COMMUNITY AND INDUSTRY PARTICIPATION IN LOCAL ENERGY CODE DEVELOPMENT AND ENFORCEMENT

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ABSTRACT

The City of Austin amended the local energy code in December 1984 to incorporate the principal recommendations of ASHRAE Standard Project #41. Revisions to the code were recommended by a special task force appointed by the Austin City Council; Task force members represented major elements of the construction industry and local community. The code revisions were reviewed and supported by numerous local city boards and commissions after nearly a year's work by the task force.

The code revisions produced by a consensus methodology and problems with implementation and enforcement are outlined in this paper. Training and communication of construction professionals and interpretation of research documents were the first major tasks required for implementation of the new code.

Austin is a rapidly growing city with a strong energy conservation program designed to achieve 553 megawatts of deferred electric generation plant capacity by 1992. The new code revisions are only a part of an overall plan to improve the energy efficiency of buildings in Austin, Texas. Review and upgrading of the energy code are planned for 1987. Proposed monitoring of energy savings due to code changes is discussed with preliminary projections for potential energy savings.

INTRODUCTION

The City of Austin, Texas, is experiencing rapid growth with the influx of new business and the growth of existing hi-tech employers. Austin is a progressive community, which owns the local electric utility plant and distribution system. The City Council passed a resolution on March 10, 1983, stating a goal of increasing energy efficiency in all new residential and commercial construction by 50% by 1985. In support of this very aggressive goal, 13 citizens representing the construction industry and general public were appointed in September 1983 to serve on a Building Code Task Force. The task force was charged to review and make recommendations for increasing the energy efficiency requirements for residential and commercial structures by changing the Uniform Building Code and local amendments.

The task force met and discussed the challenge. A decision was reached to divide into residential and commercial subcommittees. Each subcommittee elected a chairman who also served as co-chairman of the task force. The subcommittee met once a week for several hours over a six-month period to develop preliminary recommendations.

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The task force agreed to three basic criteria to justify changes in the code:

1. It must be proven effective in improving energy efficiency

2. It must be cost effective

3. It must not put an undue burden on the building community

APPROACH TO REVISIONS

The two subcommittees started their tasks by reviewing the local energy code requirements, Chapter 53 of the Uniform Building Code. The existing code was based on ASHRAE Standard 90A-1980. After a few weeks the subcommittees took different directions in approaching their proposed revisions. The residential subcommittee began to compile a long list of specific changes and major additions to the code based upon the individual members' experience and opinions. While several good ideas were developed, many hours of debate and analysis were required to produce a consensus recommendation. The commercial subcommittee approached their task by researching what efforts were being made on a national basis to update and improve upon ASHRAE Standard 90 and the AIA Research Corporation Building Energy Performance Standards. The subcommittee was fortunate to obtain draft copies of a laboratory report, "Recommendations for Energy Conservation Standards and Guidelines for New Commercial Buildings."[1]

The report was precisely what the committee was looking for in a resource document. It made specific recommendations that had been developed and tested over an 18-month period by a collection of professionals from across the country. The commercial subcommittee found that the federal government had funded the research they were seeking. The report produced an unusual opportunity for Austin to implement the best thinking and most current procedures on a timely basis. The recommended changes will ultimately become a part of ASHRAE's update of Standard 90 and most likely be included in the 1988 Uniform Building Code. Since local adoption and enforcement of the Uniform Code normally lag the issue date by one year, Austin had the opportunity to achieve a four-year headstart on future energy code changes.

The commercial subcommittee reviewed and evaluated the major changes proposed by the report. Weekly committee meetings were used to educate and inform committee members on the impacts of the proposed changes by looking at example buildings. Familiarity with the proposed changes and potential energy savings converted several committee members from hesitant or reluctant participants to aggressive or eager supporters of energy code changes, and "status quo" conservative members became eager to go beyond the report's recommendations. Prudence dictated that the recommendations stay consistent with a recognized source so that other public and private interest groups could be referred to the source documents.

COMMUNITY REVIEW AND SUPPORT

The two subcommittees met jointly about once a month to coordinate and schedule the recommendations.

On April 16, 1984, the task force presented the preliminary recommendations to the Austin City Council. The recommendations were forwarded to the following boards and commissions for review and comment:

1. Building Code Board of Appeals

2. Heating and Air Conditioning Board

3. Electric Board

4. Plumbing Advisory Board

5. Energy Advisory Commission

6. Electric Utility Commission

One member from each subcommittee was assigned to attend the meetings of the above groups to discuss the task force recommendations and seek the endorsement of the board or commission. Copies of the recommendations were made available to all interested professional and trade groups. Many of the impacted groups had representation on the task force. Newspaper advertising was used to announce the completion of the recommendations and dates for public hearings. News articles were written about the work and recommendations of the task force on several occasions.

