; and door assemblies. Areas of vents, grilles, and pipes are excluded.

Area of all fenestration assemblies: Interior surface area of such assemblies including all glazed surfaces (such as windows, skylights, and sliding glass doors), sashes, curbing, or framing elements that enclose conditioned space. For doors where the daylight opening area is less than 50% of the door area, the fenestration area is the daylight opening area. For all other doors, the fenestration area is the door area.

Area of all floor assemblies: Interior surface area of such assemblies that enclose conditioned space.

Area of all opaque wall assemblies: Gross area of exterior walls measured on the exterior consisting of all opaque wall areas (including foundation walls, between-floor spandrels, peripheral edges of floors, etc.) that enclose conditioned space (including empty spaces).

Assembly: Portion of an envelope component represented by an arrangement and connection of building construction materials with a specific thermal transmittance or thermal conductance.

Building: A structure entirely or partially enclosed within exterior walls, or within exterior and partition walls, and a roof, affording shelter to persons, animals, or property.

Building Air Infiltration or Leakage: Uncontrolled and unintentional flow of outdoor air into a building through cracks or openings and as a result of normal use of exterior doors. Another related term is ex-filtration, which is defined as the leakage of indoor air out of a building. Both types of leakage, expressed in terms of air-change per hour (ACH), result from natural or artificial pressure differences. ACH is the ratio of the outdoor airflow in a building in an hour to its volume.

Building Automation System (BAS): Processes or techniques that allow monitoring and control of building air conditioning, lighting systems and CO_2 concentration from a central location whether in the same building or from a remote location.

Building envelope: The exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

-Building envelope, exterior: the elements of a building that separate conditioned spaces from the exterior.

-Building envelope, semi-exterior: The elements of a building that separate conditioned space from unconditioned space or partially conditioned spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from conditioned spaces.

***Buildings, Residential*:** all types of buildings meant for residential purposes, including single- and multiple-family residences, such as villas, apartments, and the like.

Building type, standard: Common buildings having similar design features and can be categorized as follows:

- Commercial buildings: all types of buildings meant for private commercial business such as offices, shops, malls, souks, hotels, banks, schools, universities, schools, hospitals and clinics as well as mosques built with private funds, and the like.
- Governmental buildings: all types of buildings meant for public convenience such as government institutional buildings (ministries, authorities, buildings of non-profit organizations (under the jurisdiction of Ministry of Labor and Social Affairs), buildings owned by government establishments and companies and their subsidiaries, etc.), schools, universities, hospitals, clinics, mosques, police stations. This category also includes residential buildings built by the government through its Housing Welfare program.
- Mixed-use buildings: commercial buildings with two or more functional uses.

Buildings type, special: All types of buildings such as hospitals, laboratories, industrial warehouses, factories, workshops, and central plants substations and power plants.

Building type, partially occupied: Where building use extends to 16 hours per day or less such as government buildings, offices, community centers, schools, colleges, banks, games and sport centers, gymnasiums, clubs, shopping malls, restaurant buildings, etc.

Chilled water, air-cooled A/C systems: In these systems, cooling is supplied to room air by chilled water in air-handling units or fan-coil units, and the condensing unit is cooled by ambient air.

Chilled water, water-cooled A/C systems: in these systems, cooling is supplied to room air by chilled water in air-handling units or fan-coil units, and the condenser is cooled by water from cooling towers, or from other sources.

Coastal and interior regions: The coastal region is the region within 2.5 kilometers of the coastline, and the rest is considered as the interior region.

Conditioned space: an enclosed space occupied by people within a building that is provided with mechanical heating and/or cooling.

Diversity factor (DF): The ratio of building peak load to the sum of individual zones' peak loads.

DX, air-cooled A/C systems: In these systems, cooling is supplied to room air directly from refrigerant boiling in a heat exchanger called an evaporator; and the condenser is cooled by ambient air (e.g.; mini-split units, ducted split units, VRF, packaged units, etc.).

DX, water-cooled A/C systems: In these systems, cooling is supplied to room air directly through ducts from refrigerant boiling in a heat exchanger, called an evaporator; and the condenser is cooled by water.

DX Inverter: DX packaged, ducted split or mini split with inverter compressor.

Effective On-Grade Floor Heat Gain: Effective heat gain from the on-ground floor of an air-conditioned building is defined as the product of the perimeter or exposed edge, the heat gain coefficient per unit perimeter and the temperature difference between the indoor and the outdoor temperatures.

Energy efficiency ratio (EER): the ratio of net cooling capacity (Btu/h) to total rate of electric input in watts under designated operating conditions.

Envelope component: A major section of the entire envelope, such as the opaque walls above grade, ceilings, slabs, floors, glazing, doors, or walls below grade.

External Shaded Construction: All types of shading devices (passive) that form part and parcel of a building's construction.

Floor area, gross: The sum of the floor areas of the spaces within the building, including basements, mezzanine and intermediate-floored tiers, and penthouses with a headroom height of 7.5 ft (2.3 m) or greater. It is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings, but excluding covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

Gross building envelope floor area: The gross floor area of the building envelope, but excluding slab-on-grade floors.

Gross conditioned floor area: The gross floor area of conditioned spaces.

Gross lighted floor area: The gross floor area of lighted spaces.

Floor, Envelope: The lower portion of the building envelope, including opaque area and fenestration, that has conditioned or partially conditioned space above and is horizontal or tilted at an angle of less than 60 degrees from horizontal but excluding slab-on-grade floors. For the purposes of determining building envelope requirements, the classifications are defined as follows:

Glazing: A part of the fenestration (an opening in the building envelope), whether fixed or operable, that serves as a physical and/or visual connection to the outdoors, as well as admitting light. Types of glazing include different designs and constructions with the intent of minimizing the A/C load by reducing direct radiation input and/or conduction. Important Related definitions are:

- ***Glazed area:*** This is the total projected area, in square meters or square feet, of the fenestration, an opening in the building envelope, that serves as a window or a door. The area measurement includes transparent glazing and any opaque element comprising the sash and frame.

- ***Solar heat gain coefficient (SHGC):*** The ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convicted into the space. (See fenestration area).

- ***Shading coefficient (SC):*** This is a multiplier that adjusts the solar gain value for clear glass to a value for tinted glass. The relationship between the solar heat gain coefficient (SHGC) and the SC is defined as SC = (SHGC)/0.87. The SHGC is the fraction of incident irradiance that enters the glazing and becomes heat gain. It includes both transmitted and absorbed irradiance, where the latter is subsequently conducted, convected and radiated to the interior of the building.

Gross roof area: The area of the roof measured from the exterior faces of walls or from the centerline of adjacent (neighboring) walls. (See roof and wall.)

Gross wall area: The area of the wall measured on the exterior face from the top of the floor to the bottom of the roof.

Opaque areas: All areas in the building envelope, except fenestration and building service openings such as vents and grilles (See building envelope and fenestration).

Peak Electrical Load: The maximum electrical load of a building as a whole and is expressed in kilowatts (kW).

