Seventh Canadian Masonry Symposium
McMaster University
Hamilton, Ontario
June 4-7, 1995

MASONRY PROVISIONS FOR ENERGY EFFICIENCY IN ASHRAE/IES STANDARD 90.1

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ABSTRACT

This paper reviews the impact of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and Illuminating Engineering Society (IES) energy efficiency standard on new, non-residential, masonry buildings. Standard 90.1 represents an advance in the comprehensiveness of energy standards. For example, the standard includes a separate set of compliance criteria for buildings which have thermal storage capacity, such as concrete and masonry. Although this capacity, often referred to as thermal mass, has long been recognized, it has traditionally been difficult to quantify for the purposes of energy code compliance.

INTRODUCTION

ASHRAE/IES Standard 90.1-1989, *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings*, is widely referenced in the United States for energy code compliance. This Standard is considerably more comprehensive in its requirements than previous standards, which has resulted in a significantly different format than previous energy code criteria. This paper gives an overview of the historical development of the criteria and how the criteria impact masonry buildings, particularly with respect to the thermal storage capabilities of masonry.

OVERVIEW OF STANDARD

History of Development

ASHRAE published its first energy conservation standard, Standard 90, *Energy Conservation in New Building Design* in 1975. In 1977, a model energy code for energy conservation in

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new buildings, based on Standard 90, was published by a consortium of national code bodies in the United States. Over the ensuing ten years, all fifty states enacted regulations based on Standard 90, the model energy code, or regional codes which also used the Standard as a technical base.

Several revisions have since been made to Standard 90. The most current revisions have split the original standard into two separate standards, based on building type. Standard 90.1 applies to all new buildings except low-rise residential buildings. The second standard, ASHRAE 90.2-93, *Energy Efficient Design of New Low-Rise Residential Buildings*, applies to all residential buildings three stories or less above grade.

Since its original publication in 1989, several addenda have been published. These deal with issues such as service water heating, lighting control, ventilation, R-value calculations for metal stud walls, and HVAC performance criteria. Addenda m, which is currently undergoing final approval by the Committee, adds Canadian weather data, so the Standard can be easily applied to new buildings in Canada.

In the United States, the Standard is currently referenced for compliance by the Model Energy Code, is the basis for several state energy codes, and is included in the National Energy Policy Act of 1992, which requires states to adopt an energy standard that meets or exceeds the requirements of ASHRAE/IES 90.1-1989.

Scope

Standard 90.1 provides a comprehensive set of requirements designed to promote design technologies which minimize energy consumption without constraining either the building function or the occupant comfort or productivity. The Standard contains both minimum requirements and guidance on energy efficient practices.

The Standard applies to new commercial and high-rise residential construction which is intended for human occupancy. Buildings which have very low energy use requirements due to small building size or low usage are exempt. Also exempt are manufacturing, commercial, and industrial processing facilities, such as a warehouse which may maintain a minimum level of heating or cooling to maintain the inventory, rather than for human comfort.

Standard 90.1 regulates a wide array of design-related parameters which impact energy efficiency in these buildings. Criteria is included for: the building envelope; lighting; heating, ventilating, and air-conditioning systems; distribution of energy; service water heating; and energy management. The requirements for masonry are included in the building envelope section, Chapter 8. The remainder of this paper focuses on that section.

ENHANCEMENTS IN STANDARD 90.1

The amount of energy a given building uses depends on the climate (both temperature and amount of sunshine); building type, size, and shape; component U-factors and thermal storage capacity; equipment efficiencies; lighting requirements and design; occupancy; etc. Traditionally, building envelope requirements in energy codes traded off accuracy for simplicity by mandating a maximum U-factor for exterior walls based on heating needs and building type. This is a straightforward approach which facilitates demonstrating compliance. Standards such as ASHRAE 90-75 and 90A-1980 allowed the user to account for other factors, but provided no guidance on how this should be accomplished. For example, these Standards included the following statement: "In addition to the criteria set forth in this section, the proposed design *should* consider energy conservation in determining the orientation of the building on its site; the geometric shape of the building; the building aspect ratio (ratio of length to width; the number of stories for a given floor area requirement; the thermal mass of the building;..." (ASHRAE 1975, 1980) Demonstration of the impact of these design parameters on energy efficiency was left to the user.

