The Revised Austin Energy Code
and Comparisons with the Texas State Energy Standard

Glenn Crow, Ph.D., M.Arch., Architect
Chairman of the Austin Energy Code Task Force
Chairman of the Resource Management Commission of the City of Austin
Regional Codes Chairman for the Illuminating Engineering Society
G.W. Crow, Ph.D., Architect
7604 Hemingway, Austin, Tx. 78752

ABSTRACT

For the past two years the City of Austin Energy Code has been under review using the State Energy Standard and ASHRAE 90.2P as models for the revised Austin Energy Code. The major changes to these documents are presented in this paper.

INTRODUCTION

Why have an energy standard or code? One side of the issue we have the position that more regulation creates bureaucratic inefficiency and unnecessarily limits our freedom, while the other side views energy regulation as a protection of our natural resources and environment. In addition, the construction of new power plants places additional debt on our already strained economic system. We have seen how interconnected our world has become and that we are no longer isolated from competition abroad. Increasing the efficiency of our buildings strengthens our economy. The more we can produce with less cost, the greater will be the efficiency of our economic system. Energy, the environment, and economic issues are key to our future.

The performance of our buildings is typically controlled by the marketplace that often excludes energy and maintenance costs in design decisions. This is not surprising as few architects, engineers, or builders are required to make the calculations or have adequate budgets to provide this type of service. Providing a custom energy analysis can be cost effective when produced by an experienced analyst who can focus on the energy "hot spots" of the building. However, most building owners are rarely willing and often unable to pay for these additional services.

The least expensive route to achieving a reasonable level of energy efficiency is by the use of an energy standard or code. This does not guarantee efficient buildings but rather prevents very inefficient buildings. We have used this approach for many years in our building codes to provide minimal life safety standards; that is, a building that complies is not necessarily extremely safe or energy efficient but rather has met minimum standards. An energy code is designed to provide adequate paybacks to the building owner, protect the common good by minimizing the financial strain of new power plants on a community, and reduce the degradation to the environment. In addition, an energy code will provide compliance methods with adequate flexibility and can give sound design guidance to architects, engineers, and builders. Energy codes are not meant to circumvent safety, health, or environmental requirements.

In 1977 the State of Texas implemented an Energy Conservation Manual for State buildings. The manual was taken from ASHRAE 90-75 with envelope criteria customized for Texas. In 1986 the City of Austin adopted an early version of ASHRAE, IES, 90.1P as the Austin Energy Code[1]. This document has helped, at a local level, to discover what types of code issues were viable. In 1988 a process began to develop the State Energy Standard from a more current draft of 90.1P[3]. This process has produced three major changes to 90.1P. First, criteria not appropriate to Texas were eliminated; second, items important to the Texas climate were strengthened; and third, local public review clarified several incomplete aspects of the standard.

Shortly after the development of the State Standard, a task force was created by the Resource Management Commission of the City of Austin to update the Austin Energy Code to the current State Standard for commercial and ASHRAE 90.2P for residential dwelling units[2]. The revised Austin Energy Code will contain a superior format with clear language. It will contain a more appropriate level of sophistication that takes advantage of current research in building energy efficiency, and it will cover a more appropriate level of detail than the previous code. An additional benefit from updating the Code comes from the fact that on a national level many building material and air conditioning equipment manufacturers are designing their products to conform to the ASHRAE standards. This will minimize the impact upon the building industry while at the same time improving national energy efficiency. The City of Austin and all other code agencies should keep in step with national developments to reduce confusion and simplify the marketing of products from one region to another.

Each section of the code outlines the scope of that section and any exemptions. This is followed by basic requirements that are obligatory for all buildings governed by the code. The basic requirements are then followed by two compliance pathways. The first is the Prescriptive Path. This pathway is designed to be the fast and easy compliance method. The second pathway is the performance path. The performance pathway typically requires more calculations but allows additional flexibility by providing tradeoffs between energy saving strategies. In addition, code compliance can be accomplished by building energy simulations. This provides ultimate flexibility but is the most time-consuming. This route is referred to as the energy cost budget method and requires the building as designed to have lower utility bills than a model of the building that passes all basic and prescriptive requirements.

