CALIFORNIA
ENERGY
COMMISSION

Appendices to:
ALTERNATIVE CALCULATION METHOD (ACM) APPROVAL MANUAL for the 2001 Energy Efficiency Standards for Residential Buildings

Adopted by the Commission
April 4, 2001

COMMISSION ADOPTED APPENDICES

Revised
April 5, 2001
P400-01-012A

Gray Davis, *Governor*

Note: "15 Day Language" revisions adopted on April 4, 2001 are marked in double underline and ~~double strikeout~~. "45 Day Language" revisions, which were adopted on January 3, 2001 as the emergency regulations and are the original "Express Terms" for the permanent adoption rulemaking, are marked in single underline and ~~single strikeout~~.

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California Energy Commission
Assembly Bill 970 Building Energy Efficiency Standards

Appendices to AB 970 Low-Rise Residential Alternative Calculation Method Approval Manual

Energy Commission Publication No. P 400-01-012A

These AB 970 Residential Energy Calculation Method Approval Manual Appendices include computer programming details that computer programs used to determine compliance with the 2001 AB 970 Energy Efficiency Standards for Residential Buildings must meet. These Appendices were adopted at the Energy Commission's April 4, 2001 Business Meeting. These Appendices are used in conjunction with the Title 24 Building Energy Efficiency Standards (California Code of Regulations, Title 24, Part 6 and the Administrative Regulations, Title 24, Part 1.)

This manual was prepared by California Energy Commission staff. Neither the State of California, the California Energy Commission, nor any of their employees, contractors, or subcontractors, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process enclosed, or represents that its use would not infringe on privately-owned rights.

April 5, 2001

APPENDIX A

Certification of Alternative Calculation Method

Energy Efficiency Standards for Residential Buildings, Sections ~~2~~ 150 to 152

I, _____ (name), certify that this alternative calculation method (ACM), _____ (name of ACM), version number _____, dated _____, developed by, _____ (personnel or company), _____ (address) _____ (city, state) _____ (zip),

passes all of the ACM tests and gives results that are reliable and accurate when used for calculating custom budgets and annual energy use estimates to comply with CEC (California Energy Commission) regulations, subject to the fixed and restricted assumptions specified in the *Alternative Calculation Method (ACM) Approval Manual for the ~~1998~~2001 Energy Efficiency Standards for Residential Buildings*, and the fixed and restricted inputs specified in the manuals describing the use of this method (Users Manual and Compliance Supplement thereto). I certify that the calculation of energy use in buildings, following the instructions in the manuals, and using accurate and complete plans and specifications for a building will achieve reliable and accurate energy analysis results with this ACM. Moreover, the calculations are verifiable when modeling the same building and accurately applying the fixed and restricted assumptions and inputs mentioned above. I further certify that all variables used by the program that are not subject to ready verification in the plans and specifications or that are subject to occupant use are either fixed, carefully restricted, or defaulted in this ACM.

I also certify that the inputs, default values, and assumptions specified for compliance runs in the manuals, and used in the accompanying application for the CEC residential ACM approval, are consistent with the inputs, default values, and assumptions specified by the CEC in the *Alternative Calculation Method (ACM) Approval Manual for the ~~1998~~2001 Energy Efficiency Standards for Residential Buildings* for use when generating standard design budgets and annual energy use estimates. I also certify that all specific inputs, variables, and assumptions needed to achieve the accuracy required to pass the capability tests in the *ACM Approval Manual* are either not subject to user variation, are defaulted to the values used for compliance, or are clearly specified as restricted or required inputs in the manuals for the ACM. In addition, the manuals clearly indicates that an easily verified list of the actual values of any such variables used for performance approach compliance which are subject to programmatic or user variation are to be included with the compliance documentation supplied by a building permit applicant to the enforcement agency. In summary, I also certify that the results of this alternative calculation method as specified in the manuals for the ACM in conjunction with an accurate and adequate set of plans and specifications for a building are not subject to significant variation by the manipulation of unrestricted user specified inputs that are difficult or impossible to verify.

In certifying the reliability and accuracy of this ACM, I certify that the results of this ACM's calculations, algorithms and assumptions are open to inspection by any individual or State entity, that this ACM may be challenged for its validity and accuracy as specified by the ACM Approval Manual, and that if challenged, I will prepare an adequate response or face possible withdrawal of ACM approval.

This certification is based upon the tests and requirements specified in the *Alternative Calculation Method (ACM) Approval Manual for the ~~1998~~2001 Energy Efficiency Standards for Residential Buildings*, and upon personal knowledge and experience with the use of this alternative calculation method.

Signed _____

Date _____ Title _____

Space Conditioning Test 1

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
01A00	_____	_____	_____	01A01	_____	_____	_____
02A00	_____	_____	_____	02A01	_____	_____	_____
03A00	_____	_____	_____	03A01	_____	_____	_____
04A00	_____	_____	_____	04A01	_____	_____	_____
05A00	_____	_____	_____	05A01	_____	_____	_____
06A00	_____	_____	_____	06A01	_____	_____	_____
07A00	_____	_____	_____	07A01	_____	_____	_____
08A00	_____	_____	_____	08A01	_____	_____	_____
09A00	_____	_____	_____	09A01	_____	_____	_____
10A00	_____	_____	_____	10A01	_____	_____	_____
11A00	_____	_____	_____	11A01	_____	_____	_____
12A00	_____	_____	_____	12A01	_____	_____	_____
13A00	_____	_____	_____	13A01	_____	_____	_____
14A00	_____	_____	_____	14A01	_____	_____	_____
15A00	_____	_____	_____	15A01	_____	_____	_____
16A00	_____	_____	_____	16A01	_____	_____	_____
03B00	_____	_____	_____	03B01	_____	_____	_____
09B00	_____	_____	_____	09B01	_____	_____	_____
12B00	_____	_____	_____	12B01	_____	_____	_____
14B00	_____	_____	_____	14B01	_____	_____	_____
16B00	_____	_____	_____	16B01	_____	_____	_____

Space Conditioning Test 2

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
01A00	_____	_____	_____	01A02	_____	_____	_____
02A00	_____	_____	_____	02A02	_____	_____	_____
03A00	_____	_____	_____	03A02	_____	_____	_____
04A00	_____	_____	_____	04A02	_____	_____	_____
05A00	_____	_____	_____	05A02	_____	_____	_____
06A00	_____	_____	_____	06A02	_____	_____	_____
07A00	_____	_____	_____	07A02	_____	_____	_____
08A00	_____	_____	_____	08A02	_____	_____	_____
09A00	_____	_____	_____	09A02	_____	_____	_____
10A00	_____	_____	_____	10A02	_____	_____	_____
11A00	_____	_____	_____	11A02	_____	_____	_____
12A00	_____	_____	_____	12A02	_____	_____	_____
13A00	_____	_____	_____	13A02	_____	_____	_____
14A00	_____	_____	_____	14A02	_____	_____	_____
15A00	_____	_____	_____	15A02	_____	_____	_____
16A00	_____	_____	_____	16A02	_____	_____	_____
03B00	_____	_____	_____	03B02	_____	_____	_____
09B00	_____	_____	_____	09B02	_____	_____	_____
12B00	_____	_____	_____	12B02	_____	_____	_____
14B00	_____	_____	_____	14B02	_____	_____	_____
16B00	_____	_____	_____	16B02	_____	_____	_____

Space Conditioning Test 3

Reduce ceiling U-value and increase south glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A03	_____	_____	_____
09A00	_____	_____	_____	09A03	_____	_____	_____
12A00	_____	_____	_____	12A03	_____	_____	_____
14A00	_____	_____	_____	14A03	_____	_____	_____
16A00	_____	_____	_____	16A03	_____	_____	_____

Space Conditioning Test 4

Reduce wall U-value and increase west glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A04	_____	_____	_____
09A00	_____	_____	_____	09A04	_____	_____	_____
12A00	_____	_____	_____	12A04	_____	_____	_____
14A00	_____	_____	_____	14A04	_____	_____	_____
16A00	_____	_____	_____	16A04	_____	_____	_____

Space Conditioning Test 5

Add slab insulation and increase north glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A05	_____	_____	_____
09A00	_____	_____	_____	09A05	_____	_____	_____
12A00	_____	_____	_____	12A05	_____	_____	_____
14A00	_____	_____	_____	14A05	_____	_____	_____
16A00	_____	_____	_____	16A05	_____	_____	_____

Space Conditioning Test 6

Reduce glazing U-value and add north glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A06	_____	_____	_____
09A00	_____	_____	_____	09A06	_____	_____	_____
12A00	_____	_____	_____	12A06	_____	_____	_____
14A00	_____	_____	_____	14A06	_____	_____	_____
16A00	_____	_____	_____	16A06	_____	_____	_____

Space Conditioning Test 7

Increase glazing U-value and reduce glass area on all orientations

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A06	_____	_____	_____
09A00	_____	_____	_____	09A07	_____	_____	_____
12A00	_____	_____	_____	12A07	_____	_____	_____
14A00	_____	_____	_____	14A07	_____	_____	_____
16A00	_____	_____	_____	16A07	_____	_____	_____

Space Conditioning Test 8

Increase exposed mass and increase south glass area

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A08	_____	_____	_____
09A00	_____	_____	_____	09A08	_____	_____	_____
12A00	_____	_____	_____	12A08	_____	_____	_____
14A00	_____	_____	_____	14A08	_____	_____	_____
16A00	_____	_____	_____	16A08	_____	_____	_____

Space Conditioning Test 9

Increase exposed mass and increase west glass area

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A09	_____	_____	_____
09A00	_____	_____	_____	09A09	_____	_____	_____
12A00	_____	_____	_____	12A09	_____	_____	_____
14A00	_____	_____	_____	14A09	_____	_____	_____
16A00	_____	_____	_____	16A09	_____	_____	_____

Space Conditioning Test 10

Increase exposed mass and increase north glass area

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A10	_____	_____	_____
09A00	_____	_____	_____	09A10	_____	_____	_____
12A00	_____	_____	_____	12A10	_____	_____	_____
14A00	_____	_____	_____	14A10	_____	_____	_____
16A00	_____	_____	_____	16A10	_____	_____	_____

Space Conditioning Test 11

Increase exposed mass and increase east glass area

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A~~06~~11	_____	_____	_____
09A00	_____	_____	_____	09A11	_____	_____	_____
12A00	_____	_____	_____	12A11	_____	_____	_____
14A00	_____	_____	_____	14A11	_____	_____	_____
16A00	_____	_____	_____	16A11	_____	_____	_____

Space Conditioning Test 12

Reduce exposed thermal mass, add exterior shading and increase west glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A12	_____	_____	_____
09A00	_____	_____	_____	09A12	_____	_____	_____
12A00	_____	_____	_____	12A12	_____	_____	_____
14A00	_____	_____	_____	14A12	_____	_____	_____
16A00	_____	_____	_____	16A12	_____	_____	_____

Space Conditioning Test 13

Increase exposed thermal mass, add better interior shading and increase south glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A13	_____	_____	_____
09A00	_____	_____	_____	09A13	_____	_____	_____
12A00	_____	_____	_____	12A13	_____	_____	_____
14A00	_____	_____	_____	14A13	_____	_____	_____
16A00	_____	_____	_____	16A13	_____	_____	_____

Space Conditioning Test 14

Add south overhang and increase south glass

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A14	_____	_____	_____
09A00	_____	_____	_____	09A14	_____	_____	_____
12A00	_____	_____	_____	12A14	_____	_____	_____
14A00	_____	_____	_____	14A14	_____	_____	_____
16A00	_____	_____	_____	16A14	_____	_____	_____

Space Conditioning Test 15

Move ducts to conditioned space and increase glass on all orientations

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A15	_____	_____	_____
09A00	_____	_____	_____	09A15	_____	_____	_____
12A00	_____	_____	_____	12A15	_____	_____	_____
14A00	_____	_____	_____	14A15	_____	_____	_____
16A00	_____	_____	_____	16A15	_____	_____	_____

Water Heating Tests

Enter the calculated values

Climate Zone	D	E	F	G	H	I	J
Energy Budget	_____	_____	_____	_____	_____	_____	_____
Standard	_____	_____	_____	_____	_____	_____	_____
POU/HWR	_____	_____	_____	_____	_____	_____	_____
Pipe Insulation	_____	_____	_____	_____	_____	_____	_____
Recirc/NoControl	_____	_____	_____	_____	_____	_____	_____
Recirc/Timer	_____	_____	_____	_____	_____	_____	_____
Recirc/Demand	_____	_____	_____	_____	_____	_____	_____
Recirc/Time+Temp	_____	_____	_____	_____	_____	_____	_____
Recirc/Temp	_____	_____	_____	_____	_____	_____	_____
Parallel Piping	_____	_____	_____	_____	_____	_____	_____

Custom Budget Space Conditioning 31

Gas heated slab floor building

	Basecase Building (from custom budget column)				Standard Design Equivalent (from proposed design column)		
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
01C31	_____	_____	_____	01C31C	_____	_____	_____
02C31	_____	_____	_____	02C31C	_____	_____	_____
03C31	_____	_____	_____	03C31C	_____	_____	_____
04C31	_____	_____	_____	04C31C	_____	_____	_____
05C31	_____	_____	_____	05C31C	_____	_____	_____
06C31	_____	_____	_____	06C31C	_____	_____	_____
07C31	_____	_____	_____	07C31C	_____	_____	_____
08C31	_____	_____	_____	08C31C	_____	_____	_____
09C31	_____	_____	_____	09C31C	_____	_____	_____
10C31	_____	_____	_____	10C31C	_____	_____	_____
11C31	_____	_____	_____	11C31C	_____	_____	_____
12C31	_____	_____	_____	12C31C	_____	_____	_____
13C31	_____	_____	_____	13C31C	_____	_____	_____
14C31	_____	_____	_____	14C31C	_____	_____	_____
15C31	_____	_____	_____	15C31C	_____	_____	_____
16C31	_____	_____	_____	16C31C	_____	_____	_____

Custom Budget Space Conditioning 32

Gas heated raised floor building

	Basecase Building (from custom budget column)				Standard Design Equivalent (from proposed design column)		
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
01C32	_____	_____	_____	01C32C	_____	_____	_____
02C32	_____	_____	_____	02C32C	_____	_____	_____
03C32	_____	_____	_____	03C32C	_____	_____	_____
04C32	_____	_____	_____	04C32C	_____	_____	_____
05C32	_____	_____	_____	05C32C	_____	_____	_____
06C32	_____	_____	_____	06C32C	_____	_____	_____
07C32	_____	_____	_____	07C32C	_____	_____	_____
08C32	_____	_____	_____	08C32C	_____	_____	_____
09C32	_____	_____	_____	09C32C	_____	_____	_____
10C32	_____	_____	_____	10C32C	_____	_____	_____
11C32	_____	_____	_____	11C32C	_____	_____	_____
12C32	_____	_____	_____	12C32C	_____	_____	_____
13C32	_____	_____	_____	13C32C	_____	_____	_____
14C32	_____	_____	_____	14C32C	_____	_____	_____
15C32	_____	_____	_____	15C32C	_____	_____	_____
16C32	_____	_____	_____	16C32C	_____	_____	_____

Custom Budget Space Conditioning 33

Electric heated slab floor building

Basecase Building (from custom budget column)				Standard Design Equivalent (from proposed design column)			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
01C33	_____	_____	_____	01C33C	_____	_____	_____
02C33	_____	_____	_____	02C33C	_____	_____	_____
03C33	_____	_____	_____	03C33C	_____	_____	_____
04C33	_____	_____	_____	04C33C	_____	_____	_____
05C33	_____	_____	_____	05C33C	_____	_____	_____
06C33	_____	_____	_____	06C33C	_____	_____	_____
07C33	_____	_____	_____	07C33C	_____	_____	_____
08C33	_____	_____	_____	08C33C	_____	_____	_____
09C33	_____	_____	_____	09C33C	_____	_____	_____
10C33	_____	_____	_____	10C33C	_____	_____	_____
11C33	_____	_____	_____	11C33C	_____	_____	_____
12C33	_____	_____	_____	12C33C	_____	_____	_____
13C33	_____	_____	_____	13C33C	_____	_____	_____
14C33	_____	_____	_____	14C33C	_____	_____	_____
15C33	_____	_____	_____	15C33C	_____	_____	_____
16C33	_____	_____	_____	16C33C	_____	_____	_____

Space Conditioning Ducts Test 34

Duct designed to meet ACCA Manual D with sealed and tested ducts

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A34	_____	_____	_____
09A00	_____	_____	_____	09A34	_____	_____	_____
12A00	_____	_____	_____	12A34	_____	_____	_____
14A00	_____	_____	_____	14A34	_____	_____	_____
16A00	_____	_____	_____	16A34	_____	_____	_____

Space Conditioning Ducts Test 35

Sealed and tested ducts

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00				03A35			
09A00				09A35			
12A00				12A35			
14A00				14A35			
16A00				16A35			

Space Conditioning Ducts Test 36

Ducts and air handler in conditioned space with sealed and tested ducts

03A00				03A36			
09A00				09A36			
12A00				12A36			
14A00				14A36			
16A00				16A36			

Addition Plus Existing Test 37

Mandatory minimum R-19 ceiling, R-13 walls in addition

03A00				03A37			
09A00				09A37			
12A00				12A37			
14A00				14A37			
16A00				16A37			

Addition Plus Existing Test 38

Existing and addition roof meets Package D, change west facing glazing

03A00				03A38			
09A00				09A38			
12A00				12A38			
14A00				14A38			
16A00				16A38			

Space Cooling SSEER Test 39

Split system, 12 SEER, TXV, sealed and tested ducts, and ACCA Manual D duct design

03A00				03A39			
09A00				09A39			
12A00				12A39			
14A00				14A39			
16A00				16A39			

Space Cooling SSEER Test 40

Split system, 10.5 SEER and TXV

03A00				03A40			
09A00				09A40			
12A00				12A40			
14A00				14A40			
16A00				16A40			

Space Cooling SSEER Test 41

Split system with 19 SEER

03A00				03A41			
09A00				09A41			
12A00				12A41			
14A00				14A41			
16A00				16A41			

Space Cooling SSEER Test 42

Package system, 11.7 SEER, sealed and tested ducts, and ACCA Manual D duct design