Members of the task force worked very hard to identify and hear all concerns. Reasonable adjustments and changes were made in the residential recommendations to accommodate concerns for low-cost housing and multifamily construction. Major political forces were identified and lobbied for support, specifically the Austin Home Builders Association. Ultimately, all the boards and commissions voted unanimously for the changes. Endorsements were received from a variety of groups including the Home Builders Association and the Building Owners and Manager Association (BOMA). A variety of recommendations about code enforcement were included in the final recommendations to balance the role of mandatory requirements with incentives and administrative enforcement.

During the public hearing in August 1984 before the Austin City Council, no negative or dissenting voices were heard. All the testimony regarding the task force recommendations was supportive. Education of the industry representatives and patient reviewing and listening to specific concerns were the keys to the successful adoption of the task force recommendations.

The City Council instructed the staff to draft the appropriate ordinances to implement the recommended changes. A unanimous vote on the ordinance changes was made on December 13, 1984. Enforcement of the new code began on March 1, 1985.

RECOMMENDATIONS

A summary of the major changes to the Residential Energy Code follows:

INSULATION	OLD	NEW
Walls[1]	R-11	R-11
Ceiling	R-19	R-22
Floors Over Enclosed Crawl Space	R-7	R-11
Floors Over Outdoor Air	R-19	R-22

[1] Knee-walls separating vaulted ceilings and attics require R-22.

Note: Vapor barriers, when installed, must be on the warm side of insulation, between the insulation and the conditioned space.

Air Leakage

1. All penetrations and seams must be sealed at interior walls, floors, and ceilings, in addition to exterior walls. All A/C duct outlets, electrical fixtures and boxes, plumbing fireplaces, and vents must be sealed to walls, floors, and ceilings at points of penetration. Ceiling beams, stairways, and other interior components must be sealed to walls, floors, and ceilings at point of attachment to envelope. Doors of HVAC or water heater closets must be weatherstripped if the ceiling of the closet is open to the attic.

2. All aluminum windows and doors must be labeled to show compliance with Architectural Aluminum Manufacturers' Association "Qualify Certified" master specifications as follows:

UNIT TYPE	SPECIFICATION
Single Hung Window	DH-B1-HP-40
Horizontal Slider Window	HS-B1-HP-40, HS-B2-HP-40
Sliding Glass Doors	SGD-B1-HP-40

ROOFS

Dark roofs with a solar absorptivity greater than .85 are no longer permitted (see table below).

(Approximate Values)	Absorptivity
White, smooth surface	0.25 to 0.40
Grey to dark grey	0.40 to 0.50
Green, red, and brown	0.50 to 0.70
Dark brown to blue	0.70 to 0.80
Dark blue to black	0.80 to 0.90

Mechanical

1. Heat pumps are required as the primary heat source for all electric dwellings over 1000 square feet. Resistance heat may be used only as backup. This requirement also applies to multifamily units greater than 1,000 square feet.

2. EER and COP requirements for cooling mode are as follows:

	OLD			NEW		
	SEER	EER	COP	SEER	EER	COP
(Single Phase, Split System) (Under 65,000 Btu/h)	6.5	7.0	1.99	8.5	8.0	2.28

Service Water Heating

1. Water heaters for all-electric dwellings over 1,000 square feet must be heat pump, heat recovery or solar. Resistance-type heaters may be used as backup if piped in series with the primary system. This requirement also applies to multifamily units greater than 1,000 square feet.

2. Heat loss from unfired hot water storage tanks is limited to a maximum of 7.0 Btu/h·ft^2 of external tank surface area.

3. Pipe Insulation - For recirculating systems, piping heat loss limited to a maximum of 10 Btu/h per linear foot of pipe (see table 5-8).

Glazing Shade Coefficient

All exposed fenestration facing a direction inclusive of 15° north of east, clockwise to 45° north of west, shall have a shading coefficient equal to, or less than 0.5. Only shading devices that are directly applied to the window or are attached to the external structure are acceptable. Trees are not allowed in this calculation.

Exceptions

Glazing units, including but not limited to:

a. Stained, etched, or beveled glass,
b. Window shapes other than rectangular,
c. Casement or hopper type windows,
d. Atrium, french or sliding glass doors,

may be exempted from the shade coefficient requirement, provided the total area of such units does not exceed 20% of the total glazing area subject to the above standard. Approved manufacturer's specifications must accompany the house plans when solar screens or solar film are used.

