"Implementation of Building Energy Standards in New York State"

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1. INTRODUCTION

The fourth largest energy user among the states, New York requires more petroleum products than does any other state. New York depends upon oil for 66% of its energy needs compared to 46% for the whole nation. New York produces little of its own energy, and is dependent on out of state sources for over 92% of its energy needs, 40% of which must be met by foreign imports.

As New York residents are too well aware, their costs for energy are among the highest in the nation. Residents of the metropolitan New York City area pay more than twice the national average for their electricity. High electric costs affect not only lifestyle, but the ability of industry and commerce to operate economically in New York State.

Many solutions to the State's energy needs are being explored; however, the common drawback is that most alternatives are not available today. There is no question that energy conservation will be the least expensive and environmentally safest energy supply alternative available to New York. Conservation will also tend to create economic benefits in the State by reducing the outflow of capital to out of state energy sources.

In 1976 the New York State Legislature established the State Energy Office (SEO) with a prime policy objective of encouraging and promoting energy conservation. As a part of this effort, SEO was charged with the responsibility for development and implementation of the State's Energy Conservation plan (which had been originally mandated by the Federal Energy Policy and Conservation Act of 1975). The New York State Plan, which was approved by the Department of Energy in August 1977, contains 21 major program elements ranging from a ban on gas pilot lights to energy conservation practices for agriculture.

Participation by New York homeowners and businessmen in many of the program measures is entirely voluntary. For this Plan to be successful, however, not all of the energy savings could be achieved soley through voluntary and educational programs; several mandatory programs were thus included. These programs were designed both to be cost-effective for individual energy users and to result in substantial energy savings. The New York State Plan contains the following 5 mandatory program measures:

1. Implementation of Right-turn-on-red.
2. Development of vanpooling program in a major city.
3. Establishment of energy efficiency in state and local government.
4. Development of lighting efficiency standards for existing public buildings.
5. Development of thermal efficiency standards for new and renovated buildings.

The SEO incorporated the construction related aspects of the lighting and thermal efficiency

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standards into one program element, the Energy Conservation Construction Code.

In order for the SEO to promulgate the Energy Code, it was necessary to secure passage of State legislation which would grant SEO this authority. Legislation had been passed in 1974 which directed the State Building Code Council to develop an Energy Code. However, neither the funds for this development nor the authority to promulgate the Code were provided. This legislative mandate was thus never fulfilled.

In 1977 legislation was again passed, this time with the support of the newly formed Energy Office. This legislation now directed the Energy Office to develop and promulgate an Energy Code no less stringent than ASHRAE 90-75. However, due to the desire of the State ligislature for oversight of such regulatory activity, a provision was included in the statute which required that any proposed amendment to the Energy Code be presented to the legislature for its consideration. In the opinion of the Governor, this provision caused the legislation to be an unconstitutional conflict between the legislative and executive branches of state government. The Governor consequently vetoed the bill.

In 1978, after much work to satisfy the concerns of both the legislative and executive branches, an amended bill was passed by the legislature, signed by the Governor, and became chapter 397 of the New York State Laws of 1978. This law required that the Energy Office develop and promulgate a State Energy Conservation Construction Code equal to the Standard ASHRAE 90-75 dated August 11, 1975, provided, however, that any portion of the Code applicable to residential construction be equivalant to the requirements set forth in the existing "Public Service Commission Insulation Standards". (PSC Opinion 76-16 (c)). As discussed in subsequent sections of this paper, the combination of these two requirements posed some problems during development of the Energy Code.

The law further required that the Energy Code apply to all buildings for which application for a building permit was made and plans filed in New York State on or after January 1, 1979. In addition to new buildings, the Code was required to cover additions and alterations and renovations of existing buildings.

2. DEVELOPMENT OF THE NEW YORK ENERGY CODE

During development of the Energy Code, it was necessary to adhere to the several legislated requirements described in the preceding section of this paper. In addition to being equivalent to the original Standard ASHRAE 90-75, the Energy Code had to incorporate the New York State Public Service Commission Residential Insulation Standards which had been based on the HUD Minimum Property Standards. For commercial buildings, there had been no previous mandatory energy standards in New York State; consequently, the New York Energy Code requirements for commercial buildings were simply modeled on the corresponding standards of ASHRAE 90-75. The inclusion of the Residential Insulation Standards resulted in requirements for residential windows and basement walls that are more stringent than specified in ASHRAE 90-75, and set restrictions on the U-value trade-off procedure for residential buildings.