03A00	_____	_____	_____	03A42	_____	_____	_____
09A00	_____	_____	_____	09A42	_____	_____	_____
12A00	_____	_____	_____	12A42	_____	_____	_____
14A00	_____	_____	_____	14A42	_____	_____	_____
16A00	_____	_____	_____	16A42	_____	_____	_____

Optional Capability Test 51

Controlled ventilation crawlspaces

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03B00	_____	_____	_____	03B51	_____	_____	_____
09B00	_____	_____	_____	09B51	_____	_____	_____
12B00	_____	_____	_____	12B51	_____	_____	_____
14B00	_____	_____	_____	14B51	_____	_____	_____
16B00	_____	_____	_____	16B51	_____	_____	_____
Custom Budget Test							
12B51	_____	_____	_____	12B51C	_____	_____	_____

Optional Capability Test 52

Zonal Control

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A52	_____	_____	_____
09A00	_____	_____	_____	09A52	_____	_____	_____
12A00	_____	_____	_____	12A52	_____	_____	_____
14A00	_____	_____	_____	14A52	_____	_____	_____
16A00	_____	_____	_____	16A52	_____	_____	_____
Custom Budget Test							
12A52	_____	_____	_____	12A52C	_____	_____	_____

Optional Capability Test 53

Sunspaces

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A53	_____	_____	_____
09A00	_____	_____	_____	09A53	_____	_____	_____
12A00	_____	_____	_____	12A53	_____	_____	_____
14A00	_____	_____	_____	14A53	_____	_____	_____
16A00	_____	_____	_____	16A53	_____	_____	_____
Custom Budget Test							
12A53	_____	_____	_____	12A53C	_____	_____	_____

Optional Capability Test 54

Side Fin Shading

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A54	_____	_____	_____
09A00	_____	_____	_____	09A54	_____	_____	_____
12A00	_____	_____	_____	12A54	_____	_____	_____
14A00	_____	_____	_____	14A54	_____	_____	_____
16A00	_____	_____	_____	16A54	_____	_____	_____
Custom Budget Test							
12A54	_____	_____	_____	12A54C	_____	_____	_____

Optional Capability Test 55

Exterior Mass Walls

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A55	_____	_____	_____
09A00	_____	_____	_____	09A55	_____	_____	_____
12A00	_____	_____	_____	12A55	_____	_____	_____
14A00	_____	_____	_____	14A55	_____	_____	_____
16A00	_____	_____	_____	16A55	_____	_____	_____
Custom Budget Test							
12A55	_____	_____	_____	12A55C	_____	_____	_____

Optional Capability Test 56

Combined Hydronic Space and Water Heating

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A56K	_____	_____	_____
09A00	_____	_____	_____	09A56K	_____	_____	_____
12A00	_____	_____	_____	12A56K	_____	_____	_____
14A00	_____	_____	_____	14A56K	_____	_____	_____
16A00	_____	_____	_____	16A56K	_____	_____	_____

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A56L	_____	_____	_____
09A00	_____	_____	_____	09A56L	_____	_____	_____
12A00	_____	_____	_____	12A56L	_____	_____	_____
14A00	_____	_____	_____	14A56L	_____	_____	_____
16A00	_____	_____	_____	16A56L	_____	_____	_____

Basecase Building				Prototype Variation			
Label	Heating	Cooling	Total	Label	Heating	Cooling	Total
03A00	_____	_____	_____	03A56M	_____	_____	_____
09A00	_____	_____	_____	09A56M	_____	_____	_____
12A00	_____	_____	_____	12A56M	_____	_____	_____
14A00	_____	_____	_____	14A56M	_____	_____	_____
16A00	_____	_____	_____	16A56M	_____	_____	_____

Custom Budget Test

12A56	_____	_____	_____	12A56C	_____	_____	_____

Optional Capability Test 57

Form 3 Generator

Label	U-value	R-value
W.19.EQ2	_____	_____
FC.30.2x10.16	_____	_____
FX.30.2x10.16	_____	_____
R.22.2x6.24	_____	_____
RP.22.2x6.48	_____	_____
R.38.2x4.24	_____	_____

APPENDIX B

The Contents of Appendix B Have Been Deleted.
Appendix B is
Reserved for Future Use for Sample CALRES Test Run
Files and Input Descriptions for Tests 00 to 15.

These sample files will be added for information
purposes only, and will not be adopted as regulations.

APPENDIX C

Pages C-4 through C-60 have been deleted but are reserved for future use for final versions of the sample CALRES input descriptions of the C prototype building and the Custom Budget tests.

These sample files will be added for information purposes only, and will not be adopted as regulations.

Pages C-1 to C-3 are available upon request by calling Debbie Friese at (916) 654-4067.

APPENDIX D

The Contents of Appendix D Have Been Deleted.
Appendix D is
Reserved for Future Use for Sample CALRES Test Run Files and Input Descriptions for the Optional Capabilities Tests

These sample files will be added for information purposes only, and will not be adopted as regulations.

APPENDIX E

This appendix is provided to accept Commission Approved descriptions of framing assemblies. These assembly descriptions are in Appendix B of the Nonresidential ACM Manual.

APPENDIX F

Appendix F
Standard Procedure for Determining the Seasonal Energy Efficiencies of Residential Air Distribution Systems

1.0 Introduction

This appendix describes the measurement and calculation methods for determining air distribution system efficiency.

2.0 Definitions

aerosol sealant closure system*:* A method of sealing leaks by blowing aerosolized sealant particles into the duct system and which must include minute-by-minute documentation of the sealing process.

floor area :The floor area of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces enclosing the conditioned space.

delivery effectiveness :The ratio of the thermal energy delivered to the conditioned space and the thermal energy entering the distribution system at the equipment heat exchanger.

distribution system efficiency :The ratio of the thermal energy consumed by the equipment with the distribution system to the energy consumed if the distribution system had no losses or impact on the equipment or building loads.

equipment efficiency :The ratio between the thermal energy entering the distribution system at the equipment heat exchanger and the energy being consumed by the equipment.

equipment factor : F_{equip} is the ratio of the equipment efficiency including the effects of the distribution system to the equipment efficiency of the equipment in isolation.

fan flowmeter device*:* A device used to measure air flow rates under a range of test pressure differences.

flowhood**:** A device used to capture and measure the airflow at a register.

load factor : F_{load} is the ratio of the building energy load without including distribution effects to the load including distribution system effects.

pressure pan : a device used to seal individual forced air system registers and to measure the static pressure from the register.

radiant barrier : a surface of low emissivity (less than 0.05) placed inside an attic or roof space to reduce radiant heat transfer.

recovery factor : F_{recov} is the fraction of energy lost from the distribution system that enters the conditioned space.

thermal regain: The fraction of delivery system losses that are returned to the building.

3.0 Nomenclature

a_r = duct leakage factor (1-return eakage) for return ducts

a_s = duct leakage factor (1-supply leakage)p for supply ducts

A_{floor} = conditioned floor area of building , ft^2

$A_{r,out}$ = surface area of return duct outside conditioned space ,ft^2

$A_{r,attic}$ = return duct area in attic , ft^2

$A_{r,base}$ = return duct area in basement , ft^2

$A_{r,crawl}$ = return duct area in crawlspace, ft^2

$A_{r,gar}$= return duct area inside garage, ft^2

$A_{s,out}$ = surface area of supply duct outside conditioned space,ft^2

$A_{s,attic}$ = supply duct area in attic , ft^2

$A_{s,base}$ = supply duct area in basement , ft^2

$A_{s,crawl}$ = supply duct area in crawlspace,ft^2

$A_{s,gar}$ = supply duct area inside garage, ft^2

$A_{s,in}$ = supply duct area inside conditioned space, ft^2

B_r = conduction fraction for return

B_s = conduction fraction for supply

DE = delivery effectiveness_

DE_{design} = design delivery effectiveness

$DE_{seasonal}$ = seasonal delivery effectiveness

E_{equip} = rate of energy exchanged between equipment and delivery system, Btu/hour

$F_{cycloss}$ = cyclic loss factor

F_{equip} = load factor for equipment

F_{flow} = load factor for fan flow effect on equipment efficiency

F_{leak} = fraction of system fan flow that leaks out of supply or return ducts

F_{load} = load factor for delivery system

F_{recov} = thermal loss recovery factor

F_{regain} = thermal regain factor

K_r = return duct surface area coefficient

K_s = supply duct surface area coefficient

N_{story} = number of stories of the building

P_{sp} = pressure difference between supply plenum and conditioned space [Pa]

P_{test} = test pressure for duct leakage [Pa]

Q_e = Flow through air handler fan at operating conditions, cfm

$Q_{total,25}$ = total duct leakage at 25 Pascal, cfm

R_r = thermal resistance of return duct, h ft^2 F/Btu

R_s = thermal resistance of supply duct, h ft^2 F/Btu

$T_{amb,r}$ = ambient temperature for return , F

$T_{amb,s}$ = ambient temperature for supply , F

T_{attic} = attic air temperature , F

T_{base} - return duct temperature in basement, F

T_{crawl} - return duct temperature in crawlspace,F

T_{design} = outdoor air design temperature , F

T_{ground} = ground temperature , F

T_{gar} = temperature of garage air , F

T_{in} = temperature of indoor air , F

T_{rp} = return plenum air temperature , F

$T_{seasonal}$ = outdoor air seasonal temperature, F

T_{sp} = supply plenum air temperature , F

ΔT_e = temperature rise across heat exchanger , F

ΔT_r = temperature difference between indoors and the ambient for the return , F

ΔT_s = temperature difference between indoors and the ambient for the supply,

$\eta_{dist,seasonal}$ = seasonal distribution system efficiency

4.0 Air Distribution Diagnostic Measurement and Default Assumptions

4.1 Instrumentation Specifications

The instrumentation for the air distribution diagnostic measurements shall conform to the following specifications:

4.1.1 Pressure Measurements

All pressure measurements shall be measured with measurement systems (i.e. sensor plus data acquisition system) having an accuracy of ± 0.2 Pa. All pressure measurements within the duct system shall be made with static pressure probes.

4.1.2 Fan Flow Measurements

All measurements of distribution fan flows shall be made with measurement systems (i.e. sensor plus data acquisition system) having an accuracy of ±5% reading or ±5 cfm whichever is greater.

4.1.3 Duct Leakage Measurements

The measurement of air flows during duct leakage testing shall have an accuracy of ±3% of measured flow using digital gauges.

All instrumentation used for fan flow and duct leakage diagnostic measurements shall be calibrated according to the manufacturer's calibration procedure to conform to the above accuracy requirement. All testers performing diagnostic tests shall obtain evidence from the manufacturer that the equipment meets the accuracy specifications. The evidence shall include equipment model, serial number, the name and signature of the person of the test laboratory verifying the accuracy, and the instrument accuracy. All diagnostic testing equipment is subject to re-calibration when the period of the manufacturer's guaranteed accuracy expires.

4.2 Apparatus

4.2.1 System Fan Flows

HVAC system fan flow shall be measured using one of the following methods.

4.2.1.1 Plenum pressure matching measurement

The apparatus for measuring the system fan flow shall consist of a duct pressurization and flow measurement device (subsequently referred to as a fan flowmeter [see section 4.3.7.2.2.]) meeting the specifications in 4.1.3, a static pressure transducer meeting the specifications in Section 4.1.1, and an air barrier between the return duct system and the air handler inlet. The measuring device shall be attached at the air handler blower compartment door. All registers shall be in their normal operating condition. The static pressure probe shall be fixed to the supply plenum so that it is not moved during this test.

4.2.1.2 Flow hood measurement

A flow hood meeting the specifications in section 4.1.2. can be used to verify the fan flow at the return register(s) after the completion of a rough-in duct leakage measurement. All registers shall be in their normal operating position. Measurement(s) shall be taken at the return grill(s).

4.2.2 Duct Leakage

The apparatus for fan pressurization duct leakage measurements shall consist of a duct pressurization and flow measurement device meeting the specifications in Section 4.1.3.

4.3 Procedure

The following sections identify input values for building and HVAC system (including ducts) using either default or diagnostic information.

4.3.1 Building Information

The calculation procedure for determining air distribution efficiencies requires the following building information:

1. climate zone for the building,
2. conditioned floor area,
3. number of stories,
4. supply duct location and
5. floor type.

4.3.1.1 Default Input

Using default values rather than diagnostic procedures produce relatively low air distribution-system efficiencies.

Default values shall be obtained from following sections:

1. the location of the duct system in Section 4.3.4,
2. the surface area and insulation level of the ducts in Sections 4.3.3, 4.3.4 and 4.3.6,
3. the system fan flow in Section 4.3.7, and
4. the leakage of the duct system in Section 4.3.8.

4.3.2 Diagnostic Input

Diagnostic inputs are used for the calculation of improved duct efficiency. The diagnostics include observation of various duct characteristics and measurement of duct leakage and system fan flows as described in Sections 4.3.5 through 4.3.8. These observations and measurements replace those assumed as default values.

The diagnostic procedures include

- measure supply duct surface area as described in Section 4.3.3.2.
- measure total duct system leakage as described in Section 4.3.8.

- measure system fan flow or observe the presence of a thermostatic expansion valve for claiming ACCA manual D design credit as described in Section 4.3.7.
- Observe the insulation level for the supply (R_s) and return (R_r) ducts outside the conditioned space as described in Section 4.3.6.
- Observe the presence of radiant barriers.

4.3.3 Duct Surface Area

The supply-side and return-side duct surface areas shall be calculated separately. If the supply or return duct is located in more than one zone, the area of that duct in each zone shall be calculated separately. The duct surface area shall be determined using the following methods.

4.3.3.1 Default Duct Surface Area

4.3.3.1.1 Duct Surface Area for More Than 12 feet of Duct Outside Conditioned Space

The default duct surface area for supply and return shall be calculated as follows:
For supplies:

$$A_{s,total} = 0.27A_{floor} \quad (4.1)$$

For returns:

$$A_{r,total} = K_r \; A_{floor} \quad (4.2)$$

Where K_r (return duct surface area coefficient) shall be 0.05 for one story building and 0.1 for two or more stories.

4.3.3.1.1 Duct Surface Area for Less Than 12 feet of Duct Outside Conditioned Space

For HVAC systems with air handlers located outside the conditioned space but with less than 12 feet of duct located outside the conditioned space including air handler and plenum, the duct surface area outside the conditioned space shall be calculated as follows:

$$A_{s,out} = 0.027 \; A_{floor} \quad (4.3)$$

Where $A_{s,out}$ is substituted for $A_{s,attic}$; $A_{s,crawl}$; or $A_{s,base}$ depending on the location of the ducts.

4.3.3.2 Diagnostic Duct Surface Area

A well designed duct system can reduce the length of the supply duct. Smaller duct surface area will result in reduced duct conduction losses. Duct surface area shall be calculated from measured duct lengths and nominal outside diameters (for round ducts) or outside perimeters (for rectangular ducts) of each duct run in the building. Improved conduction losses can be claimed for reduced supply duct

surface area only (it does not apply to the return duct). Supply plenum surface area shall be included in the supply duct surface area. Diagnostic duct surface area requires measuring duct surface areas separately for each location outside conditioned space ($A_{s,attic}$; $A_{s,crawl}$; or $A_{s,base}$) and the system fan flow to ensure that there is sufficient air flow to deliver the designed heating and cooling loads.

4.3.4 Duct Location

Duct location determines the external temperature for duct conduction losses, the temperature for return leaks, and the thermal regain of duct losses. Default duct surface areas by locations of the supply duct shall be obtained from Table 4.1. The default duct surface area for crawlspace and basement applies only to buildings with all supply ducts installed in the crawlspace or basement. If the supply duct is installed in locations other than crawlspace or basement, the default supply duct location shall be "Other".

If ducts are installed in multiple locations, air distribution efficiency shall be calculated for each duct location. Total air distribution efficiency for the house shall be the weighted average based on the floor area served by each duct system.

Table 4.1 Default Assumptions for Duct Locations

	Supply Duct Surface Area		Return Duct Surface Area	
Supply or Return Duct Location	One story	Two or more story	One story	Two or more story
Attic	100% attic	65% attic 35% conditioned space	100% attic	100% attic
Crawlspace	100% crawlspace	65% crawlspace 35% conditioned space	100% attic	100% attic
Basement	100% Basement	65% basement 35% conditioned space	100% Basement	100% Basement
Other	100% attic	65% attic 35% conditioned space	100% attic	100% attic

4.3.5 Climate and Duct Ambient Conditions for Ducts Outside Conditioned Space

Duct ambient temperature for both heating and cooling at different duct locations shall be obtained from Table 4.2. Indoor dry-bulb (T_{in}) temperature for cooling is 78°F. The indoor dry-bulb temperature for heating is 70°F. Reduction of attic temperature and the reduction in solar radiation effect due to radiant barriers shall only be applied to cooling calculations. The procedures for the installation of radiant barriers shall be as described in ACM Section 4.23. Attic temperatures for houses with radiant barriers shall be obtained from Table 4.2.

Table 4.2 Default Assumptions for Duct Ambient Temperature								
	Duct Ambient Temperature for Heating, $T_{heat,amb}$			Duct Ambient Temperature for Cooling, $T_{cool,amb}$				
Climate zone	**Attic**	**Crawlspace**	**Basement**	**Attic**	**Attic w/ radiant barrier (supply)**	**Attic w/ radiant barrier (return)**	**Crawlspace**	**Basement**
1	52.0	52.2	48.9	60.0	65.4	61.2	54.0	49.1
2	48.0	48.7	56.5	87.0	84.3	84.2	78.0	64.5
3	55.0	54.9	58.3	80.0	79.4	78.2	71.8	62.8
4	53.0	53.1	56.6	79.0	78.7	77.4	70.9	61.4
5	49.0	49.6	52.3	74.0	75.2	73.1	66.4	56.8
6	57.0	56.7	59.9	81.0	80.1	79.1	72.7	64.1
7	62.0	61.1	60.4	74.0	75.2	73.1	66.4	61.6
8	58.0	57.6	60.1	80.0	79.4	78.2	71.8	63.9
9	53.0	53.1	59.6	87.0	84.3	84.2	78.0	66.4
10	53.0	53.1	61.1	91.0	87.1	87.6	81.6	68.9
11	48.0	48.7	59.5	95.0	89.9	91.0	85.1	69.5
12	50.0	50.4	59.3	91.0	87.1	87.6	81.6	67.8
13	48.0	48.7	58.4	92.0	87.8	88.4	82.4	67.6
14	39.0	40.7	55.4	99.0	92.7	94.4	88.7	68.6
15	50.0	50.4	63.4	102.	94.8	96.9	91.3	74.6
16	32.0	34.4	43.9	80.0	79.4	78.2	71.8	54.1

4.3.6 Duct Wall Thermal Resistance

4.3.6.1 Default Duct Insulation R value

Default duct wall thermal resistance is R4.2. An air film resistance of 0.7 [h ft^2 ^oF/BTU] shall be added to the duct insulation R value to account for external and internal film resistance.

