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Recommendations for Energy Conservation Standards for New Residential Buildings

Volume 4: Description of the Testing Process

May 1989

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

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RECOMMENDATIONS FOR ENERGY CONSERVATION STANDARDS
FOR NEW RESIDENTIAL BUILDINGS

VOLUME 4: Description of the Testing Process

ASHRAE TEC SP-53

May 1989

Prepared for
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PREFACE

The Energy Conservation for New Buildings Act of 1976, as amended, 42 U.S.C Section 6831 et. seq. requires the U.S. Department of Energy to issue energy conservation standards for the design of new residential and commercial buildings. The standards will be mandatory only for the design of new federal buildings, and will serve as voluntary guidelines for the design of new non-federal buildings.

This report documents the development and testing of a set of recommendations, from the American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE) Special Projects Committee No. 53, designed to provide the technical foundation for the Congressionally-mandated energy standard for new residential buildings. The recommendations were developed over a 25-month period by a multidisciplinary project team, under the management of the U.S. Department of Energy and its prime contractor, Pacific Northwest Laboratory.

The report has been issued in four volumes that are briefly described below:

- VOLUME I - Text of the Standard contains the text of the recommendations for the residential energy conservation standard. The text contains a microcomputer program used in developing the Standard's requirements.
- VOLUME II - Automated Residential Energy Standard - User's Guide provides a description of how to use the program, suggests methods for obtaining and deriving input data, and provides the interpretation of the output.
- VOLUME III - Introduction and Background to the Standard Development Effort is a description of the Standard development process and contains the rationale for the general approach and specific criteria contained within the recommendations.
- VOLUME IV - Description of the Testing Process details how the Standard was tested and provides case studies of the possible impact of the Standard in select locations throughout the country. It is supported by a description of the assumptions and input data, and an analysis of the results.

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1.0 INTRODUCTION

Testing of the Standard recommendations was conducted in two parts. The first test examined the apparent equity and accuracy of the requirements that are generated by the procedures and data that support the Standard. The second test was performed to delineate problems that may exist with the points compliance procedure.

The scope of the tests was limited by schedule and financial considerations and intended only to uncover any substantive and obvious problems. Where errors were found that had an impact on the requirements, corrections were made. In addition, modifications were described that simplified the use, and improved the graphic quality of the Standard materials. Where time and resources allowed, these primarily cosmetic changes were implemented.

In the sections that follow, the scope of the tests, the method of analysis, the results, and the conclusions are discussed. In general, the first test indicated that the requirements generated by the Standard procedures and formulae appear to yield reasonable results, although some of the cost data provided as defaults in the Standard should be reevaluated. The second test provided experience that was useful in modifying the points compliance format, but did not uncover any procedural issues that would lead to unreasonable results.

These conclusions are based on analysis using the Automated Residential Energy Standard (ARES) computer program, developed to simplify the process of standards generation. Time and resource constraints prohibited assessing the accuracy of the ARES program in reproducing the results of the algorithms (selected or created by the SP-53 committee) that determine the Standard's requirements. These assessments were, however, made during the software development stages at Pacific Northwest Laboratory (PNL), and are documented in the project files.

2.0 TESTING THE PROCESS FOR GENERATING THE STANDARD'S REQUIREMENTS

This test sought to assess the procedures and data used in generating the Standard's requirements. The test was qualitative as opposed to quantitative. The intent was not to rigorously evaluate the numeric accuracy of the algorithms and standard development procedures. Rather the test was conducted to determine whether the requirements they generate, through running the ARES program, appear to be "reasonable" and provide regionally equitable results.

In cases where the resulting requirements were suspect, probable causes were identified and, if the required changes were minor, they were implemented. Suggested changes that were implemented prior to publication of this document are not recorded herein. None of the problems identified in this test required substantial changes to the Standard materials.

For five geographically and climatically disparate locations the ARES program was run, yielding Standard requirements for select housing types and energy types (see Appendix A). The requirements for the five locations - Fort Lauderdale, FL, South Bend, IN, Spokane, WA, Syracuse, NY and Tucson, AZ - were generated using local energy and energy conservation measure costs provided by the National Association of Home Builders National Research Center^(a) as modified by the SP-53 committee (see ECM Costs Position Paper).

Requirements were generated for the housing and energy types listed in the table below.

(a) An Economic Data Base in Support of SPC 90.2: Costs of Residential Energy, Thermal Envelope and HVAC Equipment, NAHB National Research Center, ASHRAE Research Project 494-RP, December 1986.

Summary of Test Runs Performed

Location/ Table No./Housing Type ⁽¹⁾	Equipment Type (Heating/Cooling)				
	Oil/ DX Clg.	N. Gas/ DX Clg.	LP Gas/ DX Clg.	Elec/ DX Clg.	Heat Pump
Fort Lauderdale, FL					
1a. Manufactured housing			0	0	0
1b. Single Family Detached			0	0	0
1c. Multi-Family Attached			0	0	0
South Bend, IN					
2a. Manufactured housing	0		0	0	
2b. Single Family Detached	0			0	0
Spokane, WA					
3a. Manufactured housing			0	0	0
3b. Single Family Detached				0	0
3c. Multi-Family Attached				0	0
Syracuse, NY					
4a. Single Family Detached	0	0			0
4b. Multi-Family Attached	0	0			0
Tucson, AZ					
5a. Manufactured housing		0	0		
5b. Single Family Detached		0	0		0
5c. Multi-Family Attached		0	0		0

(1) Table No. refers to the tables in Appendix A of this volume that contain the results of the computer runs.

General Observations

1. Low-E Glazing in the Basic Package - The Low-E glazing options appear to be cost-effective in most locations. This result is a reflection of the improved performance at little extra first cost. The Low-E option, in providing a more stringent energy target, places an inequitable burden on home construction where this product is not available.

The Low-E glazing option may be particularly difficult to acquire in the manufactured housing market (e.g. see results for Fort Lauderdale, FL). One possible rectifying action would be to default Low-E glazing to a "disallow" status for purposes of the optimization but, retain it as an option in the points and package compliance paths.