The writing of the Energy Code, however, involved much more than simply integrating two sets of technical standards. Several non-technical and legal considerations inherent in the development and implementation of mandatory building standards had to be addressed. Perhaps the most important and complex legal aspect considered was how the Energy Code was to be enforced and administered.

New York State has had a state specific Building Construction Code for many years. Administration and enforcement functions related to this Code have been the responsibility of the municipalities of the State; these responsibilities, however, have been carried out only by those municipalities who have specifically adopted the Building Code by local ordinance. The above-mentioned Public Service Commission Residential Insulation Standards had been administered by the electric utilities of New York State through a self-certification program.

To effect a procedure for consistent enforcement of building regulations, the Energy Code was written to provide for enforcement by the municipalities utilizing the same procedures followed by them for enforcement of the Building Construction Code. The intention quite clearly was to integrate Energy Code enforcement activities into the general plan review and site inspection procedures previously established for enforcement of the Building Code.

Although most urban and suburban communities with any significant building activity have adopted the Building Construction Code (or have adopted similar local building codes) and have established building departments, there are many small communities across New York State that have not adopted mandatory building regulations. Quite naturally, such communities who have not adopted a Building Code generally have no enforcement mechanism in place by which they may enforce the Energy Code. As was described in the preceding section of this paper, unlike the Building Code, the Energy Code is not a voluntary standard; rather, it is a State law mandatory throughout the entire State. The State Energy Office therefore faced the difficulty of developing an effective Energy Code enforcement mechanism for those communities having no building department.

To fill this gap, the State Energy Office proposed, in action separate from writing the Energy Code itself, that the investor-owned electric utilities of New York State continue their enforcement responsibilities for the residential insulation standards now contained in the Energy Code in those municipalities which did not have a Building Code. Because of the involvement of the electric utilities in the enforcement of the previous Public Service Commission residential insulation standards, it was felt that their enforcement of the Energy Code residential insultation standards would be a continuation of ongoing activities. The Public Service Commission did in fact order the utilities to continue to enforce the residential insultation standards contained in the Energy Code in municipalities with no building departments, but to cease their enforcement activities in those municipalities whose building departments were now enforcing the Energy Code. This enforcement activity by the utilities will remain in effect until the end of the year 1980. The issue of Energy Code enforcement beyond the year 1980 in those communities not having building departments remains yet to be fully resolved.

The New York Energy Code was written to provide designers with three alternate means of demonstrating compliance, each of differing complexity. In addition to the component performance and systems analysis methods contained in ASHRAE 90-75, a method was provided to demonstrate compliance by adherence to specified acceptable practice criteria.

The intent of the acceptable practice method was to enable a designer to show Energy Code compliance with a minimum of complex calculation. For small single family residential construction (less than 1500 square feet) in particular, builders could easily document Energy Code compliance without having to utilize the services of a licensed professional. (New York State law currently requires the stamp of a licensed professional architect or engineer, for all new construction of 1500 square feet or greater.) For small residential construction, compliance by the acceptable practice method can be demonstrated by meeting prescriptive insulation standards for the envelope and by meeting the ASHRAE-based mechanical equipment requirements.

To facilitate the use of the prescriptive insulation standards of the acceptable practice compliance alternative, the section was written to include diagrams of typical wall and ceiling/roof assemblies with U-values listed for common levels of insulation. Complicated U-value and heat loss calculations are thus generally not necessary for showing Energy Code compliance under this particular method.

The component performance method of compliance for the New York Energy Code is similar to the corresponding section of the standard ASHRAE 90-75. A number of additional provisions were included, however, to satisfy State legislative requirements, and to provide economically feasible energy standards for elements of new building construction not covered by ASHRAE 90-75. Specifically for residential construction, the Energy Code restricts the use of decreased glazing percentages as a basis for increasing U-values in other building components, and requires without exception that residential window conduction U-values be equal to or less than $U_g = .69$ when tested with a 15 mph exterior wind velocity. Additionally, above-grade basement walls have a separate insulation standard of $U_W = .08$, and below-grade basement walls must be insulated from grade-level down to 24 inches below grade to the same R-value standard that applies in ASHRAE 90-75 to unheated slab edges. As a means of reducing excessive infiltration, the Energy Code also requires that residential fireplace units be limited to an infiltration loss of 20 cfm through either the use of a rated flue damper or installation of non-combustible fireplace doors. For non-residential construction, the Energy Code lighting power budget section contains an alternate to the standard IES lumen calculation procedure. This alternate simplified calculation procedure utilizes unit power densities for various space use categories.