Peak Power Density of an A/C System: The ratio of the total electrical load of the A/C system, as defined for 'Peak Electrical Load for A/C Systems,' expressed in watts, to the air-conditioned area of the building as defined for 'Air-Conditioned Space,' expressed as square meters.

Peak Power Density of Lighting: The ratio of the total electrical load of a building's lighting fixtures, inclusive of associated losses, as defined for 'Peak electrical Load for Lighting,' expressed as watts, to the air-conditioned area of the building as defined for 'Air-Conditioned Space,' expressed as square meters.

***Peak Power Density*:** The peak electrical load (Watts) per unit area (m^2) for A/C and lighting systems of a building.

Power Rating: The power required (kW) per unit of cooling (RT) for an A/C system and its components.

Project: One or more buildings for which there is only one Municipality building permit.

Proposed design: Design of the living unit or building to be constructed. The design takes into account all qualities, details, and characteristics of the building that significantly affect the use of energy, such as construction, geometry, orientation, exposure, materials, equipment, and renewable energy sources.

Residential buildings: All types of buildings meant for residential purposes, including single-and multiple-family residences such as villas, apartments and the like.

Residential Villa: Building of three stories or fewer above grade containing three or more living units other than townhouses, including a manufactured building (modular).

Roof: The upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal.

Shall: Term used to indicate provisions that are mandatory if compliance with the standard is claimed.

Slab-on-grade floor: That portion of a slab floor of the building envelope that is in contact with the ground and that is either above grade or is less than or equal to 24 in. (610 mm) below the final elevation of the nearest exterior grade.

Specific Heat (c_p): The amount of heat required to raise the temperature of a unit mass of a substance by one unit of temperature.

Standby A/C Units: These include any units that are operated only during the failure of main A/C units and shall not be supplied with additional power.

Thermal conductivity of a material (k): The rate of heat transfer per hour, per unit area, per unit length of material in the direction of heat flow per unit temperature difference, expressed as Btu.in/h.ft^2.°F or W.m/m^2.K.

Thermal insulation materials: All types of passive insulation materials used as a part and parcel of building's wall and roof construction.

Thermal mass: The ability of a material to store thermal energy, hence it is an indicator for the ability of a building construction to dampen and delay diffusion of heat and temperature.

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 (h.ft^2.°F/Btu or m^2.K/W).

Thermal transmittance (U-factor): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side (Btu/h.ft^2.°F or W/m^2.K).

Thermally insulated buildings: Buildings that use insulation materials for the wall and roof constructions to satisfy the maximum allowable U-factor in this code.

Thermal storage: Storage of cooling capacity in a storage medium at or below the normal chiller supply temperature.

Total Peak Electrical Load for Buildings: This refers to the peak electrical load of a building, which includes the A/C system, internal lighting and other electrically operated appliances or equipment.

U-factor: see thermal transmittance.

Unconditioned space: Space within a building that is not conditioned (see conditioned space).

Variable Refrigerant Flow (VRF) System : an engineered direct expansion (DX) multi-split system incorporating at least one variable capacity compressor distributing refrigerant through a piping network to multiple indoor fan-coil units, each capable of individual zone temperature control, through integral zone temperature control devices and common communications network.

Ventilation: The process of supplying outside fresh air to or removing air from a space for the purpose of controlling air contamination levels, humidity, or temperature within the space by natural or mechanical means.

Wall and Roof Areas: These are the external surface areas of the building envelope, measured in square meters or square feet, based on the external dimensions of walls, roofs and exposed floors, as the case may be.

Wall and Roof Construction Classification: Building construction is classified into four basic types; very light, light, medium and heavy, dictated by the value of thermal mass per unit surface area of wall and roof.

Wall: That portion of the building envelope that is vertical or tilted at an angle of 60 degrees from horizontal or greater.

Above-grade wall: A wall that is not a below-grade wall.

Below-grade wall: That portion of a wall in the building envelope that is entirely below the finished grade and in contact with the ground.

Mass wall: A wall constructed of concrete, concrete masonry, insulating concrete foam (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth), and solid timber or logs.

Water vapor retarder: Material or construction that adequately impedes the transmission of water vapor under specified conditions. The water vapor permeability shall be less than 1.0 perm (0.006 μg/Pa.s.m^2) when tested in accordance with ASTM E 96.

Water-cooled A/C system: In these systems, heat is rejected to the outside environment through water, i.e., a water-cooled condenser. The water used can be potable, brackish from an underground source, or seawater. In re-circulating water-cooled system, the water is re-circulated normally in a cooling tower to conserve water. In once-through systems, the cooling water is used only once, after which it is discharged, as in seawater cooling. The cooling transport medium to the place of use may be either air (in a DX system) or chilled water.

Window-to-wall Ratio: The ratio of the glazing area to the gross wall area, excluding spandrel glass.

Zone, HVAC: A space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g. temperature) can be maintained throughout using a single sensor (e.g. thermostat or temperature sensor).

1.4 HVAC Load Calculation

To calculate the peak cooling/heating demand and the annual cooling and electrical energy requirements, it is essential to generate hourly data profiles for parameters that significantly affect the hour-to-hour cooling and/or heating demand of the building. These parameters are the dry-bulb temperature (DBT), wet-bulb temperature (WBT), wind speed and global solar radiation.

1.5 Climate Regions in Kuwait

Kuwait's meteorological data over the past several years show an appreciable difference between weather conditions in the coastal and the interior regions, particularly during the summer season. Coastal regions experience hot and humid conditions, whereas the interior regions are hot and dry.

1.6 Outdoor and Indoor Design Conditions

For each of the two climate regions, different sets of outdoor design conditions shall be selected as given in Tables 1.6.1 and 1.6.2. The frequency of occurrence shall be selected based on the type and importance of the building, and it is the designer's responsibility to select the appropriate value that ensures minimum building energy requirement.

Table 1.6.3 provides the outdoor and indoor design conditions for the summer and winter seasons. Exceptions for building designs with special requirements may be permitted on prior written approval from MEW.

Table 1.6.1 Outdoor Design Conditions for the Interior Region

Frequency of Occurrence (%)	DBT °C (°F)	WBT °C (°F)
1.0	48.0 (118.4)	27.1 (80.8)
2.5	47.0 (116.6)	25.5 (77.9)
5.0	46.2 (115.2)	24.0 (75.2)

Daily Range = 13.3°C (24.0 °F)

Table 1.6.2 Outdoor Design Conditions for the Coastal Region

Frequency of Occurrence (%)	DBT o C (oF)	WBT o C (oF)
1.0	47.4 (117.3)	31.7 (89)
2.5	46.1 (115)	30.8 (87.5)
5.0	44.8 (112.6)	30.1 (86.2)

Daily Range = 8.3°C (15.0°F)

Table 1.6.3 Summer and Winter Outdoor and Indoor Design Conditions

		Summer, °C (°F)		Winter, °C (°F)	
		Outdoor	Indoor	Outdoor	Indoor
Interior	DBT	Refer to	23.9 (75.0)	10 (50)	18.3 (65.0)
	WBT	Table	17.0 (62.5)	5 (41)	11.6 (52.9)
	RH	1.6.1	50%	40%	30%
Coastal	DBT	Refer to	23.9 (75.0)	10 (50)	18.3 (65.0)
	WBT	Table	17 (62.5)	2.0 (36.6)	11.6 (52.9)
	RH	1.6.2	50%	64%	30%

1.7 Methods and Software of Cooling Load Calculations

Different methods for calculating air-conditioning cooling load for the purpose of sizing A/C equipment can be used. These methods have to consider the thermal mass of the building envelop, the hourly outdoor temperatures, solar radiation and other weather parameters. Examples of methods that can be used for this purpose are: Heat Balance, Transfer Function

Method, Time Radiant Series, and Total Equivalent Temperature Difference (TETD). Building load calculation and energy simulation programs such as APEC, HAP, Hevacomp, Energy Plus, and Trace 700 can be used, or any other program approved by MEW.