2. Unrealistic Glazing Options - In some instances the Triple Glazing without Thermal Breaks and the Single Glazing with Thermal Breaks may be selected in the optimization analysis for the basic package. These two options are atypical and unavailable in many housing markets. It is recommended that these options be eliminated from the Standard's materials or defaulted to a "disallow" status and not included in the optimization.
3. High Mechanical Equipment Efficiency - In a number of locations the required efficiency levels for the mechanical equipment appear high, particularly in the case of manufactured housing. These levels are expected to be the result of the assumed first costs. Further corroborating analysis is appropriate here.
4. Cross Regional Requirements - One observation that deems further analysis is inconsistent selection of ECMs across regions. For example, the single family detached housing envelope requirements are more stringent in Syracuse than South Bend, while the mechanical equipment requirements are higher in South Bend (see Oil Furnace results). Additional analysis is justified to delineate the reasons for these discontinuous results.
5. House Type Comparison - In most instances the default data yield similar requirements for single and multifamily housing and different and less stringent requirements for manufactured housing. This finding is not surprising given the somewhat higher costs to achieve stringent levels of conservation in manufactured versus site built housing and the

degradation in insulation performance due to compression in manufactured homes. This finding argues a case for providing thermal requirements that differ by housing type.

3.0 TESTING THE POINTS COMPLIANCE METHOD

An example of the use of the points compliance method was developed to test the clarity of the procedure and completeness of the descriptive material and to determine the reliability of the results for homes that differ physically from the basic prototypes used to generate the energy data base. In developing the example a number of observations were made concerning the graphic presentation and the descriptive material. The recommended modifications were implemented prior to issuance of the final version of the Text of the Standard.

Where appropriate, wording changes were made and descriptions modified to reflect terms in common usage in the building industry without sacrificing numeric accuracy nor the integrity of the language. While the test indicated that the method is complete and clear it is recommended that, prior to publication, the Points Path be subjected to a Beta type test for further refinement.

The test consisted of developing Point tables for single family detached housing in South Bend, Indiana, with Oil space heating and direct expansion cooling. (The package requirements associated with this set of conditions are provided on Table 2.b.) It was then assumed that compliance was to be demonstrated for a two-story, center hall colonial home in South Bend, Indiana, with the following physical characteristics:

Floor Area:	2504 sq. ft.	Air Infiltration:	Tight Package
Ceiling Area:	1224 sq. ft.	HVAC Efficiency	
Opaque Wall Area:	2088 sq. ft.	Heating:	AFUE 88%
Fenestration Area		Cooling:	SEER 10.0
Total:	248 sq. ft.	DHW System:	Two Panel Active
North:	50 sq. ft.		Solar
East:	120 sq. ft.		
South:	25 sq. ft.		
West:	53 sq. ft.		
Basement Type:	Unheated Basement		
Basement Floor Area:	1280 sq. ft.		

The results of the Point computation analysis are provided in Appendix B. Based on that analysis, a number of graphic and procedural revisions were made. These were implemented prior to the release of the final Text of Volume I and are not reported here. In addition, the following observations were made:

1. The procedure is generally easy to follow and, while it is a considerable departure from current compliance procedures, the added degree of design flexibility is a distinct advantage.
2. As would be anticipated, the results are particularly sensitive to certain design decisions, such as selecting the "tight" level of air infiltration, a high level of mechanical equipment efficiency and the specification of a solar domestic hot water system. While the magnitude of the points associated with these options may be in the correct proportion relative to the other options, their use could allow compliance with relatively low levels of envelope insulation.
3. In compliance the same type of space conditioning equipment must be specified for both the Design and Target homes. This procedure assures that reductions in thermal integrity cannot be made simply by assuming that the Target home has electric resistance heat and the Design home has a heat pump.

This check and balance is not possible with the domestic hot water point computation. The target for the DHW system is set by the federally mandated minimum which provides values only for electric resistance. Specification of a heat pump water heater allows a credit against space conditioning conservation measures. This issue requires further consideration in the future.

APPENDIX A
BASIC STANDARD REQUIREMENT ANALYSES FOR FIVE CITIES

APPENDIX A - BASIC STANDARD REQUIREMENT ANALYSES FOR FIVE CITIES

Table 1a. Comparison of Energy Conservation Measures for Fort Lauderdale, FL

Housing Type: Manufactured Housing

<u>Energy Conservation Measure (ECM)</u>	<u>Heating Equipment Type</u>		
	<u>L-P Gas Furnace</u>	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-11	R-11	R-11
Wall Insulation:	R- 7	R-11	R- 7
Floor Insulation			
Crawl:	R- 7	R-11	R- 7
Slab:			
Heated Basement:			
Unheated Basement:			
Fenestration			
Window Type:	Double Low-E	Double Low-E	Double Low-E
	Sun	Sun	Sun
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 78 %	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Table 1b. Comparison of Energy Conservation Measures for Fort Lauderdale, FL

Housing Type: Single Family Detached

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>L-P Gas Furnace</u>	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30	R-30
Wall Insulation:	R-11	R-11	R-11
Floor Insulation			
Crawl:	R- 0	R-11	R- 0
Slab:	R- 0	R- 0	R- 0
Heated Basement:	R- 0	R- 0	R- 0
Unheated Basement:	R- 0	R- 0	R- 0
Fenestration			
Window Type:	Double Low-E	Double Low-E	Double Low-E
	Sun	Sun	Sun
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 78 %	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Table 1c. Comparison of Energy Conservation Measures for Fort Lauderdale, FL

Housing Type: Multi-Family Attached

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>L-P Gas Furnace</u>	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-19	R-19	R-19
Wall Insulation:	R-11	R-13	R-11
Floor Insulation			
Crawl:	R- 0	R-11	R- 0
Slab:	R- 0	R- 0	R- 0
Heated Basement:	R- 0	R- 0	R- 0
Unheated Basement:	R- 0	R- 0	R- 0
Fenestration			
Window Type:	Double Low-E	Double Low-E	Double Low-E
	Sun	Sun	Sun
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 78 %	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Assumptions: Fort Lauderdale, FL

1. ECM costs and economic parameters: ARES default values.
2. Local energy costs:
 - L-P Gas (\$/gallon) - 0.788
 - Electricity (\$/KWatt-hr) - 0.083 (winter)
 - 0.088 (summer)
3. Prevalent foundation type:
 - Manufactured Housing - Crawl space
 - Single Family Detached - Crawl space
 - Multi-Family Attached - Crawl space