The systems analysis method of compliance for the Energy Code is also quite similar to the corresponding section of the standard ASHRAE 90-75. Provision is made for the incorporation of non-depletable energy sources into a building energy budget; however, no more than fifty percent of the energy to be derived from a non-depletable source may be used to offset fossil fuel energy requirements. Since the actual versus design performance of any non-depletable system is dependent upon both installation practice and micro-climate conditions, the fifty percent limitation on energy consumption offset serves to minimize unreasonable reliance upon alternate energy sources for achieving the building's overall energy needs. As the technology of deriving energy from non-depletable sources evolves and improves, the limitation may be adjusted.

An aspect of Energy Code development which required particular sensitivity was in its application to building renovations and additions. In the State of New York, renovation work comprises a substantial portion of the construction market; thus, standards for building renovation have the potential to significantly upgrade the energy efficiency of the existing building inventory. The Energy Code requires compliance whenever the heating and/or cooling requirements of the building are increased, which means that in general, the building elements being altered shall comply with the Energy Code. The Energy Code also generally requires that new mechanical equipment installed in an existing building meet the corresponding standards for equipment installed in new construction. The application of the Code to additions provides that there be no requirements that the unaltered portion of an existing building be brought into compliance; however, any addition itself must meet the Energy Code.

Since the stringency of the envelope requirements of the Energy Code is dependent upon the number of heating degree days, an inherent part of the energy design process is the selection and utilization of appropriate climatic data. In order to standardize the use of climatic data, the Energy Code includes a county-by-county compilation of degree day and outdoor design temperature data. This outdoor climatic data included in the Energy Code is to be used for building envelope design unless authoritative documentation is provided by a designer in regard to specific local micro-conditions.

The Energy Code also provides some flexibility in the selection of indoor design temperatures for special types of construction (such as greenhouses and commercial warehouses), and contains provisions for relaxing the building envelope standards when the indoor heating design temperature is reduced; such a procedure maintains cost effective insulation standards over a wide range of buildings uses and functions. To minimize abuse of this particular design temperature flexibility feature, designers must document at the same time of selecting lower design temperatures that HVAC system capacities are no greater than necessary to maintain the proposed design temperature.

The standardization of information required in application for a building permit continues to be a major aspect of our technical assistance activities. The Energy Code itself contains a brief general description of information requirements, and a more recently published energy information checklist provides a detailed list covering virtually every aspect of the Code. As would be expected, the published information requirements include the U-value data for the various components of the building envelope, and the mechanical equipment and lighting power budget aspects of building design.

The procedure for Energy Code compliance has been established as the following: plans and specifications are to prescribe that equipment and/or materials will meet applicable Energy Code standards; then at the time of construction, documentation for the actual installed equipment must be made available to the building official. For small residential construction, the selection of specific manufacturers and model numbers for mechanical equipment is rarely part of the design phase; therefore, several aspects of Energy Code documentation can be completed only by field inspection of equipment at the time and place of installation. Field documentation is typically required for space heating/cooling equipment, water heaters, windows, and doors; recommended procedures and guidelines for the inspection and acceptance of each category of equipment have undergone continuing refinement, and still consume a significant portion of our Energy Code activities.

No special requirements for labeling of mechanical equipment were included in the New York Energy Code. Since the manufacture of equipment is generally an interstate commerce, it was intended that standard methods of providing information be utilized. As an example, no special "New York State" labels are required on residential windows; product specifications containing the testing results for infiltration and U-value data are sufficient to demonstrate compliance. One very important requirement, however, is that information describing the thermal performance for a product be provided by an independent testing laboratory.