4.3.6.2 Diagnostic Duct Wall Thermal Resistance

Duct wall thermal resistance shall be determined from the manufacturer's specification observed during diagnostic inspection. If ducts with multiple R values are installed, the lowest duct R value shall be used. If a duct with a higher R value than 4.2 is installed, the R-value shall be clearly stated on the building plan and a visual inspection of the ducts must be performed to verify the insulation values. In case the space on top of the duct boot is limited and can not be inspected, the insulation R value within two feet of the boot to which the duct is connected may be excluded from the determination of the overall system R value.

4.3.7 System Fan Flow

4.3.7.1 Default Fan Flow

The default cooling fan flow with an air conditioner and for heating with a heat pump for **climate zones 8 through 15** shall be calculated as follows:

$$Q_e = 0.70\ A_{floor} \quad (4.4)$$

The default cooling fan flow with an air conditioner and for heating with a heat pump for **climate zones 1 through 7 and 16** and default heating fan flow for forced air furnaces for all climate zones shall be calculated as follows:

$$Q_e = 0.50\ A_{floor} \quad (4.5)$$

4.3.7.2 Diagnostic Fan Flow

To obtain duct efficiency credit for duct systems designed according to ACCA Manual D, a diagnostic fan flow measurement must be performed or the installation of a thermostatic expansion valve must be verified. The access panel on the cooling coil shall be removable for the verification of a thermostatic expansion valve. For ACCA Manual D designed duct system, engineering calculations and the building plan for duct sizing and layout shall also be prepared. The diagnostic fan flow measurement shall be measured using one of the following methods:

4.3.7.2.1 Diagnostic Fan Flow Using Flow Hood:

To measure the system return fan flow, all registers shall be fully open, and the air filter shall be installed. Turn on the system fan and measure the fan flow at the return grille(s) with a calibrated flow hood to determine the total system return fan flow. The system fan flow (Q_e) shall be the sum of the measured return flows.

4.3.7.2.2 Diagnostic Fan Flow Using Plenum Pressure Matching:

The fan flow measurement shall be performed using the following procedures:

1. With the system fan on (in heating mode with burners on for heating, or in cooling mode with compressor on), measure the pressure difference (in pascal) between the supply plenum and the conditioned space (ΔP_{sp}). P_{sp} is the target pressure to be maintained during the fan flow tests. If there is no access to the supply plenum, then place the pressure probe in the nearest supply duct. Adjust the probe to achieve the highest pressure and then firmly attach the probe (e.g., with duct tape) to ensure that it does not move during the fan flow test.
2. Block the return duct from the plenum upstream of the air handler fan and the fan flowmeter. Filters are often located in an ideal location for this blockage.
3. Attach the fan flowmeter device to the duct system at the air handler. For many air handlers, there will be a removable section that allows access to the fan that is suitable for this purpose. Assure that there is no significant leakage between the fan flowmeter and the system fan.

4. If the fan flowmeter is connected to the air handler outside the conditioned space, then the door or access panel between the conditioned space and the air handler location shall be opened.
5. Turn on the system fan and the fan flowmeter, adjust the fan flowmeter until the pressure between supply plenum and conditioned space matches P_{sp}.
6. Record the flow through the flowmeter (Q_e, cfm) - this is the diagnostic fan flow.

In some systems, typical system fan and fan flowmeter combinations may not be able to produce enough flow to reach P_{sp}. In this case record the maximum flow (Q_{max}, cfm) and pressure (P_{max}) between the supply plenum and the conditioned space. The following equation shall be used to correct measured system flow and pressure (Q_{max} and P_{max}) to operating condition (Q_e) at operating pressure (P_{sp}).

$$Q_e = Q_{max}\left(\frac{P_{sp}}{P_{max}}\right)^{\frac{1}{2}} \qquad (4.6)$$

4.3.8 Duct Leakage

4.3.8.1 Duct Leakage Factor for Delivery Effectiveness Calculations

Default duct leakage factors shall be obtained from Table 4.3, using the "not Tested" values. Duct leakage factors shown in Table 4.3 shall be used in calculations of delivery effectiveness.

Table 4.3 Duct Leakage Factors

	Duct Leakage Diagnostic Test Performed using Section 4.3.8.2 Procedures	$a_s = a_r =$
Duct systems in homes built prior to 1999	Not tested	0.86
Duct systems in homes built after 1999	Not tested	0.89
Duct systems in homes of all ages, System with refrigerant based cooling, tested after house and HVAC system completion	(Q_{25}) Total leakage is less than 0.06 Q_{ecool}	0.96
Duct systems in homes of all ages, System without refrigerant based cooling, tested after house and HVAC system completion	(Q_{25}) Total leakage is less than 0.06 Q_{eheat}	0.96
Duct systems with refrigerant based cooling, in homes built after 1999, System tested with air handler installed, but prior to installation of the interior finishing wall	(Q_{25}) Total leakage is less than 0.06 Q_{ecool} and final duct integrity verified	0.96
Duct systems without refrigerant based cooling, in homes built after 1999, System tested with air handler installed, but prior to installation of the interior finishing wall	(Q_{25}) Total leakage is less than 0.06 Q_{eheat} and final duct integrity verified	0.96
Duct systems with refrigerant based cooling, in homes built after 1999, System tested without air handler installed, but prior to installation of the interior finishing wall	(Q_{25}) Total leakage is less than 0.04 Q_{ecool} and final duct integrity verified	0.96
Duct systems without refrigerant based cooling, in homes built after 1999, System tested without air handler installed, but prior to installation of the interior finishing wall	(Q_{25}) Total leakage is less than 0.04 Q_{eheat} and final duct integrity verified	0.96

4.3.8.2 Diagnostic Duct Leakage

Diagnostic duct leakage measurement is used to quantify total leakage for the calculation of air distribution efficiency. To obtain the improved duct efficiency for sealing the duct system, a diagnostic leakage test as described in section 4.3.8.2.1 or 4.3.8.2.2 must be performed. Houses built after 1/1/1999 shall not be allowed to claim duct leakage credit and diagnostic testing may not be done on any HVAC system that uses building cavities such as plenums or a platform return.

4.3.8.2.1 Diagnostic Duct Leakage from Fan Pressurization of Ducts

The total duct leakage shall be determined by pressurizing the ducts to 25 Pascals. The following procedure shall be used for the fan pressurization tests:

1. Seal all the supply and return registers, except for one return register or the system fan access.
2. Attach the fan flowmeter device to the duct system at the unsealed register or access door.
3. Install a static pressure probe at a supply.
4. Adjust the fan flowmeter to produce a 25 Pascal (0.1 in water) pressure difference between the supply duct and the outside or the building space with the entry door open to the outside.
5. Record the flow through the flowmeter ($Q_{total,25}$) - this is the total duct leakage flow at 25 Pascals.

When the diagnostic leakage test is performed and the measured total duct leakage is less than 6% of the total fan flow, the duct leakage factor shall be 0.96 as shown in Table 4.3.

4.3.8.2.2 Diagnostic Duct Leakage at Rough-in Construction Stage Using An Aerosol Sealant Closure System

Duct leakage in new construction may be determined by using diagnostic measurements at the rough-in building construction stage prior to installation of the interior finishing wall when using an aerosol sealant closure system. When using this measurement technique, additional verification (as described in section 4.3.8.2.2.3) of duct integrity shall be completed after the finishing wall has been installed. In addition, after the finishing wall is installed, spaces between the register boots and the wallboard shall be sealed. Cloth backed rubber adhesive duct tapes shall not be used to seal the space between the register boot and the wall board.

The duct leakage measurement at rough-in construction stage shall be performed using a fan pressurization device. The duct leakage shall be determined by pressurizing both the supply and return ducts to 25 Pa. The procedures in Sections 4.3.8.2.2.1 and 4.3.8.2.2.2 shall be used for measuring duct leakage before the interior finishing wall is installed.

4.3.8.2.2.1 For ducts with the air handling unit installed and connected:

For total leakage:

1. Verify that supply and return plenums and all the connectors, transition pieces and duct boots have been installed. If a platform is used as part of the air distribution system, it must contain a duct, and all

return connectors and transition parts shall be installed and sealed. The platform, duct and connectors shall be included in the total leakage test.
2. Seal all the supply duct boots and return boxes except for one return duct box.
3. Attach the fan flowmeter device at the unsealed duct box.
4. Insert a static pressure probe at one of the sealed supply duct boots.
5. Adjust the fan flowmeter to maintain 25 Pa(0.1 in water)between the duct system and outside or the building space with the entry door open to the outside.
6. Record the air flow through the flowmeter ($Q_{total,25}$) - This is the total duct leakage at 25 Pa at rough-in stage.
7. Divide the measured total leakage by the total fan flow calculated from equation 4.4 or 4.5.

If the total leakage is less than 6% of the total fan flow, the duct leakage factor shall be 0.96 as shown in Table 4.3.

4.3.8.2.2.2 For ducts with air handling unit not yet installed:
For total leakage:
1. Verify that all the connectors, transition pieces and duct boots have been installed. If a platform is used as part of the air distribution system, it must contain a duct, and all return connectors and transition parts shall be installed and sealed. The platform, duct and connectors shall be included in the total leakage test.
2. Use a duct connector to connect supply and/or return duct box to the fan flowmeter. Supply and return leaks may be tested separately. If there is only one return register, the supply and return leaks shall be tested at the same time.
3. Seal all the supply duct boots and/or return boxes except for one supply or return duct box.
4. Attach the fan flowmeter device at the unsealed duct box.
5. Insert a static pressure probe at one of the sealed supply duct boots.
6. Adjust the fan flowmeter to maintain 25 Pa (0.1 in water) between the building conditioned space and the duct system.
7. Record the air flow through the flowmeter ($Q_{total,25}$) - This is the total duct leakage at 25 Pa.
8. Divide the measured total leakage by the total fan flow calculated from equation 4.4 or 4.5. If the total leakage is less than 4% of the total fan flow, the total duct leakage factor shall be 0.96 as shown in Table 4.3.

4.3.8.2.2.3 Post rough-in duct leakage verification
After installing the interior finishing wall and verifying that one of the above rough-in tests was completed, one of the following post rough-in verification tests shall be performed to ensure that there is no major leakage in the duct system.

4.3.8.2.2.3.1 Visual inspection
Remove at least one supply and one return register to verify that the spaces between the register boot and the interior finishing wall are properly sealed. In addition, if the house rough-in duct leakage test was conducted without an air handler installed, inspect the connection points between the air handler

and the supply and return plenums to verify that the connection points are properly sealed. All joints shall be inspected to ensure that no cloth backed rubber adhesive duct tape is used.

4.3.8.2.2.3.2 Pressure pan test

With register dampers fully open, the house is pressurized to 25 pascals by a blower door, (If two registers are within 5 feet of each other and are connected to the same duct run, one register shall be sealed off before the pressure pan test is performed). the pressure difference across each register shall not exceed 1.5 Pa.

4.3.8.2.2.3.3 House Pressure Test

The pressure difference between the building conditioned space and a vented attic shall be measured to determine whether the house pressure is changed appreciably by the operation of the air handler. To perform this test, the pressure difference (P_{house}- P_{out}) between the building conditioned space and a vented attic (or outside if impossible to access the attic), shall be measured four times:

1. with the fan off (ΔP_{off1})
2. with the fan on (ΔP_{on})
3. with the fan on and the return grille 80% blocked (ΔP_{RB}). Block 80% on all return grilles if the house has two or more returns.
4. with the fan off (ΔP_{off2})

For each of these measurements, the five-second average pressure shall be measured 10 times and these 10 measurements shall be averaged.

For the house to pass this test, the following conditions must be true:

1. ΔP_{on} -(ΔP_{off2}+ ΔP_{off1})/2 must be between +0.8 Pa and -0.8 Pa and
2 ΔP_{RB} - ΔP_{on} must be less than 0.8 Pa.

In addition, the absolute value of (ΔP_{off2} - ΔP_{off1}) must be less than 0.25 Pa, or else the test must be repeated. If the repeated test does not meet the above specified values, visual inspection or the pressure pan test or the fan pressurization test must be used. If these tests fail, the duct system needs to be properly sealed and re-verified by a fan pressurization test.

4.4 Delivery Effectiveness (DE) Calculations

Seasonal delivery effectiveness shall be calculated using the seasonal design temperatures from Tables 4.2.

4.4.1 Calculation of Duct Zone Temperatures

The temperatures of the duct zones outside the conditioned space are determined in Section 4.3.5 for seasonal conditions for both heating and cooling. If the ducts are not all in the same location, the duct ambient temperature for use in the delivery effectiveness and distribution system efficiency calculations shall be determined using an area weighted average of the duct zone temperatures:

$$T_{amb,s} = \frac{(A_{s,attic} + 0.001)T_{attic} + A_{s,crawl}T_{crawl} + A_{s,base}T_{base}}{A_{s,out} + 0.001} \quad (4.7)$$

$$T_{amb,r} = \frac{A_{r,attic}T_{attic} + A_{r,crawl}T_{crawl} + A_{r,base}T_{base}}{A_{r,out}} \quad (4.8)$$

The return ambient temperature, $T_{amb,r}$, shall be limited as follows:
For heating, the maximum $T_{amb,r}$ is $T_{in,heat}$. For cooling, the minimum $T_{amb,r}$ is $T_{in,cool}$.

$$T_{amb,r} = \frac{T_{design} - 16^{o}F + \frac{\sum_{i=\text{duct location}}^{\substack{\text{all return duct locations} \\ \text{outside conditioned space}}} A_i T_i}{A_r}}{2} \quad (4.20b)$$

4.4.2 Seasonal Delivery Effectiveness (DE)

The supply and return conduction fractions, B_s and B_r, shall be calculated as follows:

$$B_s = \exp\left(\frac{-A_{s,out}}{1.08 Q_e R_s}\right) \quad (4.9)$$

$$B_r = \exp\left(\frac{-A_{r,out}}{1.08 Q_e R_r}\right) \quad (4.10)$$

The temperature difference across the heat exchanger in the following equation is used:
for heating:

$$\Delta T_e = 55 \quad (4.11)$$

for cooling:

$$\Delta T_e = -20 \quad (4.12)$$

The temperature difference between the building conditioned space and the ambient temperature surrounding the supply, ΔT_s, and return, ΔT_r, shall be calculated using the indoor and the duct ambient temperatures.

$$\Delta T_s = T_{in} - T_{amb,s} \quad (4.13)$$

$$\Delta T_r = T_{in} - T_{amb,r} \quad (4.14)$$

The seasonal delivery effectiveness for heating or cooling systems shall be calculated using:

$$DE_{seasonal} = a_s B_s - a_s B_s (1 - B_r a_r) \frac{\Delta T_r}{\Delta T_e} - a_s (1 - B_s) \frac{\Delta T_s}{\Delta T_e} \qquad (4.15)$$

1

4.5 Seasonal Distribution System Efficiency

Seasonal distribution system efficiency shall be calculated using delivery effectiveness, equipment, load, and recovery factors calculated for seasonal conditions.

4.5.1 Equipment Efficiency Factor (F_{equip})

Equipment efficiency factor accounts for interactions between the duct system and the operation of the heating or cooling equipment. If the duct size and layout are designed and installed according to ACCA manual D and if the fan flow measurement meets the design specifications, the efficiency factor for F_{equip} is 1. Otherwise F_{equip} shall be 0.925. For heating, F_{equip} is 1.

4.5.2 Thermal Regain (F_{regain})

The reduction in building load due to regain of duct losses shall be calculated using the thermal regain factor. The default thermal regain factors are provided in Table 4.4.

Table 4.4 Thermal Regain Factors

Supply Duct Location	Thermal Regain Factor [F_{regain}]
Attic	0.10
Crawlspace	0.12
Basement	0.30
Other	0.10

4.5.3 Recovery Factor (F_{recov})

The recovery factor, F_{recov}, is calculated based on the thermal regain factor, F_{regain}, and the duct losses without return leakage.

$$F_{recov} = 1 + F_{regain} \left(\frac{1 - a_s B_s + a_s B_s (1 - B_r) \frac{\Delta T_r}{\Delta T_e} + a_s (1 - B_s) \frac{\Delta T_s}{\Delta T_e}}{DE_{seasonal}} \right) \qquad (4.16)$$

4.5.4 Seasonal Distribution System Efficiency

The seasonal distribution system efficiency shall be calculated using the seasonal delivery effectiveness from section 4.4.2~~ or 4.4.3~~, the equipment efficiency factor from section 4.5.1~~, the load factor from section 4.5.3~~ and the thermal recovery factor from Section 4.5.3~~4~~. Note that $DE_{seasonal}$, F_{equip}, F_{recov} must be calculated separately for cooling and heating conditions. Distribution system efficiency shall be determined using the following equation:

$$\eta_{dist,seasonal} = 0.98\ DE_{seasonal}\ F_{equip}\ F_{recov} \qquad (4.17)$$

where 0.98 accounts for the energy losses from heating and cooling the duct thermal mass.