2 GOVERNMENTAL AND COMMERCIAL BUILDINGS

2.1 Basic Energy Conservation Requirements

2.1.1 Standard Buildings

The minimum energy conservation requirements for different types of standard buildings are determined by the maximum power density for the A/C and lighting systems, as given in Table 2.1.1. Further energy conservation measures to make buildings more efficient are recommended.

2.1.2 Special Buildings

The minimum energy conservation requirements related to the building and the A/C system as described below must be applied. For lighting systems, LED lights that meet approved local specifications or accepted international standards (e.g. IEC, etc.) shall be used. In addition, a verified method of load calculation shall be used, as mentioned in Section 1.7. Spaces within Standard buildings but with different thermal characteristics (such as swimming pool, data center, kitchen, laundry, mechanical and electrical plant room, etc.) shall follow the requirements of this section.

2.1.3 Mixed-Use Buildings

In mixed-use buildings, the power density (W/m^2) of A/C and lighting for each space shall be separated according to its function to ensure meeting the stipulated maximum values in Table 2.1.1. Some clarifying cases include, but not limited to, the following:

- For five-story buildings and above, no air conditioning shall be allowed in isolated staircases adjacent to air-conditioned spaces. The external wall(s) and roof(s) of such staircases and partition walls between the air-conditioned areas and staircase must be insulated to the same level of the building envelope.
- Ancillary areas of an air-conditioned space (e.g., store, toilet, pantry, changing room, and corridor) shall have 50% of the A/C power density (W/m^2) of the function they support as per Table 2.1.1.

2.1.4 Mandatory Requirements

1. The designer must ensure that the total peak electrical power drawn for any operation configuration shall not exceed the allowable peak wattage per square meter provided in Table 2.1.1.

2. If the maximum allowable Power Density (Table 2.1.1) cannot be met, the designer must resort to other energy efficiency/conservation measures to achieve the target.

3. In installations where only part of a cooling machine's capacity is considered standby, then the whole machine shall be considered as part of the basic system cooling load, and the machine's peak electrical power shall be included in the calculation of the peak wattage per square meter for A/C system.

4. No additional power shall be provided for A/C systems during the charging mode of the thermal energy storage. This shall be clearly indicated in the electrical drawings and schematics submitted to MEW.

5. All occupied spaces (such as porter rooms, guardrooms, kitchens, etc.) shall be air-conditioned.

6. All mini-split units used in governmental and commercial buildings shall be inverter type.

Table 2.1.1 Maximum Allowable Power Density (W/m²) for Lighting and Different A/C Systems for Governmental and Commercial Buildings

Building Type	Lighting	DX (All types) & DX inverter[1]	VRF[1]	Air-Cooled Chiller[2]	Water-Cooled Chiller[2]		
					<250 RT	250-500 RT	>500 RT
Clinic	9	70	65	85	65	55	55
School (classroom)	9	80	75	100	75	65	65
Mosque (religious area)	15	95	90	115	90	75	75
Fast food restaurant - stand alone	7	120	110	145	110	95	95
Fast food restaurant - In a mall	7	100	90	120	90	80	75
Office	9	55	50	65	50	45	45
Community hall, dining hall, theatre	10	95	90	115	90	75	75
Show room	15	90	85	110	85	75	70
Shopping mall	15	60	55	70	55	45	45
Supermarket	15	60	55	70	55	45	45
Stand-alone shop	15	65	60	75	60	50	50

(1) Power densities for DX systems are based on a diversity factor of 1.0.

(2) Power densities for Air- and Water-cooled chiller systems are based on a diversity factor of 0.9.

Notes:

1. Thermal energy storage is not considered in the table. Therefore, the figures shall be reduced proportionally when thermal energy storage is used, for which calculation shall be submitted for MEW approval.

2. Administration areas in schools shall be treated as Offices and assembly halls shall be treated as community halls.

3. For chilled-water systems with a diversity factor higher than 0.90, the consulting office shall provide cooling load calculations supporting his claim, and the power density (W/m^2) shall be recalculated and submitted for MEW approval.

2.2 Minimum Required Energy Conservation Measures for Buildings

In order to meet the 'Basic Energy Conservation Requirements', the code stipulates that certain minimum requirements for energy conservation measures shall be adhered to, and no deviations shall be permitted. The building designer shall abide by the aforementioned requirements, and is encouraged to consider more stringent measures for further energy conservation. Such measures may include, but not limited to, more insulation, shading devices, more efficient A/C systems, lighting systems and glazing; and better controls in a Building Automation System (BAS).

2.2.1 Building Envelope Construction

2.2.1.1 External Walls and Roofs

Table 2.2.1 provides a list of the maximum allowable overall heat transfer coefficients (U-factor) for a variety of wall and roof constructions and their external color.

Exposed floors: Exposed floors in multistory apartment buildings or similar constructions shall not have a U-factor of more than 0.256 W/(m^2.K) (0.045 Btu/h.ft^2.°F).

Columns and beams insulation: Columns and beams shall be insulated in a manner similar to corresponding walls. Accordingly, their U-factor should not exceed 0.396 W/(m^2.K) (0.070 Btu/(h.ft^2.°F)) for the columns and beams. In case the columns and beams are not insulated, this requirement shall be compensated for by additional insulation on walls/roofs.

Slab-On-Grade insulation (for buildings without basements): It should be water resistant, laid horizontally on the slab at the inner side of external walls and extends a distance of 120 cm from the wall. The U-factor of the section shall not be more than 0.256 W/m^2.K (0.045 Btu/h.ft^2. °F).

Below-Grade walls shall have a U-factor not more than the U-factor of the Above-Grade wall.

Walls, roofs and floors between conditioned and unconditioned spaces shall have U-factors of equivalent to those used for the external envelop of the conditioned spaces.

Table 2.2.1 Maximum Allowable U-factors for Different Types of Walls and Roofs for Governmental and Commercial buildings

Construction Type	Walls, Columns and Beams		Roof	
	Thermal Mass[1]	U-factor[2]	Thermal Mass[1]	U-factor[2]
Very light	< 50 (<2.4)	≤ 0.227 ≤ (0.04)	< 25 (<1.2)	≤ 0.155 ≤ (0.027)
Light	50 - 220 (2.4 - 10.8)	≤ 0.369 ≤ (0.065)	25 - 110 (1.2 - 5.4)	≤ 0.170 ≤ (0.03)
Medium[3]	221 - 440 (10.9 - 21.5)	≤ 0.397 ≤ (0.070)[4]	111 - 220 (5.5 - 10.8)	≤ 0.199 ≤ (0.035)
Heavy	> 440 > (21.5)	≤ 0.454 ≤ (0.080)	> 220 > (10.8)	≤0.256 ≤ (0.045)[5]

(1) Figures are given in $kJ/m^2.°C$ ($Btu/ft^2.°F$).

