

I. Purpose

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

II. Scope

This code (MEW/R-6/2012) is to revise and update the MEW/R-6/2010. It provides the minimum energy-efficient requirements for the design and construction of new and new portions of buildings with their heating, ventilating and air-conditioning (HVAC) systems. Also, criteria are provided for determining compliance with these requirements. The provisions of this code apply to all types of buildings including all residential, commercial, institutional and special buildings. The code shall not be used to circumvent any safety, health or environmental requirements.

III. Definitions

3.1 Building

A building is defined as 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.

3.2 Building Type

3.2.1 Standard Buildings. Such buildings are common buildings having similar design features and can be categorized as follows:

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

3.2.1.2 Commercial buildings. All types of buildings meant for commercial business such as offices, shops, malls, souks, hotels, banks and the like.

3.2.1.3 Institutional buildings. All types of buildings meant for public convenience such as governmental building, schools, universities, clinics, mosques, etc.

3.2.1.4 Mixed-Use Buildings. The mixed-use buildings are commercial type buildings with two or more functions.

3.2.2 Special Buildings. Such buildings include all types of buildings such as hospitals, laboratories, industrial warehouses, factories, workshops, and central plants.

3.3 Building Envelope

Building envelope is defined as the exterior and the semi-exterior portions of a building and classified as the following:

3.3.1 Building envelope, exterior. The element of a building that separates conditioned spaces from the outside environment.

3.3.2 Building envelope, semi-exterior. the element of a building that separates conditioned spaces from unconditioned or partially conditioned spaces through which thermal energy may be transferred.

3.4 Areas of Building Envelope Components

Components of the entire building envelope include the opaque walls above grade, ceilings, slabs, floors, glazing, doors, and walls below grade.

3.4.1 Area of all exterior walls (gross).

Exterior surface area of the following assemblies that enclose conditioned spaces: 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.

3.4.2 Area of all door assemblies

Opaque area of such assemblies (including the frame) that enclose conditioned space. For doors where the daylight opening area is greater than or equal to 50% of the door area, the entire area of the door assembly is considered fenestration area.

3.4.3 Area of all fenestration assemblies

Exterior 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.

3.4.4 Area of all floor assemblies

Interior surface area of such assemblies that enclose conditioned space.

3.4.5 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 interstitial areas).

3.4.6 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.

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

3.4.6.2 Gross conditioned floor area. the gross floor area of conditioned spaces.

3.4.6.3 Gross lighted floor area. the gross floor area of lighted spaces.

3.4.7 Gross Roof area

The area of the roof measured from the exterior faces of walls or from the centerline of party walls. (See roof and wall.)

3.4.8 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.

3.4.9 Window-to-wall Ratio

The ratio of the glazing area to the gross wall area, excluding spandrel glass.

3.5 External Shading Construction

All types of shading devices (passive) that form parts and parcels of a building's construction are considered to be as external shading construction.

3.6 Physical Properties of Building Materials

3.6.1 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.

3.6.2 Thermal mass. Describes 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. Thermal mass of a layer is equivalent to the product of its density (ρ) and its specific heat capacity (c_p). The layers' thickness (t) should be employed in the calculation of the overall thermal mass for a construction (i.e., wall or roof) – that is composed of n layers - by means of the following equation:

$$(\rho c_p)_{\text{construction}} = \sum_{i=1}^n (\rho \times c_p \times t)_i \div L \quad \text{where } L, \text{ the whole construction type}$$

For physical properties of common building materials, refer to Appendix C.

3.6.3 Thermally insulated buildings. These are buildings that use insulation materials to satisfy the maximum allowable U-value stipulated in Table 6 for the wall and roof constructions.

3.6.4 Thermal insulation materials. These are all types of passive insulation materials used as a part and parcel of building's wall and roof construction.

3.6.5 Overall thermal resistance (R-value). This is the sum of the thermal resistance of all material layers constituting the wall or roof section, and includes the thermal resistance of the outside and the inside air films in h.ft².°F/Btu or m².°K/W.

3.6.7 Overall coefficient of heat transfer (U-factor). This is the overall rate of heat transfer through a section per unit area and per unit temperature difference, expressed as Btu/h.ft².°F or W/m².°K.

3.6.8 Thermal conductivity of a material (k or λ). This is 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/h.ft².°F or Btu/h.ft².°F

3.6.9 Thermal resistance of a material. This is the inverse of the thermal conductance of a material, expressed as h.ft².°F/Btu or m².°K/W.

3.6.10 C-factor (thermal conductance)

Time rate of steady-state heat flow through unit area of a material or construction, induced by a unit temperature difference between the body surfaces. Units of C-factor are Btu/h ft².°F (W/m².°K). Note that the C-factor does not include soil or air films.

3.6.11 F-factor

The perimeter heat loss factor for slab-on-grade floors, expressed in Btu/h ft °F (W/m °K).

3.6.12 U-factor (thermal transmittance)

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. Units of U are Btu/h ft².°F (W/m².°K).

3.6.13 U-effective (thermal transmittance)

An area weighted average heat transmission in unit time through unit area of a wall or roof construction, where heat takes 2 or more parallel configuration paths. Units of U are Btu/h.ft².°F.

3.7 Building Construction

3.7.1 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 as per Table 1.

Table 1. Classification of Building Construction accordingly to Overall Thermal Mass $\text{kJ/m}^2\cdot^\circ\text{C}$ ($\text{Btu/ft}^2\cdot^\circ\text{F}$)

Building Construction Type	Wall	Roof
Very light	< 50 (< 2.4)	< 25 (< 1.2)
Light	50 – 220 (2.4 – 10.8)	25 – 110 (1.2 – 5.4)
Medium	221 – 440 (10.9 – 21.5)	111 – 220 (5.5 – 10.8)
Heavy	> 440 (> 21.5)	> 220 (> 10.8)

3.7.2 Floor. That 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:

3.7.2.1 Mass floor. a floor with a heat capacity that exceeds (1) $7 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$ ($143 \text{ kJ/m}^2 \cdot \text{K}$) or (2) $5 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$ ($102 \text{ kJ/m}^2 \cdot \text{K}$) provided that the floor has a material unit mass not greater than 120 lb/ft^3 (1920 kg/m^3) .

3.7.2.2 Steel-joist floor. a floor that (1) is not a mass floor and (2) that has steel joist members supported by structural members.

3.7.2.3 Wood-framed and other floors. all other floor types, including wood joist floors. (See building envelope, fenestration, opaque area, and slab-on-grade floor).

3.7.3 Walls

Those portions of the building envelope that are vertical or tilted at an angle of 30 degrees or less from the vertical plane.

3.7.3.1 Above-grade: all the exterior walls of any given story if 50% or more of the gross exterior wall area of the story is exposed to outside air.

3.7.3.2 Below-grade: all the exterior walls of any given story if more than 50% of the gross exterior wall area of the story is below grade.

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

3.7.4 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.

3.7.5 Opaque

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

3.7.6 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.