APPENDIX G

APPENDIX G

APPLICATION PACKAGE FOR CERTIFICATION OF SOLAR WATER HEATING ENERGY PERFORMANCE CALCULATION METHODS FOR RESIDENTIAL BUILDINGS

California Energy Commission

1516 Ninth Street

Sacramento California 95814

June 25, 1985

Revision: June 1, 1998

TABLE OF CONTENTS

Page

I. Introduction. 3

II. Application Package Requirements 5

III. Specific Criteria for Certification ..... ~~6~~7

IV. Alternative Modeling Parameters 7

V. Fixed Input Parameters 7

VI. Program Reference Information 8

VII. Certification Forms 10

VIII. A~~ppendix~~ttachments ..... 1~~1~~5

I. INTRODUCTION

On July 15, 1981 the California Energy Commission (CEC) adopted new standards for residential buildings that include a performance or energy budget approach for demonstrating compliance. The new building standards were devised to reduce energy consumption in the housing market through the use of more efficient appliances and greater utilization of conservation and solar design technologies.

These performance standards establish energy budgets for both the space conditioning and water heating elements of a proposed building. One option for demonstrating compliance requires the designer to calculate the building's estimated annual energy use using a certified energy analysis calculation method in conjunction with established weather and building operation information. Solar domestic hot water systems are an integral part of these standards and can be used to demonstrate compliance with the water heating element. For typical flat plate solar collector systems as used in active solar water heating systems, the CEC has certified F-Chart 4.0 and 4.1. For all passive type water heating systems, thermosyphon and integral collector/storage (ICS) systems, the CEC has certified a calculation procedure to calculate system total annual energy contribution (Attachment J). Passive solar water heating credits are derived from test results published by the Solar Rating and Certification Corporation (SRCC) in conjunction with climate zone specific weather data for California. Climate zone insolation data and ambient air temperature and water main temperature data are required to calculate passive solar credit. Documentation for each analysis approach can be obtained from the following sources:

F-Chart

Solar Energy Laboratory
University of Wisconsin
Madison, WI 53706
(608)263-1590

Passive Method

California Energy Commission
Residential Office
1516 Ninth Street, MS-25
Sacramento CA 95814-5512

The purpose of this certification package is: (1) to provide a procedure by which other analytical approaches can be used for solar water heating compliance purposes; and (2) to establish a method for certifying their use.

Other methods may be used in lieu of F-Chart 4.0 or 4.1 or the CEC's Passive Solar Heating Calculation Method to demonstrate compliance once they have been certified by the Commission. Section 10-109 (b)(1) of the California Code of Regulations, Energy Efficiency Standards for Residential and Non-residential Buildings, provides that certification may be given if documentation is provided demonstrating that the alternative calculation method:

A. Makes no changes in any input parameter values specified by the Commission;

B. Provides input and output documentation that facilitates the enforcement agency's review and meets the formatting and content criteria found in the appropriate ACM Manual;

C. Is supported by clear and concise instructions for using the method to demonstrate that the energy budget requirements of Part 6 , are met;

D. Is reliable and accurate relative to the appropriate public domain computer program; and

E. Establishes factors that, when applied to method's outputs, result in energy budgets for that alternative calculation method that are equivalent to those in Part 6 , when the buildings used to develop the energy budgets in Part 6 are modeled.

This certification process will be used to verify comparability of computer calculation results against results of the Commission's public domain solar water heating computer programs. An applicant for certification is required to perform three types of simulations in three different California specified climate zones. For those methods which are able to generate water heating budgets, the CEC's assumptions and calculation procedure for establishing the water heating budgets are presented in Section 4.21 of this ACM Manual. Section 4.21.4 considers credits for active and passive solar water heating systems. The completed certification application package must be sent to:

California Energy Commission
1516 Ninth Street, MS-25
Sacramento, CA 95814

Attn: RESIDENTIAL SOLAR WATER HEATING
CALCULATION METHOD CERTIFICATION

Any questions regarding the application package should be directed to the above address or by telephone (916) 654-4064.

Only complete applications for programs meeting the minimum requirements discussed in Section II will be evaluated.

A list of certified programs including a program abstract, an information form, and certified budget forms for each program will be made available and updated periodically as new programs are certified. Write the above address for a current list.

II. APPLICATION PACKAGE REQUIREMENTS

In order to ensure rapid processing of applications it is essential that each application be complete and be presented in a consistent format. Each certification package must contain the following items:

A. Application Form for certification of An Energy Analysis Computer Program (Form 1)

B. Tabulated Sensitivity Runs (Form 2)

C. Program Abstract

D. Table of Fixed Input Parameters and Explanation of Fixed Values

E. Summary of Sensitivity Analysis

F. Program User's Manual

If any one of these elements is missing, processing of the application will be postponed until the missing information is provided.

A. Application Form

Form 1: " Application Form for Certification of an Energy Analysis Computer Program" must be filled out completely. This form will be used by CEC staff to assess the completeness of the application package and to notify the applicant upon certification of the computer program. The applicant may then attach this form with local building department permit requests as verification to local jurisdictions of certification.

B. Tabulated Sensitivity Runs

Form 2: The program's calculated energy performance, based on net solar fractions (NSF) in "Sensitivity Analysis", must be tabulated for easy reference against the base case systems of F-Chart 4.1. Use of this form will ensure consistency in building department and program user interpretation of program results.

C. Program Abstract

This summary will enable building departments to quickly determine if the program is being used in the correct application. The abstract must briefly describe measures the program simulates and the method used for simulation such as hourly calculations, thermal equilibrium, degree days, etc. The description should include types of buildings, solar system types, applicable climate zones, output descriptions (hourly, daily, etc.) and any other features significant to the program.

D. Table of Fixed Input Parameters

This table shall list all input parameters necessary to run the program and provide definitions for their use. Explanations shall also be provided for any parameter which is different than those provided by the reference program F-Chart 4.1. This table will be used to distinguish program characteristics and to identify areas where unit values are not comparable.

E. Program Sensitivity Analysis

The results of each sensitivity analysis run must be provided as support for the summarized data presented in Form 2. Each summary must reference the particular computer input / output runs using a code or some other easily recognized means.

F. Program User's Manual

A program user's guide / manual must be submitted which describes how the program works and how one may use it in a particular computer service facility. The information provided to CEC must include all documentation that would be needed by a user of this method.

The manual must list all of the variables used, provide an explanation of each variable, and explain how to read the input and output data and distinguish their significance. It should also explain how to enter the data to run the program and describe the default values if there are any.

The User's Manual must also contain a separate section / chapter dealing specifically with California Title 24 requirements. This section should include a general description of the Title 24 process, a listing of all fixed parameters, description and listing of California weather data and climate zones and other water heating compliance criteria.

NOTE: In addition to the above certification package requirements, all applicants must submit a copy of the program on the appropriate software (3 2 " diskette) and must be compatible with MS-DOS formats.

III. SPECIFIC CRITERIA FOR CERTIFICATION

1. Input data shall be in a standard format as specified in Attachment A.

2. Output data shall be in a standard format as specified in Attachment B.

3. The discrepancy in each individual run shall not exceed "10% of the result of the same run for F-Chart 4.1.

   Example: If the nth run of F-Chart 4.1 yields .63, then the nth run of an applicant program must yield .63 ".06 or 0.57 to 0.69.

4. Solar system data used for certification runs shall be the same data used from the test for solar equipment certification (SRCC, ARI).

   Example: Collector efficiencies and flow rates specified in the SRCC and ARI Directories must be used for certification runs.

   For program use, flow rates shall be converted from gallons per minute per square foot to pounds per hour per square foot in the following manner:

$$\frac{\text{gal.}}{\text{min}} \times \frac{60\text{ min.}}{\text{hr.}} \times \frac{8.33\text{ lb.}}{\text{gal.}} \times \frac{1}{\text{ft}^2} = \text{flow rate } \frac{\text{lb.}}{\text{hr. ft}^2}$$

5. The average water use profile as given in Attachment C shall be used for certification purposes. No other load profile may be substituted.

IV. ALTERNATIVE MODELING PARAMETERS

Alternative modeling parameters such as storage tank stratification are allowed. They must, however, be completely defined and proven suitable as modeling parameters through calculation and empirical test documentation. Certification runs will exclude alternative modeling parameters.

V. FIXED INPUT PARAMETERS

The following is a list of fixed input parameters for modeling purposes:

1. Water main temperatures (variable, see Table 1).
2. Ambient air temperatures (variable, see Table 1).
3. Minimum hot water set point (140 1F).
4. Hot water demand: 50 gallons per day per unit for single family dwellings, 35 gallons per day per unit for multi-family dwellings.
5. California specific weather, by climate zone (see Attachment I).

6. Auxiliary water heater efficiency
7. Incident angle modifier constant: compliance can be determined by: (a) use of the incidence angle modifier constant, determined experimentally as described in the ASHRAE Standards 96-1980 and 93-1986 collector test procedure and provided by SRCC and ARI in the collector Directory; or (b) setting this parameter to 0.00 and allowing the program to automatically calculate the incident angle modifier using Fresnel equations for the number of glass panes.
8. Ground reflectance: 0.20 (may use up to 0.90 if documented).

Note: See Attachment E for a listing of all certification modeling parameters. Individual sensitivity parameters for computer certification are listed on FORM 2, Section VII of this Appendix.

VI. PROGRAM REFERENCE INFORMATION

The water heating budgets were calculated according to the methodology presented in Section 4.21 of this ACM Manual. Section 4.21.4 considers credits for active and passive solar systems.

The water heating methodology provides all assumptions used to determine the water heating budgets. It documents the method use to determine water heater recovery efficiency and standby losses, and can be used for all conventional gas and electric hot water heaters, as well as heat pump water heaters, instantaneous systems, systems requiring pumping energy and recirculated water, and solar water heating systems.

For purposes of this certification procedure, all programs for certification will be compared against the performance results of the reference F-Chart 4.1 program. However, the applicant is encouraged to thoroughly review Section 4.21 of this manual and this Attachment regarding the CEC's general water heating methodology.

Those areas which are critical to comparing performance results are:

(1) comparing the thermal performance of a solar hot water heating system using fixed system values;

(2) comparing the thermal performance of a solar water heating system using variable system values; and

(3) comparing the thermal performance of a solar water heating system under different weather conditions.

A. Active Systems

All active solar water heating programs shall be compared against the results of F-Chart 4.1. The following parameters must be varied to demonstrate the program's sensitivities (this will result in 21 separate sensitivity runs):

- ✓ Collector efficiency rates
- ✓ Collector area
- ✓ Hot water use (load)
- ✓ Collector orientation
- ✓ Weather

1. Collector Efficiency
   Sensitivity runs shall be made for the following three conditions: Slope (FR-UL Product) and Y-intercept (FR-TAU-ALPHA).
   Slope: .55, .70, and 1.25
   Y-intercept: .75, .65, and .50

2. Collector Area
   Sensitivity runs shall be made for the following two conditions:
   Collector area: 48 sq. ft. and 64 sq. ft.
   The storage tank shall be sized at the ratio of 1.5-2.0 gallons of water storage per square foot of collector area.

3. Hot Water Use
   Sensitivity for the following three conditions:
   Hot water use: 30, 50, and 80 gallons

4. Collector Orientation
   Sensitivity for the following three conditions:
   Collector orientation: South (0"), West (90"), North (180")

5. Weather

   Sensitivity runs shall be made for three California Climate Zones: Zone 5 (Santa Maria), Zone 7 (San Diego), and Zone 13 (Fresno). All solar water heating programs certified for use in the Residential Building Standards must use the weather data as specified in Attachment I.

B. Passive Systems

The CEC has certified a calculation procedure for determining the annual performance of passive solar water heating systems (Attachment J). Passive solar water heating credits are derived from test results published by the Solar Rating and Certification Corporation (SRCC) in conjunction with climate zone specific weather data for California. Climate zone insolation data and ambient air temperature and water main temperature data are required to calculate passive solar credit. Applicants wishing to certify programs to be used for demonstrating compliance for passive type solar water heating systems must provide the CEC with all documentation specified in this certification package. The applicant's analysis methodology will be reviewed by CEC staff against the existing method.

Parameters which all passive solar water heating calculation methods must incorporate are the following:

(1) Qsav rating from SRCC test
(2) L rating from SRCC test.
(3) All fixed parameters as specified in Section V.

Table 2 lists SRCC Qsav, Qcap and L rating for most of the passive solar water heating systems currently listed with SRCC. For those systems that are not listed in the Table please contact SRCC or Florida Solar Energy Center for certification.

Solar Rating and Certification Corporation
c/o FSEC
1679 Clearlake Road
Cocoa, FL 32926
(407) 638-1537
(407) 638-1010 Fax
SRCC@fsec.ucf.edu

VII. CERTIFICATION FORMS

See the attached forms.

Form 1

CALIFORNIA ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

APPLICATION FORM FOR CERTIFICATION OF AN ENERGY ANALYSIS COMPUTER PROGRAM

Part 1: General Information

1. Organization requesting certification:
   Name: _____ Phone: (___) _____
   Address: _____
   _____
   Contact person: _____
   Applicant~~s~~ signature: _____
   Application date: _____

2. Program Name: _____

3. The above named program is to be used for:
   [ ] Space Conditioning [ ] Space Conditioning and Solar Water Heating
   [ ] Solar Water Heating

4. Has the above-named program ever been used to analyze the energy use of a new residential building in California? [ ] YES [ ] NO

For Staff Use Only. Do Not Write Below These Lines.

---

1. Date received: _____

2. Application checklist:

	Complete	Incomplete
Form 1	_____	_____
Form 2	_____	_____
Program Abstract	_____	_____
Fixed Input Parameters	_____	_____
Sensitivity Summary	_____	_____
User's Manual	_____	_____

3. Comments: _____
   _____
   _____

---

4. The above named program is certified for use in demonstrating compliance for California's Residential Building Regulations: [ ] YES [ ] NO

5. Staff signature: _____ Date: _____

6. Executive Director approval: _____ Date: _____

Form 2

SENSITIVITY ANALYSIS
FOR INTERIM CERTIFICATION OF A SOLAR WATER HEATING ENERGY ANALYSIS COMPUTER PROGRAM

Program Name: _____
Organization Name: _____
Applicant Name: _____

Run	Collector Area (sq.ft.)	Slope (FR-UL)	Y-intercept (FR-TAU-ALPHA)	Hot Water Use (Gal.)	Climate Zone	Annual S (0°)	F-Chart W (90°)	N (180°)	Comparison Program
1	48	.70	.65	50	5	.60			
2	48	.70	.65	50	7	.63			
3	48	.70	.65	50	13	.67			
4	48	.55	.75	50	5	.74			
5	48	.55	.75	50	7	.77			
6	48	.55	.75	50	13	.77			
7	48	1.25	.50	50	5	.37			
8	48	1.25	.50	50	7	.38			
9	48	1.25	.50	50	13	.44			
10	64	.70	.65	50	5	.71			
11	64	.70	.65	50	7	.74			
12	64	.70	.65	50	13	.76			
13	48	.70	.65	30	5	.72			
14	48	.70	.65	30	7	.75			
15	48	.70	.65	30	13	.77			
16	48	.70	.65	80	5	.48			
17	48	.70	.65	80	7	.50			
18	48	.70	.65	80	13	.55			
19	48	.70	.65	50	5		.53	.42	
20	48	.70	.65	50	7		.55	.44	
21	48	.70	.65	50	13		.60	.48	
22	48	.70	.65	50	5				
23	48	.70	.65	50	7				
24	48	.70	.65	50	13				

TABLE 1

Solar Radiation

Climate Zone	Average Daily Temperature (°F)	Btu/ft^2/day on horizontal surface	Btu/ft^2/day on tilted surface*	Average Water Main Temperatures (°F)
1	52.1	1,241	1,340	60
2	57.9	1,535	1,658	65
3	56.9	1,559	1,684	65
4	59.6	1,606	1,734	65
5	60.3	1,623	1,753	65
6	63.5	1,596	1,724	70
7	62.9	1,619	1,748	70
8	63.0	1,637	1,768	70
9	63.6	1,618	1,747	70
10	63.3	1,777	1,919	70
11	62.8	1,580	1,706	65
12	60.3	1,641	1,772	65
13	62.3	1,708	1,845	65
14	55.9	1,841	1,988	65
15	72.6	1,858	2,007	70
16	42.8	1,656	1,788	60

* These values represent the correction for tilted surface based upon the ratio multiplier (1.08) of total horizontal radiation to total south facing radiation on a 30° tilt.

Table 2
Input Parameters for Passive Solar Water Heating Systems

Company	Model	ID #	Volume (gal)	L (Btu/hr-F)	Q Save (Btu/day)	Q cap (Btu)
Radco	CSHX60	94006A	60	5.3	20131	22466
Radco	CSHX80	94006B	80	6.8	23238	22466
Radco	CSHX100	94006C	100	8.4	24865	22466
Radco	CSHX40	94006D	40	3.8	15928	22466
SunEarth	CC-30	92011A	32	13.5	19889	22466
SunEarth	CC-40	92011B	42	17.0	22728	22466
SunEarth	CC-60P	92011C	64	28.4	28564	22466
SunEarth	CC-60S	92011D	64	16.8	28564	22466
SunEarth	CP-30	92011E	32	16.0	20016	22466
SunEarth	CP-40	92011F	42	20.1	22700	22466
SunEarth	CP-60P	92011G	64	33.6	27951	22466
SunEarth	CP-60S	92011H	64	16.8	28561	22466
TCT	PT-30-CN	95002A	30	13.7	21416	22466
TCT	PT-35-CN	95002B	35	13.7	21388	22466
TCT	PT-40-CN	95002C	40	17.7	26047	22466
TCT	PT-50-CN	95002D	50	17.7	25872	22466

Qsave = Energy Savings
L = Heat Loss Coefficient, UA
Qcap = Storage capacity of tank at 131°F

VIII. ATTACHMENTS

Attachment		**Page**
A	Standard Input	16
B	Standard Output	17
C	Water Use Profile	18
D	Examples of Solar Water Heating Systems	19
E	F-Chart 4.1 Computer Certification Base Case Input Parameters	21
F	F-Chart 4.1 Default Parameters	22
G	F-Chart 4.0 Input Parameters for the Solar Sizing Charts Pursuant to the Residential Building Standards	~~24~~25
H	F-Chart 4.0 Assumptions Used for Residential Solar Domestic Hot Water Sizing Tables	~~25~~26
I	Climate Zone Weather Data	~~26~~27
J	Alternative Calculation Method for Passive Solar Credit	~~31~~33

ATTACHMENT A

STANDARD INPUT

The input parameters shall be listed under the appropriate headings for clarity. When listing the parameters all units shall be specified. The following is a list of headings that shall be used:

1. Collector Parameter
2. Collector-Store-Transfer
3. Storage Unit
4. Load Parameters
5. Loss Correction
6. Weather

Additional parameters such as economic and auxiliary parameters may be used but shall be listed after the parameters listed above.