The standard contains a lighting and envelope compliance software program that helps simplify the complexity of the performance path calculations. This software runs on DOS machines.

The review effort by the City of Austin task force has made many amendments to the State Standard that will be included in the Austin Energy Code. These amendments will be passed along to the Governor's Energy Office for consideration as amendments to the State Energy Standard. The State Standard will be reviewed again in mid 1992. In principle, our codes and standards are living documents that must evolve with our technology and understanding.

The Energy Code Task Force that reviewed the Standards was broken down into four subcommittees. Three of the groups addressed the State Energy Standard, that is, commercial buildings; while the fourth reviewed 90.2P, the Residential Standard. The commercial subcommittees were broken down into a lighting and power subcommittee, an envelope subcommittee, and a mechanical subcommittee. All subcommittees used a 7 year payback criterion. When a significant difference existed between the current Austin Energy Code and the State Standard or 90.2P, payback calculations were not always performed. In general, the committee preferred to use the more current information in the two new standards rather than the current Austin Energy Code. If the effectiveness of the change was questioned, the item was marked for future payback calculations. In some cases the committees felt that the Austin Energy Code should go beyond the two standards, when this was the case the items were usually marked for a future payback study unless the committee felt that a payback calculation was unnecessary. As of the date of this writing not all payback calculations are complete.

The following is a summary of the major amendments. This listing is not intended to cover all amendments or details. These amendments do not change the basic structure of the Standards. However, some modifications do go beyond minimal energy efficient standards where there is a clear economic advantage to the building owner.

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AMENDMENTS TO THE STATE ENERGY STANDARD FOR COMMERCIAL CONSTRUCTION

LIGHTING AND POWER:

This section of the Standard was the most problematic. Many terms were poorly defined. The task force concentrated on expanding the definitions and improving clarity.

Daylighting and the control of artificial light fixtures were viewed to be an economical building strategy. Often the architecture of buildings provides ample daylight into spaces without any provisions for control of the artificial lighting. The State Standard was weak on the definitions and control of artificial lighting concerning daylighting. Therefore, the following definitions and requirements were added. The definition of the daylighting zone was expanded: the daylighting zone has a depth of 1.5 times the floor to window head height from the wall into the room, or extends to the nearest opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is less. The daylight zone width was the width of the window plus 2 feet on both sides (this may be extended to 3 feet if an adjacent window is within 6 feet). Those fixtures that fall in the daylighting zone are required to be controlled separately from the remainder of the space, provided ample glazing is available and enough wattage can be offset by the daylight.

The amount of glazing to qualify as a daylighting aperture was determined from computer simulations[5]. It was found that the effective area of the glazing should average 2 square feet for each linear foot of the aperture wall to qualify. The effective area is found by the sum of all glazed openings multiplied by their respective daylight transmittances. Only the glazed area 3.5 feet above the finished floor can be counted as a portion of the effective area. Glazed areas 6 feet apart or less are considered to be within the same daylighting zone and should be combined into a common effective aperture. The weighted sums of all windows within the zone should then be divided by the total length of wall to determine if the effective area is at least 2 square feet of opening per linear foot of wall.

In addition, for the daylighting zone to require separate controls, the amount of artificial lights within the daylighting zone must be at least 400 watts. This prevents requiring extra controls in small spaces and assures a payback period of 5 years.

Another definition that has given designers problems was general ambient lighting. There is currently no definition for general ambient lighting in the code. The lighting task force recommends the following definition: lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for task requirements. This type of lighting applies to illuminance categories A, B, and C in the 1987 IES Handbook[4].

The following spaces were exempted from compliance in the State Standard: manufacturing and processing facilities, outdoor athletic facilities, and nursing homes. These spaces were not exempt in the current Austin Energy Code and will be retained in the revised Energy Code. However, the following exemptions were added: lighting show rooms and signs both interior and exterior whose purpose is to convey information. In addition, power densities for manufacturing and exterior applications that exist in the original Austin Energy Code but not in the State Standard have been retained in the revised Energy Code.

