Chapter 3 [CE]: General Requirements

General Comments

Chapter 3 [CE] specifies the climate zones that establish exterior design conditions and provides general requirements for interior design conditions, and materials, systems and equipment. In general, the climate zone provisions are determined simply by referring to the map (see Figure C301.1) or by looking at the tables [see Tables C301.1, C301.3(1) and C301.3(2)]. In addition, Section C302 provides the interior design conditions that are used for heating and cooling load calculations. Section C303 provides requirements for fenestration, identification of insulation and other basic general requirements for insulation materials.

Purpose

Climate has a major impact on the energy use of most commercial and residential buildings. The code establishes many requirements such as wall and roof insulation *R*-values, window and door thermal transmittance requirements (*U*-factors) and provisions that affect the mechanical systems based on the climate where the building is located. This chapter contains the information that will be used to properly assign the building location into the correct climate zone, which will then be used as the basis for establishing or eliminating requirements.

Materials and systems used to provide insulation and fenestration values, including *U*-factor and solar heat gain coefficient (SHGC) ratings, must be based on data used by appropriate tests. This establishes a level playing field for manufacturers of products.

Discussion and Development of the Climate Zone Map

The 2006 code made a dramatic shift in the classification of climate zones. While this change in the climate zone map was a part of the major revision to help simplify the code and make both compliance and enforcement easier, the climate zone revisions were a lengthy, very detailed and complicated process. Much of the new climate zone development was based on a paper titled "Climate Classification for Building Energy Codes and Standards." This paper was written by Robert S. Briggs, Robert G. Lucas and Z. Todd Taylor of the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL). Some aspects of this paper may help users better understand climate zones and also feel comfortable with these new classifications.

Climate zones were developed based on the following criteria:

1. Offer consistent climate materials for all compliance methods and code sections (including both commercial and residential).
2. Enable the code to be self-contained with respect to climate data.
3. Be technically sound.
4. Map to political boundaries.
5. Provide a long-term climate classification solution.
6. Be generic and neutral (i.e., not overly tailored to current code requirements).
7. Be useful in beyond-code and future-code contexts.
8. Offer a more concise set of climate zones and presentation formats.
9. Be acceptable to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and usable in ASHRAE standards and guidelines.
10. Provide a basis for use outside of the United States.

The reasons that the authors cited for some of the less-obvious items include:

Item 4 – Mapping climate zones to easily recognizable political boundaries instead of to abstract climatic parameters facilitates code implementation. Users and jurisdictions are able to easily tell what requirements apply, which is not the case in some locations when climate parameters are used.

Item 7 – "Useful in future-code and beyond-code contexts" reflects the view that minimum acceptable practice codes and standards can provide an effective platform on which to build other efficiency programs. Beyond-code programs are likely to encourage features and technologies not included in current codes, many of which are likely to be more climate-sensitive than current requirements.

Item 9 – "Usable in ASHRAE standards and guidelines" is important because effective coordination of both content and formats used in the code and ASHRAE standards offers the potential to facilitate rapid migration of ASHRAE standards into model codes. Previous efforts to translate ASHRAE criteria into the simpler and more prescriptive forms most desired by the code enforcement community has, in some cases, added years to the process of getting updated criteria adopted and into widespread use.

The belief in developing the climate zones was that any new system needed to show substantial improvement over previous systems. In addition, any new classification must be at least roughly compatible with the previous climate-dependent requirements in order to allow for the conversion and inclusion of existing, generally accepted requirements. The intent was to develop a set of climate classifications that could support simple, approximate ways of prescribing energy-efficiency measures for buildings. It was not intending to develop a set of categories that could be used for all purposes.

The new climate zones were developed in an open process involving several standards committees of ASHRAE, the U.S. Department of Energy (DOE) staff and other interested parties.

Given the interest of the International Code Council (ICC)® and ASHRAE in producing documents that are capable of being used internationally, an effort was made to develop a system of climate zones that could work outside of the United States. The new climate definitions were developed using SI (The International System of Units, abbreviated SI from the French Le Systéme International d'Unités). By using the SI units and climate indices, which are widely available internationally, the climate zones and the development of building energy-efficiency provisions can be applied anywhere in the world. The boundaries between the various climate zones in Table C301.3(2) occur in multiples of 900 degree days Fahrenheit, which converts to 500 degree days Celsius. Distinguishing the climate zones at these numbers results in a clean and understandable division between the climate zones in either system of temperature measurement.

