The Impact of Building Codes and Regulations on Indoor Air Quality

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ABSTRACT

In the United States there is a comprehensive complex and often inconsistent system of regulations which relates to building design, construction and occupancy. These regulations, in the various States, are examined to assess the technical bases for their ventilation provisions and to determine if they permit innovation in indoor air quality technology.

INTRODUCTION

The regulations related to the construction and occupancy of the building itself are the building codes, housing codes, and, in some cases, factory-built or mobile home codes. Ventilation requirements are usually found in the mechanical code provisions. Energy conservation provisions have been added recently, and these often specify the maximum ventilation rates thought to protect health and to reduce energy consumption.

The purpose of this paper is to assess the technical bases for the ventilation provisions and to determine if they permit innovation in indoor air quality technology.

BUILDING CODE DEVELOPMENT

Historically, building regulations were created and enforced to satisfy the objectives of protecting the "health" and "safety" of the building occupants and the public in general. In recent years, a third objective, "welfare," has been added and has received increased emphasis by legislators, code officials, and others writing regulations. Furthermore, during recent years, building codes have become more and more stringent; and new provisions have been added, with very few deletions.

The Constitution of the United States delegates the authority to regulate building design and construction to the States under the provisions reserving police power to the States. In the past, with few exceptions, this authority has been exercised by political jurisdictions at the local level, mostly cities and counties. Recently, there has been a broad movement by the individual States to reclaim authority for the development and implementation of statewide building codes. There are now 35 States that have statewide building codes, in various forms, which are implemented in different ways.[1] Some States offer entirely voluntary use at the local level (Maryland and New York), while others require mandatory usage for the entire State, without amendment (Kentucky, Montana, New Jersey, and Virginia).

Over the years, several national organizations have been formed to improve both the code content and the process for building code enforcement. Three of these organizations are

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associations of building officials; and each promulgates a model building code (i.e., the Building Officials and Code Administrators International (BOCA), the Basic Building Code;[2] the Southern Building Code Congress International (SBCCI), the Standard Building Code;[3] and the International Conference of Building Officials (ICBO), the Uniform Building Code[4]). These model codes are developed and promulgated with the intent that they can be adopted in whole or in part as codes or regulations by appropriate authorities.

The three model building codes cited above are gaining in acceptance and use by State and local governments. Of the 35 States with statewide building codes, 32 are based on either the Basic, Standard, or Uniform model codes. The major cities of the United States also appear to be moving toward the adoption and use of one of the three model codes. The Association of Major City Building Officials (AMCBO), made up of the 31 cities of over 500,000 population, reports that 80 percent of these cities now use the model codes as the bases for their regulations, although many of these cities amended the model.[1] The model building codes are not uniform in format, scope, or content; however, there is a great deal of similarity in scope and technical intent.

VENTILATION AND ENERGY CONSERVATION PROVISIONS IN THE MODEL CODES

The model codes are organized on the bases of building occupancy or use, developed originally for fire safety. They cover one- and two-family residences separately from commercial, industrial and other building uses. Mobile homes are covered separately as well.

Ventilation requirements are found in the code sections on mechanical systems. As energy conservation provisions were added, often ASHRAE 62-73, "Standard for Natural and Mechanical Ventilation,"[5] was included in the energy conservation provisions, since it is a part of ASHRAE 90-75, "Energy Conservation in New Building Design."[6] ASHRAE 90-75 is the basis for the model code energy conservation provisions. Therefore, both the mechanical and energy conservation provisions were considered in this study.

Natural ventilation requirements are the only ventilation provisions covered for one- and two-family dwelling codes and mobile home codes. These natural ventilation provisions are prescriptive and specify minimum operable openings. They are originally based on the concept of openable windows when light and ventilation were covered together. Since it is presently impossible to determine the actual ventilation performance of these natural ventilation provisions, they will not be analyzed.

The Basic Model Code, while not specifically referencing ASHRAE 62-73, publishes tables of the minimum ventilation air in cubic feet per minute per human occupant (cfm/person) for various classifications of spaces, which are identical to those in ASHRAE 62-73. In addition, a recirculation option of up to 67 percent is given, provided the recirculated air meets the outdoor air standards of ASHRAE 62-73. No air treatment provisions are included. It also allows 85 percent recirculation, with "effective absorption or filtering equipment" provided the outdoor standards of ASHRAE 62-73 are met. The 5 cfm/person minimum is used, as in ASHRAE 62-73. For practical purposes, the Basic Model Code is equivalent to ASHRAE 62-73 except for allowing the 67 percent recirculation without air treatment. This option, if used, would result in higher indoor levels of internally generated contaminants than ASHRAE 62-73.