Lighting control points are used to determine the degree of control required in each space. The minimum number of lighting control points was originally determined to be the sum of the following: 1) one control point, and 2) one control point for each task location or group of task locations within an area of 450 square feet or less. The task force felt that this was excessive for small spaces. In other words, this would result in two switches in small offices. Therefore this was changed to the greater of 1) one control point or 2) one control point for each task location or group of task locations within an area of 450 square feet or less. The minimum number and type of lighting controls is determined by Table 6.3 of the Standard that lists the types of lighting controls and the number of control points each represents. Lighting controls must be selected which have sufficient points to meet the criteria, and the minimum number of control devices shall not be less than one for each branch lighting circuit.

One of the most significant problems that the current Austin Energy Code has experienced is the taking of allowable power from one area and using it in another. For example, taking power from the parking lot and using it inside the building, or in shell buildings, using up all the interior power allowed for the first tenants. This practice will not be allowed in the revised Energy code. Power can not be transferred from the exterior to the interior nor from one tenant finish out to another. In addition, the allowable power for exterior applications has been increased. Since this load does not coincide with the power plant peak, this is an appropriate change.

A second problem with the current Austin Energy Code has been in high-end retail lighting. The new State Standard breaks down retail display into six categories that recognize the difference between a jewelry store versus a grocery store. For example, 5.6 watts/sq.ft. is allowed for jewelry while 2.8 watts/sq.ft. may be used in a grocery store. In the past high-end retailers have circumvented the Austin Energy Code by putting in more lighting as a retrofit after passing the energy code. This is possible because the Energy Code is a part of the Building Code. However, the building owner does not need to go through the Building Code if they want to add lighting later. They only need an electrical permit that does not require Energy Code compliance. Since the new State Standard does allow more power in the high-end stores, this should decrease this practice.

Chapter 6 covers electric power that includes electric motors. The motor efficiencies within the State Standard were found to be low and are not sound investments. Minimum motor efficiency standards will be based on the minimum levels currently set by the City of Austin Motor Rebate Program. These rebates have rarely been taken advantage of even though they are very beneficial to the building owner. Table 1 lists the motor efficiencies. These efficiency levels are almost identical to those in the pending bill (H.R. 2451) before the House of Representatives that will effect lighting, plumbing hardware, and electric motors.

H.P.	Eff.	H.P.	Eff.
1	.821	30	.922
1.5	.835	40	.928
2	.846	50	.928
3	.863	60	.936
5	.874	75	.939
7.5	.890	100	.941
10	.895	125	.945
15	.905	150	.947
20	.911	200	.951
25	.918	250	.951

Table 1: Minimum Motor Efficiencies

ENVELOPE:

The chapter on the thermal envelope created few difficulties. The only significant change was in the required roof conductance value. The current state standard requires a conductance of 0.063 or less (R = 15.8). Extensive payback analyses have shown this value not to be cost effective in this climate. Therefore, the task force changed this value to 0.0789 (R = 12.7). The reasoning behind this change is that commercial buildings are primarily internally load-dominated buildings. Higher levels of insulation do not significantly decrease energy consumption or peak loads, for the added insulation can trap internally generated heat within the building. Since the current Austin Energy Code requires a conductance of 0.1 (R = 10) for roofs, this represents a minor change.

Other minor amendments were added. These include the following:

Vestibules or revolving doors are required on all public entries in buildings five stories or greater in height. This is to decrease stack effects in tall buildings that draws outside air in at the bottom of the building and exhausts air at the top.

Vapor barriers are not required in wall assemblies.

There are no insulation requirements for slabs, footings, or below-grade wall assemblies. However, heated slabs are required to have an R of 2 to extend 24 inches below grade around the perimeter. The insulation shall be adequately protected on the exposed exterior surface as required by the building code official.

Thermal transmittances for the fenestration shall include the effects of sash, frames, edge effects, and spacers for multiple-glazed units. The calculation results of the computer program Window 3.1 from Lawrence Berkeley Labs. will be accepted for fenestration thermal transmittance and shading coefficient. Additional tables are included in the amendments to provide easy access to typical values where manufacturers' data are not available.

A significant improvement in the State Standard compared to the current Austin Energy Code is in the inclusion of the thermal mass effects in wall systems. In addition, the State Standard is provided with a compliance software package that simplifies the calculations. This allows the designer to trade off conductances, thermal mass, surface areas, shading, shading coefficient, visible light transmission, and daylighting controls.

