Passing with a "D" Is Failure—Flexibility of the Model Energy Code in Building Design: New Mexico Experience

K.E. Scheuch, P.E.
Member **ASHRAE**

R.D. Busch, Ph.D., P.E.
Member **ASHRAE**

ABSTRACT

The Model Energy Code (MEC) is the basis of energy codes in over 40 states. In 1988, the state of New Mexico adopted the 1986 edition of the MEC to supersede previous versions and contracted with the authors to revise the New Mexico Energy Conservation Code Applications Manual. This revision included translating the code into specific design parameters for both residential and commercial buildings. Unfortunately, deficiencies in the MEC exist; including lack of tabulated insulation values for walls, roof/ceilings, etc. for major locations within each state and provision for discrete, commercially available insulation values, as well as procedural details for the performance of the insulation. Simply meeting the prescriptive requirements of the code often results in the adherence to the letter but neither the spirit nor intent of the code. In other words, these buildings pass the legal test of energy efficiency, but with only a "D."

INTRODUCTION

In 1977, as part of a program to encourage energy conservation, the state of New Mexico adopted Appendix Chapter 53 of the Uniform Building Code (UBC). The state realized that adoption of a new code requirement by itself would not save energy, so it developed an applications manual and carried out training workshops in support of the program prior to its implementation. The program was a success.

In 1986, New Mexico adopted the 1985 edition of the UBC, which included the 1983 edition of the Model Energy Code (MEC). The 1986 edition of the MEC automatically superseded the 1983 edition and became part of the New Mexico Building Code (excluding Sections 505 and 605 covering lighting) in 1988.

Karl E. Scheuch, P.E. is Vice President of Bovay/McGinty, Inc., Albuquerque, New Mexico. Robert D. Busch, P.E., Ph.D., is the director of the Nuclear Engineering Laboratory at the University of New Mexico, Albuquerque, New Mexico.

In the spring of 1988, the New Mexico Energy, Minerals, and Natural Resources Department issued a contract to Bovay Engineers, Inc. (now Bovay/McGinty, Inc.) for updating of the New Mexico Energy Conservation Applications Manual and training on its use. The source of the funding was oil overcharge monies distributed to the state of New Mexico. Specifically, the goal of the project was to update the existing applications manual and conduct training in various locations for code officials, architects, engineers, and contractors.

The old applications manual contained information on both residential and commercial building applications but was oriented toward the residential builder. The authors decided to split the new manual into a commercial building manual and a residential building manual to simplify the use of the code and to allow each manual to specifically address those items unique to each type of construction.

As a result of the authors' experiences in developing and complying with state energy codes, a number of changes to the applications manual were included in the update. These were intended to facilitate compliance and clarify applications of the Model Energy Code specific to its implementation in New Mexico.

Specific improvements included:

-- Development of graphic tables detailing typical wall and roof sections and associated U-values (see Figure 1).

-- Development of tabular data for particular New Mexico locations in lieu of the nondiscrete graphs in the MEC.

-- Development of the New Mexico climate zones to avoid the need for interpolation.

-- Development of a table showing maximum allowable skylight area for various locations.

-- Development of trade-off forms for analysis of allowable trade-offs, e.g., wall vs. roof insulation.

-- Development of a code verification checklist to show code compliance.

The second phase dealt with conducting training sessions in two New Mexico locations. Each training session was geared toward a specific audience. Those for the code officials dealt with the requirements of the MEC as adopted in New Mexico, while those for the contractors, builders, architects, and engineers spent more time on compliance issues. The overall goal of the training sessions was to explain the changes in the new code, to demonstrate the application of the code for specific examples in specific climate zones, to introduce the compliance checklist, and to encourage use of the code.

MISAPPLICATIONS OF THE CODE

In our review of code compliance examples, several misapplications came to light, which guided our development of the manuals. One specific example, which illustrates a number of issues, was an energy code analysis on a new school in western New Mexico.