(2) Figures are given in $W/m^2.°C$ ($Btu/h.ft^2.°F$).

Notes:

1. Walls built with AAC white block are categorized as medium construction.
2. Achievable for walls using 30 cm-thick white aerated blocks with density of ≤ 500 kg/m^3 and conductivity k ≤ 6.4477 W/m.K (0.93 $Btu.in/ft^2.h.°F$).
3. Achievable for roofs using a 10 cm- thick insulation materials such as polyurethane or extruded polystyrene.

2.2.1.2 Fenestration

Glazing characteristics for windows used in governmental and commercial buildings, and for curtain walls used in residential buildings, are given in Table 2.2.2. All windows shall have a thermal break between metallic frame and glazing, and between the inner and outer metallic frames. All glazing shall have labels indicating their specifications and performance characteristics.

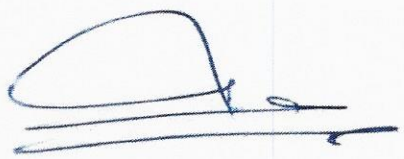


Table 2.2.2 Glazing Specifications for Governmental and Commercial Buildings

Glazing Type	Max. SHGC	Max. U-factor[1] [2] $W/m^2.°C$ ($Btu/ft^2.h.°F$)
Double/triple 6-mm Super glass High Performance (HP Series) spectrally selective	0.22	1.14 (0.20)

(1) U-factors above include frame and glazing.

(2) As per ANSI/NFRC 100 @ 24 °C and 48 °C for the interior and exterior conditions, respectively

2.2.2 Infiltration Control

2.2.2.1 Building Envelope

Building envelope shall be made tight with no cracks or open joints in order to minimize air infiltration. Buildings using pre-cast concrete elements in their wall construction must have joints permanently sealed with a durable seal, through the whole depth of the joint.

2.2.2.2 Fenestration

All exterior windows, skylights and doors shall be properly sealed and weather-stripped to limit infiltration. All cracks shall be sealed with caulking or similar materials. Positive pressure inside buildings shall be maintained by the air-handling system to minimize air and dust infiltration. The air leakage through windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm/ft^2 (1.5 $L/s/m^2$), and swinging doors no more than 0.5 cfm/ft^2 (2.6 $L/s/m^2$), when tested according to NFRC standards by an accredited and independent laboratory.

2.2.2.3 Building and Shop Entrances

Except for small shops with single access/entrance, all main exterior entrances to buildings shall have double doors with vestibule in between. Both doors shall close automatically after use. Alternately, revolving doors may be used.

2.2.2.4 Exhaust Fans

All exhaust fans shall have back-draft dampers, which shall automatically close when fans are not in use.

2.3 Minimum Required Energy Conservation Measures for A/C Systems

2.3.1 Maximum Power Rating of A/C Systems

The power rating of different types of A/C systems and their components are given in Table 2.3.1.

Table 2.3.1 Maximum Allowable Power Rating for Different Types of A/C Systems (kW/RT)

System Type	Capacity (RT)	PR_T (kW/RT) [1]			
Implementation Date		1/1/2019	1/1/2020	1/1/2022	1/1/2024
DX units without inverter compressor [2]	All	1.5	1.4	1.25	Start of Phase out
DX with inverter compressor [2]	All	1.5 (1.10)	1.4 (1.10)	1.25 (1.0)	1.20 (0.90)
Variable refrigerant flow (VRF) [2]	All	1.35 (1.05)	1.20 (0.90)	1.15 (0.85)	1.10 (0.83)
Air-cooled chilled water system [3]	All	1.60/2.00	1.40/1.80	1.20/1.60	0.85/1.25
Water-cooled chilled water system [3]	<250	0.85/1.40	0.80/1.35	0.75/1.3	0.70/1.25
	250–500	0.75/1.30	0.70/1.25	0.65/1.15	0.58/1.10
	>500	0.70/1.25	0.65/1.20	0.60/1.10	0.58/1.05

(1) All power ratings are at condenser conditions: DBT 48°C (118.4°F) and WBT 26.9°C (80.5°F), except those in brackets ( ) are at DBT 35°C (95°F) and WBT 23.9°C (75.0°F).

(2) Approval of DX units (including VRF) shall be as per the requirements and conditions in the form titled "Approval of A/C DX Units" given in Appendix A.

(3) Power ratings of chiller / total power rating.

Notes:

1. Rating for air-cooled and water-cooled chillers is based on the following parameters:
   - Water temperature at the chiller outlet is 6.67°C (44°F).
   - Temperature drop of chilled water across the evaporator is 5.56 °C (10 °F). However, higher temperature differential may be used for loads exceeding 500 RT to reduce pumping power while maintaining the above maximum kW/RT system rating.
   - Temperature drop of cooling water across the condenser is 5.56 °C (10 °F).
   - Fouling factors for the evaporator and condenser are 0.00025 (ft^2.h.°F) /Btu (0.000044 (m^2.°C)/W) and 0.00075 (ft^2.h.°F)/Btu (0.000132 (m^2.°C)/W), respectively.
   - Water pressure drop in the evaporator and condenser of chiller and AHU coil is 4.6 m (15 ft)

2. For governmental projects, VRF system is permitted only if central air handling unit with provision for fresh air and two stages of filtration are used (e.g. primary filter – 2" thick metallic cleanable with 75% average arrestance efficiency, and secondary filter – bag filter with minimum 65% dust spot efficiency). In such case, the maximum power rating shall not exceed 120% of the values stipulated in table 2.3.1 above, and subject to prior MEW approval.
3. Energy Efficiency Ratio (EER) = 12/(kW/RT).

2.3.2 A/C System Selection

Table 2.3.2 shall strictly be followed when selecting A/C systems for various applications. However, if the proper A/C system cannot be selected in accordance with the table for any reason, a technical report shall be submitted to MEW, Electrical Installation Dept. ASHRAE Safety Standard 15 & 34-2010 (or the latest) shall be strictly adhered to when designing and installing VRF systems. The Consultant shall obtain MEW approval for the availability of the total electricity and water demands during the initial design stage.

Table 2.3.2 A/C System Selection

	Commercial	Governmental	Commercial/Governmental			
Plant Capacity (RT)	≤500	≤500	501 - 1000		>1000	
Building Operation (Hrs)	-	-	>16	≤16	>16	≤16
Coastal	-DX -VRF -DX inverter	-VRF -DX inverter	-VRF -AC	-VRF -AC +TES	-WC	-WC + TES
Interior	-DX -VRF -DX inverter	-VRF -DX inverter	-VRF -WC	-VRF -AC+TES	-WC	-WC + TES

Notes:

1. Minimum thermal energy storage (TES) capacity for governmental and commercial sectors shall be 30% and 20%, respectively, of the project block load, for a minimum duration of 4 hours discharge.
2. Schools, both governmental and private, with cooling capacities higher than 1000 RT are exempted from using WC chilled water systems and may use either VRF or Air-cooled chilled water system with TES.

