**M E M O R A N D U M**

**To:** Mayor and Council

**From:** Zero Energy Capable Homes Task Force

**Date:** September 5, 2007

**Subject:** Final Report to Council

## Authorization

On August 10, 2006, the City Council passed resolution No. 20060810-060 directing the City Manager to create a task force to develop a plan for consideration by Council that by 2015 all new single-family homes be built as "Zero Energy Capable Homes."

## Implementation

A task force representing local construction industry trade associations (including builders, HVAC and other trades), affordable housing providers, energy efficiency advocates, the City Resource Management Commission, the Electric Utility Commission, Texas Gas Service, and City staff was created and began meeting in September, 2006. The members of the Task Force are listed on Appendix 1.

The task force initially developed a charter laying out 3 high level deliverables. Those deliverables are:

- Recommendations to council regarding proposed local amendments to the 2006 International Energy Conservation Code (IECC) for adoption as City of Austin Energy Code;
- Goals for energy efficiency improvements for the IECC code cycles 2009, 2012, and 2015; and
- A process and plan for passing responsibility for oversight of the project to the City of Austin Resource Management Commission.

## Defining the Goal of Zero Energy Capable Homes

The Task Force defined a Zero Energy Capable Home as:
"homes that are energy efficient enough to be net zero energy homes with the addition of on-site or its equivalent, energy generation. This level of energy efficiency is approximately 65% more efficient than homes built to the City of Austin Energy Code in effect in November, 2006."

**Local Amendments to the 2006 International Energy Conservation Code**

Between October, 2006 and April, 2007 the task force reviewed, discussed and approved a package of local amendments to the IECC that, if approved by council, will improve overall (electric and gas) efficiency of homes built to that code by 11%. Use of electricity will be reduced by 19% and use of gas reduced by 1%. The focus of these amendments was improvement of air conditioning systems, which are the major user of energy in typical homes in the Austin area. The primary amendments are:

- Requirement for building thermal envelope testing.
- Requirement for installation of a radiant barrier system.
- Requirement for testing of duct system leakage.
- Requirement for submittal of HVAC sizing calculations.
- Requirement for testing of air balancing of HVAC systems.
- Requirement for system static pressure testing.
- Revision of the restriction on electric resistance water heating.
- Requirement for 25% of lighting to be high efficacy.

Energy savings per home are 2515 kWh of electricity and 4 therms of gas. This will reduce energy costs for a typical home by $227.68 per year. The local amendments will increase the cost of building a home by $1,179. Thus the estimated payback period for these amendments is 5.2 years, or approximately 20% per year.
The proposed local amendments to the 2006 IECC are in Attachment 2.

**Goals for Future Code Adoption Cycles**

Major revisions are made to the International Energy Conservation Code (IECC) every three years. The 2006 version of the IECC is the first code adoption cycle which falls under the purview of the Task Force.

The methodology used to determine progress toward meeting the goal of Zero Energy Capable Homes was to perform computer building energy modeling on a typical new home built in Austin in 2006. This modeling has been performed on a home plan provided by a volume builder building in the City. A baseline for energy use has been established and local amendments have been modeled to determine progress made with the local amendments for 2006. The baseline is established using computer energy modeling of a typical home currently being built by a volume builder in Austin. That home is of approximately average size for a new home in Austin. The home is modeled using specifications that meet the current energy code to establish the baseline energy use. The same home plan is then modified using specifications based on the 2006 IECC with local amendments to determine energy savings. Modeling has also been done to determine the effectiveness of potential local amendments for 2009 and 2012. The table below shows baseline energy use, percent energy reduction goal for each cycle, energy use in MBTU per home for the goals, incremental MBTU (Thousand British Thermal Units) reduction for each cycle goal, and the resulting CO2 emissions per 1,000 homes under the goals.

Table 1
Energy use goals for code adoption cycles

| Year | Recommended energy use reduction goal in % | MBTU use per home meeting recommended goal | Incremental MBTU reduction per year | CO2 emissions per 1,000 homes (with cumulative reduction) |
|---|---|---|---|---|
| Baseline | 0 | 82,499 | 0 | 10,568 tons (0) |
| 2006 IECC | 11%* | 73,468* | 9,031* | 8,958 (1,610 tons)* |
| 2009 IECC | 19% | 57,749 | 15,719 | 7,410 (3,158 tons) |
| 2012 IECC | 18% | 42,899 | 14,850 | 5,500 (5,068 tons) |
| 2015 IECC | 17% | 28,875 | 14,024 | 3,701 (6,867 tons) |
| Total | 65% | | 53,624 MBTU | |

*2006 savings are for local amendments approved by the ZECH Task Force

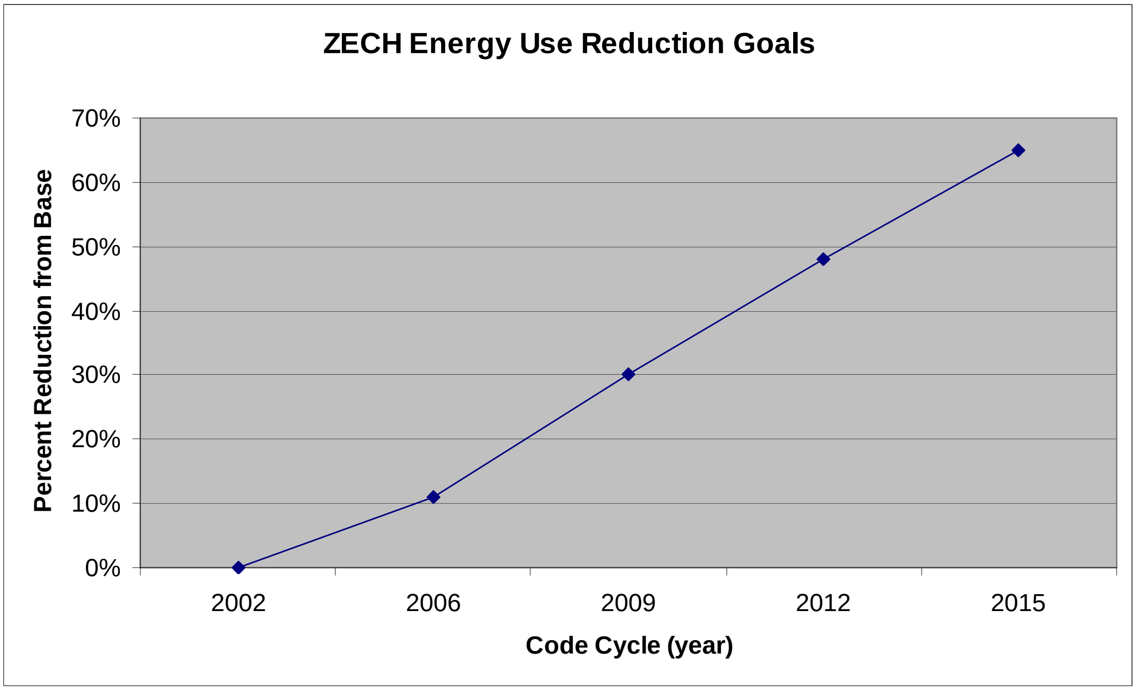
2009 and 2012 projected savings are estimated based on Task Force's best judgment for local amendments that may be adopted in those cycles as well as national appliance efficiency standards that have been proposed for adoption between 2010 and 2012. 2015 is considered to be too far into the future to make reliable predictions on design and technology changes.