The developers of the climate zone map selected bands of 1,000 Heating Degree Days (HDD) 18°C (1800 HDD65°F) because they resulted in boundaries that align with boundaries established in ANSI/ASHRAE/IESNA 90.1-2001, plus they facilitate the use of both SI and inch-pound units, and were able to affect a significant reduction in the number of climate zones.

An objective for any effective classification is to maximize the differences between the selected criteria for each climate zone, while minimizing the variations that occur within the group. A large variation between the groups enables generalizations embodied in the code requirements to be better tailored to each climate zone. A small variation within each climate zone will ensure that the generalizations better fit the climate zones. It was the developers' feeling that the new classification better represents the climatic diversity, while defining more coherent climate zones than what the code previously used. It should be noted that mountainous regions defy clean geographic separation of clusters.

SECTION C301
CLIMATE ZONES

C301.1 General. Climate zones from Figure C301.1 or Table C301.1 shall be used in determining the applicable requirements from Chapter 4. Locations not in Table C301.1 (outside the United States) shall be assigned a climate zone based on Section C301.3.

❖ Climate involves temperature, moisture, wind and sun, and also includes both daily and seasonal patterns of variation of the parameters. To account for these variations, the code establishes climate zones that serve as the basis for the code provisions.

This section serves as the starting point for determining virtually all of the code requirements, especially under the prescriptive compliance paths. Because of their easy-to-understand graphic nature, maps have proven useful over the years as an effective way to enable code users to determine climate-dependent requirements. Therefore, for the United States, the climate zones are shown in the map in Figure C301.1. Because of the limited size of the map, the code also includes a listing of the climate zones by states and counties in Table C301.1. Table C301.1 will allow users to positively identify climate zone assignments in those few locations for which the map interpretation may be difficult. Whether the map or the county list is used, the climate classification for each area will be the same.

When dealing with the prescriptive compliance paths, the code user would simply look at the map or listing and select the proper climate zone based on the location of the building. When using a performance approach, additional climatic data may be needed.

Virtually every building energy code that has been developed for use in the United States has included a performance-based compliance path, which allows users to perform an energy analysis and demonstrate compliance based on equivalence with the prescriptive requirements. To perform these analyses, users must select appropriate weather data for their given project's location. The selection of appropriate weather data is straightforward for any project located in or around one of the various weather stations within the United States. For other locations, selecting the most appropriate weather site can be problematic. The codes themselves provide little guidance to help with this selection process. During the development of the new climate zones, the developers mapped every county in the United States to the most appropriate National Climatic Data Center "Solar and Meteorological Surface Observation Network" (SAMSON) station for each county as a whole.

This mapping is not included in the code but may be used in some compliance software. Designating an appropriate SAMSON station should not be considered to be the only climate data permitted for a given county. It could, however, be used in the absence of better information. Where local data better reflects regional or microclimatic conditions of an area, they would be appropriate to use. For example, elevation has a large impact on climate, and elevation can vary dramatically within individual counties, especially in the western United States. Where elevation differences are significant, code officials may require the use of sites that differ from the sites designated as being the most appropriate for the county. For additional information on this topic, review the paper "Climate Classification for Building Energy Codes and Standards," which is referenced in the commentary text that precedes Section C301.

The new climate classifications do not attempt to resolve the issue of what the appropriate treatment for elevation differences is. This aspect is left in the hands of the local code official.

C301.2 Warm humid counties. Warm humid counties are identified in Table C301.1 by an asterisk.

❖ Table C301.1 provides a listing of the counties within the southeastern United States that fall south and east of the white dashed line that appears in the map in Figure C301.1. The warm-humid climate designation includes parts of eight states and also covers all of Florida, Hawaii and the U.S. territories. Table C301.3(1) provides the details that were used to determine the classification of the warm-humid designation for the counties.

There currently are very few requirements in the code that are specifically tied to the warm-humid climate criteria. Although not tied directly to the warm-humid designation, many other code sections, such as those addressing moisture control and energy recovery ventilation systems, do take these climatic features into account.