2.3.3 Cooling Recovery Units (CRU)

CRU shall be used when:

1. The recoverable exhaust air quantity is equal to or more than 2,000 CFM (940 l/s) for buildings in the coastal region,

2. The recoverable exhaust air quantity is equal to or more than 3,000 CFM (1410 l/s) for buildings in the interior region.

The CRU shall have a minimum efficiency of 75% for all buildings. Exception can be granted when health hazards that may accrue such as in operation theaters and toilets, for such applications, a fixed-plate or heat-pipe CRU (non-mixing CRU) shall be used having a minimum efficiency of 55%. A central exhaust system shall be incorporated in the design stage of the building to facilitate the above requirement.

2.3.4 Time-of-Day Controls for Energy Savings (programmable thermostat)

Use of programmable thermostats (controlled by either an automatic time clock or programmable control system) is mandatory for all zones with part-day occupancy. Exception is granted to rooms with units having cooling capacities not exceeding 24,000 BTU/H (7 kW, nominal) with a manual On/Off switch, which shall be switched off during extended non-occupancy periods. The programmable thermostat shall facilitate seven different schedules for each day of the week. In addition, it shall allow a manual override that invokes temporary operation of the cooling system for up to 2 hours. The setback minimum value is 5.6°C (10 °F) from the normal set temperature of 24 °C (75 °F) with alternative durations. These settings should not cause any discomfort during the occupancy period or increase in demand for cooling or power from 12:00 to 16:00 (the peak demand period).

2.3.5 Thermal Energy Storage (TES)

Use of thermal energy storage (water, ice, eutectic, etc.) is mandatory for all partially occupied buildings (maximum operating time 16 hours per day) using chilled water system of capacities above 500 RT. After applying diversity, the TES capacity for commercial and governmental buildings shall be at least 20% and 30% of total project peak load for 4 hours, respectively. Figure of merit (FOM) of the thermal energy storage shall be 0.85 or above. During TES charging mode, set point temperature of non-occupied zones shall be 29.5°C (85 °F). The Consulting office shall provide daily building load profile that forms the basis for the design strategy.

The A/C connected loads for buildings with TES shall be calculated as per the following formulae:

For commercial buildings:

$$CL_{B,A/C} = CL_{P,A/C} - (0.20 * PL_{B,A/C} * PR_c)$$

For governmental buildings:

$$CL_{B,A/C} = CL_{P,A/C} - (0.30 * PL_{B,A/C} * PR_c)$$

Where:

$CL_{P,A/C}$ = air conditioning connected load calculated as per Section 1.4 and not to exceed values in Table 2.1.1, (kW).

$CL_{B,A/C}$ = air conditioning building connected load, (kW)

$PL_{B,A/C}$ = air conditioning building peak load calculated as per Section 1.4 or Table 2.1.1, whichever is lower.

PR_c = chiller power rating from Table 2.3.1.

2.3.6 Electrical Motors and Lighting Fixtures

All inductive motors including those in A/C systems shall have a power factor (PF) and efficiency not less than the values given in Table 2.3.3. Furthermore, it is mandatory for all governmental and commercial buildings to install and replace all lighting systems with LED lights, occupancy sensors, and time-of-day-control for the lighting systems. Discharge and LED lamps shall have a minimum PF of 0.90.

Table 2.3.3 Power Factor for Electrical Motors for governmental and commercial buildings

Motors	Full-Load PF	Full-Load Motor Efficiency (%)
Single Phase Motors, 240 Volts, 1450 rpm. and 50 Hz: All range	≥ 0.95	≥75
3-Phase motors, 415 Volts, 1500 rpm, 50 Hz: >0.5 hp	≥ 0.95	≥90

Notes:

1. For equipment having more than one motor (e.g. A/C units), power factor is considered for the entire equipment and shall not be less than 0.8.

2.3.7 Use of Variable Frequency Drives (VFD)

2.3.7.1 Use of Variable Frequency Drives for Cooling Towers

Fan motors of cooling towers for all sizes and for all locations shall have variable frequency drives (VFD) and optimized power factor of ≥ 0.95. The fan speed shall be regulated by a temperature sensor monitoring the temperature of water leaving the cooling tower. For minimizing water consumption and optimizing power consumption, it is recommended that:

1. Regardless of weather conditions or the load on the cooling tower, the temperature of water leaving the cooling tower shall be kept fixed at the design value.
2. Regardless of the number of chillers in operation, all the cooling towers, including the standby with their fans in operation, shall share the water from the common header.
3. A Single temperature sensor should regulate all the VFDs, thus ensuring similar speed for all the fans.

2.3.7.2 Use of Variable Frequency Drives for Other Motors

Variable frequency drives shall also be provided for motors of AHUs, chilled water pumps, condenser water pumps and compressors of chillers.

2.3.8 Ventilation

All air-conditioned spaces shall have a minimum quantity of ventilation air that is the highest of the following values:

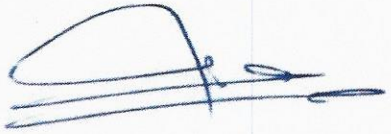
1. 0.250 ACH for pressurization + exhaust air from kitchens, toilets and other areas.
2. Recommended air quantity as given by the Ventilation Rate Procedure described in the latest version of the ASHRAE 62.1 Standard (Ventilation for Acceptable Indoor Air Quality). This new procedure ensures that the design outdoor airflow required in the breathing zone of the occupied space(s) is met by taking into account both the occupancy and floor area simultaneously. The effectiveness of the air distribution system shall be determined accordingly and used to obtain the final quantity of the required ventilation rate.

2.3.9 Building Automation Systems

It is mandatory to use a BAS in all projects having a cooling production capacity of 500RT and above. For projects with lower than 500 RT cooling production capacity BAS is recommended to be used, however programmable thermostats and lighting controls (occupancy sensors, and daylight control where applicable) shall be used.

2.3.10 Thermostat Requirement

All thermostats (analog, digital) or sensors (individual or part of a BAS) shall have a minimum indoor temperature setting of 20°C.



3 RESIDENTIAL BUILDINGS

3.1 Basic Energy Conservation Requirements

3.1.1 Villas

The minimum energy conservation requirement for villas is determined by the maximum power density for the A/C and lighting systems are given in Table 3.1.1. Further energy conservation measures to make buildings more efficient are recommended.

3.1.2 Apartment Buildings

The power density (W/m^2) of A/C and lighting systems for each space shall be separated according to its function to ensure meeting the stipulated maximum values in Table 3.1.1. Some clarifying cases include, but not limited to, the following:

- For five-story buildings and above, no air conditioning shall be provided for isolated staircases adjacent to air-conditioned spaces. The external wall(s) and roof(s) of such staircases as well as partition walls between the air-conditioned areas and staircase must be insulated to the same level of the building envelope.
- Ancillary areas of an air-conditioned space (e.g., store, toilet, pantry, changing room, and corridor) shall have 50% of the A/C power density (W/m^2) of the function they support as per Table 3.1.1.