Standard 90.1 has moved beyond this traditional approach by incorporating the effects of a wide range of factors on building energy efficiency, producing a more comprehensive and realistic estimate of energy efficiency. The Standard accounts for cooling as well as heating, internal heat gains from lights, equipment, and occupants, window shading or coatings to reduce solar gains, window orientation, and the thermal storage capacity of building materials such as masonry. The exterior wall criteria are based on 2,898 whole building simulations of annual energy use, using hourly weather data, for various building types and climates. The resulting exterior wall load data were subjected to a multiple-stage linear regression. This analysis produced a set of equations which can be used to calculate the interactive thermal performance of the exterior walls. These equations were then used to develop energy performance criteria for the Standard. The ENVSTD computer program was developed to make the equations easier for the user to apply.

This broad-based approach recognizes that as buildings become more energy efficient, simply adding more insulation will not necessarily provide an equivalent additional energy savings. This "law of diminishing returns" is illustrated in Fig. 1. For this particular example, the addition of R-1.8 $m^2 \cdot K/W$ (10 $hr \cdot ft^2 \cdot {}^\circ F/Btu$) insulation to an uninsulated wall saves approximately 4.6 kW/m^2 (12.6 $MBtu/ft^2 \cdot yr$). Doubling the insulation to R-3.5 (20 $hr \cdot ft^2 \cdot {}^\circ F/Btu$), however, only produces an additional 0.5 kW/m^2 (1.4 $MBtu/ft^2 \cdot yr$) energy savings.

Climate

Standard 90.1 includes compliance criteria for 234 United States locations. The analysis used to develop the envelope requirements correlates building envelope energy use to both the amount of mechanical heating and cooling required to maintain comfort and to the incident solar radiation. This analysis resulted in energy requirements that are much more sensitive to climate than those of previous standards.

If the building is not located in one of the 234 cities listed in the Standard, compliance should be based on the location with a climate that is most similar to the building site. In many cases,

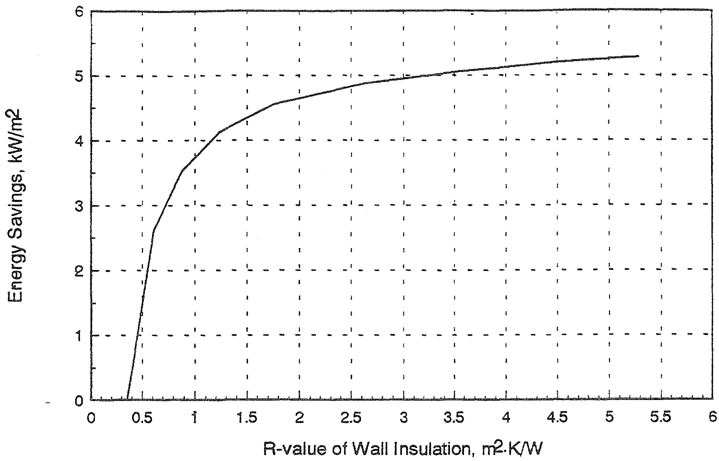

Fig. 1—Effect of Additional Insulation on Energy Savings

Notes for Figure 1: based on a three-story office building, 4521 m^2 (48,664 ft^2) gross floor area, 2004 m^2 (21,572 ft^2) opaque wall area, 569 m^2 (6130 ft^2) single glazing with a reflective coating. The performance numbers cited are based on total heating and cooling coil loads, adjusted to the relative proportions of the perimeter zone of the building. The values do not, therefore, accurately represent the zone loads for the building perimeter. Building is located in El Paso, Texas.

this will be the geographically closest location. However, in some cases, especially coastal or mountainous areas, the closest city may have a very different climate than the building site.

