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THE RELATIONSHIP OF ENERGY CONSERVATION STANDARDS AND INDOOR AIR QUALITY STANDARDS

John M. Talbot, P.E.
Office of Buildings and Community Systems
Office of Conservation and Renewable Energy
U.S. Department of Energy

In recent years, energy conservation has influenced the environment provided in our buildings. Examples of energy conservation technologies that have affected our indoor air quality include: Variable Air Volume (VAV) systems, Energy Management and Control systems, general tightening of building envelopes, and the introduction of insulation materials that may change indoor pollutant concentrations. Consequently, energy conservation standards have addressed, and should continue to address, impacts on indoor air quality. This paper discusses the relationship of energy conservation and indoor air quality within the context of standards.

INTRODUCTION

Many technical papers have been presented that report on the relationship or, more often, the lack of a relationship between energy conservation practices and indoor air quality. Generally, most would agree that energy conservation practices are not the primary determinant of indoor air quality. However the goal of providing comfortable, productive, and healthful indoor environments in energy efficient buildings requires an integrated approach to building systems that takes proper account of all the factors influencing the built environment. To this end this paper discusses the policies and policy options which impact this integration of energy conservation and IAQ.

The energy conservation policies that most directly impact indoor air quality (IAQ) are those activities associated with the regulation of the energy used in buildings. An important first step in discussing such a complicated issue is to provide clear meanings of the terms and expressions used. Accordingly, the following definitions are offered for the purposes of this discussion.

A **"Measure of Merit"** is a numerical expression of performance that is reasonably quantifiable by calculation, simulation, or actual measurement. Examples can range from prescriptive type measures of R-value, or ventilation rate to more comprehensive measures of performance such as Annual Energy Consumed per Unit Floor Area. In the latter case the relative differences between specific measures of merit define the relative benefits of alternatives.

A **"Standard"** is a document that, when complied with, requires demonstration of compliance to one or more minimum measures of merit. Depending on how comprehensive the measures of merit are, the requirements are typed as either prescriptive or performance. A Standard may include methods of test or calculation procedures. A Standard also may include non-numerical expressions or requirements, e.g., " This standard requires the inclusion of a widget in compliant designs."

A **"Guideline"** is a document that can include everything a standard can, however it recommends rather than requires.

A **"Code"** is a document that implements, within a particular juristriction, the requirements of a Standard or the recommendations of a Guideline.

Notwithstanding discussions of semantics, these definitions allow one to relate the similarities and differences in the policies of IAQ and energy conservation.

ENERGY CONSERVATION STANDARDS, GUIDELINES AND MEASURES OF MERIT

Since the energy crisis of the early 1970's many different forms of energy conservation standards have evolved. In the United States, as well as many other countries, prescriptive requirements such as specified R-values and minimum steady-state efficiencies were early examples of simple measures of merit that have been used to reduce energy consumption in new buildings. Although relatively easy to implement, these simple measures of merit required vast assumptions by those developing the standards. For example, estimates had to be made as to the cost and value of the specified improvements without regard to regional variations in costs or climates. In addition, many energy intensive concepts are not included in such a simple approach, e.g., thermal mass effects, seasonal efficiencies, advanced energy management and controls systems, solar orientation effects and the interaction of equipment efficiency improvements with thermal envelope improvements. As a result, comprehensive approaches were developed based on total building energy analysis. Examples include "energy point systems" and "annual energy budget systems." The calculations associated with these latter methods have become so formidable that the recent efforts of the U.S. Department of Energy and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) have included computer software as an integral part of their latest versions of energy conservation standards for buildings. These methods not only improve the accuracy and completeness of the standard setting process, but also an added benefit is realized by the users of the method. That is, the user is now provided some latitude when complying with the standard. More specifically, the building designer is now part of the process. The standard developers establish what is cost effective energy conservation and how it should be determined. The measure of merit is decided on as well, e.g., annual energy consumption per unit floor area or equivalent energy expenditures as in a prototypical building. Code developers may add some regional specifics. The designer is left with considerable latitude in demonstrating compliance. Architectural or aesthetic considerations can be addressed by the designer. Trade-offs of excess energy efficiency of specific building components are allowed provided the minimum measure of merit is met for the entire building.

As a matter of policy, most energy conservation standards include the prescriptive methods as another method of compliance. However, notwithstanding the simplicity of the prescriptive methods, incentives exist to use the performance methods, namely reduced cost and/or improved function.

A key concept is whether there are parallels between the developments in energy conservation standards and indoor air quality standards. To consider this concept the following questions are posed:

Is it possible to develop a comprehensive measure of merit for indoor air quality?
If so, can indoor air quality be effectively addressed within energy conservation standards?