The first error occurred when the architect selected the incorrect value of heating degree-days (HDD). The architect used a HDD value of 4300, which does not apply to any of the towns in the vicinity. The actual value is 6500, while the value for the nearest town is 6200 HDD. In many cases the code official is local and well acquainted with the region's climatic conditions, however, as in this case, the review was done at the state level since the project did not fall within a local code jurisdiction. Without a climate zone map or listing of heating degree-days for specific towns, it was difficult for code officials to spot such an error. The authors attempted to reduce the use of inappropriate HDD values by developing specific New Mexico climate zones and associated tables of values for towns and zones (see Figure 2). This helps the user by providing specific data values for a large number of locations. We also developed a map, which can be used to identify the closest HDD location to the proposed building site.

A second error occurred when the architect traded off wall insulation for slab-on-grade floor insulation - a trade-off excluded by Section 502.1.1 of the 1986 Edition of the Model

Energy Code. To solve this problem, the authors provided examples within the applications manual that specifically addressed the issue of trade-offs among building components. In addition, a series of compliance checklists and forms were provided for the users with instruction as to what trade-offs were allowed.

However well the authors did in developing solutions to potential problems, in developing an easy-to-use applications manual, or in conducting training for potential users, problems still remain in the Model Energy Code that need to be addressed directly by the national code community.

PROBLEMS INHERENT WITHIN THE FRAMEWORK OF THE MODEL ENERGY CODE

Passing With a D

The first problem the authors encountered was the easy acceptance by both the code officials and the building design community of buildings that just barely complied with the MEC. In the course of developing examples for the applications manuals, the authors found that a residence with 13% of the floor area as glazing and a minimum wall surface area just barely complied in a 6200 HDD climate. However, if the design was altered to include substantially more wall surface area (e.g., addition of a number of corners and cutbacks), the design easily complied. In either case, there was a minimal amount of wall insulation and a significant area of north-facing glazing (e.g., to allow for a view of the mountains). Both structures complied; both would probably create significant discomfort for occupants sitting near the north glass in the winter; and, most importantly, neither structure was particularly energy efficient.

The problem arises primarily due to a lack of education in the difference between the philosophy of an energy code and that of a health and safety code. If a structure meets a health and safety code, then it is deemed safe - there are no levels of more safe or safest. However, with an energy code, compliance usually means the bare minimum of energy-conserving options. There probably are a number of economical approaches and options that can be added to a complying structure to make it more energy efficient. Thus, compliance really is not sufficient if we are searching for energy efficiency.

Compliance with the energy code is analogous to passing a test in school with a D; you passed, but it is nothing to shout about. Unfortunately, in the energy game grades are not given; it's only a matter of pass/fail. This problem may be traced back to the question of prescriptive vs. performance standards. Prescriptive standards detail the specific features of the design, for example, R-11 batt insulation in a 2 by 4 cavity wall. In contrast, performance standards establish performance requirements either in energy use per year or through the assignment of "points," where points are related to energy dollars saved through the installation of particular energy-saving measures. The advantage of the performance method is that the customer can identify the grade or the energy efficiency of the structure, while the advantage of the prescriptive method is that the builder can quickly determine compliance and then label any complying house as "energy efficient."

Foundations Are Not a Strong Part of the Code

Because heat transfer to the ground has been difficult to model and not easy to characterize in a prescriptive format, insulation requirements for foundations have lagged behind those of other components. As of the 1988 amendments to the MEC, there are no requirements for insulation or thermal performance on basement walls or floors if these enclose unconditioned spaces. If the space is conditioned, walls have to meet the same requirements as exterior walls and floors must be insulated to R-12 in most areas of the country. This is an obvious problem where there are no adequate construction details for R-12 insulation below a slab, basement floor. These requirements may be energy conservative, but without details for installation, much of the energy savings opportunity may be negated by poor detailing during construction.

A similar problem arises with slab insulation; the MEC is fairly specific as to the amount but leaves the details up to the builder. Problems with installation include:

1. If the insulation is placed on the outside of the stem wall, there may be problems with damage before finished grading and stucco or face brick application (for example, see Figure 3A).

2. If the insulation is placed between the slab and stem wall, there may not be adequate width for anchoring the sole plate or carpet strips (see Figure 3B).

3. Although the code requires a depth of 24 in. below grade, in many areas the footing depth requirement is much less. This either requires a major change in traditional construction practice or leaves 6 in. of insulation dangling in the ground, where it is unlikely to last beyond the fill and compaction, if the contractor is even willing to overexcavate.