The basic changes impacting commercial construction follow the recommendations of the ASHRAE S.P. #41 and the research report. Specific areas that were changed include:

1. Envelope criteria

2. HVAC system and equipment

3. Tank and pipe insulation

4. Light power and controls

Principal changes to the envelope section of the code involved deleting the overall thermal transfer value (OTTV) criteria and adding three new criteria:

1. Wall heating compliance

2. Wall cooling compliance

3. Peak cooling compliance

The new envelope criteria consider building geometry orientation, shading, insulation, lighting power, and controls. Each of the three criteria is evaluated by calculating three subcomponents that impact energy efficiency:

1. Conduction - loss/gain

2. Solar gain

3. Lighting load

The compliance values for the three required envelope criteria are calculated by using three variables:

1. Lighting and power diversity (W/ft^2)

2. Fraction of wall glazed

3. Ratio of wall to floor, ft^2

Nomagraphs are provided in the code to allow a quick graphical lookup of the compliance criteria.

New HVAC control requirements impact control of outside air and require separate control and override of individual units. Cooling equipment efficiencies were increased to the ASHRAE 90A levels for 1984. Pipe and tank insulation levels were raised and and a variety of minor control modifications were added. A new transport energy factor was added to limit distribution energy used in fans and pumps. The transport factor is based on a ratio of distribution energy to total sensible cooling loads.

The lighting code was changed by deleting the IES lumen method and replacing it with a simplified lighting power budget utilizing W/ft^2 budgets for different types of areas. The old method was too complex for most people in the construction trade and subject to abuse in interpretation of subjective items regarding lighting quality and color. The new power density standard is simple for contractors and building managers. The new standard has adjustments for room size and ceiling height. The simple procedure is particularly valuable for speculative buildings with future lease finish out because the lighting systems are typically not engineered. The new lighting requirements include a variety of controls requirements to reduce cleanup light levels and provide proper area switching.

IMPLEMENTATION AND ENFORCEMENT

Successful implementation of the new energy code was a high priority of the task force members and the city staff. Several public meetings were scheduled to inform and train contractors, architects, engineers, and developers. The public

meetings were scheduled during January to allow about ten weeks for self-education and planning. Additional training meetings were arranged through trade and professional organizations for their members. Despite the good intentions and best efforts of many individuals, a variety of problems were encountered. A partial list of problems and discussion follows:

1. Identification and correction of transcription and typographical errors.

2. Production of new energy code compliance forms for building code application.

3. Hiring and training of new inspectors.

4. Clarification and interpretation of new code requirements.

5. Unresolved conflicts with existing codes.

6. Definition of geographic area of authority.

7. Increased building plan review time. The code did not respond adequately to the spectrum of building types.

Language used in the draft document, although adequate for a technical paper, was found in several cases to be inappropriate for construction code provisions. All ambiguities had to be resolved in order to provide an enforceable ordinance. It was also determined that, in a few instances, reference charts and figures were misquoted, which led to errors in the prescribed standards. These errors likewise required correction.

The original reference standards and charts were not regionalized and thus had to be revised specifically for Austin. This was done graphically and with simple charts, so as to present as few translation problems as possible. The format for compliance forms had to be revised entirely, so as to present a procedure consistent with existing practices and to diminish the occurrence of inconsistent or erroneous data insofar as possible.

It was determined that inspectors needed an increased level of technical preparation and increased knowledge of conservation methods and systems. The professional development of building inspection staff and new procedures were needed to respond to the challenge. To this end, energy conservation was established as a separate inspection division with sole authority and responsibility in that area. In order to present consistent interpretations, it was determined that a common frame of reference and perspective was appropriate for all technical and inspection staff. Formal training was provided for key personnel in all other divisions of the department, as well as for all energy inspectors and code specialists.

Some provisions of the energy code are also considered in the local mechanical, electrical, and plumbing codes. At the time of the energy code's adoption, no effort was made to incorporate the new standards into amendments to those codes. Consequently, there exists the possibility of conflict between the provisions of the energy code and the other codes. The resolution of the inconsistencies must be done in the formal ordinance amendment process.

Although it seems logical to expect that the code should be enforceable anywhere within the city's utility service area, such is not the case. Municipalities must confine their operations to the manner and in the area prescribed by state law. In Austin's case, the energy code was adopted as a chapter of the building code and thus is presently enforceable only within the city limits.