ATTACHMENT B

STANDARD OUTPUT

The standard output to be used for computer program certification purposes is defined as the solar contribution to the hot water load (including backup tank losses). This output shall be provided by all solar computer programs in kBtu/yr. Other system parameters may be shown on the standard data summary output summary but each output must contain at least the following:

System Type (See Attachment D) _____
Annual Delivered Energy _____KBtu/yr.
California Climate Zone _____

THERMAL PERFORMANCE

HT (MMBTU)	TA (°F)	HWLOAD (MMBTU)	QU (MMBTU)	QLOSS (MMBTU)	FDHW
	*		*	*	

Other output may be added here.

ATTACHMENT C

WATER USE PROFILE

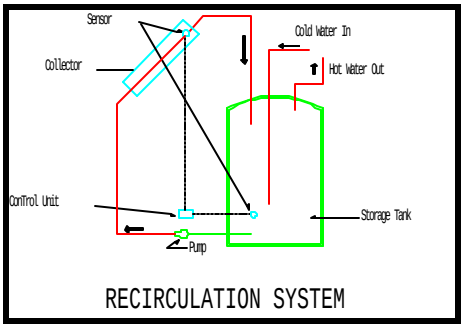
The following Table is a load profile of average water use by the hour for a given day. This must be a basic assumption in the calculations of an applicant's computer program.

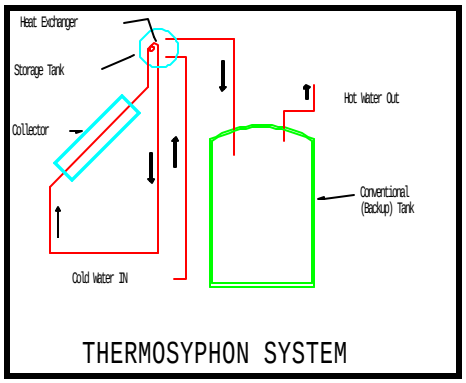
Time of Day	% of Daily Water Use	Time of Day	% of Daily Water Use
1AM	0	1PM	5.5
2AM	0	2PM	2.8
3AM	0	3PM	2.6
4AM	0	4PM	2.2
5AM	0	5PM	3.7
6AM	1.4	6PM	7.2
7AM	4.7	7PM	12.2
8AM	7.5	8PM	9.6
9AM	8.7	9PM	7.2
10AM	7.2	10PM	5.5
11AM	4.4	11PM	4.7
12PM	3.7	12AM	2.0

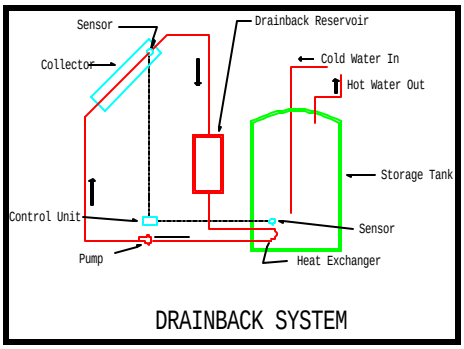
Average Time Distribution Of Water Usage is derived from Beckman, Klein, Duffie; Solar Heating Design By the F-Chart Method, John Wiley & Sons, Inc., New York, 1977, p.56.

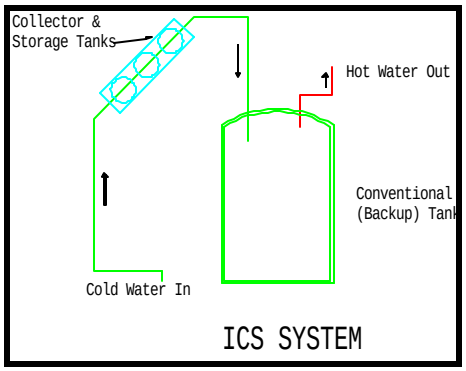
ATTACHMENT D

TYPICAL SOLAR WATER HEATING SYSTEMS



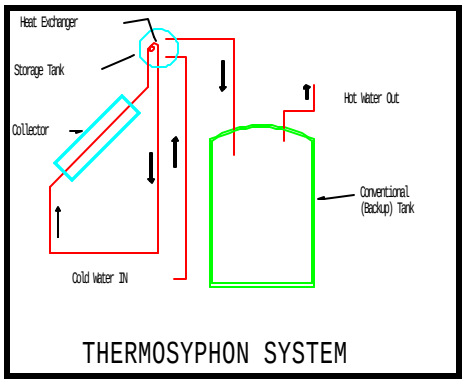






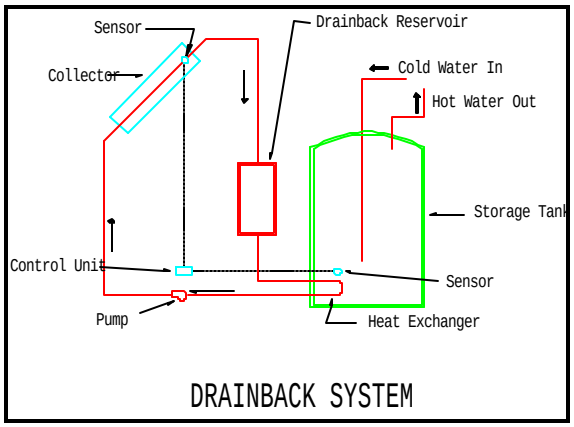
DIRECT ACTIVE SYSTEMS

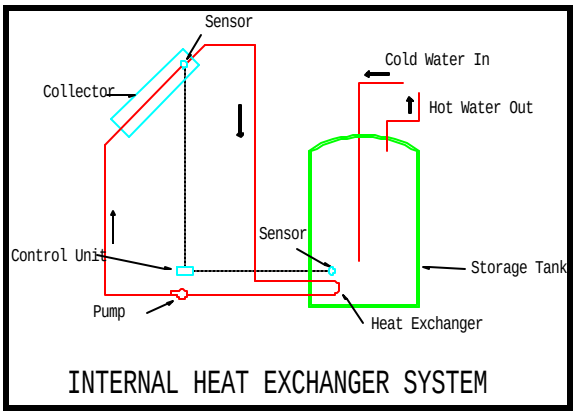
DIRECT PASSIVE SYSTEMS

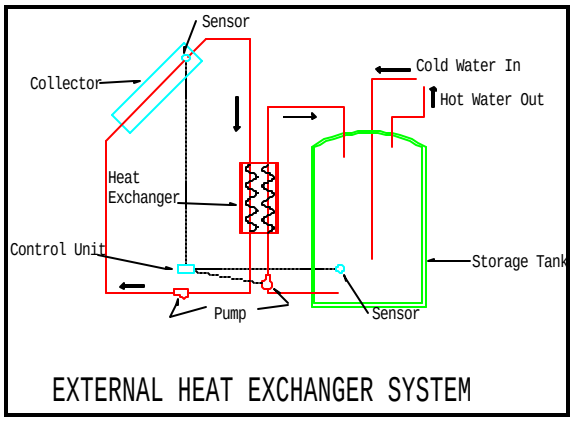


INDIRECT PASSIVE SYSTEMS

ATTACHMENT D -- cont'd.







INDIRECT ACTIVE SYSTEMS

ATTACHMENT E

F-Chart 4.1 Base Case Input Parameters

COLLECTOR PARAMETERS

C1. COLLECTOR AREA 48.00 FT2
C2. FR-UL PRODUCT..... .70 BTU/HR-FT2-DEG F
C3. FR-TAU-ALPHA (NORMAL INCIDENCE)..... .65
C6. NUMBER OF CURVERS..... 1.00
C7. INDEX OF REFRACTION..... 1.53
C8. EXTINCTION COEFFICIENT × LENGTH (KL) ..... .04
C9. INCIDENCE ANGLE MODIFIER CONSTANT ..... .00
C10. COLLECTOR FLOW RATE * SPECIFIC HEAT/AREA .. 9.69 BTU/HR-FT2-DEG F
C12. COLLECTOR SLOPE..... 18.50 DEGREES
C13. COLLECTOR AZIMUTH..... .00 DEGREES
C14. GROUND REFLECTANCE..... .20
C15. INCIDENCE ANGLE MODIFIERS (10, 20, 30, 40, 50, 60, 70, 80, DEG.)
1.00 .99 .98 .95 .90 .80 .63 .37

COLLECTOR-STORE TRANSFER PARAMETERS

T2. UA OF COLLECTOR INLET PIPE OR DUCT..... 4.25 BTU/HR-DEG F
T3. UA OF COLLECTOR OUTLET PIPE OR DUCT ..... 4.25 BTU/HR-DEG F

STORAGE UNIT PARAMETERS

S1. TANK CAPACITY/COLLECTOR AREA ..... 13.88 BTU/DEG F-FT2
S2. STORAGE UNIT HEIGHT/DIAMETER RATIO 2.00
S3. HEAT LOSS COEFFICIENT ..... 08 BTU/HR-FT2-DEG F
S4. ENVIRONMENT TEMP. (-1000 FOR TENV=TAMB) 68.00 DEG F
S5. HOT WATER AUXILIARY TANK UA..... 13.45 BTU/HR-DEG F
S6. HOT WATER AUX TANK ENVIRONMENT TEMP.... 68.00 DEG F

LOAD PARAMETERS

L3. HOT WATER USE ..... 50.00 GALLONS/DAY
L4. HOT WATER SET TEMPERATURE ..... 140.00 DEG F
L5. WATER MAINS TEMPERATU7E..... 65.00 DEG F

AUXILIARY PARAMETERS

A3. HOT WATER AUXILIARY FUEL
(1=GAS, 2=ELEC, 3=OIL) ..... 1.
A4. AUXILIARY WATER HEATER EFFICIENCY..... .76

ATTACHMENT F

F-Chart 4.1 Default Parameters

COLLECTOR PARAMETERS

C1. COLLECTOR AREA..... 538.20 FT2
C2. FR-UL PRODUCT ..... .74 BTU/HR-FT2-DEG F
C3. FR-TAU-ALPHA (NORMAL INCIDENCE) 70
C4. CONCENTRATION RATIO 2.00
C5. CPC ACCEPTANCE HALF-ANGLE..... 30.00 DEGREES
C6. NUMBER OF COVERS (IF 0, CIS IS USED)..... 2.00
C7. INDEX OF REFRACTION..... 1.53
C8. EXTINCTION COEFFICIENT X LENGTH (KL) ..... .04
C9. INC. ANGLE MOD. CONSTANT (IF 0, C6-C USED)..... .00
C10. COLLECTOR FLOW RATE & SPECIFIC HEAT/AREA..... 9.69 BTU/HR-FT2-DEG F
C11. TRACKING AXIS (1=EW, 2=NS, 3=2-AXIS)..... 3.00
C12. COLLECTOR SLOPE..... 43.00 DEGREES
C13. COLLECTOR AZIMUTH..... .00 DEGREES
C14. GROUND REFLECTANCE ..... .20
C15. INCIDENCE ANGLE MODIFIERS (10, 20, 30, 40, 50, 60, 70, 80 DEG.)
1.00 .99 .98 .95 .90 .80 .63 .37

COLLECTOR-STORE TRANSFER PARAMETERS

T1. EPS-CHIN OF COLLECTOR-STORE HX/COLLECTOR AREA 9.69 BTU/HR-FT2-DEG F
T2. UA OF COLLECTOR INLET PIPE OR DUCT ..... .00 BTU/HR-DEG F
T3. UA OF COLLECTOR OUTLET PIPE OR DUCT..... .00 BTU/HR-DEG F
T4. COLLECTOR DUCT LEAK RATE (PER CENT)..... 15.00
T5. DUCT LEAK LOCATION (1=INLET, 2=OUTLET, 3=BOTH)..... 3.00

STORAGE UNIT PARAMETERS

S1. TANK CAPACITY/COLLECTOR AREA..... 17.12 BTU/DEG F-T2
S2. STORAGE UNIT HEIGHT/DIAMETER RATIO..... 2.00
S3. HEAT LOSS COEFFICIENT ..... .09 BTU/HR-FT2-DEG F
S4. ENVIRONMENT TEMPERATURE (-1000 FOR TENV=TAMB).. 68.00 DEG F
S5. HOT WATER AUXILIARY TANK UA ..... 7.58 BTU/HR-DEG F
S6. HOT WATER AUX TANK ENVIRONMENT TEMPERATURE..... 68.00 DEG F
S7. ROCK BED CAPACITY/COLLECTOR AREA..... 17.12 BTU/DEG F-T2
S8. PHASE-CHANGE VOLUME/COLLECTOR AREA (X1000) 246.07 FT3/FT2
S9. PHASE-CHANGE MATERIAL DENSITY 91.15 LB/FT3
S10. VOID FRACTION..... .25
S11. SOLID PHASE SPECIFIC HEAT..... .46 BTU/LB-DEG F
S12. LIQUID PHASE SPECIFIC HEAT ..... .78 BTULB-DEG F
S13. HEAT OF MELTING..... 107.94 BTU/LB
S14. MELTING TEMPERATURE..... 89.60 DEG F

ATTACHMENT F-cont'd

DELIVERY DEVICE PARAMETERS

D1.	EPS-CHIN OF LOAD HEAT EXCHANGER	2274.72 BTU/HR-DEG F
D2.	MINIMUM TEMPERATURE FOR HX OPERATION	68.00 DEG F
D3.	DELIVERY HEAT PUMP NUMBER	2.00
D4.	MINIMUM HEAT PUMP ABSORBER TEMPERATURE	50.00 DEG F
D5.	HEAT PUMP BYPASS TEMPERATURE	104.00 DEG F

LOAD PARAMETERS

L1.	BUILDING UA	521.29 BTU/HR-DEG F
L2.	ROOM TEMPERATURE	68.00 DEG F
L3.	HOT WATER USE	79.26 GALLONS/DAY
L4.	HOT WATER SET TEMPERATURE	140.00 DEG F
L5.	WATER MAINS TEMPERATURE	51.80 DEG F
L6.	TOTAL PROCESS OR SPACE HEATING LOAD	473.90 MBTU/DAY
L7.	HOURS PER DAY	24.00
L8.	LOAD RETURN TEMPERATURE	63.00 DEG F

AUXILIARY PARAMETERS

A1.	AUXILIARY FUEL TYPE (1=GAS, 2=ELEC, 3=OIL)	2.
A2.	AUXILIARY DEVICE EFFICIENT	1.00
A3.	HOT WATER AUXILIARY FUEL (1=GAS, 2=ELEC, 3=OIL)	2.
A4.	AUXILIARY WATER HEATER EFFICIENCY	1.00
A5.	AUXILIARY HEAT PUMP NUMBER	1.

ECONOMIC PARAMETERS

E1.	ECONOMIC OUTPUT DETAIL (1, 2 OR 3)	2.00
E2.	REFERENCE OR COMPARISON SYSTEM (1 OR 2)	1.00
E3.	CALCULATE RATE OF RETURN (YES=1, NO=2)	2.00
E4.	INCOME PRODUCING BUILDING (YES=1, 2=NO)	2.00
E5.	DEPRC: STR, LN,=1, DC,BAL.=2, SM-YR-DGT=3, NONE 4	1.00
E6.	CONSIDER FEDERAL TAX CREDITS (YES=1, 2=NO)	1.00
E7.	LENGTH OF ANALYSIS	20.00 YEARS
E8.	TAX CREDITABLE SYSTEM BASE COST	$6000.00
E9.	NON-TAX CREDITABLE SYSTEM BASE COST	$ .00
E10.	ANNUAL INCREASE IN PURCHASED ENERGY DEMAND	00 %/YR
E11.	TERM OF MORTGAGE	20.00 YEARS
E12.	DOWN PAYMENT	10.00 %
E13.	MORTGAGE ANNUAL INTEREST RATE (% OF ORIG. INV.)	8.00 %
E14.	RESALE VALUE (% OF ORIGINAL INVESTMENT)	.00 %
E15.	ANNUAL NOMINAL (MARKET) DISCOUNT RATE	8.00 %
E16.	EXTRA INSUR., MAINT. IN YEAR 1 (% OF ORIG. INV.)	1.00 %
E17.	ANNUAL % INCREASE IN ABOVE EXPENSES	6.00 %

ATTACHMENT F-cont'd

E18.	EFFECTIVE FEDERAL-STATE INCOME TAX RATE.....	35.00 %
E19.	TRUE PROP. TAX RATE PER $ OF ORIGINAL INVEST.....	2.00 %
E20.	ANNUAL % INCREASE IN PROPERTY TAX RATE.....	6.00 %/YR
E21.	STATE CREDIT IN TIER ONE.....	24.00 %
E22.	STATE CREDIT TIER ONE BREAK.....	$10000.00
E23.	STATE CREDIT IN TIER TWO.....	.00 %
E24.	STATE CREDIT TIER TWO BREAK.....	$10000.00
E25.	USEFUL LIFE FOR DEPREC. PURPOSES.....	20.00 YEARS
E26.	% OF ST. LINE DEP. RATE (DC. BAL. DEPRC.).....	150.00 %

ATTACHMENT G

F-Chart 4.0 Input Parameters
for the Solar Sizing Charts
Pursuant to the Residential Building Standards

COLLECTOR PARAMETERS

C1.	COLLECTOR AREA	VARIES
C2.	FR-UL PRODUCT	VARIES
C3.	FR-TAU-ALPHA (NORMAL INCIDENCE)	VARIES
C6.	NUMBER OF COVERS	1.00
C7.	INDEX OF REFRACTION	1.53
C8.	EXTINCTION COEFFICIENT X LENGTH (KL)	0.04
C9.	INCIDENCE ANGLE MODIFIER CONSTANT	0.0
C10.	COLLECTOR FLOW RATE * SPECIFIC HEAT/AREA	9.69 BTU/HR-FT2-DEG F
C12.	COLLECTOR SLOPE	18.50 DEGREES
C13.	COLLECTOR AZIMUTH	0.00 DEGREES
C14.	GROUND REFLECTANCE	0.20 DEGREES

COLLECTOR-STORE TRANSFER PARAMETERS

T2.	UA OF COLLECTOR INLET PIPE OR DUCT	4.25 BTU/HR/DEG F
T3.	UA OF COLLECTOR OUTLET PIPE OR DUCT	4.25 BTU/HR-DEG F

STORAGE UNIT PARAMETERS

S1.	TANK CAPACITY/COLLECTOR AREA	10.40 BTU/DEG F-FT^2
S2.	STORAGE UNIT HEIGHT/DIAMETER RATIO	2.14
S3.	HEAT LOSS COEFFICIENT	0.08 BTU/HR-FT^2-DEG
S4.	ENVIRONMENT TEMPERATURE (-1000 FOR TENV=TAMB)	68.00 DEG F
S5.	HOT WATER AUXILIARY TANK UA	13.45 BTU/HR-DEG F
S6.	HOT WATER AUX TANK ENVIRONMENT TEMPERATURE	68.00 DEG F

LOAD PARAMETERS

L3.	HOT WATER USE	50.00 GALLONS/DAY
L4.	HOT WATER SET TEMPERATURE	140.00 DEG F
L5.	WATER MAINS TEMPERATURE	VARIES BY CLIMATE ZONE

AUXILIARY PARAMETERS

A3.	HOT WATER AUXILIARY FUEL (1=GAS, 2=ELEC, 3=OIL)	1.
A4.	AUXILIARY WATER HEATER EFFICIENCY	0.76

ATTACHMENT H

F-Chart 4.0 Assumptions
Used for Residential
Solar Domestic Hot Water Sizing Tables

1. Two-tank gas backup solar system

2. C12: collectors are mounted flush on the roof, with a pitch of 4 in 12

3. T2 and T3 assumes heat losses from the collector to storage piping (2.5 feet of outside piping with 3/4 inch insulation, nominal pipe diameter of 3/4 inch; and 15 feet of inside piping with 1/2 inch insulation on the collector inlet).