The goals set out in the Table 1 are based on the best judgment of the task force members, the Green Building staff, and an analysis of timelines established under the National Appliance Energy Conservation Act for new standards for energy efficiency for various household appliances.

**Linear Improvement in Energy Efficiency Goals:**

Chart 1 below demonstrates the linear progression of the improvement in energy efficiency that would result from achieving the goals set out in Table 1.

Chart 1




The Task Force recognized that subsequent code cycles are expected to produce greater savings than those generated by the 2006 code cycle. For example, the 2009 cycle is expected to achieve a 19% reduction in energy use while the 2006 cycle will achieve an 11% reduction in total energy use. The Task Force decided this was both reasonable and expedient as the 2006 code cycle will serve as the foundation for gaining broad community and stakeholder support for the roadmap to achieving those later savings. The energy savings achieved through later code cycles can be expected to be both more costly and intrusive into people's lives. Therefore the Task Force reasoned that focusing initially on obtaining broad based support for the overall goals would be critical to the ultimate success of the 2015 goal. Accordingly, the Task Force recommends that the City coordinate both public information campaigns with programs to encourage education of trades on the value of achieving the 2015 goals as a means of achieving the goals.

## Benefits to the Community

Achieving the energy efficiency goals set out in Table 1 will provide very significant benefits to the community. Citizens will save money on their utility bills, Austin Energy will see a reduction in the need for new generation capacity, the City's emissions of carbon dioxide will be substantially reduced. Table 2 below provides a summary of these benefits.

Table 2
Cumulative benefits from ZECH electricity use reductions

| Years | AE demand reduction in mW * | Energy savings in mWh | Citizens savings on electric bills | CO2 reduction in tons | SO2 in tons | NOx in tons | CO2 equivalent in cars taken off the road |
|---|---|---|---|---|---|---|---|
| 2008-09 | 5.3 mW | 32,192 | $2,865,088 | 20,532 | 3.9 | 19.8 | 4,489 |
| 2010-12 | 22.4 | 108,781 | $9,681,509 | 69,373 | 13.25 | 66.9 | 15,169 |
| 2013-15 | 46.2 | 215,302 | $19,161,878 | 137,306 | 26.23 | 132.4 | 30,023 |
| 2015-18 | 82.2 | 347,475 | $30,925,275 | 221,597 | 42.33 | 278.4 | 48,453 |

All savings are cumulative
* Demand reduction based on new starts in AE service area being approximately 66% of total new starts

Assumptions of Table 2:
5 year historic average of approximately 6400 homes per year will continue
Ratio of electric to gas energy reductions for 2006-09 will continue into 2012 and 2015
Electric and gas rates are calculated at May, 2007 costs

**Cost to implement compared to energy cost savings**
Table 3 shows the cost to implement the 2006 IECC with local amendments for a single home and for the average number of homes built in the Austin Code Jurisdiction, 6,400 per year compared to the annual energy cost savings for a single home and the 10 year energy cost savings for the 6,400 homes built in a typical year. Ten years was chosen as a conservative effective life of measures. These measures could reasonable be expected to last several years longer.

Table 3
Costs and benefits of 2006 IECC local amendments

| Amendment | Cost to implement Per home | Annual utility bill savings per home | Cost to implement, 6400 homes, average built per year in Austin area | Utility bill savings, 6400 homes over 10 year estimated life of savings |
|---|---|---|---|---|
| Install Radiant Barrier | $355. | ↓ | $2,272,000 | ↓ |
| HVAC system testing | $425. | ↓ | $2,720,000 | ↓ |
| Building modifications required for HVAC improvements | $273. | ↓ | $1,692,600 | ↓ |
| Improved Duct insulation | $250. | ↓ | $1,747,200 | |
| High efficiency HVAC filter | $10. | ↓ | $64,000 | ↓ |
| Enforce proper HVAC sizing | 0 | $187. (all HVAC measures combined) | $0 | $11,968,000 (all HVAC measures combined |
| Water heating, eliminate cost of heat recovery system | ($150.) | $0 | ($960,000) | $0 |
| Lighting, 25% high efficacy | $16. | $41. | $102,400 | $2,624,000 |
| Total | $1179. | $228. | $7,638,200 | $14,592,000 |

**CO2 Reduction**

Table 3 shows the costs of implementation compared to the energy cost savings of the 2006 IECC with the proposed local amendments. At least equally important to this project is the reduction of Greenhouse Gas emissions due to these code improvements. Assuming that about 6,400 new single family homes will be built in Austin under this code in 2008, the annual CO2 reduction for those homes will be 10,265 tons. When we consider that these energy saving measures will remain in place and effective for at least 10 years the total CO2 reduction for the homes built in 2008 will be 102,650 tons. When that 102,650 is compared to the cost of implementing the measures, the cost per ton of

$CO_2$ is $74.40 per ton. This compares favorably with the typical cost per ton of Austin Energy's energy efficiency programs of $80.30 per ton.

**Roadmap for Future Cycle Amendments**

Table 4 below shows the potential energy efficiency measures that have been identified for possible adoption in code cycles 2009, 2012, and 2015. The energy use impacts of those measures and the gap between the goals and energy efficiency levels that would be achieved by implementing those measures is also included. The Task Force assumes that new measures will be identified through field testing done by AE Green Building and the builders and designers working with the program. It is also assumed that new energy efficiency technologies will come into use in the period between now and 2015 which will help move the City toward its goals.

A good example of this technological change is the adoption of Low-E window technology in the 1990s. In 1995 the first national standard for measuring solar heat gain co-efficient (shgc) for windows was developed. At that time almost all windows installed in homes were clear glass. By the year 2000, when minimum SHGC ratings were first incorporated into energy codes, most manufacturers were no longer making clear glass windows. The market had been transformed faster than national codes could incorporate the new standards.

There are several technologies beginning to be available today that could have the same transformative effect on energy efficiency in homes. LED (light emitting diode) lighting systems are currently being developed that could reduce the energy use dramatically. A 60 watt incandescent bulb produces about 1,000 lumens, currently available CFLs produce the same amount of light using only 18 watts, LEDs now being tested produce the same amount of light using only 4.5 watts of power.