Thermal mass

Thermal mass describes the ability of certain materials to store heat. Because of its comparatively high density and specific heat, masonry provides very effective thermal storage. Masonry walls remain warm or cool long after the heat or air-conditioning has shut off. This, in turn, can effectively reduce heating and cooling loads, moderate indoor temperature swings, and shift heating and cooling loads to off-peak hours.

The impact of thermal mass on building energy efficiency varies with several interrelated factors. The most important of these are the local climate, the building design and occupancy, and the wall insulation position relative to the mass. Mass has the greatest impact in climates with large daily temperature fluctuations above and below the comfort point of the building. Although few climates are this ideal, thermal mass buildings will still improve the performance of the building envelope in most climates. In heating dominated climates, thermal mass can be used to effectively collect and store solar heat gains or to store heat provided by the mechanical system to allow it to operate at off-peak hours.

Building design and occupancy also impact the effectiveness of thermal mass. In commercial buildings, heating and cooling loads are greatly influenced by internal heat gains from occupants, lights, and equipment. Because exposed thermal mass can absorb intermittent internal gains, thermal mass is generally more effective in commercial buildings than in low-rise residential buildings, where loads are primarily determined by the performance of the building envelope.

Thermal mass is most effective when insulation is placed on the exterior of masonry. This insulation strategy keeps the mass directly in contact with the interior conditioned air. Integral insulation (either insulated masonry cores or an insulated masonry cavity wall) also results in excellent thermal mass benefits. Interior insulation results in some thermal mass benefit, primarily by moderating the effect of the exterior temperature swings on the buildings' interior.

The prescriptive and system performance requirements for exterior walls not only include the interaction of exterior wall thermal mass with the outdoor temperature cycles and insulation position, but also with solar heat gains, the overall building envelope heat conductance, and internal heat gains from lights, equipment, and occupants.

Determining R-values

Standard 90.1 not only includes a greater level of accuracy in setting criteria, it also requires a higher level of accuracy in determining R-values of building materials for compliance. The Standard mandates the use of certain calculation procedures to ensure thermal bridging is properly accounted for in metal stud wall, concrete masonry wall, and fenestration R-values.

COMPLIANCE OPTIONS

Criteria for the design of exterior wall systems is based on equivalent energy use. The Standard allows various designs to comply, as long as the proposed design meets or exceeds the level of energy efficiency prescribed by the Standard. Standard 90.1 provides three methods to make this comparison: the prescriptive compliance option; the system performance option; and the energy cost budget option.

Prescriptive

The first compliance option is prescriptive, which uses look-up tables containing minimum requirements for each building envelope component. The requirements vary depending on building location, building type, and amount and type of fenestration. The criteria for each envelope component (opaque wall, fenestration, roof, etc.) is determined independently of the other components. This makes compliance very straightforward, since the user simply checks that the wall and roof U-factors do not exceed the maximums, that the fenestration area falls within the allowable range, etc. However, this option also does not allow any trade-off between components. For example, the user is not permitted reduce the level of wall insulation when highly efficient windows are used.

The Standard includes 38 of these Alternate Component Package (ACP) tables, each one representing a different climate zone within the United States. Addenda m will add climate criteria for Canada to the Standard, so that the ACP tables can be used for Canadian locations. The prescriptive option is the simplest method of compliance to the Standard, but also the most restrictive, because the criteria in each ACP table is based on the most restrictive location included within that particular climate zone, and because of the lack of trade-offs between envelope components.

System Performance
The system performance compliance option requires each system (building envelope or lighting) to comply, rather than requiring each individual component within that system to meet a minimum requirement. It allows exterior wall components to be combined in various ways to meet the energy requirement, thereby increasing design flexibility. However, this option is still limited in that roof or floor performance cannot be traded off against exterior wall performance. Building envelope compliance can be demonstrated using a PC-based computer program, ENVSTD (short for envelope standard), which is supplied with the Standard. Unlike the prescriptive approach, compliance is determined based on the individual attributes of a particular building. Because the actual building parameters and the individual component interactions are accounted for, the system performance approach is not nearly as conservative as the prescriptive. Although the computer program, ENVSTD, is a straightforward spreadsheet-type program, it does add an additional level of complexity to complying with the system performance approach versus the prescriptive.