3.8 Air films

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

3.9 Assembly

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

3.10 Fenestration.

All light-transmitting assemblies in a building envelope, including the glazing material, sash, frame, and permanently affixed external or internal shading devices, where such component assemblies enclose conditioned space.

3.10.1 Glazing. Glazing is 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:

3.10.1.1 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.

3.10.1.2 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.

3.10.1.3 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 convected into the space. (See fenestration area.)

3.11 Building Air Infiltration or Leakage

This refers to 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.

3.12 Natural and Forced Ventilation

Ventilation includes any intentional introduction of outdoor air into the building, either natural or forced. Natural ventilation is the intentional flow of outdoor air through planned openings in the building envelope like windows, doors, and grilles, driven as a result of natural or artificially produced pressure differences. Forced ventilation, also called mechanical ventilation, is the intentional movement of air into and out of a building using fans, and intake and exhaust vents. Ventilation is expressed in terms of ACH.

3.13 Air-conditioners (A/C)

A/C system(s) shall refer to all active mechanical and electrical systems employed to provide control of indoor environment.

3.13.1 A/C systems. It is commonly practiced in the region to refer to the HVAC systems as air-conditioner (A/C) systems since the former are predominantly used for cooling. The term A/C system will be used instead of HVAC system thereafter.

A/C systems are categorized based on the medium of heat transfer in the condenser and evaporator. Systems covered in this code correspond to vapor-compression A/C systems.

3.13.1.1 Air-cooled A/C system: In these systems, 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.

3.13.1.2 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 recirculated 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.

3.13.1.3 Chilled water A/C system. In these systems, cooling is supplied to room air by chilled water in air-handling units or fan-coil units.

3.13.1.4 DX A/C system. In these systems, cooling is supplied to room air directly from refrigerant boiling in a heat exchanger, called an evaporator.

3.13.2 Standby A/C Units. These include any units that are operated only during the failure of main A/C units.

3.14 Peak Electrical Load

This term refers to the peak electrical load of a building as a whole or its different load components, and is expressed as kilowatts (kW).

3.14.1 Peak Electrical Load for A/C Systems. This refers to the peak electrical load on the A/C system, which is comprised of subsystems for cooling production excluding standby units, cooling distribution, heat rejection and all other auxiliary equipment.

3.14.2 Peak Electrical Load for Cooling Production Subsystems. This refers to the peak electrical load of the cooling production subsystem, which is comprised of the chiller equipment, the heat rejection subsystem and accompanying auxiliary equipment.

3.14.3 Peak Electrical Load for Lighting. This refers to the peak electrical load for lighting of buildings.

3.14.4 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.

3.15 Peak Power Density

This refers to the peak electrical load, expressed in watts per square meter for the building as a whole or for its different load components.

3.15.1 Peak Power Density of an A/C System. This is 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.

3.15.2 Peak Power Density of Lighting. This is 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..

3.15.3 Peak Power Density of a Building. This is the ratio of the total electrical load of the building, as defined for 'Total Peak Electrical Load for Buildings,' expressed as watts, to the air-conditioned area of the building as defined for 'Air-Conditioned Space,' expressed as square meters.

3.16 Power Rating

This refers to the power required, expressed as kilowatts per unit of cooling expressed as refrigeration tons, for an A/C system and its components.

3.16.1 Power Rating of the Chiller (PR_{CHIL}). This refers to the chiller of a vapor-compression A/C system.

3.16.2 Power Rating Cooling Tower Fan (PR_{CTF}). This refers to the cooling tower fan of a vapor-compression A/C system with a water-cooled condenser.

3.16.3 Power Rating of a Condenser Water Pump (PR_{CW}). This refers to the condenser water pump of a vapor-compression A/C system with a water-cooled condenser.

3.16.4 Power Rating Chilled Water Pump (PR_{CHW}). This refers to the chilled water pumps of an A/C system.

3.16.5 Power Rating of an Air-handling System (PR_{AH}). This refers to the air-handling system of an A/C system.

3.16.6 Power Rating of a Total A/C System (PR_T). This refers to the total A/C system.

3.17 Cool storage

Storage of cooling capacity in a storage medium at temperature below the nominal temperature of the space or process.

3.18 Conditioned space

An enclosed space within a building that is provided with mechanical heating and/or cooling energy.

3.19 District cooling (DC)

System distributes chilled water from a thermal sink (i.e., central plant) to thermal sources, such as residential, commercial, and/or industrial buildings for use in space cooling. Thus, cooling effect comes from a distribution medium rather than being generated on site at each building. Whether the system is a public utility or user owned, such as a multi-building campus, it has economic and environmental benefits depending somewhat on the particular application.

3.20 Grey-water

Waste water from taps, showers and laundries

3.21 Living unit

One or more rooms designed or used as living quarters providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

3.22 Multi-family structure

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

3.23 Prescriptive design

Design of a living unit or building of the same size and occupancy type as the proposed design that complies with the prescriptive requirements of this standard. The prescriptive design includes specified assumptions concerning shape, orientation, ventilation and air conditioning, and other system design features.

3.24 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.

3.25 Shall

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

3.26 Single-family house

Building containing one or two living units or a townhouse, including a modular house.

3.27 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. (600 mm) below the final elevation of the nearest exterior grade.

3.28 Space-conditioning category

Residential conditioned space and residential semi conditioned space.

3.29 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. Units of R are $\text{h ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ($\text{m}^2 \cdot \text{K}/\text{W}$).

3.30 Thermal transmittance

See U-factor.

3.31 Townhouse

A living unit in which one or more walls are partition, lot line, or common walls but not containing common floor and ceiling combinations.

3.32 Unconditioned space

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

3.33 Vapor retarder

See water vapor retarder.

3.34 Water vapor retarder

Material or construction that adequately impedes the transmission of water vapor under specified conditions. Water vapor retarders have a water vapor permeability of less than 1.0 perm (0.006 $\mu\text{g}/\text{Pa}\cdot\text{s}\cdot\text{m}^2$) when tested in accordance with ASTM E 96.

3.35 Zone

A separately controlled heated or cooled space in a building.

IV. Typical Meteorological Year (TMY), Design Conditions and Design Day Profiles

Kuwait's meteorological data over the past several years show an appreciable difference in weather conditions in the coastal and the interior areas, particularly during the summer season. Coastal areas experience hot and humid conditions, whereas the interior area is hot and dry. It is imperative that the A/C plant capacity for a building be accurately determined to conserve power and energy, and to provide a comfortable indoor environment throughout the summer. Over sizing leads to higher initial investments and greater energy consumption by auxiliaries such as pumps and fans, while under sizing results in discomfort during the peak summer season. It is for this reason that separate sets of recommendations are made for the coastal (i.e., within 2.5 kilometers of the coastline) and interior areas.

4.1 TMY

To estimate the peak cooling 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. Two typical meteorological years (TMYs), giving the hourly values for these parameters for the coastal and the interior areas can be obtained from the Kuwait National Meteorological Network at the Kuwait Institute for Scientific Research.