C301.3 International climate zones. The climate zone for any location outside the United States shall be determined by applying Table C301.3(1) and then Table C301.3(2).

❖ Although the code and the climate zone classifications are predominantly used within the United States, they can be used in any location. Because the mapping and decisions that were made during the development of the new climate zones focused primarily on the United States, this section provides the details of how to properly classify the climate zones based on the thermal criteria [see Table C301.3(2)], the major climate types [see Table C301.3(1)] and warm-humid criteria (see Commentary Figure C301.3) for locations outside of the United States.

In developing the new climate zone designations, two climate zones were defined in the classification, but not thoroughly evaluated or actively applied because no sites in the United States or its territories required their use. The two climate zones are 1B [dry and > 5000 CDD10°C (9000 CDD50°F)], characterized as "very hot-dry," and 5°C [marine and 3000 < HDD18°C = 400 (5400, HDD65°F = 7200)], characterized as "cool marine." The marine (C) designation was not used for climate zones colder than Climate Zone 5 or hotter than Climate Zone 3, as marine climates are inherently neither very cold nor very hot. In addition, the humid (A) and dry (B) divisions were dropped for climate zones colder than Climate Zone 6 because they did not appear to be warranted based on differences in appropriate building design requirements. Reevaluation of these decisions might be warranted before applying the new climate classifications to locations outside of the United States.

C301.4 Tropical climate zone. The tropical climate zone shall be defined as:

1. Hawaii, Puerto Rico, Guam, American Samoa, U.S. Virgin Islands, Commonwealth of Northern Mariana Islands; and
2. Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.

❖ The tropical climate zone was established as a subset of Climate Zone 1. The climate of tropical islands is uniquely constant, with moderate temperatures throughout the year. Similar to the development of the balance of the climate zones for the 2006 code, the tropical climate zone is also based on Koppen's classification of climates. Koppen divided the earth's climates into five major types, one of those being "tropical." According to Koppen, tropical climates are characterized by constant high temperature (at sea level and lower elevations) all 12 months of the year. Because of the constant nature of the climate, traditional construction methods and traditional HVAC installation found in buildings outside of the tropical environment may not be needed. For commercial buildings, the code does not provide different design or construction standards than provided for other Climate Zone 1 locations. Standards applicable to residential construction are provided in the residential provisions of the code.