Ductless air conditioning systems now being used in apartments and small homes also show potential for significant increases in energy efficiency.

Also included in table 4 are estimates of energy savings from new national standards for energy efficiency for appliances. These estimates are important to this work because under the National Appliance Energy Conservation Act (NAECA) building or energy codes can not mandate a higher level of energy efficiency for most appliances but those appliances use almost 30% of the total energy used in a home. These estimates are based on published DOE timelines for reviewing and revising these standards and the level of energy efficiency that studies by the American Council for an Energy Efficient Economy show to be cost effective today.

Table 4
Future cycle potential measures

| Code Cycle | Potential measures | Energy impact of measures | Gap between potential measures and goals |
|---|---|---|---|
| 2009 IECC | Increase high efficacy lighting requirement from 25% to 90%.<br>Increase wall assembly performance<br>Increase window efficiency, SHGC from .4 to .3, increase u-Factor from .65 to .4<br>Improve efficiency of gas water heater 5% | Lighting 1,191 kWh<br><br>Heating and cooling, 283 kWh + 10 therms gas<br><br>Water heating, 91 therms gas<br><br>Total MBTU 58,339 | 2009 goal for total MBTU use = 57,749<br><br>Gap- 58,339 less 57,749 = 590 MBTU |
| 2012 IECC | All HVAC equipment and ducts installed in conditioned space<br>Reflective roofing<br>Improve furnace efficiency (new fed standard)<br>New appliance efficiency standards for Clothes washers and dryers, Dish washers, Ranges and ovens, & refrigerators<br>Other measures to be indentified | HVAC 744 kWh + 22 therms gas,<br><br>Appliances, 404 kWh<br><br>Total MBTU with currently identified measures, 52,221 | 2012 goal for MBTU use = 42,899<br><br>Gap, 52,221 – 42,899 = 9,322 MBTU |
| 2015 IECC | New national standard for A/C efficiency,<br>Other measures to be indentified | 499 kWh<br><br>Total MBTU with 2012 goal met and currently identified measures, 42,400 MBTU | 2015 goal for MBTU use = 28,875<br><br>Gap, 42,400 – 28,875 = 13,525 MBTU |

**Estimated Costs of Future Cycle Amendments**

While it is not possible to definitively calculate the future costs of the potential energy code amendments proposed for the 2009, 12, and 15, we can provide some estimates of these costs. Table 4 shows the measures listed in Table 3, an estimate of the energy savings from each and incremental costs based on the pricing available today. The energy savings are conservative because synergies between the identified measures and those still to be identified can not be calculated. Pricing is based on the costs of these systems in June of 2007. The cost of implementing these measures will almost certainly change but the table will provide some guidance for future cycles.

Table 5
Estimated Costs and Savings of Future Code Cycle Amendments

| Code Cycles | Measures | Estimated Cost | Estimated savings |
|---|---|---|---|
| 2009 | Increase high efficacy lighting requirement from 25% to 90%.<br>Increase wall assembly performance<br>Increase window efficiency, SHGC from .4 to .3, increase u-Factor from .65 to .4<br>Improve efficiency of gas water heater 5% | $150<br>$200<br>$600 (30x$20)<br>$200<br>Total $1500 | 1191 kWh<br>10 therms<br>283 kWh<br>91 therms<br>Total 15,129 MBTU |
| 2012 | All HVAC equipment and ducts installed in conditioned space<br>Reflective roofing<br>Improve furnace efficiency (new fed standard)<br>New appliance efficiency standards for Clothes washers and dryers, Dish washers, Ranges and ovens, & refrigerators<br>Other measures to be indentified | $800-1200<br>$320<br>National standards not calculated as incremental to code<br>Total $1120-1520 | 744 kWh<br>Included above<br>22 therms<br>404 kWh<br>Total 6118 MBTU |
| 2015 | New national standard for A/C efficiency,<br>Other measures to be indentified | National standard | 499 kWh<br>1531 MBTU |

**Plan for Implementation of Future Code Cycles:**

This section of the report assumes that the 2006 IECC with local amendments will be adopted by Council. The work described in this section begins after code adoption and release of the Task Force.

**Verification of energy savings due to code adoption**

- 1 year after code implementation, GB staff will select a statistically valid sample of homes built after new code adoption that did not participate in a GB rating.
- The sample of homes will be evaluated for energy use using AE billing data, TX Gas billing data (if available), and TCAD sq. footage data.
- An energy intensity (energy use per sq. ft.) will be established for sample homes and compared to estimated energy intensity of model home used by the task force.
- Data will be reported to COA RMC to compare original estimates of energy savings made at time of code adoption with those actually experienced approximately 14-16 months after code adoption.
- AE staff and [RMC] will review data to evaluate progress and take corrective action if required.
- Approximately 12 months after code adoption GB staff will conduct surveys of builders to determine actual implementation costs of the code amendments.
- Results of investigations are to be shared with the City Council in annual interim reports by AE staff and with key stakeholders/organizations represented on Task Force.

**Research proposed and new measures for next code adoption cycle**

- GB staff incorporate existing recommended measures into GB Single Family rating for evaluation of energy savings and cost effectiveness by builders
- Staff performs basic modeling and verification to determine efficacy of each measure
- Staff gathers input from builders and designers on cost effectiveness and practicality
- Staff recommends most cost effective and energy efficient measures for adoption as local amendments
- 3 months before new codes are published staff reports to RMC on anticipated new measures and distributed to stakeholders represented in Task Force.

**Code Adoption Process**

Upon publication of new energy codes, GB staff will:

- Verify with TAMU Energy Systems Lab that new code meets requirements for adoption in Texas;
- Incorporate any changes to new code that are required for code to be compliant with state code

prepare draft of local amendments based on recommendations to and feedback from RMC and trade associations.Once GB staff has prepared a proposed draft of local amendments, the following steps will occur:

- GB Manager convenes COA interdepartmental working group to review language, enforceability and basic cost effectiveness of proposed local amendments
- Interdepartmental working group may add new measures or alter recommended measures
- Interdepartmental working group (NHCD, WPDR, and AE) agree on local amendment package and forward to stakeholders
- GB Manager will convene stakeholder group (similar to task force makeup) to review, comment and recommend further new measures.

**Stakeholder Input and feedback**

- GB report to RMC including amendment package, modeled energy savings and progress toward goal
- Amendment package submitted to Building and Safety Board and other boards as needed for approval
- Final amendment package submitted to RMC for approval
- Resolution submitted to Council for adoption

**Recommendations to Council for further action**:

Major advances in energy efficiency are possible and practical using the City Energy Code as the primary tool. But at some point these local changes to the energy code may become prohibitively costly to the City and to homebuyers. Other avenues should be considered in any sustained effort to reduce the carbon footprint of single family homes. The Zero Energy Capable Homes Task Force recommends that the City also consider the following.