Even with specific "cookbook" instructions for each submittal plan set, an inordinate amount of staff time must be devoted to explanation, either by telephone or appointment. This additional workload must be considered if normal plan review and inspections are to continue in a productive manner. The commercial code changes as adopted apply to all commercial structures, including such diverse building types as retail strip centers, office warehouse complexes, and converted residential structures. In many cases it seemed inappropriate to require the same depth of inquiry into a corner convenience store as a high-rise office building, which forced a disproportionate increase in developmental costs upon the small-scale builder and owner. To alleviate this disparity, a shortened version of the original required calculations was developed. Based

upon experience with the code and with local conditions, a "worst case" scenario, which included the use of standard construction systems and materials, was determined. This short form may be used for any commercial project of 3,000 square feet or smaller. This shortens the plan review and permit procedure while maintaining the standards described by the code. Inspection and review procedures must be able to respond to changing conditions in order to remain viable.

PROJECTED SAVINGS

The expected savings from the recommended changes is very difficult to define. For purposes of analysis, the previous energy code (Chapter 53, 1983 Uniform Building Code - ASHRAE 90A-1980) was used as the base case for comparison. The savings may be less due to market forces historically encouraging construction of buildings exceeding energy code requirements in some areas. The reorganization of the Inspections Office to designate specific energy inspectors is anticipated to produce a much higher level of compliance in all areas covered by the energy code.

The City of Austin Resource Management Department staff prepared preliminary analysis of potential savings for the residential changes. The recommended changes were estimated to add between $950 and $1,400 to the first cost of residential units greater than 1,000 square feet. The energy savings were calculated to pay back the additional cost in two to six years depending on the fuel source and usage patterns of the residents. Residential code changes were estimated to save 4.2 megawatts in peak electrical demand, assuming construction of 7,000 new single-family units and 7,000 new multifamily units each year.

Dr. Jerold W. Jones, P.E., a professor of mechanical engineering at the University of Texas at Austin, completed a preliminary assessment of potential savings for the commercial code changes. Dr. Jones was a member of the ASHRAE Special Project 41 and a summary of his analysis follows:

Effects of code changes were analyzed on three office buildings, a small single-story suburban branch bank, (2,500 ft^2), a medium-sized three-floor office building (50,000 ft^2) and a 38-story office tower (600,000 ft^2). The peak space cooling loads of the three buildings considered were reduced by 12% to 17%. These savings came primarily through reduction in solar gain and in the lighting load. The peak load due to conduction increased by a few percent in the small office building while it was decreased slightly in the other two buildings. The building envelope criteria in the recommendations are considerably more flexible than those of 1983 code. They were designed to allow a greater degree of design freedom and tradeoff between wall and glazing options while still providing a significant overall reduction in peak and annual loads.

The recommended code lighting criteria would reduce the power density of the installed lighting by roughly 25%. This represents a significant reduction in the peak connected electrical load. The recommendations also include lighting control criteria not previously in the code, which can reduce lighting energy use further. The inclusion of the lighting control criteria is an important feature of the recommended code.

Total energy savings range from 18% to 25%. These savings come primarily from reductions in energy required for cooling, for air moving, and for lighting. The cooling energy savings come not only from the reduction in cooling loads but also from updating the criteria for cooling equipment coefficient of performance. The Austin code was using the COP values ASHRAE recommended for 1980. It had not been updated to the 1984 levels of ASHRAE Standard 90A.

The first cost of the medium and large office buildings both decreased very slightly when specified for compliance with the recommended code as opposed to the 1983 Uniform Building Code. Estimates of the repair and maintenance costs over 25 years also decreased slightly for these two buildings. All operating cost estimates also decreased, with a significant decrease in energy costs over 25 years. In the case of the small office building, the first cost was increased by about sixty cents per square foot and repair and maintenance costs increased by approximately $2,000 over 25 years. These changes are, of course, negligible in relation to the total project costs and are quickly offset by energy costs savings. The life-cycle costs of the three projects were

considered in terms of net present value of all costs for an assumed project lifetime of 25 years. The net present value of costs was lower for the buildings built in compliance with the recommended code criteria than for the same buildings constructed in compliance with the 1983 Uniform Building Code.[2]

REFERENCES

1. "Recommendations for Energy Conservation Standards and Guidelines for New Commercial Buildings," prepared for U.S. Department of Energy by Battelle Pacific Northwest Laboratory, Richland, Washington 99352, under Contract DE-AC06-76RL01830 NTIS-PR-360.

2. "Comparison of the Recommendations of the Building Code Task Force Commercial Subcommittee with the 1983 Edition Code for Energy Conservation in New Construction," prepared by Jerold W. Jones, P.E., May 29, 1984.