3.1.3 Mandatory Requirements:

1. The designer must ensure that the total peak electrical power drawn for any operation configuration shall not exceed the allowable peak wattage per square meter.
2. If the maximum allowable Power Density (Table 3.1.1) cannot be met, the designer must resort to other energy conservation/efficiency measures to achieve the target.
3. In installations where only part of a cooling machine's capacity is considered standby, then the whole machine shall be considered as part of the cooling load, and the machine's peak electrical power shall be included in the calculation of the peak wattage per square meter for A/C system.
4. All occupied spaces such as maids' rooms, guardrooms, kitchens, etc. shall be air-conditioned.
5. Mini-split and window type units shall not be used for driver's room, kitchen and stand-alone guard room if the overall W/m^2 of the entire villa exceeds the maximum allowable limit.
6. All mini-split units shall be inverter type.

Table 3.1.1 Maximum Allowable Power Density (W/m²) for Lighting and A/C Systems in Residential Buildings

Building Type	Lighting	DX (All types)	VRF	Air-Cooled Chiller	Water-Cooled Chiller		
					<250 RT	250-500 RT	>500 RT
Residential: -Villas	5	50	45	65	45	40	40
- Apartments	5	55	50	70	50	50	45
Diwaniya, Reception & Dining (in villas only)	7	70	65	93	65	60	58

Notes:

1. Power densities for DX systems are based on a diversity factor of 1.0.
2. Power densities for Air- and Water-cooled chiller systems are based on a diversity factor of 0.9.
3. For chilled-water systems with a diversity factor higher than 0.90, the consulting office shall provide cooling load calculations supporting his claim, and the power density (W/m^2) shall be recalculated and submitted for MEW approval.

3.2 Minimum Required Energy Conservation Measures for Buildings

In order to meet the 'Basic Energy Conservation Requirements', the code stipulates that certain minimum requirements for energy conservation measures be adhered to. These requirements may or may not guarantee that a given building will meet the Basic Energy Conservation Requirements described herein. The building designer shall abide by the aforementioned requirements by considering more stringent measures and no deviations shall be permitted. Such measures may include, but not limited to, more insulation, shading devices, more efficient A/C system, more efficient lighting systems, glazing that is more efficient and better controls leading to a Building Automation System (BAS).

3.2.1 Building Envelope Construction

3.2.1.1 Walls and Roofs

Table 3.2.1 provides a list of the maximum allowable overall heat transfer coefficients (U-factor) for a variety of wall and roof constructions.

a) Exposed floors: Exposed floors in multistory apartment buildings or similar constructions shall not have a U-factor of more than 0.256 W/(m^2.K) (0.045 Btu/(h.ft^2. °F)).

b) Columns and beams insulation: Columns and beams shall be insulated in a manner similar to adjacent walls. Accordingly, their U-factors should not exceed 0.483 W/(m^2.K) (0.085 Btu/(h.ft^2.°F)) for the columns and beams. In case the columns and beams are not insulated, this requirement shall be compensated for by additional insulation on walls and/or roofs.

c) Slab-On-Grade Insulation (for buildings without basements): It shall be water resistant, laid horizontally on the slab at the inner side of external walls and extends a distance of 120 cm from the wall. The U-factor for the insulation material should not be more than 0.256 W/m^2.K (0.045 Btu/h.ft^2. °F).

d) Below-Grade Wall Insulation: Below-grade walls shall have a rated U-factor not more than the U-factor of the above-grade wall.

e) Exterior walls, roofs and floors of unconditioned spaces connected to conditioned spaces shall have U-factors similar to the external envelop of conditioned spaces.

Table 3.2.1 Maximum Allowable U-factors for Different Types of Walls and Roofs for residential buildings

Description	Walls, Columns and Beams		Roof	
	Thermal Mass (1)	U-factor (2)	Thermal Mass (1)	U-factor (2)
Very light construction	< 50 (2.4)	≤ 0.227 (0.04)	< 25 (1.2)	≤ 0.155 (0.027)
Light construction	50 - 220 (2.4 - 10.8)	≤ 0.369 (0.065)	25 – 110 (1.2 - 5.4)	≤ 0.170 (0.03)
Medium construction (3)	221 – 440 (10.9 - 21.5)	≤ 0.483 (0.085)	111 – 220 (5.5 - 10.8)	≤ 0.199 (0.035)
Heavy construction	> 440 (21.5)	≤ 0.454 (0.085)	> 220 (10.8)	≤0.256 (0.045)(4)

(1) Figures are given in kJ/m^2.°C (Btu/ft^2.°F).

(2) Figures are given in W/m^2.°C (Btu/h.ft^2.°F).

(3) Walls built with 25-cm AAC white Azel block are categorized as medium construction.

(4) Achievable using 10 cm-thick insulation material such as polyurethane, extruded polystyrene, or equivalent.

3.2.1.2 White Areated Blocks

As a minimum requirement, building insulation shall achieve the U-factors stipulated in Table 3.2.1. This can be achieved by using 25 cm-thick white aerated blocks with density of ≤ 500 kg/m^3 and thermal conductivity $k \leq 6.4477$ W/m.K (0.93 Btu.in/ft^2.h.°F). Alternative, this is achievable by using 20 cm thick aerated blocks and completely wrapping up the building with 5cm insulation material of thermal conductivity, $k \leq 0.025$ W/m.K. If the k-value is higher than the aforementioned value, the deficiency shall be compensated for by increasing the thickness of the insulating material proportionately, (i.e. required thickness (cm) = 5 * k of the insulation material/0.025).

3.2.1.3 Fenestration

Glazing characteristics for windows and curtain walls used in residential buildings are given in Table 3.2.2. All glazing shall have labels indicating their specifications and performance characteristics.

Table 3.2.2 Glazing Specifications for Different Window-to-Wall Ratios [(1)].

Window-to-wall ratio (%)	Glazing Type	Max. SHGC	Max. U-factor [(1)(2)] W/m^2.C (Btu/ft^2.hr.°F)
0 - 15	6-mm double-tinted	0.40	3.61 (0.64)
16 - 50	6-mm double-reflective	0.25	3.33 (0.59)
51 - 100	6-mm double-spectrally selective[(4)]	0.22	2.0 (0.35)

(1) U-factor include frame and glazing.

(2) As per ANSI/NFRC 100 @ 24 °C for the interior conditions and 48 °C for the exterior conditions.

3.2.2 Infiltration Control

3.2.2.1 Building Envelope

In order to minimize air infiltration building envelope shall be made tight with no cracks or open joints. Buildings using pre-cast concrete elements in their wall construction must have joints permanently sealed with a durable seal through the whole depth of the joint.

3.2.2.2 Fenestration

All exterior windows, skylights and doors shall be properly sealed and weather-stripped to limit infiltration. All cracks shall be sealed with caulking or similar materials. Positive pressure inside buildings shall be maintained and to minimize air and dust infiltration. The air

leakage through windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm/ft^2 (1.5 L/s/m^2), and swinging doors no more than 0.5 cfm/ft^2 (2.6 L/s/m^2), when tested according to NFRC standards by an accredited and independent laboratory.