- Review the Land Development Code to determine the feasibility of revisions that would encourage energy efficiency from changes in the land development process, such as passive solar lot orientation, incentives for subdivisions designed to meet energy efficiency or renewable energy goals.
- Comprehensive review of the entire land development, permitting and construction process (including AE subsidies for renewable energy) to encourage original development of homes that are not only Zero Energy Capable, but constructed with on-site or near-site renewable energy source so that the homes truly are Zero Energy.
- Design standards for residential homes that require or provide incentives for energy efficient design improvements, such as window orientation, overhangs, kitchen design etc.
- Public education of trades. Code compliance will be enhanced to the extent individual tradespeople understand and adopt the goals behind the code amendments.
- Review Commercial Construction Codes for changes that may facilitate later code cycle amendments to residential construction.
- Coordinate with other cities nationwide to learn best practices and, when possible, share costs.

- Coordinate with other cities in the Austin area to encourage implementation of similar code amendments to reduce market anomalies faced by trades based on differing code requirements.
- Solicit private partnerships with key trades, on a local, regional or national level, to facilitate investigations, study and implementation of goals, including for example construction of test or model homes.
- Develop Urban Forestry initiatives that would encourage tree shading on east and west sides of lots.

# Attachment 1
# Zero Energy Capable Homes Task Force

| Name | Title, Company | Representing |
|---|---|---|
| Curt Blaskowski | Ryland Homes | Home Builders Association (HBA) of Greater Austin |
| Al D'Andrea | HVAC Contractor, McCullough Heating & Air | ACCA, Austin Chapter |
| Lee Doar | Design Coord., Austin Habitat for Humanity | CHDO Round Table |
| Michael Gatto | Architect Intern, Foundation Communities | Foundation Communities |
| Larry Graham | Customer Development Manager | Texas Gas Service |
| Everett Hicks | HVAC Contractor,<br>Triad Mechanical | Plumbing & Air Conditioning Contractors, Austin |
| Adan Martinez | Attorney, Texas General Land Office | COA Resource Management Commission, Chair |
| Ron Menard | Watershed Protection & Development Review staff member | City of Austin, WPDR |
| Richard Morgan | Green Building Program Manager | Austin Energy |
| Peter Pfeiffer | Architect, Barley + Pfeiffer Architects | HBA of Greater Austin |
| Jane Pulaski | Consultant | Solar Austin |
| Bob Ross | Owner, G&R Construction Services | HBA of Greater Austin |
| Phillip Schmandt | Attorney, McGinnis, Lockridge, & Kilgore, L.L.P. | COA Electric Utility Commission |
| Chris Strand | HVAC Contractor,<br>Strand Brothers | ACCA, Austin Chapter |
| Karen Strnad | Real Estate Broker,<br>Kare Properties | COA Resource Management Commission |
| Bryan Swindell | Home Builder,<br>Centex Homes | HBA of Greater Austin |
| Ray Tonjes | Builder,<br>Ray Tonjes Builder | HBA of Greater Austin,<br>NAHB Green Bldg. Subcommittee. |
| Michele Van Hyfte | Architect, Monarch Design/Consulting | AIA COTE, Austin Chapter; USGBC Balcones Chapter |

Attachment 2
Proposed local amendments to the 2006 International Energy Conservation Code

# Local Amendments to Energy Code

______. Appendix Chapter 13 of Section 25-12-3 of the City Code is repealed. A new Appendix Chapter 13 is added to read as follows:

(A) The International Energy Conservation Code, 2006 Edition, published by the International Code Council, Inc., is adopted and incorporated by reference into this appendix with the deletions and amendments in Subsections (B) and (D)

(B) Chapter 11 of the International Residential Code, 2006 Edition, is deleted.

(C) The following provisions of the 2006 International Energy Conservation Code are deleted:

Section 201.3
Section 202 (Vapor Retarder definition)
Section 301.1
Figure 301.1
Table 301.1
Section 302.2

Table 402.1.1
Table 402.1.3
Section 402.5
Section 403.2.1
Section 505.2.4

(D) In the City Code "Energy Code" means the International Energy Conservation Code adopted by Subsection (A). In this appendix, "Code" means the Energy Code.

**Section 201.3 Terms defined in other codes.** Terms not defined in this Code that are defined in the Building Code, Electrical Code, Fire Code, Mechanical Code, the Plumbing Code or the Residential Code, have the meaning ascribed to them as in those codes.

**Section 202. Definitions.**

**Vapor Barrier.** A vapor resistant material, membrane or covering such as foil, plastic sheeting or insulation facing having a permeance rating of one perm ($5.7 \times 10^{-11}$ kg/Pa · s · m$^2$) or less when tested in accordance with the desiccant method using Procedure A of ASTM E 96.

**Vapor Retarder**. A vapor resistant material, membrane or covering such as foil, plastic sheeting or insulation facing having a permeance rating greater than one perm ($5.7 \times 10^{-11}$ kg/Pa · s · m$^2$) when tested in accordance with the desiccant method using Procedure A of ASTM E 96.

**301.1 General.** Climate zones from Figure 301.1 or Table 301.1 shall be used in determining the applicable requirements from Chapters 4 and 5. Locations not in Table 301.1 (outside the U.S.) shall be assigned a climate zone based on Sections 301.3. Table 301.3(3) shall be used for Texas sub-climate zone definitions.