Table 2a. Comparison of Energy Conservation Measures for South Bend, IN

Housing Type: Manufactured Housing

Energy Conservation Measure (ECM)	Heating Equipment Type			
	<u>Oil Furnace</u>	<u>L-P Gas Furnace</u>	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-19	R-19	R-33	R-19
Wall Insulation:	R-19	R-19	R-19	R-19
Floor Insulation				
Crawl:	R-19	R-19	R-28	R-19
Slab:				
Heated Basement:				
Unheated Basement:				
Fenestration				
Window Type:	Triple w/o TB	Double Low-E	Double Low-E	Double Low-E
Max. Window Area:	12 %	12 %	12 %	12 %
Min. South Window:	8 %	8 %	8 %	8 %
Infiltration:	Average	Average	Average	Average
Equipment Efficiency				
Heating:	AFUE 85 %	AFUE 90 %	100%	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10	SEER 10

Table 2b. Comparison of Energy Conservation Measures for South Bend, IN

Housing Type: Single Family Detached

Energy Conservation Measure (ECM)	Oil Furnace	Heating Equipment Type Electric Furnace	Heat Pump
Ceiling Insulation:	R-30	R-60	R-30
Wall Insulation:	R-23	R-26	R-23
Floor Insulation			
Crawl:	R-19	R-30	R-30
Slab:	R- 5 (2 ft.)	R-10 (4 ft.)	R-10 (4 ft.)
Heated Basement:	R- 5 (4 ft.)	R-10 (4 ft.)	R- 5 (4 ft.)
Unheated Basement:	R-13	R-30	R-19
Fenestration			
Window Type:	Triple w/o TB	Triple Low-E	Triple w/o TB
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 95 %	100 %	HSPF 8.5
Cooling:	SEER 10	SEER 10	SEER 11

Assumptions: South Bend, IN

- ECM costs and economic parameters: ARES default values.
- Local energy costs:
 - Oil (\$/gallon) - 0.987
 - L-P Gas (\$/gallon) - 0.788
 - Electricity (\$/KWatt-hr) - 0.064 (winter)
 - 0.062 (summer)
- Prevalent foundation type:
 - Manufactured Housing - Crawl space
 - Single Family Detached - Unheated Basement
 - Multi-Family Attached - Unheated Basement

Table 3a. Comparison of Energy Conservation Measures for Spokane, WA

Housing Type: Manufactured Housing

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>L-P Gas Furnace</u>	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-19	R-19	R-19
Wall Insulation:	R-19	R-19	R-11
Floor Insulation			
Crawl:	R-19	R-22	R-19
Slab:			
Heated Basement:			
Unheated Basement:			
Fenestration			
Window Type:	Double Low-E	Double Low-E	Double w/o TB
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 90 %	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Table 3b. Comparison of Energy Conservation Measures for Spokane, WA

Housing Type: Single Family Detached

<u>Energy Conservation Measure (ECM)</u>	<u>Heating Equipment Type</u>	
	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30
Wall Insulation:	R-26	R-23
Floor Insulation		
Crawl:	R-30	R-13
Slab:	R-10 (4 ft.)	R- 5 (2 ft.)
Heated Basement:	R-10 (4 ft.)	R- 5 (4 ft.)
Unheated Basement:	R-30	R-13
Fenestration		
Window Type:	Double Low-E	Triple w/o TB
Max. Window Area:	12 %	12 %
Min. South Window:	0 %	0 %
Infiltration:	Average	Average
Equipment Efficiency		
Heating:	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10

Table 3c. Comparison of Energy Conservation Measures for Spokane, WA

Housing Type: Multi-Family Attached

<u>Energy Conservation Measure (ECM)</u>	<u>Heating Equipment Type</u>	
	<u>Electric Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30
Wall Insulation:	R-23	R-23
Floor Insulation		
Crawl:	R-30	R-13
Slab:	R-10 (4 ft.)	R- 5 (2 ft.)
Heated Basement:	R-10 (4 ft.)	R- 5 (4 ft.)
Unheated Basement:	R-30	R-11
Fenestration		
Window Type:	Double Low-E	Triple w/o TB
Max. Window Area:	12 %	12 %
Min. South Window:	0 %	0 %
Infiltration:	Average	Average
Equipment Efficiency		
Heating:	100 %	HSPF 7.3
Cooling:	SEER 10	SEER 10

Assumptions: Spokane, WA

1. ECM costs and economic parameters: ARES default values.
2. Local energy costs:
 - L-P Gas (\$/gallon) - 0.788
 - Electricity (\$/KWatt-hr) - 0.031 (winter)
 - 0.032 (summer)
3. Prevalent foundation type:
 - Manufactured Housing - Crawl space
 - Single Family Detached - Unheated Basement
 - Multi-Family Attached - Unheated Basement

Table 4a. Comparison of Energy Conservation Measures for Syracuse, NY

Housing Type: Single Family Detached Housing

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>Oil Furnace</u>	<u>Nat. Gas Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30	R-30
Wall Insulation:	R-26	R-23	R-26
Floor Insulation			
Crawl:	R-30	R-30	R-30
Slab:	R-10 (4 ft)	R- 5 (2 ft)	R-10 (4 ft)
Heated Basement:	R-10 (4 ft)	R- 5 (4 ft)	R-10 (4 ft)
Unheated Basement:	R-30	R-19	R-30
Fenestration			
Window Type:	Double Low-E	Triple w/o TB	Double Low-E
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 90 %	AFUE 90 %	HSPF 9.8
Cooling:	SEER 10	SEER 10	SEER 12

Table 4b. Comparison of Energy Conservation Measures for Syracuse, NY

Housing Type: Multi-Family Attached Housing

Energy Conservation Measure (ECM)	Heating Equipment Type		
	Oil Furnace	Nat. Gas Furnace	Heat Pump
Ceiling Insulation:	R-30	R-30	R-30
Wall Insulation:	R-23	R-23	R-26
Floor Insulation			
Crawl:	R-30	R-30	R-30
Slab:	R-10 (4 ft.)	R- 5 (2 ft.)	R-10 (4 ft.)
Heated Basement:	R-10 (4 ft.)	R-10 (4 ft.)	R-10 (4 ft.)
Unheated Basement:	R-30	R-13	R-30
Fenestration			
Window Type:	Double Low-E	Triple w/o TB	Double Low-E
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 80 %	AFUE 80 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Assumptions: Syracuse, NY