INDOOR AIR QUALITY, STANDARDS, GUIDELINES, AND MEASURES OF MERIT

To consider whether IAQ can be effectively addressed within energy conservation standards it is helpful to discuss past and current activities. In the United States, building energy conservation standards have essentially deferred the IAQ issue to the ASHRAE Standard 62 " Ventilation for Acceptable Indoor Air Quality." As a result, very little discussion of IAQ issues occurred in the ASHRAE consensus process regarding its building energy conservation standards, i.e., the Standard 90 series. Similarly, to date, the building energy conservation standards of the DOE have had little interaction with the IAQ issue. However, since the DOE process is a formal rulemaking process and not a consensus process it does provide for a more structured format to address IAQ impacts. Specifically, by federal law, an Environmental Assessment is required for any proposed rule that may impact the environment. As an example, the Environmental Assessment in support of DOE's Proposed Energy Conservation Standards for New Commercial and Multi-family Highrise Residential Buildings (1) includes an analysis of IAQ impacts of the proposed standard. This analysis reported on the attributable changes in indoor concentrations of selected pollutants (radon, organics, including formaldehyde, particulates, CO and CO_2). The attributable changes in pollutant concentrations were those that could be associated with the incremental change in building construction that would be caused by the proposed standard. By mathematically modeling ten different building types, the analysis concluded that very little or no changes in concentration of indoor pollutants could be associated with the proposed standard and consequently no adjustment or change in the standard was justified.

This conclusion should be of no surprise when one considers the following. The analysis is done <u>incrementally</u> and as such is not likely to report significant change in pollutant concentrations. In this case, the building constructions of the proposed standard were compared to the building constructions of ASHRAE Standard 90-1980. These two standards are not different enough to result in significant differences in construction. Therefore no significant change in pollutant concentration can be reported. Significant change in pollutant concentration would be necessary to attribute an adverse effect considering the large amount of uncertainty associated with health effects of long-term exposures to low concentrations. Secondly, the conclusion is not surprising considering the fact that the context of the Environmental Assessment is dominated by the environmentally positive action of saving energy. Accordingly, even if there was a finding of a possible adverse health effect, it would be difficult, on an environmental basis, to have this finding impact the standard.

This type of treatment of IAQ within the energy conservation standards is likely to continue until a more comprehensive approach or measure of merit is developed for IAQ. To assess this possibility, a look at the evolution of ASHRAE Standard 62 may provide some useful insight.

The 1973 version of ASHRAE Standard -62 was primarily a list of recommended and minimum ventilation rates for 140 different applications. These ventilation rates were developed though the consensus process and represented the best available guidance for the building design community. An important development occurred in 1975 when ASHRAE's first building energy standard recommended use of the minimum ventilation rates in Standard 62-73. This action increased the emphasis on the scientific basis of the minimum ventilation rate. I believe, this self-imposed emphasis more than anything else caused ASHRAE to rethink its role in ventilation standards. It became apparent, that although ventilation rates are simple measures of merit that can be easily understood and used, a more comprehensive treatment of the subject was needed. Consequently, the 1981 version of Standard 62 included more complete guidance regarding ventilation rates and, perhaps more importantly, a whole new procedure was added, i.e., the Air Quality Procedure. The Air Quality Procedure leaves the outdoor air flow rate unspecified but requires compliance to short term concentration limits for 4 pollutants and long term concentration limits for 7 pollutants. The 1989 revision of

ASHRAE 62 includes some increases in the minimum ventilation rates and some added opportunities for energy conservation in the Air Quality Procedure.

These developments parallel the developments in energy conservation standards in that the Air Quality Procedure represents a more comprehensive performance-based approach compared to the prescriptive approach of specifying ventilation rates. Additionally, as with energy conservation standards, Standard 62 includes both the prescriptive and performance approaches as options.

Even though Standard 62 has been revised extensively, discussions as to its completeness and adequacy continue. Of particular note is the IAQ legislation before the U.S. Congress which would, among many other things, require U.S. Environmental Protection Agency to analyze the adequacy of existing ventilation standards to protect the public from indoor contaminants.

Although concentration limits are comprehensive measures of merit for IAQ, the scientific basis for establishing these limits has not been rigorous. The appropriate scientific basis and the ideal standard have been discussed by Grimsrud and Teichman (2) (1989). In this discussion the authors describe the ideal standard as a more extensive list of concentration limits that must be met in both the prescriptive and performance methods. The concentration limits would be established based on uniform risk of exposure.

The concentration limit format would grant some latitude to the designer in that ventilation rates can be related to source strengths. This would be particularly helpful in cases where the designer has some control over source strengths. Additional latitude could be provided the designer if in the ideal standard the performance method allowed for demonstration of compliance based on computer simulation. In such a case, compliance could include a statement of source strength assumptions as part of the submitted design.

Again the parallels with energy conservation standards are obvious, i.e., the discussion of the ideal IAQ standard includes many concepts already in place in the latest energy conservation standards. Unfortunately, the information gaps are so extensive that the ideal IAQ standard is not likely in our immediate future.

CONCLUSIONS

Many parallels exist in the developments of energy conservation standards and IAQ standards, i.e., simple prescriptive methods have evolved, or are evolving, into performance methods; and simple performance methods have evolved, or could evolve, into more comprehensive performance methods including computer modeling applications.

Deliberations of IAQ issues have occurred in energy conservation standards and vice versa. To date few examples of substantive interaction can be cited. As IAQ standards include comprehensive measures of merit, more substantive interaction may be possible.

DISCLAIMER

The opinions expressed in this paper are those of the author, and do not necessarily reflect those of the U.S. Department of Energy, nor is any official endorsement to be implied.

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