**FIGURE 301.1**
**CLIMATE ZONES - TEXAS**

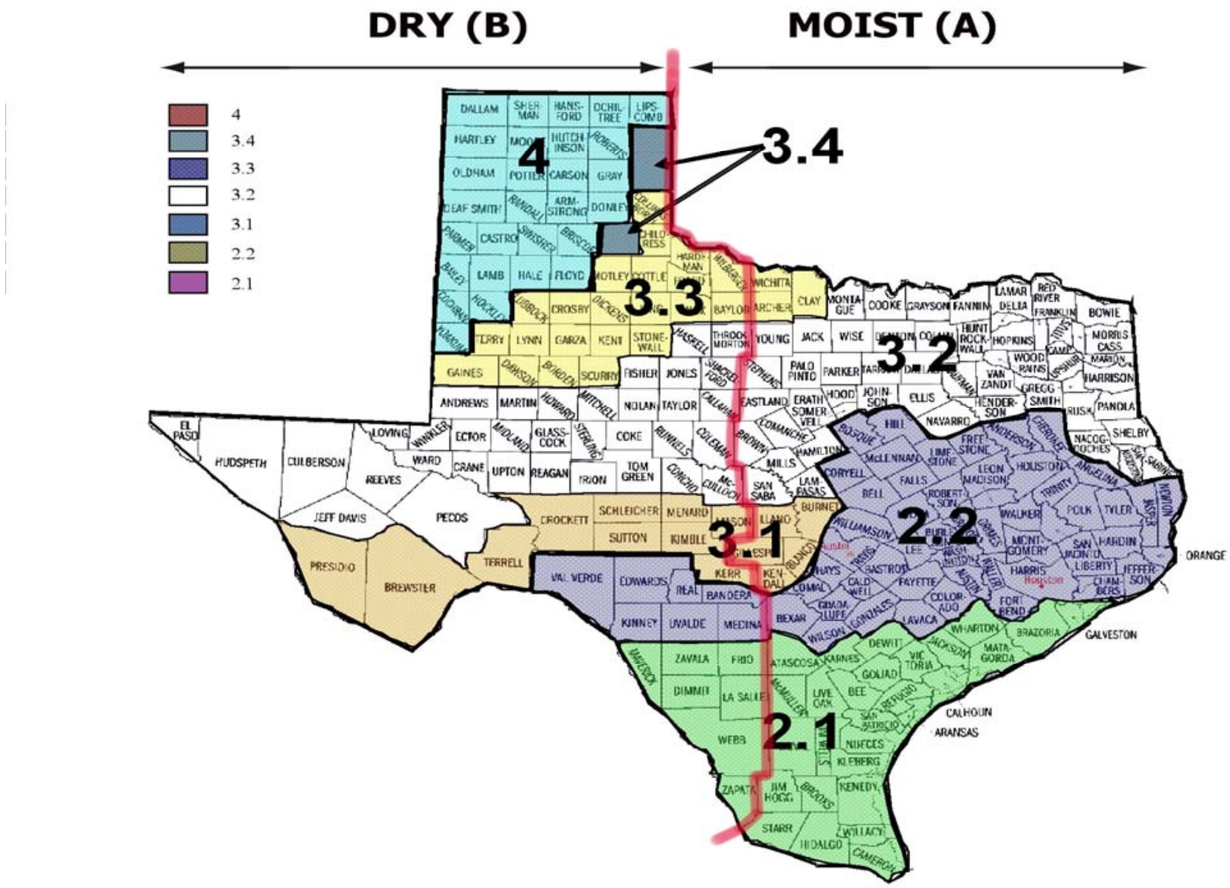



**TABLE 301.1**
**CLIMATE ZONES BY COUNTY - TEXAS**

**Zone 2**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ANDERSON | 2.2 | DE WITT | 2.1 | JIM HOGG | 2.1 | ORANGE | 2.2 |
| ANGELINA | 2.2 | DIMMIT | 2.1 | JIM WELLS | 2.1 | POLK | 2.2 |
| ARANSAS | 2.1 | DUVAL | 2.1 | KARNES | 2.1 | REAL | 2.2 |
| ATASCOSA | 2.1 | EDWARDS | 2.2 | KENEDY | 2.1 | REFUGIO | 2.1 |
| AUSTIN | 2.2 | FALLS | 2.2 | KINNEY | 2.2 | ROBERTSON | 2.2 |
| BANDERA | 2.2 | FAYETTE | 2.2 | KLEBERG | 2.1 | SAN JACINTO | 2.2 |
| BASTROP | 2.2 | FORT BEND | 2.2 | LA SALLE | 2.1 | SAN PATRICIO | 2.1 |
| BEE | 2.1 | FREESTONE | 2.2 | LAVACA | 2.2 | STARR | 2.1 |
| BELL | 2.2 | FRIO | 2.1 | LEE | 2.2 | TRAVIS | 2.2 |
| BEXAR | 2.2 | GALVESTON | 2.1 | LEON | 2.2 | TRINITY | 2.2 |
| BOSQUE | 2.2 | GOLIAD | 2.1 | LIBERTY | 2.2 | TYLER | 2.2 |
| BRAZORIA | 2.1 | GONZALES | 2.2 | LIMESTONE | 2.2 | UVALDE | 2.2 |
| BRAZOS | 2.2 | GRIMES | 2.2 | LIVE OAK | 2.1 | VAL VERDE | 2.2 |
| BROOKS | 2.1 | GUADALUPE | 2.2 | MADISON | 2.2 | VICTORIA | 2.1 |
| BURLESON | 2.2 | HARDIN | 2.2 | MATAGORDA | 2.1 | WALKER | 2.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CALDWELL | 2.2 | HARRIS | 2.2 | MAVERICK | 2.1 | WALLER | 2.2 |
| CALHOUN | 2.1 | HAYS | 2.2 | MCLENNAN | 2.2 | WASHINGTON | 2.2 |
| CAMERON | 2.1 | HIDALGO | 2.1 | MCMULLEN | 2.1 | WEBB | 2.1 |
| CHAMBERS | 2.2 | HILL | 2.2 | MEDINA | 2.2 | WHARTON | 2.1 |
| CHEROKEE | 2.2 | HOUSTON | 2.2 | MILAM | 2.2 | WILLACY | 2.1 |
| COLORADO | 2.2 | JACKSON | 2.1 | MONTGOMERY | 2.2 | WILLIAMSON | 2.2 |
| COMAL | 2.2 | JASPER | 2.2 | NEWTON | 2.2 | WILSON | 2.2 |
| CORYELL | 2.2 | JEFFERSON | 2.2 | NUECES | 2.1 | ZAPATA | 2.1 |

**302.2 Exterior Design Conditions.** The design parameters in Table 302.2 shall be used for calculations under this code.

**TABLE 302.2**

| CONDITION | VALUE |
|---|---|
| **Winter[a], Design Dry-bulb ($^{o}$F)** | **28** |
| **Summer[a], Design Dry-bulb ($^{o}$F)** | **99** |
| **Summer[a], Design Wet-bulb ($^{o}$F)** | **74** |
| **Degree days heating[b]** | **1735** |
| **Degree days cooling[b]** | **2862** |
| **Climate Zone[c]** | **2.2** |
| **For SI: deg C=[(deg F)-32]/1.8.** | |

**a** The outdoor design temperature shall be selected from the columns of 0.4 percent values for winter and 0.4 percent values for summer from tables in the Handbook of Fundamentals published by ASHRAE. Adjustments shall be permitted to reflect local climates, which differ from the tabulated temperatures, or local weather experience determined by the building official.
**b** The degree-days heating (base 65OF) and cooling (base 65°F) shall be selected from the Energy Conservation Design Standards for New State Buildings, State Energy Conservation Office, State of Texas (effective June 1, 1989, as revised May 10, 1990 and February 1, 1993).
**c** The climate zone shall be selected from Figure 302.1 of this Code.