- ECM costs and economic parameters: ARES default values.
- Local energy costs:
 - Oil (\$/gallon) - 1.113
 - Natural Gas (\$/therm) - 0.593
 - Electricity (\$/KWatt-hr) - 0.078 (winter)
 - 0.063 (summer)
- Prevalent foundation type: Single Family Detached - Unheated Basement
Multi-Family Attached - Unheated Basement

Table 5a. Comparison of Energy Conservation Measures for Tucson, AZ

Housing Type: Manufactured Housing

<u>Energy Conservation Measure (ECM)</u>	<u>Heating Equipment Type</u>	
	<u>Nat. Gas Furnace</u>	<u>L-P Gas Furnace</u>
Ceiling Insulation:	R-19	R-19
Wall Insulation:	R-11	R-13
Floor Insulation		
Crawl:	R-19	R-19
Slab:		
Heated Basement:		
Unheated Basement:		
Fenestration		
Window Type:	Double Low-E	Double Low-E
	Sun	Sun
Max. Window Area:	12 %	12 %
Min. South Window:	0 %	0 %
Infiltration:	Average	Average
Equipment Efficiency		
Heating:	AFUE 78 %	AFUE 78 %
Cooling:	SEER 10	SEER 10

Table 5b. Comparison of Energy Conservation Measures for Tucson, AZ

Housing Type: Single Family Detached

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>Nat. Gas Furnace</u>	<u>L-P Gas Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30	R-38
Wall Insulation:	R-19	R-23	R-23
Floor Insulation			
Crawl:	R-11	R-19	R-13
Slab:	R- 0	R- 5 (2 ft.)	R- 0
Heated Basement:	R- 0	R-10 (4 ft.)	R- 5 (4 ft.)
Unheated Basement:	R- 0	R-11	R- 0
Fenestration			
Window Type:	Double Low-E	Double Low-E	Double Low-E
	Sun	Sun	Sun
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 78 %	AFUE 80 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Table 5c. Comparison of Energy Conservation Measures for Tucson, AZ

Housing Type: Multi-Family Attached

Energy Conservation Measure (ECM)	Heating Equipment Type		
	<u>Nat. Gas Furnace</u>	<u>L-P Gas Furnace</u>	<u>Heat Pump</u>
Ceiling Insulation:	R-30	R-30	R-38
Wall Insulation:	R-19	R-19	R-23
Floor Insulation			
Crawl:	R-11	R-11	R-13
Slab:	R- 0	R- 0	R- 0
Heated Basement:	R- 5 (4 ft.)	R- 5 (4 ft.)	R- 5 (4 ft.)
Unheated Basement:	R- 0	R- 0	R- 0
Fenestration			
Window Type:	Double Low-E Sun	Double Low-E Sun	Double Low-E Sun
Max. Window Area:	12 %	12 %	12 %
Min. South Window:	0 %	0 %	0 %
Infiltration:	Average	Average	Average
Equipment Efficiency			
Heating:	AFUE 78 %	AFUE 78 %	HSPF 7.3
Cooling:	SEER 10	SEER 10	SEER 10

Assumptions: Tucson, AZ

1. ECM costs and economic parameters: ARES default values.
2. Local energy costs:
 - Natural Gas (\$/therm) - 0.478
 - L-P Gas (\$/gallon) - 0.788
 - Electricity (\$/KWatt-hr) - 0.071 (winter)
 - 0.071 (summer)
3. Prevalent foundation type:
 - Manufactured Housing - Crawl space
 - Single Family Detached - Slab-on-Grade
 - Multi-Family Attached - Slab-on-Grade

APPENDIX B
SAMPLE POINTS COMPLIANCE ANALYSIS

APPENDIX B - SAMPLE POINTS COMPLIANCE ANALYSIS

This appendix contains a worked example of the point system. ARES was run for a single family detached house in South Bend, Indiana, with oil space heating and direct expansion cooling. The house was assumed to be a two story center hall home with the following characteristics:

Floor Area:	2504 sq. ft.
Ceiling Area:	1224 sq. ft.
Opaque Wall Area:	2088 sq. ft.
Fenestration Area	
Total:	248 sq. ft.
North:	50 sq. ft.
East:	120 sq. ft.
South:	25 sq. ft.
West:	53 sq. ft.
Foundation Type:	Unheated Basement
Basement Floor Area:	1280 sq. ft.

All page numbers that follow refer to Section 7 of the Text of the Standard (Volume I of this set).

ARES version 1.1

Point System (Section 7)

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Created 12/28/1987 10:01:22

Table 7.2 TARGET Ceiling Insulation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Heating Equipment Type	Multiplier	
	Heating	Cooling
Oil	51	6
Natural Gas	N/A	N/A
L. P. Gas	N/A	N/A
Electric Res.	N/A	N/A
Elec. Heat Pump	N/A	N/A

Table 7.3 DESIGN Ceiling Insulation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-11	R-19	112	13
R-19	R-30	79	9
R-30	R-38	51	6
R-38	R-49	40	5
R-49	R-60	32	4
R-60	--	27	3

Table 7.4 TARGET Wall Insulation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Heating Equipment Type	Multiplier	
	Heating	Cooling
Oil	78	5
Natural Gas	N/A	N/A
L. P. Gas	N/A	N/A
Electric Res.	N/A	N/A
Elec. Heat Pump	N/A	N/A

Table 7.5a DESIGN Frame Wall Insulation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-11	R-13	140	8
R-13	R-19	120	7
R-19	R-23	96	6
R-23	R-26	78	5
R-26	--	68	4

Table 7.5b DESIGN Mass Wall Insulation Multipliers
Medium Weight (40 to 110 lb/sf)

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

R-value		Multiplier	
At least	but less than	Heating	Cooling
R-0_Medium_Wt	R-5_Medium_Wt	422	17
R-5_Medium_Wt	R-10_Medium_Wt	199	7
R-10_Medium_Wt	R-15_Medium_Wt	118	4
R-15_Medium_Wt	R-30_Medium_Wt	84	3
R-30_Medium_Wt	--	44	1