Energy Cost Budget
The third compliance path requires that the total annual energy cost to operate the proposed building be less than the annual energy cost of a budget building that meets either the prescriptive or system performance requirements. The annual energy cost of both the proposed and the budget building must be determined and compared. This analysis requires the use of more sophisticated computer programs, such as DOE-2 or BLAST, which are capable of hourly energy use predictions throughout a typical design year. These analyses allow energy trade-offs at the whole building level. For example, a reduction in energy use due to the installation of very efficient lighting could be used to offset a lower wall insulation level. The energy cost budget analysis can also be used account for dynamic interactions between various building systems. For example, these analyses can account for solar heat gain through fenestration during daylight hours; the collection and storage of that heat in interior thermal mass elements; the subsequent reduction in mechanical heating required; and the use of the daylight to reduce electrical lighting demand.

The energy cost budget method allows the maximum design flexibility, but also requires some expertise to correctly model a building using these advanced computer programs. This option was included in the Standard to encourage the development and use of advanced energy efficient technologies which are not accounted for in the prescriptive and system performance approaches, such as passive solar heating. The energy cost budget analysis will provide the most accurate and realistic measure of thermal mass effects due to masonry construction. Because the analysis is so detailed and complex, however, it is beyond the scope of this paper.

BUILDING ENVELOPE REQUIREMENTS FOR MASONRY

For building envelopes, Standard 90.1 includes a set of basic requirements, in addition to the three compliance paths described above. These requirements must be met regardless of the compliance option chosen. The basic requirements include required methods of determining R-values for wall systems, air and moisture leakage requirements, daylighting credits for skylights, and prescriptive requirements for locations with heating degree days greater than 15,000.

Determination of R-values

The Standard requires the use of thermal values determined either by test or from the ASHRAE Fundamentals Handbook, an engineering reference for building energy use. The Standard also mandates calculation procedures for various wall systems, to ensure that thermal bridging is properly accounted for in reported R-values and U-factors. When calculated, R-values for masonry walls are required to be calculated using the series-parallel (also known as the isothermal planes) method, which properly accounts for thermal bridging through the webs of concrete masonry units. This is consistent with the ASHRAE Fundamentals Handbook and with industry recommendations.

Use of ACP Tables For Compliance

The first step in determining compliance using the prescriptive path is to determine the correct ACP table to use for compliance. Appendix C in Standard 90.1 lists the ACP table that should be used for each of the 234 locations included in the Standard. Fig. 2 shows ACP table 8A-31. The locations and climate variables that this table applies to are listed at the top.

Consider a medium sized office building, located in Albany, New York, three stories, 4521 m^2 (48,664 ft^2) gross floor area, 2004 m^2 (21,572 ft^2) opaque wall area, 569 m^2 (6,130 ft^2) fenestration area, using double glazing.

The first step to using the ACP table is to determine the appropriate internal load density (ILD) range for the proposed building. This is the estimate of heat gains due to lights, equipment, and occupants. The Standard provides tables of typical values for various building types. For this medium-sized office building, the sum of the equipment and lighting power densities is 2.4. The Standard assumes a default occupant load level, which can be increased or decreased if the building occupancy varies greatly from the default. For this example, assume no adjustment is necessary. By looking down the left side of Figure 1, choose the middle range of ILD, 1.51-3.00, based on the ILD of 2.4 for the example building. Most buildings will into this middle range. The lower range (0-01.5) includes multi-family, hotels, and motels. The upper range (3.01-3.5) includes some retail stores with high lighting

HDD50 = 3201 - 4000	Albany NY	Grand Rapids MI	Sioux City IA
CDD65 = 501 - 1150	Buffalo NY	Milwaukee WI	Des Moines IA
VSEW = 560 - 845	Rochester NY	La Crosse WI	Grand Island NE
	Syracuse NY	Billings MT	Rapid City SD

FENESTRATION (Max. Pct. Fenestr.)