3. ENERGY CODE EDUCATIONAL ACTIVITIES

The entire program of developing the Energy Code and putting it into place was carried out within the period of one year. During this time, perhaps the most challenging problem to the Energy Office was that of effectively communicating to the construction community that an Energy Code was to become effective on January 1, 1979. Not only were designers, builders and building officials to be affected by the new standards, but contractors and materials and equipment suppliers would also have to make adjustments. Notification of virtually the entire construction community in New York State was thus necessary.

The notification process included public media announcements and direct mailings to membership lists provided by construction trade groups and professional societies. A small but significant proportion of the construction community, however, does not maintain an active involvement with their colleagues, thus compounding the difficulty of establishing general awareness of the Energy Code. Many engineers and architects have been lax in maintaining an active knowledge of public issues which will affect their professions, and builders and manufacturers are experiencing increased difficulties in keeping up with the ever greater complexity of regulations governing their business.

Subsequent to the September 1978 promulgation of the Energy Code, a time period of three months was available for actual training programs before it was to actually take effect on January 1, 1979. A total of 22 one-day seminars were held across New York State, with an approximate attendance of over thirty-five hundred designers, builders, building officials and others. Due to the technical nature of the principles of energy conservation in building design, only a brief introduction to the Energy Code was possible in that many basic subjects had to be discussed before the specific Energy Code requirements could be presented. Quite generally, neither was it possible to cover each aspect of the Energy Code, nor was it possible to give more than just a brief presentation of any particular item. The primary accomplishment of the introductory seminars could therefore be only that of generating an awareness of the technical features and enforcement mechanism associated with the Energy Code.

4. ENERGY CODE TECHNICAL ASSISTANCE PROGRAM

An intensive Energy Code technical assistance program was started immediately following the effective date of January 1, 1979. The Energy Code technical staff established an ongoing program of presentations before trade groups and professional societies to provide active assistance to the building industry. Additionally, responding to telephone and written inquiries required the establishment of procedures by which technical staff provide advisory interpretations of the provisions of the Energy Code.

During the first two months of implementation, there were many difficulties encountered by designers and building officials as the first sets of plans designed under the Energy Code were submitted for review. The most common problems concerned heat loss calculation procedures and standardization of energy information. Quite naturally, the approval of building permit applications slowed somewhat during this period. Increased building permit activity during subsequent months, however, has generally offset the initial slowdown.

The Energy Code technical staff has received quite a large volume of inquiries from individual members of the construction community. For the benefit of the entire building industry, answers to the most frequent general questions were compiled in an Advisory Bulletin and distributed to the Energy Code computerized mailing list of almost ten thousand people (which includes all Code recipients and seminars). Additionally, the Training Manual which had been used at the early seminars was revised to provide introductory training to people who have had little prior contact with the Energy Code.

Current and future activities include the writing of an Energy Code workbook for single family homes, monitoring of and preparation for future federally mandated requirements such as the Building Energy Performance Standards (BEPS), workshops on specific topics such as lighting or windows, and the development of amendments to clarify and refine the Energy Code standards.

5. STANDARDIZATION OF PROCEDURES AND TEST METHODS FOR ENERGY CODE COMPLIANCE

In determining Energy Code compliance for a particular building element, a designer or building official must be aware of not only the criteria which must be met, but also of the methods which will be used to measure these criteria. Implementation of an ASHRAE-based Energy Code has therefore necessitated the adoption of standardized envelope heat loss calculation procedures and specific mechanical equipment efficiency test methods.

In the calculation of building envelope heat loss, the ASHRAE outdoor design temperatures have often been misunderstood. The 97 1/2% winter and 2 1/2% summer temperatures are often confused with actual climate extrema. A common error by designers is that of using actual temperature extrema for heat loss calculations and including traditionally excessive capacity factors; such a procedure usually results in the selection of significantly over-sized HVAC equipment. Although the New York Energy Code does not specifically regulate the sizing of such equipment, designers and builders almost universally express an initial misunderstanding of outdoor design temperatures when learning the fundamentals of energy design. A substantial portion of Energy Code training activities have been devoted, therefore, to the proper use of temperature data.