Another problem arises with a new construction type - that of post-tensioned slabs. Normally, the contractor wants to pour the entire slab at once, including the garage and patio, so that post-tensioning is done for one unit. Therefore, any slab insulation cannot occur at the building thermal barrier. Code precludes trade-offs of slab insulation with anything else so code officials are faced with a dilemma - either allow the contractor to build without the insulation or create an artificial trade-off and require thicker slab insulation or additional wall insulation.

<u>Other Residential Problems Which Appear To Be Here To Stay</u>

The code requirements are driven by heating, not cooling. This creates significant problems in lower latitude areas with minimal heating, e.g., Arizona, Florida, South Texas. The code may require insulation levels in walls and/or roof/ceilings that actually keep in more internal heat and aggravate the cooling problem. Somehow the prescriptive requirements need to address this issue in cooling-dominated climates.

<u>Commercial Problems</u>

The same problem with respect to the code controlling heating, not cooling, load exists in commercial buildings; however, this problem is not restricted to hot climates. In cooler climates, heat loss through the envelope is advantageous for buildings with high internal loads. The code is not based on humidity or on internal heat generation, and this allows designs that are not energy efficient. Although there is the beginning of an understanding of these parameters with the overall thermal transfer value (OTTV) calculation, the major contributors to internal heat generation, and therefore cooling energy use, are not dealt with directly. (Even though the electrical power requirements for lighting are covered in Sections 505 and 605, the requirements deal with lighting levels and not the resultant cooling load.)

The lighting requirements called for in Sections 505 and 605 were deleted from New Mexico's implementation based on protests from the lighting community as being too difficult and time consuming to demonstrate compliance, and the feeling that "you can't legislate good lighting design." While we agree that no standard is a guarantee of good design, we suggest that some definitive guidelines on a watt/ft^2 basis would certainly give the designer targets to strive for and are good indicators of energy-efficient lighting levels.

Why do we care about these problems? Certainly the builder/designer can choose the systems analysis approach (performance-based calculation) to comply unusual buildings or those that are energy efficient. However, this takes time and money. The reality is that most will take the path of least resistance, complying prescriptively - creating a building that is not energy efficient but does comply. It is another case of passing with a D but failing to make the building energy efficient.

<u>RECOMMENDATIONS</u>

We have identified a number of problems or issues with the current Model Energy Code. This does not mean that the MEC is useless. On the contrary, it has been the major force in identifying energy as an issue of concern to the building community. Just by doing compliance, builders, designers, and others are made aware of where energy uses occur and some techniques for reducing these are identified. Our purpose with this presentation is to provide some suggestions on how to strengthen the code without increasing the time required for its application. Clearly, the goal of any code should be ease of implementation.

The problems identified seem to come from two sources: a lack of clarity in code requirements and a lack of comprehensiveness in scope. The lack of clarity issues can be easily solved by the implementing jurisdictions. When the MEC is adopted by a local jurisdiction, there needs to be some additional work done to create an "applications" manual for that area. Too often jurisdictions just adopt the code and leave it to those in the field to interpret it. This leads to neglect of many of the code requirements. By providing a few pages of clarification, the jurisdiction could solve many of the gray areas by:

1. Providing for discrete values of insulation that are commercially available, for example, prescriptive levels should be R-5 or R-11 or R-13, not an R-4.7 or R-16.

2. Providing figures with U-values for typical, local construction components, e.g., R-11 wall, R-30 ceiling, joist ceiling with R-19, etc.

3. Tabulating values for walls, roof/ceilings, floors, etc., for major locations within each jurisdiction (state). This eliminates errors/discrepancies when trying to read from a graph and ends arguments as to what the HDD for a particular location is. Providing climate zone maps for extension beyond major cities.