OPAQUE WALL (Max. Uow)

LIGHT WEIGHT WALL — MASS WALL

INTERNAL LOAD DENSITY (ILD) RANGE	PROJECTION FACTOR (PF)	SHADING COEFF RANGE (SCx)	BASE CASE Uoi 0.68 to 0.46	BASE CASE Uoi 0.45 to 0.39	BASE CASE Uoi 0.38 to 0	PERIMETER DAYLIGHTING Uoi 0.68 to 0.46	PERIMETER DAYLIGHTING Uoi 0.45 to 0	PERIMETER DAYLIGHTING Uoi 0.38 to 0 (VLT>=SCI)
0 - 1.50	0.000 - 0.249	1.000 - 0.71	22	26	28	22	27	29
		0.709 - 0.60	24	31	33	24	31	34
		0.599 - 0.50	25	34	37	25	34	38
		0.499 - 0.38	27	37	42	27	37	42
		0.379 - 0.25	29	42	48	28	41	48
		0.249 - 0.00	31	48	56	30	47	55
	0.250 - 0.499	1.000 - 0.71	26	35	38	26	35	39
		0.709 - 0.60	28	39	44	28	39	45
		0.599 - 0.50	29	42	48	29	42	48
		0.499 - 0.38	30	45	52	30	44	52
		0.379 - 0.25	32	49	57	31	47	56
	0.500 +	1.000 - 0.71	29	41	46	29	41	48
		0.709 - 0.60	31	45	52	30	44	52
		0.599 - 0.50	32	47	55	30	46	55
		0.499 - 0.38	32	50	59	31	48	57
1.51 - 3.00	0.000 - 0.249	1.000 - 0.71	20	23	24	22	27	29
		0.709 - 0.60	22	27	29	25	32	35
		0.599 - 0.50	24	31	33	26	35	39
		0.499 - 0.38	27	34	37	28	39	43
		0.379 - 0.25	30	40	45	31	44	50
		0.249 - 0.00	33	48	55	33	50	59
	0.250 - 0.499	1.000 - 0.71	25	31	33	27	36	40
		0.709 - 0.60	27	36	39	29	40	46
		0.599 - 0.50	29	39	43	30	43	50
		0.499 - 0.38	31	43	48	31	46	54
		0.379 - 0.25	33	48	55	33	50	59
	0.500 +	1.000 - 0.71	28	37	41	30	42	49
		0.709 - 0.60	31	42	47	31	45	54
		0.599 - 0.50	32	45	51	32	48	57
		0.499 - 0.38	34	49	56	33	50	60
3.01 - 3.50	0.000 - 0.249	1.000 - 0.71	18	21	21	22	27	29
		0.709 - 0.60	21	25	26	24	31	34
		0.599 - 0.50	23	28	30	26	35	39
		0.499 - 0.38	25	32	34	28	38	43
		0.379 - 0.25	28	38	41	30	43	50
		0.249 - 0.00	32	46	52	33	50	59
	0.250 - 0.499	1.000 - 0.71	23	28	30	26	35	39
		0.709 - 0.60	26	33	35	28	39	45
		0.599 - 0.50	28	36	40	30	42	50
		0.499 - 0.38	29	40	44	31	45	54
		0.379 - 0.25	32	45	52	33	49	58
	0.500 +	1.000 - 0.71	27	34	37	29	41	48
		0.709 - 0.60	29	39	43	31	45	53
		0.599 - 0.50	31	42	48	32	47	57
		0.499 - 0.38	32	46	52	33	50	60

OPAQUE WALL, ILD 0 - 1.50:

Uow (HC<5)	HC RANGE	PCT FEN	INT INS	EXT INS
0.076	HC >= 5	22	0.079	0.095
	HC >= 10	22	0.085	0.10
	HC >= 15	22	0.089	0.10
	HC >= 5	59	0.079	0.093
	HC >= 10	59	0.084	0.10
	HC >= 15	59	0.087	0.10

OPAQUE WALL, ILD 1.51 - 3.00:

Uow (HC<5)	HC RANGE	PCT FEN	INT INS	EXT INS
0.076	HC >= 5	20	0.080	0.10
	HC >= 10	20	0.087	0.11
	HC >= 15	20	0.093	0.11
	HC >= 5	60	0.079	0.093
	HC >= 10	60	0.084	0.10
	HC >= 15	60	0.087	0.10

OPAQUE WALL, ILD 3.01 - 3.50:

Uow (HC<5)	HC RANGE	PCT FEN	INT INS	EXT INS
0.076	HC >= 5	18	0.080	0.10
	HC >= 10	18	0.088	0.11
	HC >= 15	18	0.094	0.12
	HC >= 5	60	0.079	0.094
	HC >= 10	60	0.084	0.10
	HC >= 15	60	0.088	0.10

Daylight Sensing Controls

OTHER CRITERIA

	Minimum R-Value				Max Uo
WALL BELOW GRADE:	10			ROOF:	0.049
UNHEATED SLAB ON GRADE:	24"	36"	48"	WALL ADJACENT TO UNCOND SPACE:	0.12
Horizontal	18	15	11	FLOOR OVER UNCOND. SPACE:	0.044
Vertical	8	6	4		

Fig. 2—Alternate Component Package (ACP) Table

requirements. The remainder of the exterior wall requirements are determined from the middle set of tables, corresponding to this middle ILD range.

The opaque wall requirements are listed on the right side of the ACP table (the circled table in Fig. 2). Note that in Standard 90.1, unlike previous energy standards, the opaque wall requirements are separate from the fenestration requirements, rather than being averaged together to achieve an overall U-factor for the exterior wall. The U-factor required for a light (non-thermal mass) wall is 0.076 Btu/hr ft^2·°F (0.43 W/m^2·K). The required U-factor for masonry walls varies with insulation position, the heat capacity of the wall, and the percentage of fenestration area.

Our example building has 22% of the exterior wall area as fenestration. For simplicity, we'll use the criteria for 20%, although criteria for fenestration areas between 20 and 60% can be interpolated. If the opaque wall heat capacity is between 5 and 10 Btu/ft^2·°F (102 to 204 kJ/m^{2}K), the required U-factor is 0.087 Btu/hr ft^2·°F (0.49 W/m^2·K) if the wall has interior or integral insulation, 0.11 Btu/hr ft^2·°F (0.63 W/m^2·K) with exterior insulation.

Use of System Performance Compliance Path
Figure 3 shows the exterior wall input screen for the ENVSTD program, for the example building described above. Masonry exterior walls were assumed, with a heat capacity of 13 Btu/ft^2·°F (266 kJ/m^{2}K) and exterior insulation. The wall U-factor was adjusted until the wall complied with the Standard. For exterior walls, the user enters: the total wall area; area, shading coefficient, visible light transmittance and U-factor of the fenestration; projection factor, which describes shading due to roof overhangs; U-factor, heat capacity, and insulation position of the opaque wall; internal heat loads due to equipment and lights; and a daylighting factor if automatic controls for daylighting are used. These values are entered under the appropriate heading for each building wall orientation (north, northeast, etc.).

ENVSTD calculates the location-specific criteria and predicted heating and cooling coil loads for the design. The loads are compared to the criteria in the lower right side of the table, and the program determines if the proposed building passes or fails the exterior wall requirements. For the example in Fig. 3, the total load for the exterior walls is determined to be 52.876, which is lower than the criteria of 53.391, so this wall system meets the Standard 90.1 criteria.