4.2 Design Conditions

For each of the two climate zones, different sets of design conditions were established. One is based on the DBT prioritization and the other is based on the WBT prioritization. For the first set of design conditions, the extreme DBTs were established for different frequencies of occurrence, and WBTs were then estimated by averaging the corresponding WBT values occurring simultaneously. The reverse was done to produce the second set for design conditions. Tables 2 and 3 give these design conditions for the 1%, 2.5% and 5% frequencies of occurrences. The recommended design conditions are more appropriate than single set of design conditions as they are representative of the locations and applications for which A/C equipment must be selected. Also, building that might have immediate effect by such less frequent outside conditions such as very light and light construction given the illegibility to be designed at 1.0% frequent, see Table 2 & 3.

Table 2. Design Conditions for Kuwait's Interior Areas.

Building Construction Type	DBT Prioritization			WBT Prioritization		
	Frequency (%)	DBT (°C)	WBT (°C)	Frequency (%)	WBT (°C)	DBT (°C)
Very Light / Light	1.0	48.0	22.1	1.0	27.1	36.3
Medium	2.5	47.0	22.1	2.5	25.5	37.0
Heavy	5.0	46.2	22.1	5.0	24.0	38.4

DBT = dry-bulb temperature; WBT = wet-bulb temperature

Table 3. Design Conditions for Kuwait's Coastal Areas.

Building Construction Type	DBT Prioritization			WBT Prioritization		
	Frequency (%)	DBT (°C)	WBT (°C)	Frequency (%)	WBT (°C)	DBT (°C)
Very Light / Light	1.0	47.4	27.1	1.0	32.6	43.4
Medium	2.5	46.1	27.1	2.5	31.8	42.9
Heavy	5.0	44.8	27.0	5.0	31.0	41.9

DBT = dry-bulb temperature; WBT = wet-bulb temperature

4.3 Design Day Profiles

Design day profiles for DBTs and WBTs are required by designers to estimate the daily maximum demand for cooling energy and electrical consumption for a building. Also these temperatures may be used to determine the peak load of individual rooms and cooling coils. These profiles are based on hour-by-hour analysis of the temperature data recorded for the months of July and August, for the interior and coastal areas. Table 4 gives the hourly temperatures for the two areas with DBT and WBT prioritization, respectively, with 1% frequency of occurrence.

Table 4. Kuwait's Hourly Design Day Temperatures.

Hour of day	Interior Areas		Coastal Areas	
	DBT (°C)	WBT (°C)	DBT (°C)	WBT (°C)
1	39.7	26.6	37.5	31.0
2	38.2	26.0	36.7	31.5
3	38.0	27.0	36.2	30.6
4	37.0	26.7	36.0	30.4
5	36.0	26.8	36.0	29.7
6	35.5	26.5	35.3	29.6
7	36.4	26.6	35.4	29.7
8	37.8	27.0	37.5	30.8
9	40.2	27.1	39.5	31.6
10	43.0	26.5	42.1	32.6
11	45.5	26.0	45.0	31.6
12	47.0	26.4	46.9	32.2
13	47.0	27.1	45.5	32.3
14	47.7	27.1	46.0	32.6
15	48.0	26.8	46.8	32.4
16	47.9	26.6	47.4	32.0
17	47.6	27.1	47.1	31.2
18	47.4	26.7	46.1	32.6
19	47.0	27.0	47.0	31.8
20	44.8	26.7	43.7	31.4
21	43.0	26.5	41.4	31.0
22	42.4	26.4	40.5	30.5
23	41.5	26.7	39.5	30.5
24	40.5	27.0	38.1	31.0

DBT = dry-bulb temperature; WBT = wet-bulb temperature

Note: The above DBT & WBT are not coincidental but are based on individual prioritization.

V. Methods of Load Estimation

Different methods of calculating air-conditioning cooling load for the purpose of sizing cooling equipment can be used. These methods have to consider the thermal storage effect in the space, the hourly values of the outdoor temperatures, solar radiation and other weather parameters. Examples of methods that can be used for this purpose are: Heat Balance, Transfer Function, Time Radiant Series and Total Equivalent Temperature Difference (TETD). In addition, traditional hand calculation techniques that are based on Transfer Function method, such as CLF/CLTD may also be used. It must also be noted that building energy simulation programs can be utilized for this purpose. Examples of such software are: eQuest, VisualDOE, E20-II, TRNSYS, ESP-r, or any other program approved by MEW.

VI. Basic Energy Conservation Requirements

6.1 Standard Buildings

The basic energy conservation requirement for different types of standard buildings is determined by peak watt limit per square meter for the A/C and lighting systems as given in Table 5. In addition, minimum required energy conservation measures for buildings should be applied. Spaces within the standard buildings with different thermal characteristics, such as swimming pool, data center, kitchen, laundry, mechanical and electrical plant room etc, shall follow the terms of section 6.2.

6.2 Special Buildings

For these buildings, the minimum energy conservation requirements related to the building and the A/C system as described in Sections VII and VIII must be applied. For lighting system, an accepted international standard should be used. In addition, a verified method of load calculation should be used, as mentioned in the section V.

6.3 Mixed Use Buildings

The mixed use buildings are commercial type buildings with two or more functional uses.

The HVAC design engineer shall separate each space accordingly to its function and ensure meeting the stipulated values in Table 5 for that function (i.e. Building Types) unless the following apply:

1. The power density (W/m^2) limit of the office floor areas that constitute less than or equal to 5% of the Air conditioned area of the building, provided that the office floor area does not exceed 500 m^2 , shall be considered the same as the main building functional type power rating.
2. Ancillary areas: The air-conditioned or indirect air-conditioned store, toilet, pantry, changing room, and corridor shall be considered to have the same power rating W/m^2 as the function they support. **Staircase should be considered at half the rate.**
3. It should be noted the above two points apply only for HVAC system, but not for lighting system

6.4 General Notes

- If the basic energy conservation requirement (Table 5) cannot be maintained, the designer must resort to reducing the building cooling load by incorporating additional energy conservation measures.
- The designer must ensure that the total peak electrical power drawn for any operation configuration (standby, backup or future expansion) shall not exceed the allowable peak wattage per square meter.
- In installations where only a portion of a cooling machine's capacity is considered to be standby, then the whole machine shall be considered as part of the basic system cooling load, and the machine's full peak electrical power shall be included in the calculation of the peak wattage per square meter for A/C.
- In installations where additional cooling machines are installed for future building expansion or future buildings, their peak wattage per square meter should be calculated separately.

Table 5. Basic Energy Conservation Requirements of Different Standard Buildings*.

Building Type	Lighting (W/m ²) **	A/C Systems (W/m ²)				
		DX***	Air-Cooled Chiller	Water-Cooled Chiller		
				<250 RT	250<RT<500	>500 RT
Residential						
- Villa	8	60	65	53	46	44
- Apartment	8	60	65	53	46	44
Clinic	11	85	100	75	65	63
School	13	100	118	88	76	74
Mosque						
- prayer area	11	115	135	101	88	85
Fast food restaurant						
- Stand-alone	13	145	171	128	111	107
- In a mall	13	120	141	106	92	88
Office	11	70	82	62	54	51
Community hall, dinning hall, theatre	11	115	135	101	88	85
Show room	17	115	135	101	88	85
Shopping mall	16	70	82	62	54	51
Stand Alone Shops	16	80	--	--	--	--

* This table is based on zero diversity. For chilled water systems apply Demand Factor (Diversity Assume=0.9)

.Note: Adjust w/m² for chw systems .For more details refer to ASHRAE 90.1- 2010

** For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaries or sconces or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 11 W/m² of such spaces.