   T2 = (.31 Btu/hr - ft^2 - $^\circ$F) $\times$ (.6 ft^2/ft) $\times$ 2.5 +
   (.51 Btu/hr - ft^2 - $^\circ$F) $\times$ (.49 ft^2/ft) $\times$ 15

   Therefore

$$T2 = UA = \frac{4.25 Btu}{hr - {}^\circ F}$$

4. S1: 82 gallon storage tank.

5. S5: Assumes pump parasitic losses, backup tank skin and pilot light losses, and corrected for electrical resource energy line losses.

   Pump Energy = 85 W <u>pump</u> $\times$ 6 hrs/day x 365 days/yr x 10,239 Btu/Wh
   = 1,906,000Btu/year

   <u>Tank</u> Standby Losses (include pilot energy loss and standby loss of 3.3 percent/hour) :

$$\left[\ 24h/d - \frac{\left(15.0\times10^6\ Btu/yr\right)}{365d/yr\times40{,}000\,Btu/h}\ \right]\times365d/yr\times\left(8.25Btu/gal\times^\circ F\right)\times.033/h\times40gal\times(140-68)^\circ F$$

   = 6,574,500 Btu/year

Therefore Hot Water Auxiliary Tank UA :

$$\frac{\left(1{,}906{,}000+6{,}574{,}500\right)Btu/year}{8{,}760hour/year\times\left(140-68\right)^\circ F} = UA = 13.45\ \text{Btu/hr-}^\circ\text{F}$$

6. L3: Household hot water load - 50 gal./day

7. L4: Hot water set temperature - 140°F.

8. A4: Gas backup tank efficiency - 76%

ATTACHMENT I Climate Zone Weather Data

CALL NO.	CITY	STATE	LATTITUDE
245	TITLE 24 ZONE 1	CA	41.00

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

663.8	760.8	1046.8	1641.7	1874.6	2103.5
1947.6	1462.7	1115.8	803.8	612.9	497.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST

637.2	489.6	543.6	462.6	408.6	358.2
313.2	198.0	214.2	313.2	379.8	496.8

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

42.8	48.2	46.4	50.0	51.8	53.6
53.6	57.2	57.2	53.6	51.8	48.2

CALL NO.	CITY	STATE	LATTITUDE
246	TITLE 24 ZONE 2	CA	38.50

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

752.8	1082.8	1477.7	2033.6	2120.6	2429.5
2488.5	2092.6	1792.6	1262.7	829.9	610.8

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST

586.8	426.6	385.2	277.2	158.4	79.2
32.4	21.6	45.0	158.4	349.2	531.0

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

44.6	48.2	51.8	55.4	59.0	64.4
66.2	64.4	64.4	59.0	51.8	46.4

CALL NO.	CITY	STATE	LATTITUDE
247	TITLE 24 ZONE 3	CA	37.70

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

843.9	904.8	1443.7	2040.5	2272.5	2392.5
2306.6	2087.5	1580.7	1086.7	843.9	590.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

518.4	410.4	403.2	207.0	223.2	120.8
111.6	41.4	102.6	144.0	262.8	478.8

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

48.2	50.0	51.8	57.2	57.2	60.8
60.8	62.6	60.8	59.0	55.4	48.2

ATTACHMENT I cont'd.

CALL NO.	CITY	STATE	LATTITUDE
248	TITLE 24 ZONE 4	CA	37.40

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

766.8	1099.8	1491.7	2046.6	2125.6	2431.5
2492.5	2100.6	1808.7	1280.7	843.9	622.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

527.4	318.6	372.6	253.8	255.6	72.0
34.2	21.6	64.8	147.6	331.2	534.6

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

46.4	53.6	51.8	57.2	57.2	64.4
66.2	66.2	64.4	60.8	53.6	48.2

CALL NO.	CITY	STATE	LATTITUDE
249	TITLE 24 ZONE 5	CA	34.90

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

843.9	1100.7	1549.7	1919.6	2043.6	2394.5
2368.5	2108.6	1687.6	1365.7	931.8	801.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

464.4	381.6	354.6	313.2	248.4	216.0
91.8	93.6	106.2	163.8	246.6	363.6

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

48.2	51.8	53.6	53.6	57.2	57.2
60.8	60.8	60.8	59.0	55.4	51.8

CALL NO.	CITY	STATE	LATTITUDE
250	TITLE 24 ZONE 6	CA	33.80

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

916.8	1282.8	1593.7	1949.6	1992.6	2123.5
2312.5	2089.6	1682.7	1358.7	1011.8	874.8

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

338.4	262.8	194.4	138.6	95.4	.0
.0	.0	1.8	18.0	120.6	315.0

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

53.6	55.4	59.0	60.8	62.6	68.0
71.6	73.4	71.6	66.2	60.8	55.4

ATTACHMENT I cont'd.

CALL NO.	CITY	STATE	LATTITUDE
251	TITLE 24 ZONE 7	CA	32.70

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00

DATA IN BTU/FT2/DAY, LISTED JAN FIRST

1012.8	1142.8	1575.6	1869.6	2031.6	1927.5
2232.5	2130.6	1749.6	1387.7	997.6	871.5

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

268.2	246.6	297.0	122.4	91.8	46.8
1.8	.0	1.8	32.4	163.8	262.8

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

55.4	55.4	55.4	60.8	60.8	62.6
66.2	69.8	66.2	64.4	59.0	55.4

CALL NO.	CITY	STATE	LATTITUDE
252	TITLE 24 ZONE 8	CA	33.70

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00

DATA IN BTU/FT2/DAY, LISTED JAN FIRST

974.8	1205.7	1636.7	2077.6	2249.5	2180.5
2477.5	2202.5	1890.6	1429.7	992.8	958.5

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

370.8	280.8	199.8	126.0	66.6	5.4
3.6	.0	.0	41.4	178.2	243.0

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

51.8	53.6	57.2	60.8	64.4	66.2
71.6	69.8	71.6	64.6	57.2	57.2

CALL NO.	CITY	STATE	LATTITUDE
253	TITLE 24 ZONE 9	CA	34.30

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00

DATA IN BTU/FT2/DAY, LISTED JAN FIRST

964.8	1196.8	1530.7	2072.6	2248.5	2184.6
2477.5	2200.6	1884.6	1421.7	983.8	946.8

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

352.8	318.6	266.4	171.0	79.2	3.6
1.8	.0	1.8	46.8	127.8	329.4

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

51.8	51.8	53.6	59.0	62.6	64.4
71.6	69.8	68.0	62.6	59.0	53.6

ATTACHMENT I cont'd.

CALL NO.	CITY	STATE	LATTITUDE
254	TITLE 24 ZONE 10	CA	33.90

SOLAR DATA FOR SURFACE SLOPE=.00 AZIMUTH=.00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

891.8	1212.8	1604.7	1926.6	2021.6	2195.6
2276.5	2085.6	1796.6	1360.7	1070.8	892.3

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

408.6	347.4	286.2	194.4	102.6	30.6
.0	.0	5.4	32.4	169.2	349.2

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

51.8	51.8	55.4	59.0	64.4	69.8
75.2	77.0	73.4	66.2	57.2	53.8

CALL NO.	CITY	STATE	LATITUDE
255	TITLE 24 ZONE 11	CA	40.20

SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

568.8	866.8	1318.7	1952.6	2338.5	2541.6
2685.4	2350.5	1855.6	1250.7	736.8	492.9

LONG TERM MONTHLY AVERAGE DEG=F DAYS, JAN FIRST.

667.8	424.8	421.2	221.4	43.2	7.2
.0	.0	10.8	81.0	403.2	608.49

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG F, JAN FIRST.

42.8	50.0	51.8	57.2	68.0	77.0
82.4	80.6	75.2	64.4	51.8	44.6

CALL NO.	CITY	STATE	LATITUDE
256	TITLE 24 ZONE 12	CA	38.50

SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

700.9	752.8	1476.7	2193.5	2453.5	2812.4
2718.5	2422.5	1938.6	1108.7	879.9	474.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

725.4	496.8	439.2	133.2	93.6	7.2
.0	.0	3.6	104.4	311.4	592.2

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG-F, JAN FIRST.

41.0	46.4	50.0	60.8	60.8	69.8
71.6	73.4	68.0	60.8	53.6	44.6

ATTACHMENT I cont'd.

CALL NO.	CITY	STATE	LATITUDE
257	TITLE 24 ZONE 13	CA	36.80

SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

669.8	1032.8	1589.6	2116.6	2501.5	2720.4
2707.5	2398.5	2023.5	1455.7	910.8	569.9

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

653.4	421.2	277.2	190.8	39.6	7.2
.0	.0	10.8	59.4	358.2	682.2

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG-F, JAN FIRST.

42.8	50.0	55.4	59.0	68.0	77.0
82.4	78.8	73.4	64.4	51.8	42.8

CALL NO.	CITY	STATE	LATITUDE
258	TITLE 24 ZONE 14	CA	35.70

SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

877.8	1187.8	1722.7	2278.6	2585.4	2732.5
2581.5	2459.5	1985.6	1504.7	1022.8	883.8

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

707.4	457.2	171.0	104.4	19.8	.0
.0	.0	.0	52.2	372.6	604.8

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG-F, JAN FIRST.

41.0	48.2	59.0	64.4	71.6	86.0
89.6	86.0	80.6	66.2	51.8	44.6

CALL NO.	CITY	STATE	LATITUDE
259	TITLE 24 ZONE 15	CA	32.80

SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00
DATA IN BTU/FT2/DAY, LISTED JAN FIRST

1150.7	1428.7	1830.6	2326.5	2533.5	2632.4
2373.5	2280.5	2032.6	1590.7	1274.8	1050.8

LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.

334.8	203.4	106.2	30.6	.0	.0
.0	.0	.0	.0	73.8	281.0

LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG-F, JAN FIRST.

53.6	57.2	64.4	71.6	78.8	86.0
91.4	91.4	86.0	75.2	62.6	55.4

ATTACHMENT I cont'd.

CALL NO.	CITY	STATE	LATITUDE		
260	TITLE 24 ZONE 16	CA	41.30		
SOLAR DATA FOR SURFACE SLOPE = .00 AZIMUTH = .00					
DATA IN BTU/FT2/DAY, LISTED JAN FIRST					
568.8	798.9	1309.7	1779.6	2198.5	2480.5
2602.4	2234.6	1786.7	1168.8	599.8	527.9
LONG TERM MONTHLY AVERAGE DEG-F DAYS, JAN FIRST.					
1004.4	720.0	646.2	543.6	304.2	156.6
30.6	64.8	111.6	437.4	687.6	878.4
LONG TERM MONTHLY AVERAGE AMBIENT TEMPERATURE, DEG-F, JAN FIRST.					
32.0	39.2	44.6	46.4	55.4	62.6
71.6	68.0	62.6	51.8	42.8	37.4

ATTACHMENT J
DETERMINING ENERGY SAVINGS FROM A PASSIVE SOLAR WATER HEATER
(ALTERNATIVE CALCULATION METHOD FOR PASSIVE SOLAR CREDIT)

Calculating the performance of a passive solar water heater is done by using test results published by the Solar Rating & Certification Corporation (SRCC) for passive solar water heaters and calculating the amount of energy which can be contributed by the equipment using local weather data. The calculation method is as follows:

Step 1. Calculate temperature difference from SRCC data:

$$T_{SRCC} = [Q_{SAV} /(100 \text{ gal/day} \times 8.25 \text{ Btu/gal-}^{o}\text{F})] + [Q_{CAP} /(V_t \times 8.25 \text{ Btu/gal-}^{o}\text{F})]$$

Where: Q_{SAV} (Btu/day) = from SRCC test results
Q_{CAP} (Btu) = from SRCC test results
V_t (gal) = total volume of solar storage tank

Step 2. Calculate energy losses during SRCC test:

$$Q_{LOSS,\ SRCC} = T_{SRCC} \times 16 \text{ hr/day} \times L \text{ Btu/hr-}^{o}\text{F}$$

Where: 16 = number of hours system is losing heat
L (Heat Loss Coefficient, Btu/hr-^{o}F from SRCC test results)

Step 3. Calculate energy collected during the SRCC test:

$$Q_{TOTAL,\ SRCC} = Q_{SAV} + Q_{LOSS,\ SRCC}$$

Step 4. Adjust energy collected to climate zone insolation values (see Table J-1)

$$Q_{TOTAL,\ LOCAL} = 1204 + [(Q_{TOTAL,\ SRCC} - 1204)/1500] \times \text{CZ insolation}$$

Table J-1

Climate Zone	CZ Insolation	Climate Zone	CZ Insolation
1	1340	9	1747
2	1658	10	1919
3	1684	11	1706
4	1734	12	1772
5	1753	13	1845
6	1724	14	1988
7	1748	15	2007
8	1768	16	1788

Step 5. Determine $T_{TANK, LOCAL}$, average tank temperature delivered to the site:

$Q_{TOTAL, LOCAL}$ = (50 gal/day) x (8.25 Btu/gal-°F) x ($T_{TANK, LOCAL}$ - CZ Water Main Temp)
+ 16 hrs/day x L x ($T_{TANK, LOCAL}$ - CZ Ambient Air Temp)

Solving for $T_{TANK, LOCAL}$:

$T_{TANK, LOCAL} = (A_1 + A_2 + Q_{TOTAL, LOCAL}) / (A_3 + A_4)$

Where: A_1 = (50 gal/day) x (8.25 Btu/gal-°F) x (CZ Water Main Temp)
A_2 = 16 hrs/day x L x (CZ Ambient Air Temp)
A_3 = (50 gal/day) x (8.25 Btu/gal-°F)
A_4 = 16 hrs/day x L
CZ Water Main Temp and CZ Ambient Air Temp from Table J-2

Table J-2
Climate Zone Water Main & Ambient Air Temp

Climate Zone	Ambient Air Temp °F	Water Main Temp °F
1	52.1	60
2	57.9	65
3	56.9	65
4	59.6	65
5	60.3	65
6	63.5	70
7	62.9	70
8	63	70
9	63.6	70
10	63.3	70
11	62.8	65
12	60.3	65
13	62.3	65
14	55.9	65
15	72.6	70
16	42.8	60

Step 6. Determine energy losses at the site:

$Q_{LOSS, LOCAL}$ = L x 16 hrs x ($T_{TANK, LOCAL}$ - CZ Ambient Air Temp)

Step 7. Determine energy used by electric resistance freeze protection devices:

ERP = (Freeze days/yr + 4) x (Collector Area) x (0.5 kBtu /ft ^{2} -freeze day)

This is calculated only if the system uses electric resistance freeze protection.

Step 8. Calculate system total annual energy contribution (mmBtu/yr):

$\{(Q_{TOTAL,\ LOCAL} - Q_{LOSS,\ LOCAL}) \times 0.365 \times 0.001 - ERP\} \times$ (No. of Dwelling Units)

Step 9. Calculate Standard Recovery Load, SRL (mmBtu/yr):

$$SRL_k = \sum_{i=1}^{n} \{0.0855347(CFA_i/1000)^2 + 3.61307\,(CFA_i/1000) + 6.036\}/\text{number of systems}$$

Step 10: Determine Distribution System Credit/Penalty:

Select Distribution System Credit/Penalty from Table J-3.