Figure 4 is another ENVSTD run, demonstrating some of the design flexibility available with ENVSTD. In this case, the wall U-factor has been lowered to allow a larger fenestration area for the building. The fenestration area can be increased from 28.4% to 36% of the exterior wall. The limit on fenestration area using the ACP table for compliance was 20 to 24%, depending on fenestration U-factor.

Figure 5 shows the same building design, but with non-thermal mass exterior walls, rather

ASHRAE/IES Standard 90.1-1989 with proposed Addenda f & m

ENERGY EFFICIENT DESIGN OF NEW BUILDINGS
EXCEPT LOW-RISE RESIDENTIAL BUILDINGS

CITY: 4 Albany NY — BUILDING: Medium Office Building
CODE <B,C,H>: Both Heated and Cooled — DATE: Masonry walls

ENVSTD Public Review Version 2.2 - January 1993

	N	E	S	W	WEIGHTED AVERAGE	CRITERIA
WL AREA	4113	7137	4299	6023	0.284	0.300
GL AREA	1096	1950	1170	1914	WWR	WWR
SCx	0.88	0.88	0.88	0.88	0.880	0.597
PF	0.20	0.18	0.18	0.20	0.190	0.000
VLT	1	1	1	1	1.000	N/A
Uof	0.063	0.063	0.063	0.063	0.063	0.553
WALL Uo	.29	.29	.29	.29	0.290	0.080
HC	13	13	13	13	13.000	1
INS POS	1	1	1	1	N/A	N/A
EQUIP	0.75	0.75	0.75	0.75	0.750	0.750
LIGHTS	1.65	1.65	1.65	1.65	1.650	1.650
DLCF	0	0	0	0	0.000	0.000
	LOADS				-TOTAL-	
HEATING	4.904	6.856	2.994	5.260	20.015<	20.321
COOLING	5.028	10.800	6.653	10.380	32.861<	33.070
TOTAL	9.932	17.656	9.648	15.640	52.876<	53.391

********** PASSES EXTERIOR WALL TOTAL CRITERIA **********

Fig. 3—ENVSTD Run For Masonry Building

than masonry. The wall U-factor was then adjusted until compliance was achieved. In this case, the frame wall is required to have a U-factor of 0.12 Btu/hr ft^{2}°F (0.682 W/m^{2}K), compared to the mass wall required U-factor of 0.29 Btu/hr ft^{2}°F (1.65 W/m^{2}K) for the same building. Note that the cooling load (38.457) exceeds the requirement (33.070). For compliance, the heating or cooling load can exceed the criteria, as long as the total heating plus cooling complies.

Once the basic building information has been entered into ENVSTD, it is easy to incorporate design changes and re-run the program to determine the impact of that change. Because many combinations of envelope components can comply to the Standard in any given location, the designer can choose which characteristics are most important based on aesthetic, thermal, or other considerations. The other wall characteristics can then be varied until compliance is achieved. ENVSTD can also be used to evaluate the relative importance of various exterior wall characteristics in a particular location or market area.

FUTURE STANDARD 90.1 DEVELOPMENT

Like most standards processes, ASHRAE allows for continual development. The second edition of Standard 90.1 is currently being prepared for a first public review. This next edition has been developed using economic criteria, rather than the equivalent energy basis of the 1989 Standard. Rather than basing criteria for different constructions on the annual energy performance of those constructions, the next version of 90.1 will base energy requirements

ASHRAE/IES Standard 90.1-1989 with proposed Addenda f & m
ENERGY EFFICIENT DESIGN OF NEW BUILDINGS
EXCEPT LOW-RISE RESIDENTIAL BUILDINGS

CITY: 4 Albany NY BUILDING: Medium Office Building
CODE <B,C,H>: Both Heated and Cooled DATE: Masonry, inc fenestration