Table 7.5c DESIGN Mass Wall Insulation Multipliers
Heavy Weight (greater than 110 lb/sf)

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

R-value		Multiplier	
At least	but less than	Heating	Cooling
-----	-----	-----	-----
R-0 Heavy_Wt	R-5 Heavy_Wt	419	14
R-5 Heavy_Wt	R-10 Heavy_Wt	197	5
R-10 Heavy_Wt	R-15 Heavy_Wt	117	2
R-15 Heavy_Wt	R-30 Heavy_Wt	83	1
R-30 Heavy_Wt	--	43	0

Table 7.5d DESIGN Solid Wood (Log) Wall Insulation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Nominal Thickness (inches)		Multiplier	
At least	but less than	Heating	Cooling
-----	-----	-----	-----
6_inch_Log	8_inch_Log	179	11
8_inch_Log	10_inch_Log	138	9
10_inch_Log	12_inch_Log	112	8
12_inch_Log	--	95	7

 Table 7.6 TARGET Floor/Foundation Insulation Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Heating Equipment Type	Slab	Heating Multiplier		
		Crawl Space	Unheated Basement	Heated Basement
Oil	N/A	N/A	27	N/A
Natural Gas	N/A	N/A	N/A	N/A
L. P. Gas	N/A	N/A	N/A	N/A
Electric Res.	N/A	N/A	N/A	N/A
Elec. Heat Pump	N/A	N/A	N/A	N/A

Heating Equipment Type	Slab	Cooling Multiplier		
		Crawl Space	Unheated Basement	Heated Basement
Oil	N/A	N/A	14	N/A
Natural Gas	N/A	N/A	N/A	N/A
L. P. Gas	N/A	N/A	N/A	N/A
Electric Res.	N/A	N/A	N/A	N/A
Elec. Heat Pump	N/A	N/A	N/A	N/A

Table 7.7a DESIGN Slab Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: Volume 4 Example

Not Included

Table 7.7b DESIGN Floor-Over-Crawlspace Insulation Multipliers

Housing Type: Single Family Detached

Jurisdiction: Volume 4 Example

Not Included

 Table 7.7c DESIGN Floor-Over-Unheated-Basement Insulation Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

R-value		Multiplier	
At least	but less than	Heating	Cooling
-----	-----	-----	-----
R-0	R-11	154	2
R-11	R-13	39	13
R-13	R-19	27	14
R-19	R-30	15	15
R-30	--	0	16

 Table 7.7d DESIGN Basement Wall Insulation Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Not Included

Table 7.8 TARGET Air Infiltration Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Heating Equipment Type	Multiplier	
	Heating	Cooling
Oil	215	9
Natural Gas	N/A	N/A
L. P. Gas	N/A	N/A
Electric Res.	N/A	N/A
Elec. Heat Pump	N/A	N/A

Table 7.9 DESIGN Air Infiltration Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Infiltration Package *	Multiplier	
	Heating	Cooling
Normal	215	9
Tight	153	6
*(see Section 5.2.5 of Standard)		

 Table 7.10 TARGET Glazing Layers and Sash Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Heating Equipment Type	Multiplier	
	Heating	Cooling
Oil	56	1
Natural Gas	N/A	N/A
L. P. Gas	N/A	N/A
Electric Res.	N/A	N/A
Elec. Heat Pump	N/A	N/A

 Table 7.11 DESIGN Glazing Layers and Sash Multipliers

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Glazing Type	Multiplier	
	Heating	Cooling
Single_w/o_TB	1673	19
Double_w/o_TB	910	10
Double_TB	690	8
Triple_TB	543	6
Single_Heat_abs	1673	19
Double_Heat_abs	910	10
Triple_Heat_abs	690	8
Double_Low-E	469	5
Triple_Low-E	367	4

 Table 7.12 TARGET Fenestration Area and Orientation Points

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Heated Floor Area (sf)	Points	
	Oil Furnace Heating	Cooling
Less than 500	30	15
500 to 750	44	22
750 to 1000	58	30
1000 to 1250	72	38
1250 to 1500	85	46
1500 to 1750	98	55
1750 to 2000	111	63
2000 to 2250	123	72
2250 to 2500	135	81
2500 to 2750	146	91
2750 to 3000	157	100
3000 to 3250	168	110
3250 to 3500	178	120
3500 to 3750	188	130
3750 to 4000	197	140
4000 to 4250	206	151
4250 to 4500	215	162
4500 to 4750	224	173
4750 to 5000	232	184
5000 to 5250	239	195
5250 to 5500	246	207
Greater than 5500	246	207

Table 7.13 DESIGN Fenestration Area and Orientation Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Orientation	Shading Coefficient					
	1.0 to 0.8		0.79 to 0.5		less than 0.5	
	Heat	Cool	Heat	Cool	Heat	Cool
North	38	18	30	14	18	9
Northeast	56	25	44	19	28	12
East	75	32	59	25	37	16
Southeast	107	30	85	24	52	15
South	139	28	110	22	68	14
Southwest	104	31	82	25	51	15
West	69	35	55	27	34	17
Northwest	53	26	42	21	26	13
Northwest	53	26	42	21	26	13

Typical Shading Coefficients:

Single_w/o_TB	1.000
Double_w/o_TB	0.880
Double_TB	0.880
Triple_TB	0.740
Single_Heat_abs	0.750
Double_Heat_abs	0.660
Triple_Heat_abs	0.560
Double_Low-E	0.710
Triple_Low-E	0.600

Table 7.14 DESIGN Overhang Multipliers

Jurisdiction: Volume 4 Example

	Overhang Ratio (L/H)			
	0.000 to 0.548	0.549 to 0.999	1.0 to 1.999	2.0 and above
Heating				

North	10	10	10	10
NorthEast	10	10	9	9
East	11	9	8	6
SouthEast	11	9	7	4
South	12	8	6	3
SouthWest	11	9	7	4
West	11	9	8	6
NorthWest	10	10	9	9
Cooling				

North	10	10	10	9
NorthEast	11	9	8	7
East	12	9	7	6
SouthEast	12	8	7	6
South	13	8	7	7
SouthWest	12	8	7	6
West	12	9	7	6
NorthWest	11	9	8	7