Table J-3: Distribution System Credit/Penalty[1] (per worksheet)

Standard Recovery Load	Point-of-Use	Hot Water Recovery[1]	Pipe Insulation[1]	Recirculation Systems				
				Time/Temp	Demand	Time	Temp	Cont
< 6.3	1.1	1.1	0.5	0.2	0.1	-1.7	-0.3	-3.1
6.3 - 6.99	1.2	1.2	0.5	0.2	0.1	-1.8	-0.3	-3.4
7.0 - 7.49	1.3	1.3	0.5	0.3	0.1	-1.9	-0.4	-3.7
7.5 - 7.99	1.4	1.4	0.6	0.3	0.1	-2.1	-0.4	-3.9
8.0 - 8.49	1.5	1.5	0.6	0.3	0.1	-2.2	-0.4	-4.2
8.5 - 8.99	1.6	1.6	0.6	0.3	0.1	-2.3	-0.4	-4.4
9.0 - 9.49	1.7	1.7	0.7	0.3	0.2	-2.5	-0.5	-4.7
9.5 - 9.99	1.7	1.7	0.7	0.4	0.2	-2.6	-0.5	-5.0
10.0 - 10.99	1.8	1.8	0.8	0.4	0.2	-2.8	-0.5	-5.2
11.0 - 11.99	2.0	2.0	0.8	0.4	0.2	-3.0	-0.6	-5.7
12.0 - 12.99	2.2	2.2	0.9	0.5	0.2	-3.3	-0.6	-6.3
13.0 - 13.99	2.4	2.4	1.0	0.5	0.2	-3.6	-0.7	-6.8
14.0 - 15.99	2.6	2.6	1.1	0.5	0.2	-3.9	-0.7	-7.3
16.0 - 17.99	2.9	2.9	1.2	0.6	0.3	-4.4	-0.8	-8.4
18.0 - 19.99	3.3	3.3	1.4	0.7	0.3	-5.0	-0.9	-9.4
20.0 - 21.99	3.7	3.7	1.5	0.8	0.3	-5.5	-1.0	-10.4
22.0 - 23.99	4.0	4.0	1.7	0.8	0.4	-6.1	-1.1	-11.5
24.0 - 25.99	4.4	4.4	1.8	0.9	0.4	-6.6	-1.2	-12.5
26.0+	4.8	4.8	2.0	1.0	0.4	-7.2	-1.4	-13.6

1. Hot water recovery and pipe insulation credits may only be applied to non-recirculating systems and demand recirculating systems. All other recirculating systems must have pipe insulation.

Step 11: Adjust Recovery Load:

Adjust Recovery Load = SRL (from Step 9) - Distribution System Credit/Penalty (from Step 10)
- System total annual energy contribution (from Step 8)

The adjusted recovery load must be greater than 3 mmBtu/yr, (if the result is less than 3 assign a value of three.)

Step 12: Estimate Basic Energy Use

Estimate basic energy use using the adjust recovery load from step 11 and Table J-4

Step 13: Calculate water heating energy budget (mmBtu/yr):

$$\text{Water heating energy budget} = 0.00485 \times \sum_{i=1}^{N} CFA_i + 16.37\,N$$

Step14: Calculate Solar Savings Fraction:

Solar Savings Fraction = 1 - Basic Energy Use (Step 12) / Water Heating Energy Budget (Step 13)

Table J-4A: Basic Energy Use (BEU) - Storage Gas Heater [no interpolation]

Adjusted Load	Energy Factor																						
	0.45	**0.46**	**0.47**	**0.48**	**0.49**	**0.50**	**0.51**	**0.52**	**0.53**	**0.54**	**0.55**	**0.56**	**0.57**	**0.58**	**0.60**	**0.62**	**0.64**	**0.66**	**0.68**	**0.70**	**0.74**	**0.78**	**0.82**
3.0	19.9	18.5	17.3	16.2	15.3	14.4	13.7	13.0	12.4	11.8	11.3	10.8	10.4	10.0	9.3	8.7	8.1	7.7	7.2	6.8	6.2	5.7	5.2
3.2	19.6	18.3	17.2	16.2	15.3	14.5	13.8	13.1	12.6	12.0	11.5	11.1	10.6	10.3	9.6	8.9	8.4	7.9	7.5	7.1	6.5	5.9	5.5
3.4	19.4	18.2	17.2	16.2	15.4	14.6	14.0	13.3	12.8	12.2	11.8	11.3	10.9	10.5	9.8	9.2	8.7	8.2	7.8	7.4	6.7	6.2	5.7
3.6	19.3	18.2	17.2	16.3	15.5	14.8	14.2	13.6	13.0	12.5	12.0	11.6	11.2	10.8	10.1	9.5	9.0	8.5	8.1	7.7	7.0	6.4	5.9
3.8	19.3	18.2	17.3	16.5	15.7	15.0	14.4	13.8	13.2	12.7	12.3	11.8	11.4	11.1	10.4	9.8	9.2	8.8	8.3	7.9	7.3	6.7	6.2
4.0	19.3	18.3	17.4	16.6	15.9	15.2	14.6	14.0	13.5	13.0	12.5	12.1	11.7	11.3	10.7	10.1	9.5	9.0	8.6	8.2	7.5	6.9	6.4
4.2	19.4	18.4	17.6	16.8	16.1	15.4	14.8	14.2	13.7	13.2	12.8	12.4	12.0	11.6	10.9	10.3	9.8	9.3	8.9	8.5	7.8	7.2	6.7
4.4	19.5	18.6	17.7	17.0	16.3	15.6	15.0	14.5	14.0	13.5	13.1	12.6	12.3	11.9	11.2	10.6	10.1	9.6	9.1	8.7	8.0	7.4	6.9
4.6	19.6	18.7	17.9	17.2	16.5	15.9	15.3	14.7	14.2	13.8	13.3	12.9	12.5	12.2	11.5	10.9	10.3	9.8	9.4	9.0	8.3	7.7	7.1
4.8	19.8	18.9	18.1	17.4	16.7	16.1	15.5	15.0	14.5	14.0	13.6	13.2	12.8	12.4	11.8	11.2	10.6	10.1	9.7	9.3	8.5	7.9	7.4
5.0	19.9	19.1	18.3	17.6	17.0	16.4	15.8	15.3	14.8	14.3	13.9	13.5	13.1	12.7	12.0	11.4	10.9	10.4	9.9	9.5	8.8	8.1	7.6
5.2	20.1	19.3	18.5	17.8	17.2	16.6	16.0	15.5	15.0	14.6	14.1	13.7	13.3	13.0	12.3	11.7	11.1	10.6	10.2	9.8	9.0	8.4	7.8
5.4	20.3	19.5	18.8	18.1	17.4	16.9	16.3	15.8	15.3	14.8	14.4	14.0	13.6	13.2	12.6	12.0	11.4	10.9	10.4	10.0	9.3	8.6	8.1
5.6	20.5	19.7	19.0	18.3	17.7	17.1	16.6	16.0	15.6	15.1	14.7	14.3	13.9	13.5	12.8	12.2	11.7	11.2	10.7	10.3	9.5	8.9	8.3
5.8	20.7	19.9	19.2	18.6	17.9	17.4	16.8	16.3	15.8	15.4	14.9	14.5	14.1	13.8	13.1	12.5	11.9	11.4	11.0	10.5	9.8	9.1	8.5
6.0	20.9	20.2	19.5	18.8	18.2	17.6	17.1	16.6	16.1	15.6	15.2	14.8	14.4	14.0	13.4	12.8	12.2	11.7	11.2	10.8	10.0	9.3	8.7
6.2	21.2	20.4	19.7	19.1	18.4	17.9	17.3	16.8	16.3	15.9	15.5	15.1	14.7	14.3	13.6	13.0	12.5	11.9	11.5	11.0	10.2	9.6	9.0
6.4	21.4	20.6	20.0	19.3	18.7	18.1	17.6	17.1	16.6	16.2	15.7	15.3	14.9	14.6	13.9	13.3	12.7	12.2	11.7	11.3	10.5	9.8	9.2
6.6	21.6	20.9	20.2	19.6	19.0	18.4	17.9	17.4	16.9	16.4	16.0	15.6	15.2	14.8	14.2	13.5	13.0	12.4	12.0	11.5	10.7	10.0	9.4
6.8	21.9	21.1	20.5	19.8	19.2	18.7	18.1	17.6	17.1	16.7	16.3	15.9	15.5	15.1	14.4	13.8	13.2	12.7	12.2	11.8	10.9	10.2	9.6
7.0	22.1	21.4	20.7	20.1	19.5	18.9	18.4	17.9	17.4	17.0	16.5	16.1	15.7	15.4	14.7	14.1	13.5	12.9	12.5	12.0	11.2	10.5	9.8
7.2	22.3	21.6	21.0	20.3	19.7	19.2	18.6	18.1	17.7	17.2	16.8	16.4	16.0	15.6	14.9	14.3	13.7	13.2	12.7	12.2	11.4	10.7	10.1
7.4	22.6	21.9	21.2	20.6	20.0	19.4	18.9	18.4	17.9	17.5	17.1	16.7	16.3	15.9	15.2	14.6	14.0	13.4	12.9	12.5	11.6	10.9	10.3
7.6	22.8	22.1	21.5	20.8	20.3	19.7	19.2	18.7	18.2	17.8	17.3	16.9	16.5	16.2	15.5	14.8	14.2	13.7	13.2	12.7	11.9	11.1	10.5
7.8	23.1	22.4	21.7	21.1	20.5	20.0	19.4	18.9	18.5	18.0	17.6	17.2	16.8	16.4	15.7	15.1	14.5	13.9	13.4	13.0	12.1	11.4	10.7
8.0	23.3	22.6	22.0	21.4	20.8	20.2	19.7	19.2	18.7	18.3	17.8	17.4	17.0	16.7	16.0	15.3	14.7	14.2	13.7	13.2	12.3	11.6	10.9
8.2	23.6	22.9	22.2	21.6	21.0	20.5	20.0	19.5	19.0	18.5	18.1	17.7	17.3	16.9	16.2	15.6	15.0	14.4	13.9	13.4	12.6	11.8	11.1
8.4	23.8	23.1	22.5	21.9	21.3	20.7	20.2	19.7	19.3	18.8	18.4	18.0	17.6	17.2	16.5	15.8	15.2	14.7	14.2	13.7	12.8	12.0	11.3
8.6	24.1	23.4	22.8	22.1	21.6	21.0	20.5	20.0	19.5	19.1	18.6	18.2	17.8	17.4	16.7	16.1	15.5	14.9	14.4	13.9	13.0	12.2	11.6
8.8	24.3	23.7	23.0	22.4	21.8	21.3	20.7	20.2	19.8	19.3	18.9	18.5	18.1	17.7	17.0	16.3	15.7	15.2	14.6	14.1	13.2	12.5	11.8
9.0	24.6	23.9	23.3	22.7	22.1	21.5	21.0	20.5	20.0	19.6	19.1	18.7	18.3	18.0	17.2	16.6	16.0	15.4	14.9	14.4	13.5	12.7	12.0
9.2	24.8	24.2	23.5	22.9	22.3	21.8	21.3	20.8	20.3	19.8	19.4	19.0	18.6	18.2	17.5	16.8	16.2	15.6	15.1	14.6	13.7	12.9	12.2
9.4	25.1	24.4	23.8	23.2	22.6	22.0	21.5	21.0	20.5	20.1	19.7	19.2	18.8	18.5	17.7	17.1	16.4	15.9	15.3	14.8	13.9	13.1	12.4
9.6	25.4	24.7	24.0	23.4	22.9	22.3	21.8	21.3	20.8	20.3	19.9	19.5	19.1	18.7	18.0	17.3	16.7	16.1	15.6	15.1	14.1	13.3	12.6
9.8	25.6	24.9	24.3	23.7	23.1	22.6	22.0	21.5	21.1	20.6	20.2	19.7	19.3	19.0	18.2	17.6	16.9	16.3	15.8	15.3	14.4	13.5	12.8
10.0	25.9	25.2	24.6	23.9	23.4	22.8	22.3	21.8	21.3	20.9	20.4	20.0	19.6	19.2	18.5	17.8	17.2	16.6	16.0	15.5	14.6	13.8	13.0
10.5	26.5	25.8	25.2	24.6	24.0	23.5	22.9	22.4	22.0	21.5	21.0	20.6	20.2	19.8	19.1	18.4	17.8	17.2	16.6	16.1	15.1	14.3	13.5
11.0	27.1	26.5	25.8	25.2	24.7	24.1	23.6	23.1	22.6	22.1	21.7	21.2	20.8	20.4	19.7	19.0	18.4	17.7	17.2	16.6	15.7	14.8	14.0
11.5	27.8	27.1	26.5	25.9	25.3	24.7	24.2	23.7	23.2	22.7	22.3	21.9	21.5	21.1	20.3	19.6	18.9	18.3	17.7	17.2	16.2	15.3	14.5
12.0	28.4	27.7	27.1	26.5	25.9	25.4	24.8	24.3	23.8	23.4	22.9	22.5	22.1	21.7	20.9	20.2	19.5	18.9	18.3	17.8	16.8	15.9	15.1
12.5	29.0	28.4	27.7	27.1	26.6	26.0	25.5	25.0	24.5	24.0	23.5	23.1	22.7	22.3	21.5	20.8	20.1	19.5	18.9	18.3	17.3	16.4	15.6
13.0	29.7	29.0	28.4	27.8	27.2	26.6	26.1	25.6	25.1	24.6	24.1	23.7	23.3	22.9	22.1	21.3	20.7	20.0	19.4	18.9	17.8	16.9	16.0
13.5	30.3	29.6	29.0	28.4	27.8	27.2	26.7	26.2	25.7	25.2	24.7	24.3	23.9	23.5	22.7	21.9	21.2	20.6	20.0	19.4	18.3	17.4	16.5
14.0	30.9	30.3	29.6	29.0	28.4	27.9	27.3	26.8	26.3	25.8	25.3	24.9	24.5	24.0	23.2	22.5	21.8	21.1	20.5	19.9	18.9	17.9	17.0
14.5	31.6	30.9	30.3	29.6	29.0	28.5	27.9	27.4	26.9	26.4	25.9	25.5	25.1	24.6	23.8	23.1	22.4	21.7	21.1	20.5	19.4	18.4	17.5
15.0	32.2	31.5	30.9	30.3	29.7	29.1	28.5	28.0	27.5	27.0	26.5	26.1	25.6	25.2	24.4	23.6	22.9	22.2	21.6	21.0	19.9	18.9	18.0
15.5	32.8	32.1	31.5	30.9	30.3	29.7	29.1	28.6	28.1	27.6	27.1	26.7	26.2	25.8	25.0	24.2	23.5	22.8	22.2	21.5	20.4	19.4	18.5
16.0	33.4	32.7	32.1	31.5	30.9	30.3	29.8	29.2	28.7	28.2	27.7	27.3	26.8	26.4	25.5	24.8	24.0	23.3	22.7	22.1	20.9	19.9	19.0
16.5	34.0	33.4	32.7	32.1	31.5	30.9	30.3	29.8	29.3	28.8	28.3	27.8	27.4	26.9	26.1	25.3	24.6	23.9	23.2	22.6	21.4	20.4	19.5
17.0	34.7	34.0	33.3	32.7	32.1	31.5	30.9	30.4	29.9	29.4	28.9	28.4	28.0	27.5	26.7	25.9	25.1	24.4	23.8	23.1	22.0	20.9	19.9
17.5	35.3	34.6	33.9	33.3	32.7	32.1	31.5	31.0	30.5	30.0	29.5	29.0	28.5	28.1	27.2	26.4	25.7	25.0	24.3	23.6	22.5	21.4	20.4
18.0	35.9	35.2	34.5	33.9	33.3	32.7	32.1	31.6	31.1	30.5	30.0	29.6	29.1	28.6	27.8	27.0	26.2	25.5	24.8	24.2	23.0	21.9	20.9
18.5	36.5	35.8	35.1	34.5	33.9	33.3	32.7	32.2	31.6	31.1	30.6	30.1	29.7	29.2	28.3	27.5	26.8	26.0	25.3	24.7	23.5	22.4	21.4
19.0	37.1	36.4	35.7	35.1	34.5	33.9	33.3	32.8	32.2	31.7	31.2	30.7	30.2	29.8	28.9	28.1	27.3	26.5	25.8	25.2	24.0	22.8	21.8
19.5	37.7	37.0	36.3	35.7	35.1	34.5	33.9	33.3	32.8	32.3	31.8	31.3	30.8	30.3	29.4	28.6	27.8	27.1	26.4	25.7	24.5	23.3	22.3
20.0	38.3	37.6	36.9	36.3	35.7	35.1	34.5	33.9	33.4	32.8	32.3	31.8	31.3	30.9	30.0	29.1	28.4	27.6	26.9	26.2	24.9	23.8	22.8
21.0	39.5	38.8	38.1	37.4	36.8	36.2	35.6	35.1	34.5	34.0	33.4	32.9	32.5	32.0	31.1	30.2	29.4	28.6	27.9	27.2	25.9	24.8	23.7
22.0	40.7	40.0	39.3	38.6	38.0	37.4	36.8	36.2	35.6	35.1	34.6	34.1	33.6	33.1	32.2	31.3	30.5	29.7	28.9	28.2	26.9	25.7	24.6

Table J-4B: Basic Energy Use (BEU) - Storage Electric Heater [no interpolation]