The Standard Model Code is not specific on ventilation requirements other than natural ventilation. However, the energy provisions do specify ASHRAE 62-73 as the maximum ventilation rates allowable.

The Uniform Model Code ventilation provisions are summarized below for various use categories or groups. The category definitions are abbreviated, and are for example only.

Group A - assembly category; Group B - 50 persons or less, educational and commercial; Group E - more than 50 persons, educational; and Group H - Storage

- minimum 5 cfm/person, minimum 15 cfm/person total circulation rate (presumably for mixing)
- toilets - minimum of 4 air changes per hour
- natural ventilation openings - 1/10 of floor area, minimum

Group I - Nurseries, Nursing Homes, etc.

- minimum 5 cfm/person, minimum 15 cfm/person total circulation rate (presumably for mixing)
- toilets - minimum of 4 air changes per hour
- natural ventilation openings - 1/20 of floor area, minimum.

Group R - Hotels, Apartment Buildings

- 2 air changes per hour minimum, 1/5 or more of which shall be outdoor air (assuming 100 ft^2/person, outdoor air minimum is approximately 5 cfm/person)
- natural ventilation openings - 1/20 of floor area, minimum.

If these minimums were applied in practice, the Uniform Model Code would result in significantly higher levels of indoor contamination than ASHRAE 62-73. The energy provisions do specify ASHRAE 62-73 as maximum ventilation rates permissible, however.

The National Conference of States on Building Codes and Standards (NCSBCS) with the model code organizations, BOCA, SBCCI, and ICBO, have produced a Model Energy Code[7] which is based upon ASHRAE 90-75, including the ASHRAE 62-73 provisions. This has been the basis of the energy provisions in the model codes. The Basic Model Code, however, does not include ventilation in its energy provisions. Several States base their energy codes on the NCSBCS Model Energy Code.

No reference to ASHRAE 62-1981, "Ventilation for Acceptable Air Quality,"[8] was found in the model codes. ASHRAE 62-1981 is the current standard which replaces 62-73.

VENTILATION PROVISIONS ADOPTED BY THE STATES

Ventilation provisions adopted by the various States, and in some cases municipalities, become the regulatory requirements for buildings in those jurisdictions. Their adoption of ventilation requirements varies. Some adopt one of the model codes without change. Others modify the model codes. Still others write their own codes, but usually base them on some model or other reference document. Some have no code provisions concerning ventilation.

In all cases, of course, larger amounts of ventilation are permitted under the ventilation provisions, if a building designer so chooses. However, the energy conservation provisions generally do not permit larger ventilation rates.

Table 1[9] summarizes the 1982 status of the 50 States concerning their adopted ventilation and energy conservation provisions for new construction. Table 1 shows that 26 States have adopted, with or without modification, one of the model codes incorporating mechanical code provisions. Nine States have written their own codes, some of which are similar in content to ASHRAE 62-73. Only 15 States have no mechanical code provisions.

Energy conservation provisions for new buildings, using or modifying one of the model codes, have been adopted by 27 States. It has not been determined how many include or reference 62-73, but probably many do. Eighteen States have written their own energy codes. ASHRAE 90-75 was the basis for most, if not all, of these. Only 5 States have no energy conservation codes.

No States have adapted ASHRAE Standard 62-1981 as of this study. In 1980, ASHRAE approved a revision of ASHRAE Standard 90-75, section 1-9, and reissued it as ASHRAE 90A-1980.[10] No States have as yet adapted it in their codes. Since code revisions are a legal process requiring considerable time, it is expected that provisions of both ASHRAE Standards 62-1981 and 90A-1980 will be incorporated in many future code revisions.

CONCLUSIONS

From the brief and incomplete study made here the following conclusions are made:

1. ASHRAE 62-1981 is not yet incorporated in the codes examined.

2. In the codes, minimum ventilation rates in most cases are consistent with ASHRAE 62-73. In some cases the ASHRAE 62-73 minimum rates are specified, and in some the recommended rates of ASHRAE 62-73 are codified as the minimums.

3. The Uniform Model Code permits 5 cfm/person minimum, and therefore its application in practice permits higher levels of indoor air contamination for internally generated pollutants than ASHRAE 62-73.