## TABLE 402.1.1
## INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

| CLIMATE - SUB CLIMATE ZONE | MAXIMUM WINDOW TO WALL AREA RATIO | FENESTRATION *U*-FACTOR | SKYLIGHT *U*-FACTOR[b] | GLAZED FENESTRATION SHGC | CEILING *R*-VALUE | WOOD FRAME WALL *R*-VALUE [d] | FLOOR *R*-VALUE | BASEMENT WALL *R*-VALUE | SLAB *R*-VALUE & DEPTH[c] | CRAWL SPACE WALL *R*-VALUE |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.1 | 15 | 0.80 | 0.80 | 0.35 | 19 | 11 | 11 | 0 | 0 | 5 |
| | 20 | 0.75 | 0.75 | 0.35 | 30 | 13 | 11 | 0 | 0 | 5 |
| | 25 | 0.65 | 0.65 | 0.35 | 30 | 13 | 11 | 0 | 0 | 5 |
| | 30 | 0.51 | 0.51 | 0.35 | 38 | 13 | 11 | 0 | 0 | 5 |
| 2.2 | 15 | 0.65 | 0.65 | 0.40 | 30 | 13 | 11 | 5 | 0 | 6 |
| | 20 | 0.55 | 0.55 | 0.40 | 38 | 13 | 11 | 6 | 0 | 6 |
| | 25 | 0.51 | 0.51 | 0.35 | 38 | 13 | 19 | 8 | 0 | 10 |
| | 30 | 0.46 | 0.46 | 0.35 | 38 | 16 | 19 | 8 | 0 | 10 |
| 3.1 | 15 | 0.65 | 0.65 | 0.40 | 30 | 13 | 19 | 5 | 0 | 6 |
| | 20 | 0.55 | 0.55 | 0.40 | 38 | 13 | 19 | 6 | 0 | 6 |
| | 25 | 0.51 | 0.51 | 0.35 | 38 | 13 | 19 | 8 | 0 | 10 |
| | 30 | 0.46 | 0.46 | 0.35 | 38 | 16 | 19 | 8 | 0 | 10 |
| 3.2 | 15 | 0.60 | 0.60 | 0.40 | 30 | 13 | 19 | 6 | 0 | 7 |
| | 20 | 0.51 | 0.51 | 0.40 | 38 | 13 | 19 | 6 | 0 | 7 |
| | 25 | 0.45 | 0.45 | 0.40 | 38 | 16 | 19 | 6 | 0 | 7 |
| | 30 | 0.40 | 0.40 | 0.35 | 38 | 16 | 19 | 6 | 0 | 7 |
| 3.3 | 15 | 0.51 | 0.51 | 0.40 | 30 | 13 | 19 | 7 | 0 | 8 |
| | 20 | 0.45 | 0.45 | 0.40 | 38 | 13 | 19 | 7 | 0 | 8 |
| | 25 | 0.40 | 0.40 | 0.40 | 38 | 16 | 19 | 7 | 0 | 8 |
| | 30 | 0.40 | 0.40 | 0.40 | 38 | 19 | 19 | 7 | 0 | 8 |
| 3.4 | 15 | 0.45 | 0.45 | NR | 38 | 13 | 19 | 8 | 5, 2 ft | 11 |
| | 20 | 0.37 | 0.37 | NR | 38 | 13 | 19 | 8 | 6, 2 ft | 13 |
| | 25 | 0.37 | 0.37 | NR | 38 | 19 | 19 | 8 | 6, 2 ft | 13 |
| | 30 | 0.37 | 0.37 | NR | 38 | 19 | 30 | 13 | 6, 2 ft | 20 |
| 4 | 15 | 0.45 | 0.45 | NR | 38 | 13 | 19 | 8 | 5, 2 ft | 11 |
| | 20 | 0.37 | 0.37 | NR | 38 | 13 | 19 | 8 | 6, 2 ft | 13 |
| | 25 | 0.37 | 0.37 | NR | 38 | 19 | 19 | 8 | 6, 2 ft | 13 |
| | 30 | 0.37 | 0.37 | NR | 38 | 19 | 30 | 13 | 6, 2 ft | 20 |

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. R-19 shall be permitted to be compressed into a 2 x 6 cavity.
b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. R-5 shall be added to the required slab edge *R*-values for heated slabs.
d. The total *R*-value may be achieved with a combination of cavity and insulating sheathing that covers 100% of the exterior wall.
e. The wall insulation may be the sum of the two values where the first value is the cavity insulation and the second value is insulting sheathing. The combination of cavity insulation plus insulating sheathing may be used where structural sheathing covers not more than 25% of the exterior wall area and insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior wall area then the wall insulation requirement may only be satisfied with the single insulation value.

**TABLE 402.1.3**
**EQUIVALENT U-FACTORS[a]**

| CLIMATE - SUB CLIMATE ZONE | MAX GLAZED AREA TO WALL AREA RATIO | MAX GLAZED FENESTRATION *U*-FACTOR | MAX SKYLIGHT *U*-FACTOR[b] | MAX GLAZED FENESTRATION SHGC | MIN CEILING *R*-VALUE | MIN WOOD FRAME WALL *R*-VALUE[d] | MIN FLOOR *R*-VALUE | MIN BASEMENT WALL *R*-VALUE |
|---|---|---|---|---|---|---|---|---|
| 2.1 | 15 | 0.80 | 0.75 | 0.055 | 0.086 | 0.069 | 0.360 | 0.135 |
| | 20 | 0.75 | 0.75 | 0.035 | 0.082 | 0.069 | 0.360 | 0.135 |
| | 25 | 0.65 | 0.75 | 0.035 | 0.082 | 0.069 | 0.360 | 0.135 |
| | 30 | 0.51 | 0.75 | 0.030 | 0.082 | 0.069 | 0.360 | 0.135 |
| 2.2 | 15 | 0.65 | 0.75 | 0.035 | 0.082 | 0.069 | 0.122 | 0.106 |
| | 20 | 0.55 | 0.75 | 0.030 | 0.082 | 0.069 | 0.096 | 0.106 |
| | 25 | 0.51 | 0.75 | 0.030 | 0.082 | 0.047 | 0.087 | 0.075 |
| | 30 | 0.46 | 0.75 | 0.030 | 0.071 | 0.047 | 0.087 | 0.075 |
| 3.1 | 15 | 0.65 | 0.65 | 0.035 | 0.082 | 0.069 | 0.122 | 0.106 |
| | 20 | 0.55 | 0.55 | 0.030 | 0.082 | 0.069 | 0.096 | 0.106 |
| | 25 | 0.51 | 0.51 | 0.030 | 0.082 | 0.047 | 0.087 | 0.075 |
| | 30 | 0.46 | 0.46 | 0.030 | 0.071 | 0.047 | 0.087 | 0.075 |
| 3.2 | 15 | 0.60 | 0.65 | 0.035 | 0.082 | 0.047 | 0.096 | 0.101 |
| | 20 | 0.51 | 0.65 | 0.030 | 0.082 | 0.047 | 0.096 | 0.101 |
| | 25 | 0.45 | 0.65 | 0.030 | 0.071 | 0.047 | 0.096 | 0.101 |
| | 30 | 0.40 | 0.65 | 0.030 | 0.071 | 0.047 | 0.096 | 0.101 |
| 3.3 | 15 | 0.51 | 0.65 | 0.035 | 0.082 | 0.047 | 0.092 | 0.096 |
| | 20 | 0.45 | 0.65 | 0.030 | 0.082 | 0.047 | 0.092 | 0.096 |
| | 25 | 0.40 | 0.65 | 0.030 | 0.071 | 0.047 | 0.092 | 0.096 |
| | 30 | 0.40 | 0.65 | 0.030 | 0.060 | 0.047 | 0.092 | 0.096 |
| 3.4 | 15 | 0.45 | 0.60 | 0.030 | 0.082 | 0.047 | 0.087 | 0.075 |
| | 20 | 0.37 | 0.60 | 0.030 | 0.082 | 0.047 | 0.087 | 0.065 |
| | 25 | 0.37 | 0.60 | 0.030 | 0.060 | 0.047 | 0.087 | 0.065 |
| | 30 | 0.37 | 0.60 | 0.030 | 0.060 | 0.034 | 0.059 | 0.058 |
| 4 | 15 | 0.45 | 0.60 | 0.030 | 0.082 | 0.047 | 0.087 | 0.075 |
| | 20 | 0.37 | 0.60 | 0.030 | 0.082 | 0.047 | 0.087 | 0.065 |
| | 25 | 0.37 | 0.60 | 0.030 | 0.060 | 0.047 | 0.087 | 0.065 |
| | 30 | 0.37 | 0.60 | 0.030 | 0.060 | 0.034 | 0.059 | 0.065 |