*** DX = direct expansion

VII. Minimum Required Energy Conservation Measures for Buildings

7.1 Introduction

In order to meet the 'Basic Energy Conservation Requirements', the code stipulates that certain minimum standards for energy conservation measures be adhered to. These standards may or may not guarantee that a given building will meet the Basic Energy Conservation Requirements described herein. The building designer always has the option

to apply more stringent standard. No relaxation shall be made in applying the values specified in this section, and these measures should, therefore, be considered mandatory.

7.2 Building Envelope Construction

7.2.1 Walls and Roofs

7.2.1.1 Minimum requirements for wall and roof insulation. Table 6 provides a list of the maximum allowable overall heat transfer coefficients (U) for variety of wall and roof constructions and their external color.

7.2.1.2 Exposed floor Exposed floors in multistory apartment buildings or similar constructions shall not to have a U value of more than 0.568 W/(m².°K) (0.1 Btu/(h.ft².°F))

7.2.1.3 Columns and beam insulation: Columns and beams should be insulated in a manner similar to corresponding walls and roofs. Accordingly, their U-values should not exceed 0.568 W/(m².°K) (0.1 Btu/(h.ft².°F)) for the columns and 0.0398 W/(m².°K) (0.07 Btu/(h.ft². °F)) for the beam. In case the columns and beams are not insulated, the insulation on the wall should be increased to 0.0398 W/(m².°K) (0.07 Btu/(h.ft². °F)).

7.2.1.4 Slab-on-grade Insulation: it should be water resistant. laid horizontally at the inner side of external walls and extending a distance of 120 cm. The thermal resistance value for the insulation material should not be less than R7 (1.4 m².k/w). (See Figure).

7.2.1.5 Below-Grade Wall Insulation. Below-Grade Wall shall have a rated R-value not less than the R-value of the Above-Grade Wall.

The envelope components (Exterior Walls, Roofs and Floors) of unconditioned spaces connected to conditioned spaces shall have similar U-Values as of conditioned spaces.

Table 6. Maximum Allowable U values for Different Types of Walls and Roofs.

Description	Wall		Roof	
	Thermal Mass ¹	U-value ²	Thermal Mass ¹	U-value ²
Very light construction, light color	< 50 (< 2.4)	0.227 (0.04)	< 25 (< 1.2)	0.155 (0.027)
Light construction, dark external color	50-220 (2.4-10.8)	0.369 (0.065)	25 - 110 (1.2-5.4)	0.170 (0.03)
Light construction, medium-light external color		0.426 (0.075)		0.284 (0.05)
Medium construction, dark external color	221 - 440 (10.9-21.5)	0.426 (0.075)	111 - 220 (5.5-10.8)	0.199 (0.035)
Medium construction, medium-light external color		0.483 (0.085)		0.341 (0.06)
Heavy construction, dark external color	> 440 (> 21.5)	0.426 (0.075)	> 220 (> 10.8)	0.256 (0.045)
Heavy construction, medium-light external color		0.568 (0.1)		0.397 (0.07)

1. Figures are given in kJ/m².°C (Btu/ft².°F)

2. Figures are given in W/m².°C (Btu/h.ft².°F)

Thermal bridging must be included in calculation of U-Value of wall and roof

7.2.2 Fenestration

7.2.2.1 Maximum glazing requirements. Maximum allowable window-to-wall ratio in each direction for specific glazing type and quality, such as U-value and SHGC, are given Table 7.

7.2.2.2 Windows. All windows should have a thermal break between metallic frame and glazing.

7.2.2.3 Labeling of Fenestration Products. All manufactured fenestration products shall have a permanent name plate, installed by the manufacturer, listing the U-factor, SHGC, and air leakage rate.

Exception: When the fenestration product does not have such nameplate, the installer or supplier of such fenestration shall provide a signed and dated certification from a accredited institution for the installed fenestration listing the U-factor, SHGC, and the air leakage rate. Residential Villas are excluded.

7.2.2.4 Labeling of Doors. The U-factor and the air leakage rate for all manufactured doors installed between conditioned space, unconditioned space, and exterior space shall be identified on a permanent nameplate installed on the product by the manufacturer. Residential Villas are excluded.

Exception: When doors do not have such a nameplate, the installer or supplier of any such doors shall provide a signed and dated certification from an accredited institution for the installed doors listing the U-factor and the air leakage rate.

Table 7. Maximum Allowable Window-to-Wall Ratio for Different Types of Glazing*.

Glazing Type	SHGC**	Tv**	U-Value (W/m ² C)	Window to wall Ratio			
				East	West	South	North
6-mm single-clear	0.721	0.8	6.21	≤5	≤3	≤4	≤5
6-mm single-reflective	0.314-0.371	0.16-0.27	6.41-6.44	6-10	3-10	4-10	6-10
6-mm double-tinted	0.36-0.40	0.3-0.57	3.42-3.44	11-15	10	10	11-15
6-mm double-reflective	0.245	0.228	3.38	16-50	10-45	10-45	16-50
6-mm double-spectrally selective***	0.230	0.530	1.71	51-100	45-75	45-75	51-100

*based on combined cooling and lighting at 15:00 h.

** SHGC and Tv are solar heat gain coefficient and visible light transmittance coefficient, respectively.

***hi performance green/bronze/blue tinted glass with low e (0.05) interior clear pane.

7.3 Infiltration Control

7.3.1 Building Envelope. Building envelope shall be made tight with no cracks or open joints in order to prevent 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.

7.3.2 Fenestrations. All exterior windows and doors shall be properly sealed and weather-stripped to limit infiltration. All cracks should be sealed with caulking or similar materials. Positive pressure inside buildings should 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/ft² (1.5 L/s/m²), and

swinging doors no more than 0.5 cfm/ft² (2.6 L/s/m²), when tested according to NFRC standards by an accredited, independent laboratory. Exception of the above is residential villa.

7.3.3 Building and Shop Entrances. Except for residential buildings and small shops with single access/entrance, all exterior entrances to buildings shall be double or revolving-doors, with both entrances doors closing automatically after use.

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

VIII. Minimum Required Energy Conservation Measures for A/C Systems and their Components

8.1 Minimum Energy Efficiency of A/C Systems

Based on the operating conditions and guidelines outlined in the Appendix B, the power rating of different types of A/C systems and their components are as given in Table 8.

Table 8. Maximum Power Rating for Different Types of A/C Systems and their Components.