During the first few months of implementation, the Energy Code technical staff observed among designers and building officials a need for standardizing additional technical aspects of heat loss calculation such as envelope framing and cavity area percentages, thermal transmission data of construction materials and surface air film coefficients. For wood framed structures in particular, the selected stud and joist area percentages affect very sensitively the overall U-value calculations; different sets of air film coefficients are associated with the different building envelope components; and the selection of construction material thermal transmission data will also affect the result of a U-value calculation. Consequently, much of the published Energy Code literature has been directed at energy design calculation procedures, and sample design problems have been developed to illustrate on a step-by-step basis the proper calculation procedure for building envelope heat loss.

The documentation of thermal performance data for construction materials and mechanical equipment often proves to be a complicated task. As described previously in this paper, the Energy Code contains performance standards for windows and doors, water heaters, residential fireplaces, and space heating/cooling equipment. The original standard ASHRAE 90-75 was limited in its specification of standard laboratory test methods for several of these building elements. In order to provide for uniform enforcement, the Energy Code technical staff has therefore recommended a number of test procedures; specific examples are presented here.

The thermal testing of windows and doors has been an especially significant concern of the Energy Code program. The present ASTM C236 test method prescribes the test apparatus for thermal testing, but does not specify the environmental conditions under which thermal transmission values are to be measured. As is widely known, the U-value for a window or door tested at 0 mph will increase considerably when a 15 mph exterior wind velocity is applied. The question of whether such exterior wind velocity should be applied as a standard test procedure has not yet been resolved, however, on a national basis. During the initial period of Energy Code implementation, it was observed that window manufacturers would often present laboratory data derived from 0 mph wind velocity test conditions which implied compliance for certain window types (non-thermally broken metal frames) that would not normally have been found acceptable under 15 mph wind velocity test conditions. In order to eliminate disparities in the enforcement of residential window standards, to maintain equivalency of the $U_g = .69$ requirements for the various window construction types, and to maintain consistency with the standard ASHRAE 15 mph winter condition, the Energy Code technical staff has determined that thermal conduction data should be based upon 15 mph test conditions. The expectation remains, however, that such a policy will eventually be adopted on a national basis.

Although the enforcement of standards for separate domestic water heaters has been relatively effective, the establishment of an enforcement program for combination service water heating/ space heating boilers has been difficult. Not only has it been necessary to implement among designers and building officials a standard system for determining appropriate climatic data and probable maximum demand factors, but it has been necessary to depend upon equipment standby loss data provided by the boiler manufacturers themselves. Such a standard, where equipment efficiency requirements are site specific, and where equipment performances are not measured independently, has been difficult to enforce at the State level. It is understood, however, that the U.S. Department of Energy is seeking to establish a standard program of efficiency requirements for such equipment.

One of the most difficult HVAC standards to enforce is the seventy-five percent combustion efficiency requirement for gas and oil-fired heating equipment. Trade association directories commonly list nominal efficiency ratings (such as 75% or 80%); specific boiler efficiency data can only be obtained from the individual manufacturers, and have not been readily available. Only after the upcoming Federal Trade Commission appliance labeling program is implemented (thus mandating efficiency labels on each piece of equipment) will such HVAC standards be more enforceable.

As a final example of test procedures that have been adopted and developed for use in the enforcement of the Energy Code, the infiltration requirements and associated testing methods for residential fireplace units should be described. It is widely known that fireplaces are major sources of infiltration heat loss, and that net energy gains are rarely achieved when such units are in operation. Fireplaces were not addressed in the original standard ASHRAE 90-75, and apparently have never been regulated by any national energy standards implemented to this date. Consequently, the inclusion of a 20 cfm flue damper infiltration requirement in the Energy Code necessitated the establishment of test conditions for measuring such infiltration. Specifically, it is now required that flue dampers achieve such 20 cfm infiltration rating at the same 25 mph equivalent pressure differential that is used for window infiltration testing.

6. RECOMMENDATIONS FOR FUTURE ENERGY STANDARDS

Based upon a survey of the design community in New York State, most building designs utilize either the Component Performance or Acceptable Practice methods for showing compliance with the Energy Code. Because basic economic considerations today necessitate the use of thermally efficient designs, even passive solar design buildings are generally able to comply with these two methods.

As a means of simplifying the design and documentation procedure for buildings, it is recommended that the criteria for design by Acceptable Practice be expanded to include a wider range of typical building types. It has been the observation of the Energy Code technical staff that the availability of such a compliance method not requiring complex calculation has served to minimize the cost and complexity of design for small buildings. Particularly for residential buildings small enough to be legally designed without the services of a licensed professional designer, it is also now possible for Energy Code compliance to be documented by a builder or contractor himself.