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

**402.4.4 Testing of the Building Thermal Envelope for Infiltration.** Leakage of the building thermal envelope shall not exceed .50 Air Changes per Hour (ACH) as measured by the blower door test. The testing procedure shall be based on ASTM E779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization, or ANSI/ASHRAE 136, A Method of Determining Air Change Rates in Detached Dwellings.

Testing shall be performed by an independent third-party technician approved by the building official. Batch testing shall be allowed per attachment 1.
Documentation verifying thermal envelope air leakage equal to or less than .50 ACH shall be submitted with the final mechanical code compliance package on the jobsite and .include the following information:

a. Address of residence
b. Name and company of technician performing testing

c. Date of final test
d. Test results as percentage ACH

**Exception:** Existing construction where the volume of the conditioned space is unchanged.

**402.5 Moisture Control.** The building design shall not create conditions of accelerated deterioration from moisture condensation. Above-grade frame walls, floors and ceilings, not ventilated to allow moisture to escape, shall be provided with an approved vapor retarder. The vapor retarder shall be installed on the exterior side of the framing. A vapor barrier shall not be installed.

A vapor retarder is not required where other approved means to avoid condensation are provided.

**402.7 Radiant Barrier.** A roof radiant barrier with an emittance of 0.05 or less as tested in accordance with ASTM C-1371 or ASTM E-408 is required. The radiant barrier shall be installed according to the manufacturer's instructions.

A roof radiant barrier is not required for:

1. Roofs covered with clay or concrete tile having a solar reflectance of .40 or greater.
2. Roofs covered with other materials having a solar reflectance of .50 or greater.
3. Houses with sealed attics.
4. Houses with mechanical equipment and all duct work located wholly within the conditioned space.
5. Existing construction where there is no modification to the roof framing structure.

**402.8 Attic Ventilation.** Attic ventilation shall be installed in accordance with the City of Austin Mechanical Code. Ventilation shall not be provided where it introduces unconditioned air into the thermal envelope of the building.

**403.2.1 Insulation.** Supply and return ducts located outside the thermal envelope shall be insulated to a minimum of R-8. .

**Exceptions:**

1. Ducts or portions thereof located within the building thermal envelope shall comply with the current City of Austin Mechanical Code.
2. Supply and return boots and plenums may be insulated to a minimum of R-6 if the efficiency of the cooling equipment is upgraded to SEER-14.

**403.2.2.1 Testing of Duct Systems for Leakage.** Leakage of supply ducts and return plenum/ducts shall not exceed 10% of total design airflow. The testing procedure shall be based on ASTM E1554, Standard Test Methods for Determining External Air Leakage of Air Distribution Systems by Fan Pressurization, ASHRAE 152-2004, Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems, or a generally accepted equivalent method.

Testing shall be performed by an independent third-party technician approved by the building official. Documentation verifying duct leakage of less than 10% shall be submitted with the final mechanical code compliance package on the jobsite.
Batch testing shall be allowed per attachment 1.
Documentation shall include the following:

a. Address of residence

b. Date of final test
c. Name and company of technician performing duct testing
d. Type of test performed (duct pressurization method or blower door subtraction method).
e. Test results in percentage of airflow CFM.

**Exception:**

Existing construction with no modification of or addition to the existing ductwork.

**403.6.1 Documentation of Heating and Cooling Equipment Sizing.** Documentation verifying the methodology and accuracy of heating and cooling equipment sizing shall be submitted with the final mechanical code compliance package on the jobsite. Documentation shall include the following information:

a. Address of residence
b. Name of individual performing load calculations.
c. Name and version of load calculation software.
d. Design temperatures (outdoor and indoor) according to the Air Conditioning Contractors of America's (ACCA) Manual J, ACCA Manual N, American Society of Heating, Refrigeration and Air-Conditioning Engineers, U.S Department of Energy standards, or other methodology approved by the City of Austin.
e. Area of walls, windows, skylights and doors within +/- 10% of architectural plans or actual building.
f. Orientation of windows and glass doors, infiltration rate, duct loads, internal gains, insulation values, and Solar Heat Gain Coefficient of windows**.**
g. Heating and cooling load calculations.

**403.7 Filtration for Ventilation Systems.** Filters installed in ventilation systems shall have a minimum efficiency reporting value (MERV) rating of 6 or greater.