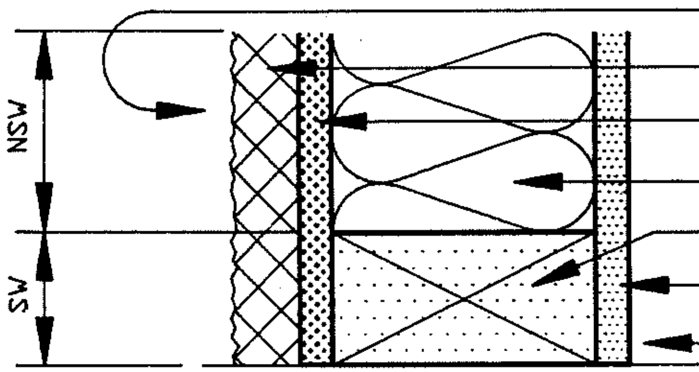
4. Defining a compliance checklist. This could be copied and put on sticky-back so that compliance can be easily verified from plans and becomes part of the record drawings.

A few pages of clarification generated at the time of implementation of the code will increase the number of users who correctly comply with its requirements. Unfortunately, this will not increase the passing grade from a D to anything higher. It is certainly a substantial step forward to increase the rate of compliance but, as we found in New Mexico, education and training are also required to promote better, energy-efficient design. The jurisdiction, or a group of jurisdictions, needs to create seminars or training sessions which educate designers and indicates to them that compliance often means passing with a D, but that it is not the path to optimum energy efficiency. Energy efficiency begins with an understanding of how the particular structure uses energy and then is implemented through a design that effectively responds to climatic, functional, and economic constraints.

The second part of the solution involves a serious look at some of the deficiencies within the code. This has to be addressed at the national level. Besides providing requirements for basements and new foundation types, there needs to be an addendum of construction details which indicates the better ways of installing the insulation. Only with the details can we be assured that the installation provides for the energy efficiency that was expected when the code was created. We also need to investigate how to integrate additional parameters that have a significant impact on energy use. Somehow we need to take into account internal load effects, the writing of simple guidelines regarding lighting, and the impact of humidity on cooling energy use. We are of the opinion that the major impact of the code is getting these issues before the building community. The prescriptive requirements don't need to be that stringent initially, but they do need to be explicitly stated so the designers become aware of the effect of other parameters on energy use.

The bottom line is one of education and clarity. If the requirements are clear and precise, then compliance becomes less time-consuming, and there is a higher percentage of those complying. Because energy efficiency is a complex issue, simple, prescriptive guidelines don't address all the problems, but they are a first step in the education process. After the first step, education must extend beyond the focus of an energy code. We are all aware that you cannot legislate good design, but you can provide the background and intuitive understanding of the processes which allow the designers to create energy-efficient structures without limiting their design flexibility. Only in this way can we convince designers that compliance alone is not energy efficient, and that passing with a D is failure in the attempt to conserve energy.

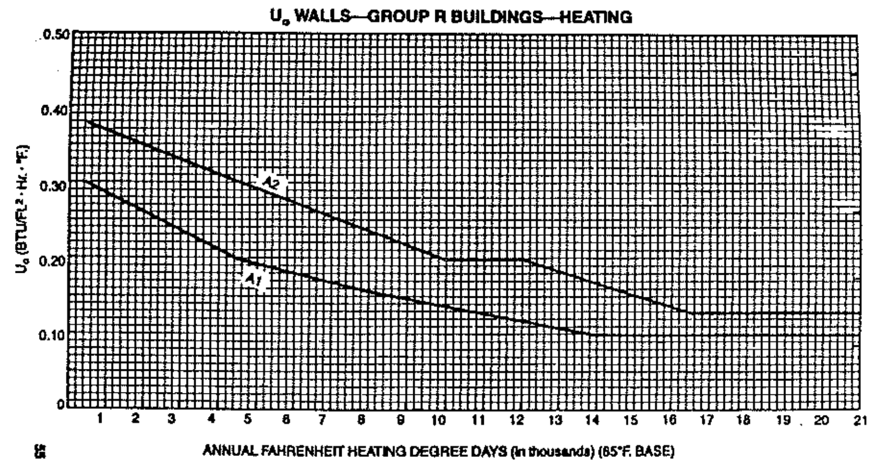
R-11 STUCCO WALL



NO STUD SECTION (NSW) (85%)	R-VALUES	STUD SECTION (SW) (15%)
0.17	OUTSIDE AIR FILM	0.17
0.20	1" STUCCO	0.20
1.38	1/2" ASPHALT SHEATHING & PAPER	1.38
11	INSULATION	-
-	2 X 4 16 O.C.	4.38
0.45	1/2" DRYWALL	0.45
0.68	INSIDE AIR FILM	0.68
13.88	TOTAL RESISTANCE	7.26