3.2.2.3 Exhaust Fans

All exhaust fans shall have back-draft dampers, which shall automatically close when fans are not in use.

3.3 Minimum Required Energy Conservation Measures for Electrical Equipment

3.3.1 Maximum Power Rating of A/C Systems

The power rating of different types of A/C systems and their components are given in Table 3.3.1.

Table 3.3.1 Maximum Allowable Power Rating for Different Types of A/C Systems (kW/RT)

System Type	Capacity (RT)	PR_T (kW/RT) [1]			
Implementation Date		1/1/2019	1/1/2020	1/1/2022	1/1/2024
DX units without inverter compressor [2]	All	1.5	1.4	1.25	Start of Phase out
DX with inverter compressor [2]	All	1.5 (1.10)	1.4 (1.10)	1.25 (1.0)	1.20 (0.90)
Variable refrigerant flow (VRF) [2] [3]	All	1.35 (1.05)	1.20 (0.90)	1.15 (0.85)	1.10 (0.83)
Air-cooled chilled water system [3], [4]	All	1.60/2.00	1.40/1.80	1.20/1.60	0.85/1.25
Water-cooled chilled water system [3], [4]	<250	0.85/1.40	0.80/1.35	0.75/1.3	0.70/1.25
	250–500	0.75/1.30	0.70/1.25	0.65/1.15	0.58/1.10
	>500	0.70/1.25	0.65/1.20	0.60/1.10	0.58/1.05

(1) All power ratings are at DBT 48°C (118.4°F) and WBT 26.9°C (80.5°F), except those in brackets ( ) are at DBT 35°C (95°F) and WBT 23.9°C (75.0°F).

(2) Approval of DX units (including VRF) shall be as per the requirements and conditions in the form titled "Approval of A/C DX Units" given in Appendix A.

(3) Power rating does not include dedicated fresh air units.

(4) Chiller power ratings/total power rating.

Notes:

1. Rating for air-cooled and water-cooled chillers is based on the following parameters:
   - Water temperature at the chiller outlet is 6.67°C (44°F).
   - Temperature drop of chilled water across the evaporator is 5.56 °C (10 °F). However, higher temperature differential may be used for loads exceeding 500 RT to reduce pumping power while maintaining the above maximum kW/RT system rating.
   - Temperature drop of cooling water across the condenser is 5.56 °C (10 °F).
   - Fouling factors for the evaporator and condenser are 0.00025 (ft^2.h.°F) /Btu (0.000044 (m^2.°C)/W) and 0.00075 (ft^2.h.°F)/Btu (0.000132 (m^2.°C)/W), respectively.
   - Water pressure drop in the evaporator and condenser of chiller and AHU coil is 4.6 m (15 ft)
2. Energy Efficiency Ratio (EER) = 12/(kW/RT).

3.3.2 Efficiency and Power Factor for Electrical Motors and Lighting Fixtures

All inductive motors including those in A/C systems shall have a power factor (PF) and efficiency not less than the values given in Table 3.3.2. Discharge and LED lamps shall have a minimum PF of 0.90.

Table 3.3.2 Power Factor for Electrical Motors for residential buildings

Motors [1]	Full-Load PF	Full-Load Motor Efficiency (%)
Single Phase Motors, 240 Volts, 1450 rpm. and 50 Hz: All range	≥ 0.95	≥75
3-Phase motors, 415 Volts, 1500 rpm, 50 Hz: >0.5 hp	≥ 0.95	≥90

Notes:

1. For equipment having more than one motor (e.g. A/C units), power factor is considered for the entire equipment and shall not be less than 0.8.

3.3.3 Ventilation

Positive pressure inside buildings shall be maintained by the air-handling system to minimize air and dust infiltration. All air conditioned spaces shall have a minimum quantity of ventilation air that is the highest of the following values:

1. 0.250 ACH for pressurization + exhaust air from kitchens, toilets and other areas.

2. Recommended air quantity as given by the Ventilation Rate Procedure described in the latest version of the ASHRAE 62.1 Standard (Ventilation for Acceptable Indoor Air Quality). This new procedure ensures that the design outdoor airflow required in the breathing zone of the occupied space(s) is met by taking into account both the occupancy and floor area simultaneously. The effectiveness of the air distribution system shall be determined accordingly and used to obtain the final quantity of the required ventilation rate.

Note: In residential projects, intermittent exhaust diversity of 50% shall be used to minimize outdoor air intake rate.

3.3.4 Thermostat Requirement

All thermostats (analog, digital) or sensors (individual or part of a BAS) shall not have a temperature setting of less than 20°C.

4 CODE IMPLEMENTATION AND ENFORCEMENT

These regulations are applicable to heating, ventilation and air-conditioning (HVAC) services for comfort applications in all air conditioned buildings in the State of Kuwait.

4.1 Code Limits

This code of practice limits the following parameters

a) Maximum power density (W/m^2) for internal lighting for various types of buildings.

b) Maximum power rating (kW/RT) for various types of A/C equipment and systems.

c) Minimum power factor for certain equipment and appliances.

d) Maximum overall U-factors for walls, exposed floors, basement walls, beams and columns, slab on grade and roofs.

e) Maximum allowable window-to-wall ratio for different types of glazing.

4.2 Code Criteria

This code of practice specifies criteria for the following:

4.2.1 The Consulting Office

a) Architectural design: The Consulting Office is responsible for ensuring the following:

1. The overall U-factor for building elements listed in Table 2.2.1 (for governmental and commercial buildings), and Table 3.2.1 (for residential buildings) are within the maximum permitted values.

2. The type of glazing used shall ensure the values specified in Table 2.2.2 and Table 3.2.2.

3. All exposed floors, columns and beams are insulated as specified in sections 2.2.1 and 3.2.2.

4. The consulting office shall compensate for any deviations in other building elements.

b) Electrical Design: The Consulting Office shall design the project according to and fully complying with the following MEW regulations:

1. MEW/R-1, 4th Edition and amendments.
2. MEW Regulations No. MEW/R-2 and amendments.
3. MEW Regulations No. MEW/R-3.
4. MEW Regulations No. MEW/R-6.

c) HVAC Design: It is the responsibility of the Consulting Office to design the HVAC system according to and in full compliance with regulation "MEW Energy Conservation Code MEW/R-6/ 2018" and the relevant executive regulations.

If these regulations cannot be fully complied with due to design constraints, the Consulting Office shall submit a detailed proposal justifying the reasons for non-adherence to the code for the prior approval of MEW before tendering the project.

4.3 Submittals to MEW

The Consulting Office shall submit the documents mentioned below to confirm that MEW's regulations are fully complied with, before commencement of any project and before ordering any equipment. All documents and drawings shall be submitted by certified HVAC and electrical engineers approved by MEW.