**403.8 Air Balancing of Ventilation System**. Volumetric airflow in cubic feet per minute (CFM) shall meet the design/application requirements. Airflow testing shall be performed by an independent third party technician approved by the building official, with all interior doors closed and all blowers turned on at cooling speed. Documentation shall be provided verifying that: individual room supply airflows are within +/-20% of the design/application requirements; that the pressure difference between each room and open area adjacent to that room does not exceed 3 Pascals; and that the pressure difference between the open area and the outside does not exceed –3 Pascals. Documentation shall also verify that total system CFM airflow is within +/- 10% of 360 CFM airflow per ton of air conditioning installed. All documentation shall be submitted with the final mechanical code compliance package on the jobsite.
Batch testing shall be allowed per attachment 1.
Documentation shall include the following:

a. Address of building
b. Name and company of technician performing the testing
c. Date of final test
d. Procedure used for the test
e. Results of room-by-room airflow tests, including design/application CFM airflow required, design/application CFM airflow required as a percentage of total CFM airflow required, actual measured CFM airflow, actual percentage of total CFM airflow measured, and percentage of design/application CFM airflow required actually attained.
f. Results of room-by- room pressure tests, including Pascal difference between room and open area adjacent to room and between open area and the outside.

g. Results of static pressure test (See 403.8.1) and manufacturers' blower data table identifying total rated CFM airflow.

Measurement of room airflow may be by one of the following procedures:

a. Flow hood used per the manufacturer's instructions
b. Traverse with anemometer (hotwire or rotary) used per manufacturer's instructions.
c. Pitot tube and slant manometer procedure as specified by the Associated Air Balance Council, National Environmental Balancing Bureau, or the American Society of Heating, Refrigeration and Air Conditioning Engineers.

**Exception:**
Existing construction with no modification of or addition to the existing ductwork.

**403.8.1 System static pressure**. Total system static pressure (with filters in place) shall not exceed .8" water column on gas furnaces and .6" water column on electric air handlers. Static pressure testing using a digital manometer or magnehelic shall be performed by an independent third party technician approved by the building official. Documentation verifying static pressure testing results within the allowed ranges shall be submitted with the final mechanical code compliance package on the jobsite.
Batch testing shall be allowed per attachment 1.

Documentation shall include the following:

h. Address of building
i. Name and company of technician performing the testing
j. Date of final test
k. Procedure used for the test
l. Results of the test listing static pressure for applications tested.

**Exception:**
Existing construction with no modification of or addition to the existing ductwork

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**403.9 Water Heating.** Residential Buildings, as defined by Chapter 2 of the 2006 International Energy Conservation Code, having an existing or planned natural (or equivalent district) gas service located within the adjacent right-of-way shall not use electric resistance water heating as the primary source for hot water.

Residential Buildings, as defined by Chapter 2 of the 2006 International Energy Conservation Code, not having natural gas service located within the adjacent right-of-way may install electric resistance water heaters having a minimum efficiency of 93% in conjunction with a preprogrammed water heater timer in lieu of gas fired water heating. The timer shall be preprogrammed to turn the water heater off between the hours of 3:00PM and 7:00PM from June 1 to September 30 and from 12:00AM to 4:00AM throughout the year. The timer shall have a readily accessible override, as defined by the building official, capable of restoring power to the water heater for one hour when activated.

In all instances an electric resistance water heater may be used as a secondary heater in series with a primary water heater that is not electric resistance.

**403.10 Space Heating**. In all residential buildings and mixed-use buildings with units in excess of 500 square feet, the primary source of space heating may not be electric resistance.

**403.11 Lighting.** A minimum of 25% of indoor lamps must be Energy Star-compliant high efficacy lamps. Lamps in closets are to be excluded from the 25% calculation. Outdoor luminaires that are permanently attached to a structure must be high efficacy or controlled by an integral photocell.

**TABLE 403.1**
**High Efficacy Lamps**

| Lamp Power | Required Lamp Efficacy |
|---|---|
| < 15 watt | 40 lumens/watt |
| 15 – 40 watts | 50 lumens/watt |
| > 40 watts | 60 lumens/watt |

## ATTACHMENT 1.

### Initial Testing
The 3rd party testing contractor performs all required tests on at least three consecutive houses or dwelling units. Test results must meet code requirements before batch testing is allowed. Initial testing is required for each new subdivision where there is a change in subcontractors. Houses must be of a substantially similar floor plan, and multifamily dwelling units must be within the same building to qualify for inclusion in a batch.

### Batch Identification and Sampling
The builder identifies a "batch" which is a group of homes or dwelling units ready for testing (drywall complete, interior door jams installed, HVAC system installed, and final air sealing completed) within a reasonable block of time.

The third-party testing contractor randomly selects at least 15% of homes from a batch for testing and inspecting. To be eligible for batch testing, the builder must either build a minimum of 85 homes per annum in the city of Austin's jurisdiction. If the builder builders fewer than 85 homes per annum in the city's jurisdiction, the batch must be within the same subdivision using the same subcontractors.

For multifamily structures, a minimum of 15% of the dwelling units in each building must be tested. At least one of each type of dwelling unit must be tested.

If each tested home or dwelling unit within the batch meets code requirements, then all homes or dwelling units are deemed to meet code.

### Failure to Meet Code Requirement(s)
a) If any home or dwelling units within the identified batch fails to meet a code requirement, the builder will be directed to fix the cause(s) of failure, and 30% of the remaining homes or dwelling units in the batch will be randomly selected for inspection and testing regarding the specific cause(s) of failure.
b) If any failures occur in the additional tested homes or dwelling units, all remaining homes or dwelling units in the batch must be individually tested for code compliance.
c) A builder subdivision or multifamily project with 3 failures within a 6-month period is no longer eligible to use the sampling protocol in that community or project until successfully repeating "Initial Testing." Sampling can be reinstated after at least 3 consecutive homes or dwelling units are individually verified to meet code all requirements.
d) No home or dwelling unit in a batch may be issued a Certificate of Occupancy until testing has been performed and passed on the home(s) or dwelling unit(s) selected for testing.

**502.7 Reflective Roofing.** Roof surfaces with an incline of two inches or less of rise per each 12 inches of horizontal run shall incorporate a roof material having a minimum reflectance of 0.70 or a minimum solar reflective index (SRI) of 78. Roof surfaces with an incline greater than two inches of rise per each 12 inches of horizontal run shall incorporate a roof material having a minimum reflectance of 0.35 or a minimum SRI of 29.

The reflectance measurement will correspond to ASTM E903-96, ASTM 1918-97 or ASTM 1549-04.

Exception: Vegetated roofs or roof top pools.

**503.2.10 Ventilation Filtration.** All ventilation systems shall incorporate filtration having a minimum efficiency reporting value (MERV) rating of 6 or greater.

**505.2.4 Exterior Lighting Controls.** Lighting for all exterior applications shall have automatic controls that shall turn off exterior lighting when sufficient daylight is available or when the lighting is not required during nighttime hours. Sufficient daylight can be determined per recommended IESNA RP-33-99 illuminance levels.

Lighting not required and designed for dusk-to-dawn operation shall be controlled by an astronomical time switch. Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or in series with a photo sensor. Astronomical time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least 10 hours.

**Exception:** Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.