System		Power Rating (kW/RT)			
Type	Capacity (RT)	PR _{CHIL}	PR _{AH}	PR _{AUX}	PR _T
Ducted Split and Packaged Units	All				1.70
Air-Cooled	All	1.60	0.35	0.05	2.00
Water-Cooled	0-499	0.95	0.38	0.17	1.50
	500-999	0.75			1.30
	>1000	0.7			1.25

A/C = air-conditioning; RT = refrigeration ton; kW = kilowatt; PR = power rating Subscripts; CHIL = chiller, AH = Air-handling fan unit, AUX = chilled water pumps &/or condenser water pumps &/or cooling tower fans, T = total

* Capacity shown is per individual chiller.

8.2 A/C System Selection

Buildings with total cooling load of 300 RT and above are limited to use chilled water A/C system. Water-cooled chillers are used for all buildings in the interior zone of Kuwait with total operating plant capacity (after applying diversity factor) of 500 RT and above, as well as for all buildings in the coastal zone of Kuwait with total operating plant capacity of 1,000 RT and above. Additionally, the Consultant/Engineer must obtain approval for the availability of the total electricity and water demands from MEW during building's initial design phase. A flow chart of the steps for A/C system selection is provided in Appendix A.

Subject to water availability, the recommended chilled water system is the water-cooled system.

8.3 Cooling Recovery Units (CRU)

All buildings must use rotary-wheel when:

- Building in the coastal zones and the recoverable exhausted air is more than 2,000 CFM (940 l/s).

- Building in the interior zone and the recoverable exhausted air is more than 3,000 CFM (1,410 l/s).

In applications where health hazards may accrue such as in operating theaters and toilets, the two streams (outdoor and exhaust air) must be separated to prevent cross contamination, thus cross flow fixed-plate, heat-pipe or run-around-coil CRUs should be used. Central exhaust system shall be incorporated in the design of building to facilitate the above requirement.

Minimum efficiency shall be 70% for sensible and latent loads in rotary wheel CRU and 50% for sensible load in other CRUs.

8.4 Time-of-Day Controls for Energy Savings

Time-of-day and day-of-week controls in air-conditioned buildings can save appreciable amounts of energy annually. Commercially available programmable thermostats provide simple, trouble-free temperature offset control and switching off the air circulating fan for energy conservation, particularly in buildings with only part-day occupancy, such as: commercial & institutional buildings.

Use of programmable thermostats (that are controlled by either an automatic time clock or programmable control system) is mandatory for all zones with part-day occupancy, except zones with units having cooling capacities not exceeding 24000 BTU/H (7.39kW) and equipped with a readily accessible manual shutoff switch. The programmable thermostat should facilitate different schedule for each day of the week. In addition, it should allow a manual override that invokes temporary operation of the cooling system for up to 2 hours. The standard setback value and duration is 2.8°C (5 °F) and 6 hours, respectively. However, these values are building related and their selection should not cause any of the following drawbacks:

1. Discomfort to the occupants during the occupancy period,
2. Increase in demand for cooling or power from 12:00 to 16:00 h, the peak demand period.

8.5 Use of Partial Cool Storage

Buildings with part-day occupancy pattern and chilled water systems serving building's peak load of 500 RT or above, partial cool storage is mandatory. Some examples of buildings with part-day occupancy are: commercial and institutional buildings.

8.6 Electrical Motors

Motors to be used for A/C systems are required to have power factor (PF) not less than in Table 9 and efficiency not less than the value given in Table 10.

Table 9. Electrical Motors

Motors	Full-Load PF Minimum
Single Phase Motors 240 Volts 1450 rpm. and 50 Hz	0.80
3-Phase motors, 415 volts, 1500 rpm, 50 Hz:	
- 15 – 49 hp	0.83
- 50 – 99 hp	0.85
- 100 – 199 hp	0.87
- 200 – 400 hp	0.88
- > 400 hp	0.89

PF = power factor; hp = horse power; 1hp = 0.75 kW

Table 10. Electrical Motors¹ Efficiency.

	Open Motors				Enclosed Motors			
Number of Poles =>	2	4	6	8	2	4	6	8
Synchronous (RPM) =>	3000	1500	1000	750	3000	1500	1000	750
Motor Horsepower								
1	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.5	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5	89.5	89.5	89.5	85.5
15	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
50	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7

¹ Minimum Nominal Full-load Efficiency for 50 HZ NEMA General Purpose Electric Motors.

For motors having power < 1 hp, the minimum efficiency shall be 59% for totally enclosed fan cooled (TEFC) motors and 62% for open drip motors.

All motors shall be specifically designed for operation with 50 HZ power

8.7 Lighting Fixtures and Control

Lighting fixture of all lamps types such as fluorescent, discharge and LED lamps should have a minimum PF of 0.9. It also should has automatic control that shout off building lighting in all spaces. This automatic control device shall function on either:

8.7.1 a scheduled basis using a time-of-day operated control device - or

8.7.2 an occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space - or

8.7.3 a signal from another control or alarm system that indicates the area is unoccupied.

The above lighting control strategy might be exempt when the space requires a 24-hour operation.

8.8 Utilization of Alternative Water Sources in Water-Cooled Central Plants

Different water sources can be used in water-cooled central plants as the following :

8.8.1 It is mandatory for water-cooled central plants with cooling capacity of 17600 kW (5000 RT) and above within a coastal areas to use seawater to cool down the refrigerant in the condenser side, unless it is proved to be not feasible.

8.8.2 Use of greywater whenever its quantity and availability is ensured.

8.9 District Cooling

District cooling systems can be either public utility or user owned. Buildings in a public utility district cooling must be connected to the district cooling distribution network; no exemptions are allowed. For privately owned projects extending across a neighborhood, such as medical or educational campuses, user owned district cooling should also be employed. However, exemptions may be granted on a case-by-case basis if supported with comprehensive study not favoring district cooling based on environmental factors or cost of power and water supply. HVAC design assessment should be documented and shall include optimization analysis for the configuration of the district cooling system layout and operation. Thermal energy storage (TES) shall be considered in district cooling systems.

8.10 Use of Variable Speed Drives for Cooling Towers

Cooling towers of all sizes and for all locations shall install variable speed drives (VSD) on their fan motors. The fan speed will 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:

8.10.1 Regardless of weather conditions or the load on the cooling tower, the temperature of water leaving the cooling tower should be kept fixed at the design value.

8.10.2 Regardless the number of chillers in operation, all the cooling towers, including the standby, with their fans in operation should be used sharing the water from the common header.

8.10.3 Single temperature sensor should regulate all the VSDs, thus ensuring similar speed for all the fans.

8.11 Ventilation

Unless otherwise mentioned, all residential- and commercial-sector buildings shall have a minimum ventilation rate of 0.50 ACH for pressurization. This is likely to maintain a positive pressure of 20 to 50 Pa in buildings of good construction quality. The ventilation rate should be the higher of the two following values:

8.11.1 0.50 ACH for pressurization + exhaust air from kitchens, toilets and other areas.

8.11.2 Recommended air quantity per person or floor area as per latest ASHRAE Standard 62-2001 (Table 11).

Table 11. Outdoor air requirements for ventilation for some common applications in accordance with ASHRAE standard 62-2001. However use of latest standard is approved.