4. The Basic Model Code 67 percent recirculation option would also permit higher indoor contamination levels than ASHRAE 62-73.

5. Prescriptive rates are specified, and therefore innovative systems which can demonstrate acceptable performance with lower ventilation rates would not be allowed without specific approval of the cognizant bodies, except in the case of the Uniform Model Code.

6. If future research indicates higher rates are necessary for improved indoor air quality, these higher rates would require jurisdictions to change their codes in order to be enforced.

7. Current codes would impede innovations in indoor air quality technologies only if such innovations make possible the use of lower quantities of outdoor air than specified in the codes.

8. The conflicting requirements of energy provisions and indoor air quality are apparent in the codes.

REFERENCES

1. Formulation and Administration of Regulations for Buildings, James G. Gross, ASCE Workshop on Civil Engineering Productivity, St. Louis, MO., September 26-28, 1983.

2. Basic Building Code, Building Officials and Code Administrators International, 1981.

   Basic Mechanical Code, Building Officials and Code Administrators International, 1981.

3. Standard Building Code, Southern Building Code Congress International, Inc., 1980-81 Revision.

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4. Uniform Building Code, International Conference of Building Officials, 1982.
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5. Standards for Natural and Mechanical Ventilation, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard 62-73, 1973.

6. Energy Conservation in New Building Design, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard 90-75, 1975.

7. Model Energy Code, Council of American Building Officials, 1983.

8. Ventilation for Acceptable Air Quality, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard 62-1981.

9. 1982 Directory of State Building Codes and Regulations, National Conference of States on Building Codes and Standards, September 1982.

10. Energy Conservation in New Building Design, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard 90A-1980.

Table 1

State Code Comparisons[9]

State	Population Ranking 1980	Mechanical Code (usually includes ventilation)	Energy in New Buildings (may include ventilation)
Alabama	22	SBCCI	ASHRAE 90-75
Alaska	50	-	-
Arizona	29	-	State provisions
Arkansas	33	State provisions	NCSBCS energy code
California	1	ICBO with changes	State provisions
Colorado	28	IBCO with change	State provisions
Connecticut	25	BOCA	ASHRAE 90-75
Delaware	47	NFPA 90	NCSBCS energy code
Florida	7	-	State provisions
Georgia	13	State provisions	NCSBCS with changes
Hawaii	39	-	ASHRAE 90-75
Idaho	41	ICBO	NCSBCS with changes
Illinois	5	-	State provisions
Indiana	12	ICBO with changes	State provisions
Iowa	27	ICBO with changes	NCSBCS with changes
Kansas	32	ICBO	-
Kentucky	23	BOCA	NCSBCS energy code
Louisiana	19	NFPA fire code	-
Maine	38	NFPA 31	State provisions
Maryland	18	BOCA	NCSBCS energy code
Massachusetts	11	BOCA	State provisions
Michigan	8	BOCA with changes	ASHARE 90-75 with changes
Minnesota	21	State provisions	State provisions
Mississippi	31	SBCCI	NCSBCS energy code
Missouri	15	-	-
Montana	44	ICBO with changes	NCSBCS with changes
Nebraska	35	-	State provisions
Nevada	43	ICBO with changes	State provisions
New Hampshire	42	-	ASHRAE 90-75 with changes
New Jersey	9	-	NCSBCS energy code
New Mexico	37	State provisions	NCSBCS energy code
New York	2	State provisions	State provisions
North Carolina	10	State provisions	State provisions
North Dakota	46	-	NCSBCS energy code
Ohio	6	State Provisions	NCSBCS energy code
Oklahama	26	-	NCSBCS energy code
Oregon	30	ICBO with changes	State provisions
Pennsylvania	4	-	State provisions
Rhode Island	40	BOCA with changes	NCSBCS with change
South Carolina	24	SBCCI	State provisions
South Dakota	45	-	State provisions
Tennessee	17	SBCCI	NCSBCS energy code
Texas	3	State provisions	ASHRAE 90-75 with changes
Utah	36	ICBO	NCSBCS with changes
Vermont	48	NFPA	ASHRAE 90-75 (public blgs only)
Virginia	14	BOCA with changes	NCSBCS with changes
Washington	20	ICBO	NCSBCS with changes
West Virginia	34	-	-
Wisconsin	16	State provisions	State provisions
Wyoming	49	-	NCSBCS energy code