ENVSTD Public Review Version 2.2 - January 1993

-------	---N---NE------	E---SE------	S---SW------	W---NW-	WEIGHTED AVERAGE	CRITERIA
WL AREA	4113	7137	4299	6023	0.360	0.300
GL AREA	1481	2569	1548	2168	WWR	WWR
SCx	0.88	0.88	0.88	0.88	0.880	0.597
PF	0.20	0.18	0.18	0.20	0.189	0.000
VLT	1	1	1	1	1.000	N/A
Uof	0.063	0.063	0.063	0.063	0.063	0.553
WALL Uo	0.11	0.11	0.11	0.11	0.110	0.080
HC	13	13	13	13	13.000	1
INS POS	1	1	1	1	N/A	N/A
EQUIP	0.75	0.75	0.75	0.75	0.750	0.750
LIGHTS	1.65	1.65	1.65	1.65	1.650	1.650
DLCF	0	0	0	0	0.000	0.000
-------		L O A D S			-TOTAL-	-------
HEATING	1.744	2.661	1.299	2.579	8.283<	20.321
COOLING	6.785	15.004	9.557	13.104	44.450>	33.070
TOTAL	8.529	17.664	10.856	15.683	52.733<	53.391

********** PASSES EXTERIOR WALL TOTAL CRITERIA **********

Fig. 4—ENVSTD Run For Masonry Building With Increased Fenestration Area

ASHRAE/IES Standard 90.1-1989 with proposed Addenda f & m
ENERGY EFFICIENT DESIGN OF NEW BUILDINGS
EXCEPT LOW-RISE RESIDENTIAL BUILDINGS

CITY: 4 Albany NY BUILDING: Medium Office Building
CODE <B,C,H>: Both Heated and Cooled DATE: Frame walls

ENVSTD Public Review Version 2.2 - January 1993

-------	---N---NE------	E---SE------	S---SW------	W---NW-	WEIGHTED AVERAGE	CRITERIA
WL AREA	4113	7137	4299	6023	0.284	0.300
GL AREA	1096	1950	1170	1914	WWR	WWR
SCx	0.88	0.88	0.88	0.88	0.880	0.597
PF	0.20	0.18	0.18	0.20	0.190	0.000
VLT	1	1	1	1	1.000	N/A
Uof	0.063	0.063	0.063	0.063	0.063	0.553
WALL Uo	.12	.12	.12	.12	0.120	0.080
HC	3	3	3	3	3.000	1
INS POS	3	3	3	3	N/A	N/A
EQUIP	0.75	0.75	0.75	0.75	0.750	0.750
LIGHTS	1.65	1.65	1.65	1.65	1.650	1.650
DLCF	0	0	0	0	0.000	0.000
-------		L O A D S			-TOTAL-	-------
HEATING	2.523	3.675	1.444	2.971	10.613<	20.321
COOLING	5.866	12.504	7.942	12.145	38.457>	33.070
TOTAL	8.388	16.179	9.386	15.116	49.070<	53.391

********** PASSES EXTERIOR WALL TOTAL CRITERIA **********

Fig. 5—ENVSTD Run For Frame-Walled Building

an economic level of energy efficiency for each particular construction type. This is consistent with language in the National Energy Policy Act of 1992, which requires energy standard revisions to be technologically feasible and economically justified.

The next edition of Standard 90.1 will contain two sets of compliance criteria. The lower tier was developed to save 25% more energy than the existing Standard, while the higher, more stringent tier, is estimated to save 50% more energy than the existing requirements. It is anticipated that the lower tier will be adopted by code bodies as a minimum energy code. The more stringent tier was developed for use in incentive programs such as existing utility-sponsored programs, which encourage energy efficiency above and beyond the level of the energy code.

Requirements for masonry building envelopes are not expected to change significantly between the existing Standard and the lower tier of the next version of Standard 90.1. The ASHRAE 90.1 committee found that saving additional energy through more stringent lighting and mechanical requirements was more economically sound than through tightening the building envelope requirements.

ENVSTD is also being updated to reflect the new criteria. One additional advantage is that the next version of ENVSTD will allow building envelope component trade offs which include roofs and floors in addition to walls. This is an improvement over the current version, which allows wall component trade offs only.

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