Application	Occupancy/ 100 m ² *	Outdoor Air Requirement			
		Occupancy-Related		Area-Related	
		CFM/person	l/(s.person)	CFM/ft ²	l/(s.m ²)
Residence					
- Living area		15	7.5	-	-
- Kitchen ^a				-	-
- Bath and toilet ^b				-	-
Office					
- Office space	7	20	10	-	-
- Reception area	60	15	8	-	-
- Conference room	50	20	10	-	-
Education					
- Classroom	50	15	8	-	-
- Laboratory	30	20	10	-	-
- Library	20	15	8	-	-
- Auditorium	150	15	8	-	-
Hotel					
- Bedroom	-	30/room	15/room	-	-
- Living room	-	30/room	15/room	-	-
- Bath and toilet	-	35/room	18/room	-	-
- Lobby	30	15	8	-	-
- Conference room	50	20	10	-	-
Assembly hall	120	15	8	-	-
Dormitory	20	15	8	-	-
Eating and Drinking					
- Dining room	70	20	10	-	-
- Cafeteria and fast-food areas	100	20	10	-	-
- Kitchen (cooking)	20	15	8	-	-
Garage and Warehouses					
- Enclosed parking	-	-	-	1.5	7.5
- Auto repair room	-	-	-	1.5	7.5
- Warehouse	5	-	-	0.05	0.25
- Factory	-	-	-	0.10	0.50
Sports and Amusement					
- Spectator area	150	15	8	-	-
- Game room	70	25	13	-	-
- Swimming pool (and deck area)	-	-	-	0.5	2.5
- Gymnasium	30	20	10	-	-
- Ballroom	100	25	13	-	-
- Bowling alley	75	25	13	-	-
Hospital ^c					

ASHRAE = American Society of Heating, Refrigerating and Air-Conditioning Engineers; ICU=intensive care unit; ACH = air-change per hour; CFM=cubic feet per minute

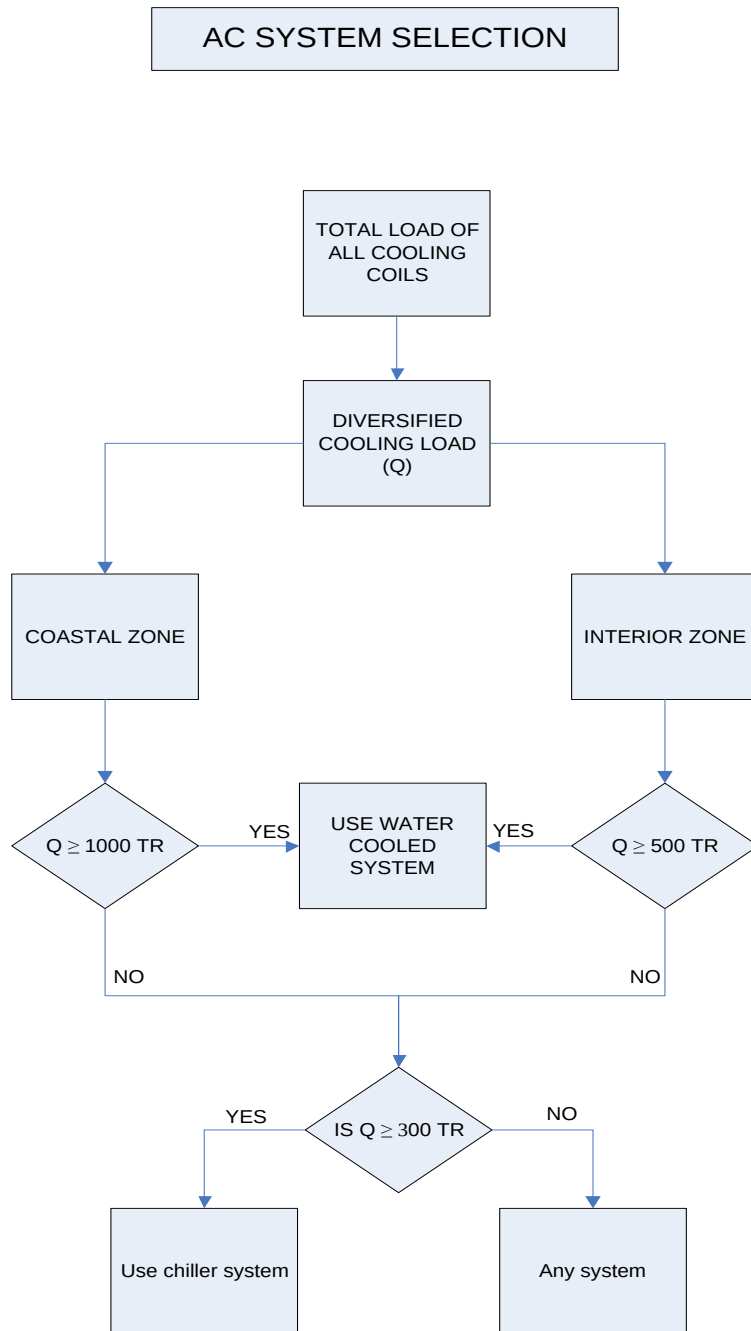
* Only for general guidelines.

^a Exhaust air flow rate shall be 5 ACH for continues local ventilation, and 100 CFM (50 L/s) for intermittent local ventilation.

^b Exhaust air flow rate shall be 20 cfm (10 L/s) for continues local ventilation, and 50 CFM (25 L/s) for intermittent local ventilation.

^c Use Ministry of Health -Kuwait standard and ASHRAE 170 Ventilation of Health Care Facilities -latest editions

Appendix A: Flowchart of selecting A/C system.



IX. Basis for Building Peak Load Calculations

For building load calculations refer to MEW-R7, Rules and Regulations for the Design of Air Conditioning Systems under Kuwait's Environmental Conditions. Acceptable Methods of Calculation:

Simulation Programs

- It shall be a computer-based program for the analysis of year round energy consumption in buildings (a program such as, but not limited to, EnergyPlus). The simulation program shall include calculation methodologies for the building components being modeled.
- For computer methods, detailed hourly weather data shall be obtained from MEW
- Exceptional Calculation Methods. The authority having jurisdiction may approve an exceptional calculation method to be used to demonstrate compliance with the code, as per ASHRAE handbook 2012 onward.

X. Application of the Code

10.1 This code of practice limits the following:

- (a) Maximum power density (W/m^2) for various types of buildings.
- (b) Maximum power density (W/m^2) for internal lighting for various types of buildings.
- (c) Maximum power rating (kW/RT) for various types of A/C equipment and systems.
- (d) Minimum power factor for certain equipment and appliances.
- (e) Maximum overall U-values for walls, exposed floor, basement walls, slab on grade and roofs.
- (f) Maximum percentage of glazed areas by type of glazing.

10.2 This code of practice specifies criteria for the following:

10.2.1 The Consulting Office:

10.2.1.1 Architecture is responsible for ensuring the following:

1. The overall U-value for building elements listed in paragraph 10.1 (e) are within the maximum permitted values.
2. The type of glazing used shall ensure the values specified in Table 8 of R-6.
3. All exposed floors, columns and beams are insulated as specified in R-6.