 Table 7.15 DESIGN Glazing Area and Orientation Points

Housing Type: Single Family Detached
 Jurisdiction: Volume 4 Example

Heating F-Factor	Heating Points	Cooling F-Factor	Cooling Points
-----	-----	-----	-----
Less than 270	28	Less than 60	6
270 to 540	56	60 to 120	12
540 to 810	86	120 to 180	19
810 to 1080	117	180 to 240	25
1080 to 1350	150	240 to 300	32
1350 to 1620	183	300 to 360	39
1620 to 1890	218	360 to 420	46
1890 to 2160	253	420 to 480	53
2160 to 2430	290	480 to 540	60
2430 to 2700	328	540 to 600	68
2700 to 2970	368	600 to 660	75
2970 to 3240	408	660 to 720	83
3240 to 3510	450	720 to 780	91
3510 to 3780	493	780 to 840	99
3780 to 4050	537	840 to 900	107
4050 to 4320	582	900 to 960	116
4320 to 4590	628	960 to 1020	124
4590 to 4860	676	1020 to 1080	133
4860 to 5130	724	1080 to 1140	142
5130 to 5400	774	1140 to 1200	151
5400 to 5670	825	1200 to 1260	160
5670 to 5940	877	1260 to 1320	169
5940 to 6210	930	1320 to 1380	179
6210 to 6480	985	1380 to 1440	188
6480 to 6750	1041	1440 to 1500	198
6750 to 7020	1097	1500 to 1560	208
7020 to 7290	1155	1560 to 1620	218
7290 to 7560	1215	1620 to 1680	228
7560 to 7830	1275	1680 to 1740	238
7830 to 8100	1336	1740 to 1800	249
8100 to 8370	1399	1800 to 1860	260
8370 to 8640	1463	1860 to 1920	270
8640 to 8910	1528	1920 to 1980	281
8910 to 9180	1594	1980 to 2040	293
Greater than 9180	1594	Greater than 2040	293

Table 7.16 TARGET and DESIGN Base Load Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

Foundation Type	Multiplier	
	Heating	Cooling
Crawl space	N/A	N/A
Unheated Basement	27	-26
Heated Basement	N/A	N/A
Slab	N/A	N/A

Table 7.17 TARGET HVAC Equipment Points

Heating Equipment Type	Heating Multiplier			Cooling Multiplier	
	Ducted	Hydronic	Baseboard	Ducted	Hydronic
Oil	77	76	N/A	60	59
Natural Gas	N/A	N/A	N/A	N/A	N/A
L. P. Gas	N/A	N/A	N/A	N/A	N/A
Electric Res.	N/A	N/A	N/A	N/A	N/A
Heat Pump	N/A	N/A	N/A	N/A	N/A

Table 7.18 TARGET and DESIGN HVAC Equipment Multipliers

Housing Type: Single Family Detached
Jurisdiction: Volume 4 Example

	Heating Equipment Type					Cooling
	Oil	Gas	LPG	Elec. Res.	Heat Pump (Heating)	DX, Heat Pump (Cooling)
Ducted	7344	N/A	N/A	N/A	N/A	598
Hydronic	7194	N/A	N/A	N/A	N/A	586
Baseboard	--	--	--	N/A	--	--

Table 7.19 TARGET Domestic Hot Water Points

Water Heating Fuel	TARGET POINTS
Oil	24553
Gas	17394
LPG	29804
Electric	34149

Table 7.20 DESIGN Domestic Hot Water Factor

Water Heating Fuel	DESIGN DHW FACTOR
Oil	12129
Gas	9462
LPG	16213
Electric	32261

Table 7.21 TARGET and DESIGN Solar Domestic Hot Water Points

Space Heating Fuel	TARGET POINTS	Active		DESIGN POINTS Integral		Thermosyphon	
		1-Panel	2-Panel	1-Panel	2-Panel	1-Panel	2-Panel
Oil	24553	21846	19678	22409	20758	21913	20129
Gas	17394	15283	13591	15721	14434	15335	13943
LPG	29804	26186	23287	26938	24732	26275	23890
Electric	34149	26951	21183	28447	24057	27128	22383

Table 7.1. Point Computation Summary Form

Component	Source Equation	TARGET		DESIGN	
		Heating	Cooling	Heating	Cooling
Ceiling Insulation	7-1,7-2	<u>62</u>	<u>7</u>	<u>62</u>	<u>7</u>
Wall Insulation	7-3,7-4	<u>163</u>	<u>10</u>	<u>251</u>	<u>15</u>
Floor Insulation	7-5,7-6	<u>35</u>	<u>18</u>	<u>35</u>	<u>18</u>
Air Infiltration	7-7,7-8	<u>538</u>	<u>23</u>	<u>383</u>	<u>15</u>
Glazing Layers	7-9,7-10	+ <u>140</u>	+ <u>3</u>	+ <u>226</u>	+ <u>2</u>
SUBTOTAL 1	Note (a)	<u>938</u>	<u>61</u>	<u>957</u>	<u>57</u>
Glazing Orientation	7-11,7-12	- <u>146</u>	+ <u>91</u>	- <u>253</u>	+ <u>107</u>
SUBTOTAL 2	Note (b)	<u>792</u>	<u>152</u>	<u>704</u>	<u>164</u>
Base Points	7-13	* <u>+68</u>	* <u>-65</u>	* <u>+68</u>	* <u>-65</u>
SUBTOTAL 3	Note (c)	<u>860</u>	<u>87</u>	<u>772</u>	<u>99</u>
HVAC Efficiency Heating Cooling	7-14,7-15	x <u>77</u>	x <u>60</u>	x <u>84</u>	x <u>60</u>
TOTAL HEATING AND COOLING POINTS	Note (d)	<u>66220</u>	<u>5220</u>	<u>64848</u>	<u>5940</u>
TOTAL SPACE CONDITIONING POINTS	Note (e)	$\left. \begin{array}{c} \downarrow \\ \hline \end{array} \right\} \begin{array}{c} \boxed{71440} \end{array} \leftarrow$		$\left. \begin{array}{c} \downarrow \\ \hline \end{array} \right\} \begin{array}{c} \boxed{70788} \end{array} \leftarrow$	
Domestic Hot Water Points	7-16,7-17	+ <u>24553</u>		+ <u>19678</u>	
TOTAL POINTS	Note (f)	<u>95993</u>		<u>90466</u>	

Notes for Table 7.1:

Complies

- Sum the points in each column to obtain entries for the four SUBTOTAL 1 boxes.
- Subtract the Glazing Layers Heating points and add Glazing Layers Cooling points to obtain entries for the four SUBTOTAL 2 boxes.