It is further recommended that future standardized procedures for mechanical equipment testing be incorporated into the ASHRAE energy conservation standards for building design. Specifically for the categories of windows and heating equipment, the establishment of standardized procedures for determining Energy Code compliance will become increasingly important in the near future, both as equipment standards become more stringent and as economic considerations warrant the selection of more efficient equipment.

Energy conservation standards should also be developed for common elements of building design which have not yet been addressed. As an example, a national standard for fireplace infiltration similar to that contained in the New York Energy Code would be both economically justifiable and practically feasible.

An increasingly important type of construction in New York is that of building renovation. As described earlier in this paper, the present New York Energy Code addresses this particular type of activity; the stringency and general nature of the Energy Code renovation requirements, however, will undergo refinement as economic conditions change and as further experience is gained in the overall enforcement of the Energy Code standards. Because of recent developments in the price and availability of energy, the present seems especially opportune for the development of a comprehensive energy conservation standard for renovation projects. The implementation of such a comprehensive renovation standard would assist in the further upgrading of existing building stock.

A recent survey of designers in the state has shown that a computerized energy analysis is very rarely utilized. Prohibitive costs and procedural complexity have limited this type of analysis almost entirely to very large commercial buildings. The Systems Analysis method has been used, nevertheless, for several commerical greenhouses, wherein the incorporation of solar heat gain into the energy usage analysis has been necessary to show compliance with the Energy Code.

The subject of non-depletable energy analysis is very new and has been the cause of numerous inquiries from both designers and building officials. Consequently, the need has arisen for standard guidelines for utilizing the concepts of solar heat gain and thermal mass. In order to provide more uniform use and enforcement of the Systems Analysis method, the Energy Code staff has begun to compile information concerning available solar radiation and other micro-climate data for different regions across New York State, and to suggest methods for calculating average daily solar input through walls and roofs.

It is the observation of the New York Energy Code technical staff, however, that basic design and documentation guidelines for the Systems Analysis method should be developed by such organizations as ASHRAE and the U.S. Department of Energy, rather than at the State level. A large volume of applicable information is contained in the ASHRAE handbooks, but must be diligently searched because of the overall detail and complexity of the handbooks themselves. Additionally, the U.S. Department of Energy has been developing standardized computer programs for building energy analysis; the financial cost of using such computer programs, however, generally limits their usefulness to large size buildings. At the present time, then, there is a strong need among designers and building officials for simply being able to incorporate basic solar principles into the design and Energy Code documentation of small buildings.

In summary, we have found that the less complex the Energy Code's requirements are, the more likely that these requirements will be enforced. We believe that to the extent we can continue to clarify, strengthen and refine the specific requirements, our ultimate goal of building energy conservation will be best served. Additionally, our experience with the Energy Code indicates that it would be difficult to promulgate any building standards mandating a more complex analysis of a building's energy performance; such analysis is well beyond the experience of all but the most sophisticated members of the building industry.

SESSION VI QUESTION AND/OR COMMENT

Blancett

a. Gerald E. Warren, Ideal Basic Industries

Q: Why do you place the emphasis upon the envelop and ignore the mechanical equipment? A/C equipment with EER's of nine (9) or better certainly save more energy than insulating the opaque walls on a retrofit. This can be done very simply.

A: The scope of the development of this rating system was limited to components of the house thermal envelope. This was done so that all energy related variables would be weather dependent. It is recognized that there are many other energy conserving opportunities available to the homeowner or builder including the mechanical heating and cooling system. A point is made in the paper that the rating technique is designed to analyze the relative impact of competing envelope retrofit opportunities.

Ercules

a. A. Castrillo Canda, INCE-MOPU

Q: Interested to receive full information on data for economical evaluation decision in envelope's choice.

A: Input data for the proposed method depend on the particular case being examined, but they always lead to the definition of four functions:

1) C_i: cost to increase the insulation of a unit surface to the lowest admissible limit.

2) C_e: fuel savings when the insulation of a unit surface is increased to the lowest admissible limit.