10.2.1.2 Electrical Design:

The Electrical engineer shall design the project according to and fully complying with the following MEW most recent regulations:

1. MEW/R-1, 4th Edition 1983 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.

10.2.1.3 HVAC Design:

The HVAC Engineer shall design the HVAC system according to and fully complying with most recent regulations:

1. MEW Regulations No. MEW/R-6.
2. MEW Regulations No. MEW/R-7.

10.3 HVAC Submittals to MEW

The Consulting Office shall submit the documents mentioned below to confirm that the MEW's regulations are fully complied with, before commencement of any project and before ordering any HVAC equipment.

10.3.1 Architectural Submittals

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

10.3.1.1 Plan drawings

- (a) Type, thickness weight and color of the building material to be used for external walls and cladding (where applicable).
- (b) Location and width of windows and glass doors and type of glazing, and the percentage of glazed area to the wall envelope area.
- (c) Location and thickness of wall cavity and type of insulation to be used, and its location in the wall and method of application.
- (d) Internal wall building material to be used and color (or internal cladding where applicable).
- (e) Overall thickness of wall.
- (f) Thickness and material of partition walls.

10.3.1.2 Wall sections drawing

- (a) Type, thickness and color of external and internal walls building materials (or cladding where applicable).
- (b) Thickness of wall cavity.
- (c) Height of roof slab and from F.F.L.
- (d) Height of false ceiling if any from F.F.L.
- (e) Height of windows and glazed areas and its level from F.F.L.
- (f) Type, location and thickness of glazing to be used & its S.F.
- (g) Overall thickness of wall.
- (h) Thickness and type of building materials and color of partition walls and cladding (where applicable).
- (i) Drop of beams from bottom of roof slab.

10.3.2 HVAC Submittals

The following are the minimum submittals required. However the Consulting Office shall submit any other additional information requested by the MEW engineer. The HVAC drawings must include the following:

- (a) All air-conditioned areas.
- (b) Type of A/C system to be used such as DX split or one piece units, or chilled water system, fan coil induction or variable systems, air cooled, water cooled, or sea water cooled condensers etc.
- (c) Fresh air percentages.

- (d) Location of plants and equipment.
- (e) kW/RT for A/C system and equipment
- (f) W/m² for the A/C system for the different types of areas used.
- (g) Schedule of all HVAC equipment (cooling and heating) showing kW input for each equipment at Kuwait conditions, model number and quantity.

Other documents shall include

- (a) Catalogue pages or computer selection for the complete HVAC system.
- (b) Copy of the HVAC Contract between the HVAC Contractor and the Client.
- (b) Copy of Consultant Office Heat load calculations for those applications where W/m² is not specified.
- (c) 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.

10.4 Inspection of Building by MEW

During construction phase and after completion of any building, but before power connection, MEW reserves its 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 do not comply with the requirements, unless and until necessary corrective measures as recommended by MEW are taken and the building is re-inspected.

XI. Enforcement of the Code

Table 12 delineates responsibilities of various governmental bodies in the enforcement of this code.

Table 12. Role of Various Governmental Bodies in the Enforcement of this Code.

Ministry/Government Authority	Responsibility
Ministry of Electricity and Water Sector (MEW)	(1) Approval of: (a) W/m² calculations for A/C and lighting. (b) All HVAC and electrical drawings (c) kW/RT for A/C systems and equipment. (d) Electrical Engineer (e) HVAC engineer (f) Energy efficiency of HVAC equipment to be certified by 3rd party internationally reputed testing agency. (g) Other energy conservation measures mentioned in R-6 and R-7. U value calculations including short circuit paths. Wall and roof weights calculations. (2) Perform non-Destructive site testing of buildings (NDT) to confirm compliance with insulation and glazing requirements.
Kuwait Municipality	- Check percent glazing on each elevation and glazing specifications to ensure compliance with MEW regulations. - Inspection during construction of insulation materials and glazing applications.
Ministry of Public Works	- Testing and certification of building materials including all insulation materials and systems.

XII. Appendix B

12.1 Operating Parameters and Guidelines for Estimation of Power Ratings (kW/RT) of Air-Conditioning (A/C) Systems

Power analysis for compressors and the air-cooled condenser fan motors for all types of air-conditioning (A/C) systems were conducted using the manufacturers' catalogues only. Analyses of the other components of A/C systems, such as condenser and chilled-water pump sets and air-handling units were fixed using field data and energy auditing experience. Specific guidelines were prepared for analyses to determine the power requirements of compressors and other components of A/C systems. Some of the following guidelines are general and others are specific to types of A/C systems.

12.1.1 General Specifications

- Ambient design dry-bulb temperatures (DBTs) and wet-bulb temperatures (WBT) are 48°C (118.4°F) and 32°C (89.6°F), respectively. This condition is valid for coastal and interior areas.
- Temperatures for air entering cooling coils are 26.67°C (80°F) DBT and 19.44°C (67°F) WBT, based on indoor temperature of 24°C (75.2°F) DBT, assuming that the fresh air supply constitute around 10% of the air in circulation.
- Power ratings should be based on gross cooling as net cooling may differ from application to application depending upon the external static pressure (ESP).

- Power ratings should be based on actual power demands and not on connected loads. The actual power demand may differ significantly from the connected load from case to case. Manufacturers are requested to provide the brake power requirements of fans, pumps, , and the efficiencies of feed motors. For design submittal the power input shall be calculated as $(0.85 \times \text{Name plate power} / \text{Motor Efficiency})$. For motors of less than 1 HP i the power input shall be considered equal to Name plate power.

12.1.2 Package Units and Ducted Splits

- All units have air-cooled condensers
- ESP does not include the pressure drop in internal components of air handling components such as coils and air filters. The expected ESPs for different package-unit and ducted-split capacities are specified in Table 13. It is advised not to round these figures to exact values, as it may not be practically possible.

Table 13. Expected ESP for Package Units and Ducted Splits.

Cooling Capacity (RTs)	Package Unit		Ducted-Split Unit	
	Pa	Water (in)	Pa	Water (in)
0-5	150	0.6	100	0.4
5-10	200	0.8	150	0.6
10-15	250	1.0	200	0.8
≥15	350	1.4	350	1.4

ESP = external static pressure; RT = refrigeration tons; Pa = Pascal; in = inches

- Airflow through the evaporator is close to 2,36 l/(s.RT) (500 CFM/RT) for the actual cooling capacity of system under Kuwait's conditions.
- The cooling capacity of equipment, based on catalogue information is gross cooling and not net cooling.
- Fan motor efficiency for different motor powers is as in Table 14.

Table 14. Assumed Efficiency for Motors at Different Powers.

Motor Power (HP)	Efficiency (%)
< 0.5	50
0.5-1.0	65

HP = horse power

12.1.3 Mini-Split Units and Unitary

- All units have air-cooled condensers.
- The ESP can be as low as 50 Pa (i.e., 0.2 in of water).
- Airflow through the evaporator is close to 236 l/(s.RT) (500 CFM/RT) for the actual cooling capacity of a system under Kuwait's conditions.