- c) Sum the Base Points and SUBTOTAL 2 to obtain SUBTOTAL 3 entries. Note:
Some Base Points may be negative. In this case, subtract them from
SUBTOTAL 2.
- d) Multiply Heating SUBTOTAL 3 by HVAC Heating Points to obtain TOTAL HEATING POINTS. Multiply Cooling SUBTOTAL 3 by HVAC Cooling Points to obtain TOTAL COOLING POINTS.
- e) Sum TOTAL HEATING and TOTAL COOLING POINTS to obtain TOTAL SPACE CONDITIONING POINTS.
- f) Sum TOTAL SPACE CONDITIDNING POINTS and Domestic Hot Water Points to obtain TOTAL POINTS.

7.3 Ceiling Insulation Points Computation

The equations below are provided to determine the number of Ceiling Insulation, Target and Design, Heating and Cooling Points. Values for the Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Ceiling Insulation

TARGET HOME:

TARGET POINTS

$$\text{Heating: } \frac{1224}{\text{Ceiling Area}} \times \frac{51}{\text{TARGET Htg. Mult. (Table 7.2)}} = \frac{62424}{1000} = \underline{62} \quad (7-1a)$$

$$\text{Cooling: } \frac{1224}{\text{Ceiling Area}} \times \frac{6}{\text{TARGET Clg. Mult. (Table 7.2)}} = \frac{7344}{1000} = \underline{7} \quad (7-1b)$$

DESIGN HOME:

DESIGN POINTS

$$\text{Heating: } \frac{1224}{\text{Ceiling Area}} \times \frac{51}{\text{DESIGN Htg. Mult. (Table 7.3)}} = \frac{62424}{1000} = \underline{62} \quad (7-2a)$$

$$\text{Cooling: } \frac{1224}{\text{Ceiling Area}} \times \frac{6}{\text{DESIGN Clg. Mult. (Table 7.3)}} = \frac{7344}{1000} = \underline{7} \quad (7-2b)$$

7.4 Wall Insulation Point Computation

The equations below are provided to determine the number of Wall Insulation, Target and Design, Heating and Cooling Points. Values for the Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Wall Insulation

TARGET HOME:

TARGET POINTS

$$\text{Heating: } \frac{2088}{\text{Wall Area}} \times \frac{78}{\text{TARGET Htg. Mult. (Table 7.4)}} = \frac{162864}{1000} = \underline{163} \quad (7-3a)$$

$$\text{Cooling: } \frac{2088}{\text{Wall Area}} \times \frac{5}{\text{TARGET Clg. Mult. (Table 7.4)}} = \frac{10440}{1000} = \underline{10} \quad (7-3b)$$

DESIGN HOME: (R-13)

DESIGN POINTS

$$\text{Heating: } \frac{2088}{\text{Wall Area}} \times \frac{120}{\text{DESIGN Htg. Mult. (Table 7.5)}} = \frac{250560}{1000} = \underline{251} \quad (7-4a)$$

$$\text{Cooling: } \frac{2088}{\text{Wall Area}} \times \frac{7}{\text{DESIGN Clg. Mult. (Table 7.5)}} = \frac{14616}{1000} = \underline{15} \quad (7-4b)$$

7.5 Floor/Foundation Insulation Point Computation

The equations below are provided to determine the number of Floor/Foundation, Target and Design, Heating and Cooling Points. Values for the Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Floor/Foundation Insulation

TARGET HOME:

TARGET POINTS

$$\text{Heating: } \frac{1280}{\text{Component Size}^*} \times \frac{27}{\text{TARGET Htg. Mult. (Table 7.6)}} = \frac{34560}{1000} = \underline{35} \quad (7-5a)$$

$$\text{Cooling: } \frac{1280}{\text{Component Size}^*} \times \frac{14}{\text{TARGET Clg. Mult. (Table 7.6)}} = \frac{17920}{1000} = \underline{18} \quad (7-5b)$$

DESIGN HOME: (R-13)

DESIGN POINTS

$$\text{Heating: } \frac{1280}{\text{Component Size}^*} \times \frac{27}{\text{DESIGN Htg. Mult. (Table 7.7)}} = \frac{34560}{1000} = \underline{35} \quad (7-6a)$$

$$\text{Cooling: } \frac{1280}{\text{Component Size}^*} \times \frac{14}{\text{DESIGN Clg. Mult. (Table 7.7)}} = \frac{17920}{1000} = \underline{18} \quad (7-6b)$$

- * Enter the area (sqft) for a floor over a crawlspace or unheated basement.
Enter the perimeter length (ft) for slabs and heated basements.

7.6 Air Infiltration Points Computation

The equations below are provided to determine the number of Air Infiltration, Target and Design, Heating and Cooling Points. Values for the Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Air Infiltration

TARGET HOME:

TARGET POINTS

$$\text{Heating: } \frac{2504}{\text{Floor Area}} \times \frac{215}{\text{TARGET Htg. Mult. (Table 7.8)}} = \frac{538360}{1000} = \underline{538} \quad (7-7a)$$

$$\text{Cooling: } \frac{2504}{\text{Floor Area}} \times \frac{9}{\text{TARGET Clg. Mult. (Table 7.8)}} = \frac{22536}{1000} = \underline{23} \quad (7-7b)$$

DESIGN HOME: (Tight Package)

DESIGN POINTS

$$\text{Heating: } \frac{2504}{\text{Floor Area}} \times \frac{153}{\text{DESIGN Htg. Mult. (Table 7.9)}} = \frac{383112}{1000} = \underline{383} \quad (7-8a)$$

$$\text{Cooling: } \frac{2504}{\text{Floor Area}} \times \frac{6}{\text{DESIGN Clg. Mult. (Table 7.9)}} = \frac{15024}{1000} = \underline{15} \quad (7-8b)$$