MECHANICAL:

Energy for transfer of air through HVAC systems with one horsepower or more was seen to be excessive and too general for both constant and variable air volume systems. This involved modifications to the minimum air transport factor that is the design sensible cooling load divided by the total fan power of the system (see Table 2). The air transport factor reestablished the basic format of the existing Austin Energy Code.

Largest Fan:	ATF:
1-10 hp	12.5
>10-25 hp	10
Over 25 hp	8.5

Table 2: Minimum Air Transport Factor

One of the most important elements of the State Standard is the Standard Rating Conditions and Minimum Performance tables for equipment. These tables are based on ASHRAE prepared tables and represent a consensus with equipment manufacturers. These tables will be updated periodically by ASHRAE and perhaps also by the Governor's Energy Office. The City of Austin will be able to rely on ASHRAE or the State updates to keep the City of Austin Energy Code current.

Perhaps the most important addition to the State Standard in the HVAC section is the requirement for manuals and procedures for operations and maintenance of HVAC systems and equipment. Currently the Uniform Mechanical Code only requires that the appliance installer leave the manufacturer's installation and operating instructions attached to the appliance. For buildings larger than 20,000 square feet of conditioned floor space, an operations and maintenance (O&M) manual shall be assembled by the engineer. Before a certificate of occupancy will be issued, three copies of the O&M manual shall be submitted as follows: one copy to the City of Austin and two copies to the building owner. One copy of the O&M manual shall be kept on the building premises. The O&M manual shall be composed of the manufacturer's installation and maintenance guides.

The current Austin Energy Code only requires that the system design shall provide a means for balancing air and water systems without actually requiring that the system be balanced. The task force has determined that for buildings with over 20,000 square feet of conditioned floor spaces that the air system shall be balanced. In addition, every 5 years after the initial air system balancing, buildings with over 2,500 cubic feet per minute of air-handling capacity should be audited and re-commissioned according to NEBB, AABC, or equivalent procedures. The term "commissioning" means air-system testing, balancing, and control adjustment.

AMENDMENTS TO ASHRAE 90.2P THE RESIDENTIAL STANDARD

The amendments to 90.2P were general clarifications. However, the task force did go beyond the Standard in the strategic planting of trees and in hot water heating.

The task force viewed tree planting requirements to be beneficial not only for their direct energy impact but also in terms of their community and global benefits. The tree planting requirements call for the strategic planting of 2 trees per single family home. A tree may be planted due east or west of any glazing facing + or - 45 degrees of east or west. The expanse of window space covered by a single tree shall be no wider than 10 feet. In addition, the trees are required to be planted between 10 and 12 feet from the window(s). Only adaptable and long lived trees will be allowed. These include but are not limited to: Live Oak, Bur Oak, Chinquapin Oak, Texas Red Oak, Cedar Elm, Chinese Pistachio, Golden Raintree, Bald Cypress, Pecan, Texas Ash, Soapberry, and Anacua. The following trees will not be allowed: American Elm, Catalpa, Box Elder, Hackberry, Mulberry, Chinaberry, Honey Locust, Arizona Ash, Sycamore, Cottonwood, Willows, Siberian or Chinese Elm, and Chinese Tallow.

The second major area where the task force felt the Code must go beyond ASHRAE 90.2P was in water heating. The existing Austin Energy Code disallows the primary source of heating for water to be electric resistance. This encouraged the use of gas, heat recovery, heat pump, or solar. Solar heating has been found to be expensive from a first cost and maintenance cost perspective. Heat recovery units have also run into problems due to maintenance costs. In addition, one form of heat recovery, the so called "heat sticks," will generally void a manufacturer's warrantee and since these units are single wall heat exchangers, they have the potential for rupture and release of hot freon into the water tank. Heat sticks are a loop of hot refrigerant from the air conditioning compressor that is placed inside the hot water tank. It is typically installed by permanently removing the cathodic protection and thus violating the manufacturer's warrantee. Heat pump hot water heaters thus far have a poor performance record and high maintenance costs.