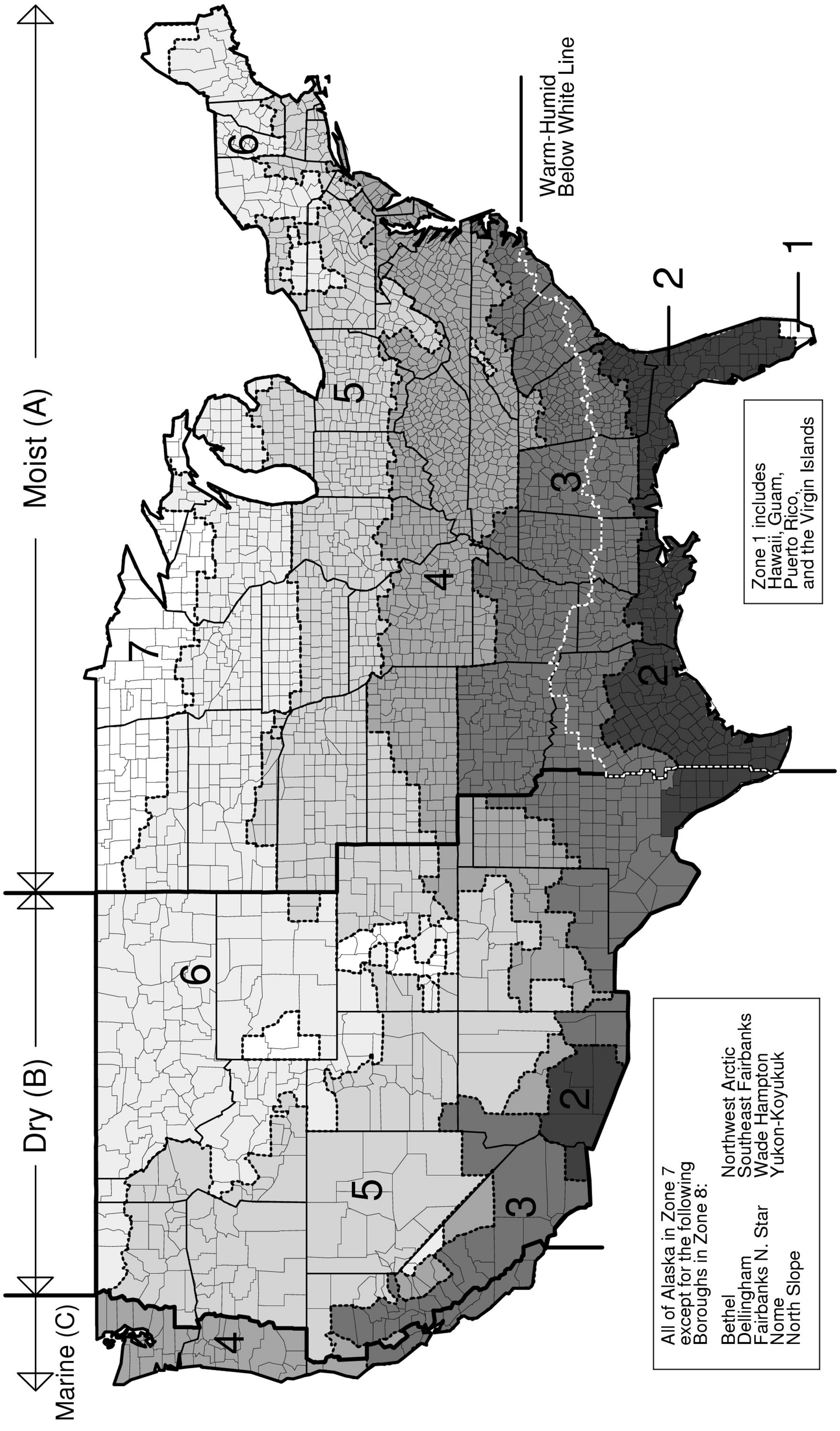

FIGURE C301.1
CLIMATE ZONES

ZONE NUMBER	CLIMATE ZONE NAME AND TYPE[2]	THERMAL CRITERIA [1, 3, 6]	REPRESENTATIVE U.S. CITY[4]
1A	Very Hot-Humid	9000 < CDD50°F	Miami, FL
1B[5]	Very Hot-Dry	9000 < CDD50°F	—
2A	Hot-Humid	6300 < CDD50°F ≤ 9000	Houston, TX
2B	Hot-Dry	6300 < CDD50°F ≤ 9000	Phoenix, AZ
3A	Warm-Humid	4500 < CDD50°F ≤ 6300	Memphis, TN
3B	Warm-Dry	4500 < CDD50°F ≤ 6300	El Paso, TX
3C	Warm-Marine	HDD65°F ≤ 3600	San Francisco, CA
4A	Mixed-Humid	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400	Baltimore, MD
4B	Mixed-Dry	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400	Albuquerque, NM
4C	Mixed-Marine	3600 < HDD65°F ≤ 5400	Salem, OR
5A	Cool-Humid	5400 < HDD65°F ≤ 7200	Chicago, IL
5B	Cool-Dry	5400 < HDD65°F ≤ 7200	Boise, ID
5C[5]	Cool-Marine	5400 < HDD65°F ≤ 7200	—
6A	Cool-Humid	7200 < HDD65°F ≤ 9000	Burlington, VT
6B	Cool-Dry	7200 < HDD65°F ≤ 9000	Helena, MT
7	Very Cold	9000 < HDD65°F ≤ 12600	Duluth, MN
8	Sub Arctic	12600 < HDD65°F	Fairbanks, AK

Notes:

1. Column 1 contains alphanumeric designations for each zone. These designations are intended for use when the climate zones are referenced in the code. The numeric part of the designation relates to the thermal properties of the zone. The letter part indicates the major climatic group to which the zone belongs; A indicates humid, B indicates dry, and C indicates marine. The climatic group designation was dropped for Zones 7 and 8 because the developers of the new climate zone classifications did not anticipate any building design criteria sensitive to the humid/dry/marine distinction in very cold climates. Zones 1B and 5C have been defined but are not used for the United States. Zone 6C (Marine and HDD18ºC > 4000 (HDD65ºF > 7200) might appear to be necessary for consistency. However, very few locations in the world are both as mild as is required by the marine zone definition and as cold as necessary to accumulate that many heating degree days. In addition, such sites do not appear climatically very different from sites in Zone 6A, which is where they are assigned in the absence of a Zone 6C.
2. Column 2 contains a descriptive name for each climate zone and the major climate type. The names can be used in place of the alphanumeric designations wherever a more descriptive designation is appropriate.
3. Column 3 contains definitions for the zone divisions based on degree day cooling and/or heating criteria. The humid/dry/marine divisions must be determined first before these criteria are applied. The definitions in Tables C301.3(1) and C301.3(2) contain logic capable of assigning a zone designation to any location with the necessary climate data anywhere in the world. However, the work to develop this classification focused on the 50 United States. Application of the classification to locations outside of the United States is untested.
4. Column 4 contains the name of a SAMSON station (National Climatic Data Center “Solar and Meteorological Surface Observation Network” station) found to best represent the climate zone as a whole. See the discussions at the beginning of this chapter regarding the development of the new climate zones for an explanation of how the representative cities were selected.
5. Zones 1B and 5C do not occur in the United States, and no representative cities were selected for these climate zones due to data limitations. Climates meeting the listed criteria do exist in such locations as Saudi Arabia; British Columbia, Canada; and Northern Europe.
6. SI to I-P Conversions:
   2500 CDD10ºC = 4500 CDD50ºF
   3000 HDD18ºC = 5400 HDD65ºF
   3500 CDD10ºC = 6300 CDD50ºF
   4000 HDD18ºC = 7200 HDD65ºF
   5000 CDD10ºC = 9000 CDD50ºF
   5000 HDD18ºC = 9000 HDD65ºF
   2000 HDD18ºC = 3600 HDD65ºF
   7000 HDD18ºC = 12600 HDD65ºF

Figure C301.3
CLIMATE ZONE DEFINITIONS

TABLE C301.3(1)
INTERNATIONAL CLIMATE ZONE DEFINITIONS

MAJOR CLIMATE TYPE DEFINITIONS
Marine (C) Definition—Locations meeting all four criteria: 1. Mean temperature of coldest month between -3°C (27°F) and 18°C (65°F). 2. Warmest month mean < 22°C (72°F). 3. At least four months with mean temperatures over 10°C (50°F). 4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.
Dry (B) Definition—Locations meeting the following criteria: Not marine and $P_{in} < 0.44 \times (TF - 19.5)$ [$P_{cm} < 2.0 \times (TC + 7)$ in SI units] where: P_{in} = Annual precipitation in inches (cm) T = Annual mean temperature in °F (°C)
Moist (A) Definition—Locations that are not marine and not dry.
Warm-humid Definition—Moist (A) locations where either of the following wet-bulb temperature conditions shall occur during the warmest six consecutive months of the year: 1. 67°F (19.4°C) or higher for 3,000 or more hours; or 2. 73°F (22.8°C) or higher for 1,500 or more hours.

For SI: °C = [(°F)-32]/1.8, 1 inch = 2.54 cm.

TABLE C301.3(2)
INTERNATIONAL CLIMATE ZONE DEFINITIONS

ZONE NUMBER	THERMAL CRITERIA	
	IP Units	SI Units
1	9000 < CDD50°F	5000 < CDD10°C
2	6300 < CDD50°F ≤ 9000	3500 < CDD10°C ≤ 5000
3A and 3B	4500 < CDD50°F ≤ 6300 AND HDD65°F ≤ 5400	2500 < CDD10°C ≤ 3500 AND HDD18°C ≤ 3000
4A and 4B	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400	CDD10°C ≤ 2500 AND HDD18°C ≤ 3000
3C	HDD65°F ≤ 3600	HDD18°C ≤ 2000
4C	3600 < HDD65°F ≤ 5400	2000 < HDD18°C ≤ 3000
5	5400 < HDD65°F ≤ 7200	3000 < HDD18°C ≤ 4000
6	7200 < HDD65°F ≤ 9000	4000 < HDD18°C ≤ 5000
7	9000 < HDD65°F ≤ 12600	5000 < HDD18°C ≤ 7000
8	12600 < HDD65°F	7000 < HDD18°C

For SI: °C = [(°F)-32]/1.8.