COMPOSITE R-11 STUCCO WALL RESISTANCE 12.21

Figure 1. *Typical wall section*



FOR RESIDENTIAL BUILDINGS IN NEW MEXICO

Maximum U_0-Values Allowed By Code
and
Minimum R-Values for Slab on Grade Insulation

City	Heating Degree Days 65~F	U-Value: Walls Detached (A-1)	U-Value: Walls Other (A-2)	U-Value: Floors Unhtd. Spaces	U-Value: Roof & Ceilings	R-Value: Slabs Heated	R-Value: Slabs Unhtd.
Alamogordo	3053	0.24	0.33	0.18	0.050	4.9	3.0
Albuquerque	4332	0.20	0.30	0.09	0.050	5.9	3.8
Artesia	3366	0.23	0.32	0.16	0.050	5.1	3.2
Carlsbad	2813	0.24	0.33	0.20	0.050	4.7	2.8
Carrizozo	4234	0.21	0.31	0.10	0.050	5.8	3.8
Chama	8254	0.15	0.23	0.08	0.033	8.8	6.5
Clayton	5150	0.19	0.29	0.08	0.047	6.5	4.4
Cloudcroft	7205	0.17	0.25	0.08	0.037	8.0	5.8
Clovis	4033	0.21	0.31	0.11	0.050	5.6	3.6
Corona	5389	0.19	0.29	0.08	0.046	6.6	4.5
Cuba	7122	0.17	0.25	0.08	0.037	7.9	5.7
Deming	3347	0.23	0.32	0.16	0.050	5.1	3.2
Eagle Nest	9254	0.14	0.21	0.08	0.033	9.5	7.1

Figure 2. *Tabular presentation of MEC graphical data*

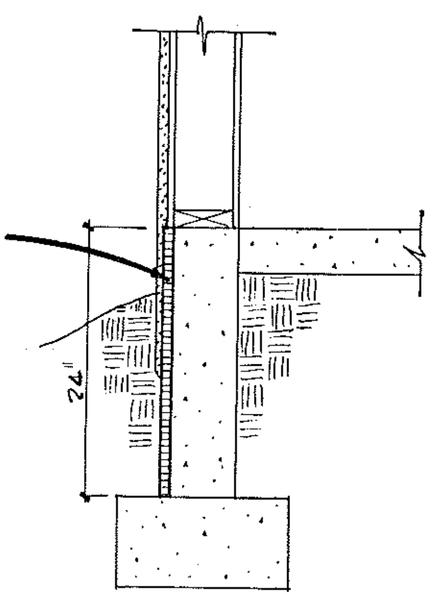


Figure 3a. *"Exterior" application of slab insulation*

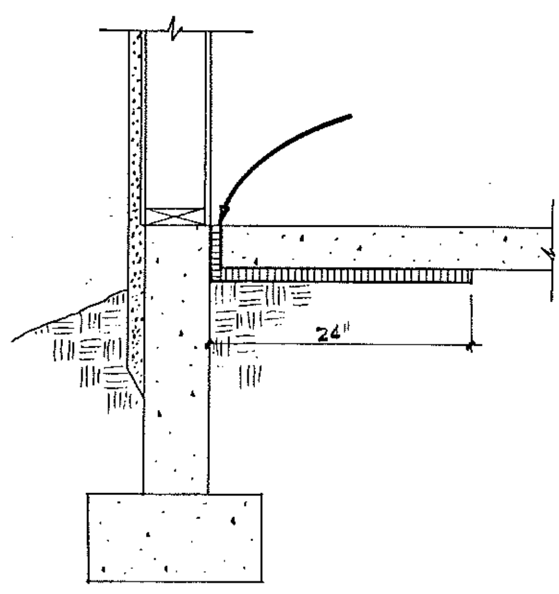


Figure 3b. *"Interior" application of slab insulation*