- The cooling capacity of the equipment based on the catalogue information is gross cooling, not net cooling.
- Fan motor efficiency for different motor powers is as in Table 14.

12.1.4 Central Chilled-Water Systems with Air-Cooled Condensers

- Design ambient temperature for selection of this equipment is 48°C (118.4°F) DBT.
- Water temperature at the chiller outlet is 6.67°C (44°F).
- Temperature drop of chilled water across the cooler is 5.56°C (10°F). However higher temperature differential may be used for large loads exceeding 500 TR to save pumping energy.
- Maximum pressure drop across the cooler or evaporator is 5 m (16.4 ft) of water for a water flow rate 0.15 l/(s.RT) (2.4 USGPM/RT).
- Chiller fouling factor is 0.00025 (ft².h.°F)/Btu (0.000044(m².°C)/W).
- Maximum power rating for the chilled water pump is 0.061 kW/RT(25.4 W/GPM) based on a maximum pump head of 25.9 m (85 ft) of water (Table 15), pump efficiency of 70% and motor efficiency of 90%. For large pumping systems having Primary, Secondary and Tertiary pumps use high chilled water temperature differentials up to 16 F (8.9 C) , select pumps for higher efficiencies and select lower pressure drop equipment and components.
- Maximum power rating for the air distribution system with central AHU having bag filter is 0.345 kW/RT (0.86 W/CFM) based on a minimum airflow rate of 190 l/(s.RT) (400CFM/RT), maximum total static pressure of 1145 Pa (4.5 in of water), fan efficiency of 70% and motor efficiency of 90% For AHUs serving Clean rooms and Hospital applications requiring use of HEPA filter the additional pressure drop shall be added and more power shall be allowed according to pressure drop calculations that shall be submitted by the Consultant and Contractor.

Table 15. Pressure Loss in Chilled Water System.

No.	Component	Pressure Loss Water (m) (Water (ft))	
1	Chiller Cooler or evaporator	5.00	(16.4)
2	Air-handling unit coil	2.40	(8.0)
3	Control valve	2.40	(8.0)
4	Coil Balancing (Globe) valve	0.60	(2.0)
5	Chilled water piping including fittings and valves	15.50	(50.0)
Total		25.90	(85.0)

12.1.5 Central Chilled-Water Systems with Water-Cooled Condensers

- Design ambient temperature for the selection of this equipment is 32°C (89.6°F) WBT.
- Cooling water is available at 35°C (95°F) from a cooling tower of 3°C (5.4°F) approach.
- Water temperature rise across the condenser is 5.56°C (10°F).
- Water temperature at the chiller outlet is 6.67°C (44°F).
- Temperature drop of chilled water across the cooler (evaporator) is 5.56°C (10°F)

- Water flow rate through the cooler is 0.186 l/(s.RT) (3 USGPM/RT)
- Maximum pressure drop across condenser is 5 m (16.4 ft) of water for a water flow rate corresponding to a temperature rise of 5.56°C (10°F).
- Maximum pressure drop across the cooler is 5 m (16.4 ft) of water for a water flow rate 0.15 l/s.RT (2.4 USGPM/RT).
- Fouling factors for the cooler and condenser are 0.00025 (ft².h.°F) /Btu (0.000044 (m².°C)/W) and 0.00075 (ft².h.°F)/Btu (0.000132 (m².°C)/W), respectively.
- Maximum power rating for the condenser water pump is 0.062 k W/RT (20.7 W/GPM) based on a maximum pump head of 21.3 m (70 ft) of water (Table 16), pump efficiency of 70% and motor efficiency 90%

Table 16. Pressure Loss in Condenser Water Systems.

No.	Component	Pressure Loss Water (m) (Water (ft))
1	Condenser	5.0 (16.4)
2	Static head for cooling tower (a fraction of C/T height)	4.6 (15.0)
3	Spray nozzles	4.6 (15.0)
4	Globe valve, 2 nos.	1.2 (4.0)
5	Condenser water piping including fittings and valves	5.9 (19.0)
Total		21.3 (70.0)

- Maximum power rating for the chilled water pump is 0.061 kW/RT (25.4 W/GPM). based on a maximum pump head of 25.9 m (85 ft) of water (Table 15), pump efficiency of 70% and motor efficiency 90% For large pumping systems with primary, secondary and tertiary pumps high chilled water temperature differentials of up to 16 F (8.9 C) are maintained while selecting pumps of high efficiencies with low pressure drop equipment and components.
- Maximum power rating for the air distribution system is 0.345 kW/RT(0.86 W/CFM) based on a minimum airflow rate of 188 l/(s.RT) (400 CFM/RT), maximum total static pressure of 1145 Pa (4.5 in of water), fan efficiency of 70% and motor efficiency of 90%.
- Maximum power rating for the cooling tower fan motor is 0.04 kW/RT (13.3 W/GPM) This is the average of 0.02 - 0.06 kW/RT in the range of 120 - 1120 RT obtained from the manufacturer's catalogue for an approach of 2.77°C (Marley, 1995).

Appendix C - Physical Properties of Common Building Materials

	Density	Specific-Heat	Conductance	Resistance	Density	Specific-Heat	Conductance	Resistance
	(lbm/ft ³)	(Btu/lbm*F)	(Btu/ hr*ft ² F)	(hr*ft ² F/Btu)	(kg/m ³)	(kJ/kg*K)	(W/m ² *K)	(m ² *K/W)
Moz-Tile	142.585	0.19	9.73	0.10	2284.0	0.796	55.18	0.0181
Cem-Motar	130.162	0.2	8.81	0.11	2085.0	0.837	49.99	0.0200
Sand	162.312	0.191	2.97	0.34	2600.0	0.800	16.87	0.0593
Sand1	162.312	0.191	0.99	1.01	2600.0	0.800	5.62	0.1779
Ext-Poly (roof)	2.872	0.29	0.07	13.86	46.0	1.214	0.41	2.4417
Water-Proof	58.31	0.36	12.13	0.08	934.0	1.507	71.35	0.0145
Sand-Screed	130.162	0.2	8.81	0.11	2085.0	0.837	49.99	0.0200
Foad-Conc	21.91	0.21	0.37	2.69	351.0	0.879	2.11	0.4746
Concrete (roof)	143.397	0.22	1.73	0.58	2297.0	0.921	9.85	0.1016
Concrete (block)	143.397	0.22	1.56	0.64	2297.0	0.921	8.86	0.1128
Plaster	130.162	0.2	8.81	0.11	2085.0	0.837	49.98	0.0200
Ext-Poly (wall)	1.873	0.29	0.11	8.77	30.0	1.214	0.65	1.5455
Lime-Bricks	119.74	0.19	2.56	0.39	1918.1	0.796	14.51	0.0689
Azel-Blocks	30.527	0.21	0.13	7.81	489.0	0.879	0.73	1.3762
Cem-Block	125.54	0.22	3.21	0.31	2011.0	0.921	18.22	0.0548
Marble	161.6	0.21	6.25	0.16	2588.6	0.879	34.48	0.0290