This leaves only one viable alternative, gas water heating. Therefore the task force has proposed the following amendment to the Code. "The use of electric resistance for water heating of single or multi-family residential units shall not be permitted where natural gas is available at the site. Units of 500 square feet or less will be exempt." Since most single family residence units are being plumbed for gas, the major impact will be on multi-family units. Currently it is very difficult to find developers who are willing to increase first costs to build multi-family dwellings with gas water heating even when gas is available at the site and provides an economic benefit to the tenants. Simple payback calculations show that gas versus electric resistance water heating has a 3.43 to 5.92 year payback for an average household of 1.75 people. With the addition of this amendment to the Code, this will put all new construction "on a level playing field" in regard to competition between developers to provide multi-family units at the most economical first cost.

The thermal envelope requirements were not seen to be controversial. Therefore, the committee adopted the levels in 90.2P. Below is a listing of the changes in insulation requirements.

Surface	Change
Walls	R11 to R13
Roofs	R26 to R30 (R19 plus a radiant barrier is acceptable)
Floors over Unconditioned	R11 to R13
Floors over Ambient	R11 to R19

Table 3: Residential Envelope Changes

The other major envelope impact was in the amount of allowable glazing. The ASHRAE 90.2P standard was seen to be clearly superior to the existing Austin Code in format. The existing code based the allowable amount of glazing on a percentage of the wall area, whereas 90.2P uses a percentage of the floor area. For double glazing this would be 25% of wall for the current Austin Code and 15% of floor area for the revised Code. Since the conditioned floor area is always known, this is a significant simplification.

The Residential Standard was seen to be weak in two additional areas that relate to air infiltration and thermal comfort. First, the section on caulking and sealants was expanded to describe in detail all areas of air leakage that should be sealed. This will help eliminate ambiguities in what should be sealed and make enforcement simple.

The second area that needed more attention was HVAC system sizing and duct design and installation. The ASHRAE Standard states that the HVAC equipment and the air distribution systems must be sized using acceptable calculation standards and installed using acceptable, referenced practices. However, many of the details are left in these reference standards and are not readily available in the Code. The task force felt that the Code would be more easily enforced if key information from these reference standards was included in the Code. Evidence of compliance for load calculations and duct sizing would require the submission of all calculations to building inspection. In addition, sealing requirements of duct systems to reduce mechanically induced infiltration were described in detail.

In addition to the above wording several additional requirements were incorporated from the reference standards to make the Code easy to use. These include minimum gauges for metal ducts, specific guidelines for flexible and fibrous glass duct installation, and sealing requirements. The task force felt that these requirements would help prevent poor duct design and installation which is a significant weakness in current residential design and installation practices.

CONCLUSIONS

The task force has concentrated on molding the energy standards into an energy code by improving the readability and local acceptance of the basic standards. The task force has been very sensitive to changes that might alter the original structure and intent of the standards.

The production of an energy standard or code is a difficult task. From our experience it has taken almost 2 years to review the standards and formulate amendments. This process must go on at a local level to establish an initial consensus. These efforts will not completely stop once the Austin Energy Code is updated, for many of these amendments will be incorporated into the State Energy Standard. In addition, this work will be available to other cities and towns that are considering establishing or updating a local energy code.

Energy standards and codes promote a higher level of professionalism by the guidance built into the documents. The improvement in efficiency of our building stock will pay back dividends to our economy in the future by preventing poor investments. In addition, it will aid the economy by helping to delay power plant construction. Additional capacity within our utilities place a long term burden of debt on a local economy and increase rates. In order to be competitive in a world market, we must not only increase quality and quantity of production but we must improve efficiency at the same time. This makes our country more competitive within a global economy.

REFERENCES

1. Austin Energy Code, Appendix Chapter 53 of the Uniform Building Code, Adopted by reference Model Energy Code 1986 Edition with local amendments.

2. ASHRAE Standard 90.2P, Public Review Draft, March 1989.

3. Energy Conservation Design Standard for New State Buildings, Energy Efficient Design of New Buildings Except Low-rise Residential Buildings, Governor's Office of Budget & Planning, Energy Management Center, 1989.

4. IES Lighting Handbook, Application Volume, Illuminating Engineering Society of North America, 1987.

5. Quicklite, Lumen-Control, Lawrence Berkeley Laboratory, 1984.