4.3.1 Architectural Submittals

The following architectural drawings approved by Kuwait Municipality, besides any additional information requested by the MEW engineer, are required to be submitted:

a) Plan drawings

1. Type, thickness, weight and color of the building materials to be used for external walls and cladding (where applicable).
2. Location and width of windows and glass doors and type of glazing including frame and thermal brakes, and the window-to-wall ratios.
3. Location and thickness of wall cavity and type of insulation used, and its location in the wall and method of application.
4. Internal wall building material to be used (or internal cladding where applicable).
5. Overall wall thickness.

b) Wall sections drawing

1. Type, thickness and color of external walls, and internal walls building materials (or cladding where applicable).
2. Thickness of wall cavity.
3. Height of roof slab from finished floor level.
4. Height of false ceiling if any from finished floor level.
5. Height of windows and glazed areas and their level from finished floor level.
6. Type, location and thickness of glazing to be used and its area
7. Overall thickness of wall.
8. Thickness and type of building materials and color of partition walls and cladding (where applicable).
9. Drop of beams from bottom of roof slab.

4.3.2 HVAC Submittals

The following are the minimum submittals required for design and as-built stages. However the Consulting Office/HVAC contractor shall submit any other additional information requested by the MEW engineer. All documents and drawings shall be submitted by a certified HVAC engineer approved by MEW. The HVAC drawings must include the following:

1. All air-conditioned areas.
2. Type of A/C system to be used (e.g. package or split system, evaporator is DX or chilled water, condenser is air cooled, water cooled, or sea water cooled, fan coil induction or variable systems, etc.)
3. Fresh air requirement (percentages from total air supply).
4. Location of plants and equipment.
5. kW/RT for A/C system and equipment.
6. W/m^2 for the A/C system for the different types of areas used.
7. Schedule of all HVAC equipment (cooling and heating) showing the model number, quantity, and total kW input for each equipment at Kuwait conditions.

Other documents shall include:

1. Catalogue pages or computer selection for the complete HVAC system.
2. Copy of the HVAC Contract between the HVAC Contractor and the Client.
3. Copy of Consultant Office Heat load calculations for applications where W/m^2 is not specified.
4. A letter of assurance from the HVAC Contractor stating that the HVAC equipment mentioned in the contract documents and drawings shall be installed at site without any deviation in model number and quantity.

4.4 Inspection of Building by MEW

During construction phase, as well as after completion of any building, but before power connection, MEW reserves the right to inspect the building and carry out necessary field tests using the latest technology to confirm compliance with the insulation and glazing requirements. No power connection will be made if the tests reveal that the building is not adequately insulated or the glazing used does not comply with the requirements, unless and until necessary corrective measures as recommended by MEW are taken and the building is re-inspected. All A/C equipment shall correspond to the model numbers in the pre-approved drawings by the Electrical Installation Department, Electrical Distribution Network Sector in MEW.

4.5 Role of Various Entities

Enforcement of the code is a key success for achieving its goals; and several governmental authorities must play a role in it. Table 4.4 summarizes the responsibilities of various governmental bodies in the enforcement of this code.

Table 4.4 Summary of the Role of Various Governmental Bodies in the Enforcement of this Code

Government Authority	Responsibility
Ministry of Electricity and Water, Electrical Installation Dept., Electrical Distribution Network Sector in MEW.	1. Approval of: a) All DX units, b) W/m2 calculations for A/C and lighting, c) All HVAC and electrical drawings, d) KW/RT for A/C systems and equipment, e) Certified Electrical Engineer, f) Certified HVAC engineer, g) Energy efficiency of HVAC equipment to be certified by 3rd party internationally reputed testing agency, h) Supporting evidence for installation of power factor optimization device for individual inductive loads (for governmental building only), i) Other energy conservation measures mentioned in R-6. U-factor calculations including short circuit paths. Wall and roof thermal mass calculations, 2. Perform non-destructive site testing of buildings (NDT) to confirm compliance with insulation and glazing requirements. 3. MEW reserves the right to test randomly selected units (one per model) in a reputable lab. at the agent's / manufacturer's cost; or alternatively requests the agent/manufacturer to supply such certificate..
Consulting Engineering Offices	1. HVAC Design: It is the responsibility of the Consulting Engineering Office to design the HVAC system according to and in full compliance with regulation "MEW Energy

	Conservation Code of Practice MEW/R-6/ 2018". 2. Check window-to-wall ratio on the elevation of each orientation and glazing specifications to ensure compliance with MEW regulations. 3. Inspection during construction of insulation materials and glazing applications.
Ministry of Public Works/ Kuwait Institute for Scientific Research	Testing and certification of building materials including all insulation materials and systems.

Appendix A

Approval of A/C DX Units

Testing Conditions

1. All DX A/C units (including inverter compressor and VRF types) shall be tested at maximum indoor airflow and on-coil DBT 26.6 °C (80 °F) & WBT 19.4 °C (67 °F). The power rating shall be as per Tables 2.3.1 and 3.3.1 above.
1. Units shall operate continuously at an ambient temperature of 52 °C (125.6 °F) for at least two hours without tripping or overheating.
2. Power supply (50 Hz):
    - Three Phase : 415 V ± 6 % (accepted range 376-440 V).
    - Single Phase : 240 V ± 6 % (accepted range 216-254 V).
3. Motor/Compressor input ≥ 3.75 kW shall be three phase.

Required Documents

1. Original test report (with two additional copies) dated within one year of submission date.
2. Valid Calibration Certificate of the testing facility from internationally reputable third party at the date of testing.
3. Three original catalogues of the A/C unit to be approved, including specifications and performance tables.

Testing Requirements

1. The tests shall be performed according to standard testing methods published by ASHRAE, AHRI, UL or equivalent as per the above test conditions.
2. Test reports from Kuwait University Center of Engineering Laboratories are accepted provided that these labs are fully calibrated and certified by an approved testing authority such as ILAC at the time of the test.
3. Witness test by an independent testing authority at the manufacturer's testing facility is acceptable under certain conditions specified by MEW.
4. The test report shall include the compressor and total unit electrical input (kW) and the gross cooling capacity (Btu/hr).
5. The test report shall include power rating (kW/RT), for which no allowance shall be given.

Notes:

1. Data presented in the performance table shall be obtained from the test report and NOT from the catalogue.

2. No approval shall be considered for brand names. Approval shall be obtained for each model separately.
3. Any modification to improve the model efficiency shall render that model as a new model and hence shall have a different model number and nameplate.
4. Approval is valid for a period of three years starting from the date of issue or until the validity of current MEW/R6 Code.
5. MEW reserves the right to revoke its approval at any time during the approval period if investigations reveal any deviation from submitted test results or catalogued data.

Appendix B

Futuristic Outlook

In keeping up with technological advances and taking into account environmental concerns, MEW **will** mandate the following actions aimed towards the reduction of energy consumption in buildings by at least 10% within the next two years from the date of implementation of this code:

a. All DX air conditioning units shall have inverter/multi-speed compressors,
b. Building envelop specifications shall be more stringent to reduce the building energy consumption by at least 15%,
c. Government and commercial buildings shall be mandated to generate 15% and 10% of their energy consumption, respectively, using available renewable energy technologies,
d. Part load efficiency (SEER, IPLV, etc.) shall be incorporated for inverter/multi-speed DX units, VRF and chiller systems.