7.7 Fenestration Layers and Sash Material Points Computation

The equations below are provided to determine the number of Fenestration Layers and Sash Material, Target and Design, Heating and Cooling Points. Values for the Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Window Layers and Sash Material

<u>TARGET HOME:</u>		<u>TARGET POINTS</u>
Heating:	$\frac{2504}{\text{Floor Area}} \times \frac{56}{\text{TARGET Htg. Mult. (Table 7.10)}} = \frac{140224}{1000} = 140$	(7-9a)
Cooling:	$\frac{2504}{\text{Floor Area}} \times \frac{1}{\text{TARGET Clg. Mult. (Table 7.10)}} = \frac{2504}{1000} = 3$	(7-9b)

<u>DESIGN HOME:</u>		<u>DESIGN POINTS</u>
Heating:	$\frac{248}{\text{Window Area}} \times \frac{910}{\text{DESIGN Htg. Mult. (Table 7.11)}} = \frac{225680}{1000} = 226$	(7-10a)
Cooling:	$\frac{248}{\text{Window Area}} \times \frac{10}{\text{DESIGN Clg. Mult. (Table 7.11)}} = \frac{2480}{1000} = 2$	(7-10b)

7.8 Glazing Area and Orientation Point Computation

The equations below are provided to determine the number of Glazing Area and Orientation Design Heating and Cooling Points. Values for the Target Heating and Cooling Points, and the Design Multipliers (Option and Overhang) are provided by the ARES Computer Program.

TARGET Point Calculation - Fenestration Area and Orientation

<u>TARGET HOME:</u>	<u>TARGET POINTS</u>
Heating: $\frac{2504}{\text{Floor Area}}$	$\frac{146}{\text{(Table 7.12)}} \quad (7-11a)$
Cooling: $\frac{2504}{\text{Floor Area}}$	$\frac{91}{\text{(Table 7.12)}} \quad (7-11b)$

DESIGN Point Calculation - Fenestration Area and Orientation

DESIGN HOME: HEATING CALCULATION

Orientation	Glazing Area	Energy Option Multiplier (Table 7.13)	Overhang Multiplier (Table 7.14)	Fenestration Factor (F)
North	<u>50</u>	x <u>38</u>	x <u>10</u> / 100 =	<u>190</u>
Northwest		x	x / 100 =	
East	<u>120</u>	x <u>75</u>	x <u>11</u> / 100 =	<u>990</u>
Southeast		x	x / 100 =	
South	<u>25</u>	x <u>139</u>	x <u>12</u> / 100 =	<u>417</u>
Southwest		x	x / 100 =	
West	<u>53</u>	x <u>69</u>	x <u>11</u> / 100 =	<u>402</u>
Northwest		x	x / 100 =	
+ Total HEATING Fenestration Factor (F)				<u>1999</u>
DESIGN Points:				<u>253</u> (7-12a)
				(Table 7.15)

DESIGN HOME: COOLING CALCULATION

Orientation	Glazing Area	Energy Option Multiplier (Table 7.13)	Overhang Multiplier (Table 7.14)	Fenestration Factor (F)
North	<u>50</u>	x <u>18</u>	x <u>10</u> / 100 =	<u>90</u>
Northwest		x	x / 100 =	
East	<u>120</u>	x <u>32</u>	x <u>12</u> / 100 =	<u>461</u>
Southeast		x	x / 100 =	
South	<u>25</u>	x <u>28</u>	x <u>13</u> / 100 =	<u>91</u>
Southwest		x	x / 100 =	
West	<u>53</u>	x <u>35</u>	x <u>12</u> / 100 =	<u>223</u>
Northwest		x	x / 100 =	
+ Total COOLING Fenestration Factor (F)				<u>865</u>
DESIGN Points:				<u>107</u> (7-12b)
				(Table 7.15)

7.9 Base Load Computation

The equations below are provided to determine the number of Base Load Heating and Cooling Points. Values for the Heating and Cooling Multipliers are provided by the ARES Computer Program.

Point Calculation - Base Load

					<u>TOTAL POINTS</u>	
Heating:	$\frac{2504}{\text{Floor Area}}$	x	$\frac{27}{\text{Heating Multiplier (Table 7.16)}}$	=	$\frac{67608}{1000}$	= <u>68</u> (7-13a)
Cooling:	$\frac{2504}{\text{Floor Area}}$	x	$\frac{-26}{\text{Cooling Multiplier (Table 7.16)}}$	=	$\frac{-65104}{1000}$	= <u>-65</u> (7-13b)

7.10 HVAC Equipment and System Efficiency Point Computation

The equations below are provided to determine the number of HVAC Systems, Target and Design, Heating and Cooling Points. Values for Target and Design Multipliers are provided by the ARES Computer Program.

Point Calculation - Mechanical Equipment

<u>TARGET HOME:</u>					<u>TARGET POINTS</u>	
Heating:					<u>77</u>	(7-14a)
					(Table 7.17)	
Cooling:					<u>60</u>	(7-14a)
					(Table 7.17)	
<u>DESIGN HOME:</u>					<u>DESIGN POINTS</u>	
Heating:	$\frac{7344}{\text{Equipment Multiplier (Table 7.18)}}$	÷	$\frac{88}{\text{Efficiency Indicator}}$	=	<u>84</u>	(7-15a)
Cooling:	$\frac{598}{\text{Equipment Multiplier (Table 7.18)}}$	÷	$\frac{10}{\text{Efficiency Indicator}}$	=	<u>60</u>	(7-15b)

7.11 Domestic Hot Water Point Calculation

Values for the Target DHW Points and Design and Target Points for demonstrating compliance using Solar DHW System, are provided by the ARES Computer Program. The ARES Computer Program is also used to determine the DHW Multiplier in calculating the Design DHW Points.

Point Calculation - Nonsolar Domestic Water Heating

TARGET HOME:

TARGET POINTS

(7-16a)

(Table 7.19)

DESIGN HOME:

DESIGN POINTS

(7-16b)

DHW Multiplier
(Table 7.20)

11

~~Energy Factor~~
$$=$$

Point Calculation - Solar Domestic Water Heating

TARGET HOME:

TARGET POINTS

(7-17a)

(Table 7.21)

DESIGN HOME:

DESIGN POINTS

(7-17b)

(Table 7.21)

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