3) f(R): envelope insulation distribution. It is a function showing the relation between the existing surface area and the corresponding thermal resistance for a retrofit problem. It is a function indicating the probability for a unit of surface of given resistance being built for new construction case.

4) U: utility function. Utility is what the decision maker wishes to maximize. It is a function of total net savings and of other factors, according to the decision maker preferance.

In Appendix B calculations for a particular case are carried out. We made the following assumptions:

-Function 1 is defined as:

$$C_i = (L_i.(1-R)+C_o)\cdot D$$

Where:

C_o is the installation cost,

D is the depreciation factor,

L_i is the cost for a unity increase of insulation resistance,

1-R is the increase in insulation resistance.

-Function 2 is defined as:

$$C_e = \frac{C}{R} \cdot \frac{1-R}{1} \cdot L_e$$

Where:

$\frac{C}{R}$ represents annual fuel consumption for a unit surface, evaluated for the situation preceding the enforcement of the resistance lower limit,

C is a constant taking into account climatic conditions, interior temperature, and combustion efficiency; it has been evaluated by the degree-day method,

$\frac{1-R}{1}$ represents the percentage decrease of thermal flow through the envelope.

L_e is the energy unit cost.

-Function 3 is assumed to be a Gamma-1 function, having the average and the most likely occurance equal to the values that can be bound in the Italian situation.

-Function 4 is defined to take net savings and comfort into account.

The random variable P is defined as L_e/L_i; we know the value it assumes today, but we do not know how it will vary in the future.

All the assumptions listed above can be varied, according to the decision maker's preferances and the particular situation being examined; only the basic structure of the method remains unchanged.

Petersen

a. George Barney, Portland Cement Association

Q: What assumptions were made in the economic analysis with regard to energy cost increases and length of time (payback period).

A: The purpose of the paper is to provide a methodoligy which can be used to find the economically optimal insulation resistance for any set of assumptions regarding these variables. In the example solution, a thirty-year life for the insulation is assumed, with gas and oil price increases averaging 10% per year and electricity price increases averaging 7% per year over 30 years.

b. Thomas E. Niswonder, Applegate Insulation Systems

Q: Was the use of cellulose loose fill insulation considered in the insulation of brick and block wall construction? This insulating method is much less costly than the application of mineral wool or rigid foam insulation, in that it may fairly easily be blown into the cavity?

A: The use of loose-fill hydroscopic insulation materials such as cellulose in a brick and block cavity wall should be avoided because of the possibility of rain penetration through the brick wall.

c. M.W. Dizonfeld, U.S. Department HUD

Q: What is the basis for using $HDD55^o$ (heating degree days calculated at base 55^oF) rather than the conventional HDD_{65^o} and how can one be converted to the other:

A: The HDD_{55^0} base was used because it is better correlated with the reduction in annual heating requirements due to the wall insulation examined in this study than HDD_{65^0}. Thus, HDD_{55^0} is a better predictor of energy savings than the higher base, especially in coastal areas. However, the most appropriate HDD base depends on a number of factors (e.g., the thermal integrity of the building envelope, internal and solar heat gains, and thermostat settings) so that no one HDD base can be considered generally correct for all applications. There is no simple conversion formula from one degree day base to the other. Instead, NOAA climate data (Degree Days to Selected Bases, no date) or the HDD_{55^0} map shown can be used.

Albrecht & Jones

a. Steve McCarney, Office of Energy Conservation

Q: What percentage of commercial buildings utilize each of the two compliance options for lighting requirements?

A: No survey has yet been made; our general observation, however, is that the two lighting budget options receive approximately equal usage.

Miller

a. Steve McCarney, Colorado Office of Energy Conservation

Q: What percentage of the commercial building designs in your state use the Systems Analysis approach in lieu of the more prescriptive approach?

A: No response

b. W.H. Snyder, Johns-Manville Corporation

Q: The oral presentation included a remark by the author that he frequently observed fiber glass batts which were labeled simply 3-1/2" with no R value stated. I question the validity of this statement (particularly if it is to be included in the written paper). At least five (5) years ago, the fiber glass industry adopted R-value labeling for all their building insulation. Several alternatives are possible: 1) some very old inventory was used on some jobs. 2) the products were not intended for building insulation, and 3) the material wasn't fiber glass. If any of these are alternatives that are really the case, then the original statement is not justified.

A: No response