Adjusted Recovery Load	Energy Factor																						
	0.77	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99
3.0	22.4	21.1	20.0	19.0	18.1	17.2	16.5	15.8	15.2	14.6	14.0	13.5	13.0	12.6	12.2	11.8	11.5	11.1	10.8	10.5	10.2	9.9	9.7
3.2	23.0	21.8	20.7	19.7	18.8	18.0	17.2	16.5	15.9	15.3	14.7	14.2	13.8	13.3	12.9	12.5	12.1	11.8	11.5	11.1	10.8	10.6	10.3
3.4	23.6	22.4	21.3	20.4	19.5	18.7	17.9	17.2	16.6	16.0	15.4	14.9	14.4	14.0	13.6	13.2	12.8	12.4	12.1	11.8	11.5	11.2	10.9
3.6	24.2	23.1	22.0	21.1	20.2	19.4	18.6	17.9	17.3	16.7	16.1	15.6	15.1	14.7	14.2	13.8	13.5	13.1	12.7	12.4	12.1	11.8	11.5
3.8	24.8	23.7	22.7	21.7	20.9	20.1	19.3	18.6	18.0	17.4	16.8	16.3	15.8	15.4	14.9	14.5	14.1	13.7	13.4	13.1	12.7	12.4	12.1
4.0	25.5	24.4	23.3	22.4	21.6	20.8	20.0	19.3	18.7	18.1	17.5	17.0	16.5	16.0	15.6	15.2	14.8	14.4	14.0	13.7	13.4	13.1	12.8
4.2	26.1	25.0	24.0	23.1	22.2	21.4	20.7	20.0	19.4	18.8	18.2	17.7	17.2	16.7	16.3	15.8	15.4	15.0	14.7	14.3	14.0	13.7	13.4
4.4	26.7	25.6	24.7	23.8	22.9	22.1	21.4	20.7	20.1	19.5	18.9	18.4	17.8	17.4	16.9	16.5	16.1	15.7	15.3	15.0	14.6	14.3	14.0
4.6	27.3	26.3	25.3	24.4	23.6	22.8	22.1	21.4	20.7	20.1	19.6	19.0	18.5	18.0	17.6	17.1	16.7	16.3	15.9	15.6	15.2	14.9	14.6
4.8	28.0	26.9	26.0	25.1	24.3	23.5	22.7	22.1	21.4	20.8	20.2	19.7	19.2	18.7	18.2	17.8	17.4	17.0	16.6	16.2	15.9	15.5	15.2
5.0	28.6	27.6	26.6	25.7	24.9	24.1	23.4	22.7	22.1	21.5	20.9	20.4	19.8	19.3	18.9	18.4	18.0	17.6	17.2	16.8	16.5	16.1	15.8
5.2	29.2	28.2	27.3	26.4	25.6	24.8	24.1	23.4	22.7	22.1	21.6	21.0	20.5	20.0	19.5	19.1	18.6	18.2	17.8	17.5	17.1	16.7	16.4
5.4	29.8	28.8	27.9	27.0	26.2	25.5	24.7	24.1	23.4	22.8	22.2	21.7	21.1	20.6	20.2	19.7	19.3	18.9	18.5	18.1	17.7	17.4	17.0
5.6	30.4	29.5	28.5	27.7	26.9	26.1	25.4	24.7	24.1	23.5	22.9	22.3	21.8	21.3	20.8	20.3	19.9	19.5	19.1	18.7	18.3	18.0	17.6
5.8	31.0	30.1	29.2	28.3	27.5	26.8	26.0	25.4	24.7	24.1	23.5	23.0	22.4	21.9	21.4	21.0	20.5	20.1	19.7	19.3	18.9	18.6	18.2
6.0	31.6	30.7	29.8	29.0	28.2	27.4	26.7	26.0	25.4	24.7	24.2	23.6	23.1	22.6	22.1	21.6	21.2	20.7	20.3	19.9	19.5	19.2	18.8
6.2	32.3	31.3	30.4	29.6	28.8	28.0	27.3	26.7	26.0	25.4	24.8	24.2	23.7	23.2	22.7	22.2	21.8	21.4	20.9	20.5	20.2	19.8	19.4
6.4	32.9	31.9	31.1	30.2	29.4	28.7	28.0	27.3	26.6	26.0	25.4	24.9	24.3	23.8	23.3	22.9	22.4	22.0	21.6	21.2	20.8	20.4	20.0
6.6	33.5	32.5	31.7	30.8	30.1	29.3	28.6	27.9	27.3	26.7	26.1	25.5	25.0	24.5	24.0	23.5	23.0	22.6	22.2	21.8	21.4	21.0	20.6
6.8	34.1	33.2	32.3	31.5	30.7	29.9	29.2	28.6	27.9	27.3	26.7	26.2	25.6	25.1	24.6	24.1	23.7	23.2	22.8	22.4	22.0	21.6	21.2
7.0	34.7	33.8	32.9	32.1	31.3	30.6	29.9	29.2	28.6	27.9	27.3	26.8	26.2	25.7	25.2	24.7	24.3	23.8	23.4	23.0	22.6	22.2	21.8
7.2	35.3	34.4	33.5	32.7	31.9	31.2	30.5	29.8	29.2	28.6	28.0	27.4	26.9	26.3	25.8	25.4	24.9	24.4	24.0	23.6	23.2	22.8	22.4
7.4	35.9	35.0	34.1	33.3	32.6	31.8	31.1	30.5	29.8	29.2	28.6	28.0	27.5	27.0	26.5	26.0	25.5	25.1	24.6	24.2	23.8	23.4	23.0
7.6	36.5	35.6	34.7	33.9	33.2	32.4	31.7	31.1	30.4	29.8	29.2	28.7	28.1	27.6	27.1	26.6	26.1	25.7	25.2	24.8	24.4	24.0	23.6
7.8	37.0	36.2	35.3	34.5	33.8	33.1	32.4	31.7	31.1	30.4	29.8	29.3	28.7	28.2	27.7	27.2	26.7	26.3	25.8	25.4	25.0	24.6	24.2
8.0	37.6	36.8	35.9	35.2	34.4	33.7	33.0	32.3	31.7	31.1	30.5	29.9	29.4	28.8	28.3	27.8	27.3	26.9	26.4	26.0	25.6	25.2	24.8
8.2	38.2	37.4	36.5	35.8	35.0	34.3	33.6	32.9	32.3	31.7	31.1	30.5	30.0	29.4	28.9	28.4	28.0	27.5	27.0	26.6	26.2	25.8	25.4
8.4	38.8	37.9	37.1	36.4	35.6	34.9	34.2	33.5	32.9	32.3	31.7	31.1	30.6	30.0	29.5	29.0	28.6	28.1	27.7	27.2	26.8	26.4	26.0
8.6	39.4	38.5	37.7	37.0	36.2	35.5	34.8	34.2	33.5	32.9	32.3	31.7	31.2	30.7	30.1	29.7	29.2	28.7	28.3	27.8	27.4	27.0	26.6
8.8	40.0	39.1	38.3	37.6	36.8	36.1	35.4	34.8	34.1	33.5	32.9	32.4	31.8	31.3	30.8	30.3	29.8	29.3	28.9	28.4	28.0	27.6	27.2
9.0	40.5	39.7	38.9	38.1	37.4	36.7	36.0	35.4	34.7	34.1	33.5	33.0	32.4	31.9	31.4	30.9	30.4	29.9	29.5	29.0	28.6	28.2	27.8
9.2	41.1	40.3	39.5	38.7	38.0	37.3	36.6	36.0	35.3	34.7	34.1	33.6	33.0	32.5	32.0	31.5	31.0	30.5	30.1	29.6	29.2	28.8	28.4
9.4	41.7	40.9	40.1	39.3	38.6	37.9	37.2	36.6	35.9	35.3	34.7	34.2	33.6	33.1	32.6	32.1	31.6	31.1	30.7	30.2	29.8	29.4	29.0
9.6	42.3	41.4	40.7	39.9	39.2	38.5	37.8	37.2	36.5	35.9	35.3	34.8	34.2	33.7	33.2	32.7	32.2	31.7	31.3	30.8	30.4	30.0	29.5
9.8	42.8	42.0	41.2	40.5	39.8	39.1	38.4	37.8	37.1	36.5	35.9	35.4	34.8	34.3	33.8	33.3	32.8	32.3	31.9	31.4	31.0	30.5	30.1
10.0	43.4	42.6	41.8	41.1	40.4	39.7	39.0	38.4	37.7	37.1	36.5	36.0	35.4	34.9	34.4	33.9	33.4	32.9	32.4	32.0	31.6	31.1	30.7
10.5	44.8	44.0	43.3	42.5	41.8	41.1	40.5	39.8	39.2	38.6	38.0	37.5	36.9	36.4	35.9	35.4	34.9	34.4	33.9	33.5	33.0	32.6	32.2
11.0	46.2	45.4	44.7	44.0	43.3	42.6	41.9	41.3	40.7	40.1	39.5	39.0	38.4	37.9	37.4	36.8	36.4	35.9	35.4	35.0	34.5	34.1	33.7
11.5	47.6	46.8	46.1	45.4	44.7	44.0	43.4	42.8	42.2	41.6	41.0	40.4	39.9	39.3	38.8	38.3	37.8	37.4	36.9	36.4	36.0	35.6	35.1
12.0	49.0	48.2	47.5	46.8	46.1	45.5	44.8	44.2	43.6	43.0	42.5	41.9	41.3	40.8	40.3	39.8	39.3	38.8	38.4	37.9	37.5	37.0	36.6
12.5	50.3	49.6	48.9	48.2	47.6	46.9	46.3	45.7	45.1	44.5	43.9	43.4	42.8	42.3	41.8	41.3	40.8	40.3	39.8	39.4	38.9	38.5	38.1
13.0	51.7	51.0	50.3	49.6	49.0	48.3	47.7	47.1	46.5	45.9	45.4	44.8	44.3	43.7	43.2	42.7	42.2	41.8	41.3	40.8	40.4	40.0	39.5
13.5	53.1	52.4	51.7	51.0	50.4	49.7	49.1	48.5	47.9	47.3	46.8	46.2	45.7	45.2	44.7	44.2	43.7	43.2	42.8	42.3	41.8	41.4	41.0
14.0	54.4	53.7	53.0	52.4	51.7	51.1	50.5	49.9	49.3	48.8	48.2	47.7	47.2	46.6	46.1	45.6	45.1	44.7	44.2	43.8	43.3	42.9	42.4
14.5	55.7	55.1	54.4	53.8	53.1	52.5	51.9	51.3	50.8	50.2	49.6	49.1	48.6	48.1	47.6	47.1	46.6	46.1	45.7	45.2	44.8	44.3	43.9
15.0	57.1	56.4	55.7	55.1	54.5	53.9	53.3	52.7	52.2	51.6	51.1	50.5	50.0	49.5	49.0	48.5	48.0	47.6	47.1	46.7	46.2	45.8	45.3
15.5	58.4	57.7	57.1	56.5	55.9	55.3	54.7	54.1	53.6	53.0	52.5	52.0	51.4	50.9	50.4	50.0	49.5	49.0	48.5	48.1	47.7	47.2	46.8
16.0	59.7	59.1	58.4	57.8	57.2	56.6	56.1	55.5	54.9	54.4	53.9	53.4	52.9	52.4	51.9	51.4	50.9	50.4	50.0	49.5	49.1	48.7	48.2
16.5	61.0	60.4	59.8	59.2	58.6	58.0	57.4	56.9	56.3	55.8	55.3	54.8	54.3	53.8	53.3	52.8	52.3	51.9	51.4	51.0	50.5	50.1	49.7
17.0	62.3	61.7	61.1	60.5	59.9	59.4	58.8	58.3	57.7	57.2	56.7	56.2	55.7	55.2	54.7	54.2	53.8	53.3	52.9	52.4	52.0	51.6	51.1
17.5	63.6	63.0	62.4	61.8	61.3	60.7	60.2	59.6	59.1	58.6	58.1	57.6	57.1	56.6	56.1	55.6	55.2	54.7	54.3	53.9	53.4	53.0	52.6
18.0	64.9	64.3	63.7	63.1	62.6	62.0	61.5	61.0	60.5	59.9	59.4	59.0	58.5	58.0	57.5	57.1	56.6	56.2	55.7	55.3	54.9	54.4	54.0
18.5	66.1	65.6	65.0	64.5	63.9	63.4	62.8	62.3	61.8	61.3	60.8	60.3	59.9	59.4	58.9	58.5	58.0	57.6	57.1	56.7	56.3	55.9	55.5
19.0	67.4	66.9	66.3	65.8	65.2	64.7	64.2	63.7	63.2	62.7	62.2	61.7	61.2	60.8	60.3	59.9	59.4	59.0	58.6	58.1	57.7	57.3	56.9
19.5	68.7	68.1	67.6	67.1	66.5	66.0	65.5	65.0	64.5	64.0	63.6	63.1	62.6	62.2	61.7	61.3	60.8	60.4	60.0	59.6	59.2	58.7	58.3
20.0	70.0	69.4	68.9	68.4	67.9	67.3	66.8	66.4	65.9	65.4	64.9	64.5	64.0	63.6	63.1	62.7	62.3	61.8	61.4	61.0	60.6	60.2	59.8
21.0	72.5	71.9	71.4	70.9	70.5	70.0	69.5	69.0	68.6	68.1	67.6	67.2	66.8	66.3	65.9	65.5	65.1	64.6	64.2	63.8	63.4	63.0	62.7
22.0	74.9	74.5	74.0	73.5	73.0	72.6	72.1	71.7	71.2	70.8	70.3	69.9	69.5	69.1	68.7	68.2	67.8	67.4	67.1	66.7	66.3	65.9	65.5

Table J-4C: Basic Energy Use (BEU)_- Storage Heat Pump Heater [no interpolation]

Adjusted Load	Energy Factor																				
	1.8	**1.9**	**2.0**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.7**	**2.8**	**2.9**	**3.0**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**	**3.6**	**3.7**	**3.8**
6.0	14.1	13.5	13.0	12.6	12.1	11.7	11.3	11.0	10.6	10.3	10.0	9.7	9.5	9.2	9.0	8.7	8.5	8.3	8.1	7.9	7.8
6.2	14.4	13.8	13.3	12.8	12.3	11.9	11.5	11.1	10.8	10.5	10.2	9.9	9.6	9.3	9.1	8.9	8.7	8.4	8.2	8.0	7.9
6.4	14.7	14.1	13.5	13.0	12.5	12.1	11.7	11.3	11.0	10.6	10.3	10.0	9.7	9.5	9.2	9.0	8.8	8.6	8.3	8.2	8.0
6.6	14.9	14.3	13.8	13.2	12.8	12.3	11.9	11.5	11.1	10.8	10.5	10.2	9.9	9.6	9.4	9.1	8.9	8.7	8.5	8.3	8.1
6.8	15.2	14.6	14.0	13.5	13.0	12.5	12.1	11.7	11.3	11.0	10.6	10.3	10.0	9.8	9.5	9.3	9.0	8.8	8.6	8.4	8.2
7.0	15.5	14.8	14.2	13.7	13.2	12.7	12.3	11.9	11.5	11.1	10.8	10.5	10.2	9.9	9.6	9.4	9.1	8.9	8.7	8.5	8.3
7.2	15.8	15.1	14.5	13.9	13.4	12.9	12.5	12.1	11.7	11.3	11.0	10.6	10.3	10.0	9.8	9.5	9.3	9.0	8.8	8.6	8.4
7.4	16.0	15.4	14.7	14.2	13.6	13.1	12.7	12.2	11.8	11.5	11.1	10.8	10.5	10.2	9.9	9.6	9.4	9.1	8.9	8.7	8.5
7.6	16.3	15.6	15.0	14.4	13.8	13.3	12.9	12.4	12.0	11.6	11.3	10.9	10.6	10.3	10.0	9.8	9.5	9.3	9.0	8.8	8.6
7.8	16.6	15.9	15.2	14.6	14.0	13.5	13.0	12.6	12.2	11.8	11.4	11.1	10.8	10.5	10.2	9.9	9.6	9.4	9.2	8.9	8.7
8.0	16.8	16.1	15.4	14.8	14.3	13.7	13.2	12.8	12.4	12.0	11.6	11.2	10.9	10.6	10.3	10.0	9.8	9.5	9.3	9.0	8.8
8.2	17.1	16.4	15.7	15.0	14.5	13.9	13.4	13.0	12.5	12.1	11.7	11.4	11.0	10.7	10.4	10.1	9.9	9.6	9.4	9.2	8.9
8.4	17.4	16.6	15.9	15.3	14.7	14.1	13.6	13.1	12.7	12.3	11.9	11.5	11.2	10.9	10.6	10.3	10.0	9.7	9.5	9.3	9.0
8.6	17.7	16.9	16.1	15.5	14.9	14.3	13.8	13.3	12.9	12.4	12.0	11.7	11.3	11.0	10.7	10.4	10.1	9.9	9.6	9.4	9.1
8.8	17.9	17.1	16.4	15.7	15.1	14.5	14.0	13.5	13.0	12.6	12.2	11.8	11.5	11.1	10.8	10.5	10.2	10.0	9.7	9.5	9.3
9.0	18.2	17.4	16.6	15.9	15.3	14.7	14.2	13.7	13.2	12.8	12.4	12.0	11.6	11.3	11.0	10.7	10.4	10.1	9.8	9.6	9.4
9.2	18.4	17.6	16.8	16.1	15.5	14.9	14.4	13.9	13.4	12.9	12.5	12.1	11.8	11.4	11.1	10.8	10.5	10.2	10.0	9.7	9.5
9.4	18.7	17.9	17.1	16.4	15.7	15.1	14.5	14.0	13.5	13.1	12.7	12.3	11.9	11.5	11.3	10.9	10.6	10.3	10.1	9.8	9.6
9.6	19.0	18.1	17.3	16.6	15.9	15.3	14.7	14.2	13.7	13.3	12.8	12.4	12.0	11.7	11.4	11.0	10.7	10.5	10.2	9.9	9.7
9.8	19.2	18.3	17.5	16.8	16.1	15.5	14.9	14.4	13.9	13.4	13.0	12.6	12.2	11.8	11.5	11.2	10.9	10.6	10.3	10.0	9.8
10.0	19.5	18.6	17.8	17.0	16.3	15.7	15.1	14.6	14.0	13.6	13.1	12.7	12.3	12.0	11.7	11.3	11.0	10.7	10.4	10.1	9.9
10.5	20.1	19.2	18.3	17.6	16.8	16.2	15.6	15.0	14.5	14.0	13.5	13.1	12.7	12.3	11.9	11.6	11.3	11.0	10.7	10.4	10.2
11.0	20.8	19.8	18.9	18.1	17.3	16.7	16.0	15.4	14.9	14.4	13.9	13.4	13.0	12.6	12.3	11.9	11.6	11.3	11.0	10.7	10.4
11.5	21.4	20.4	19.5	18.6	17.8	17.1	16.5	15.9	15.3	14.8	14.3	13.8	13.4	13.0	12.6	12.2	11.9	11.6	11.3	11.0	10.7
12.0	22.1	21.0	20.0	19.1	18.3	17.6	16.9	16.3	15.7	15.1	14.6	14.2	13.7	13.3	12.9	12.5	12.2	11.9	11.5	11.2	11.0
12.5	22.7	21.6	20.6	19.7	18.8	18.1	17.4	16.7	16.1	15.5	15.0	14.5	14.1	13.6	13.2	12.8	12.5	12.1	11.8	11.5	11.2
13.0	23.3	22.2	21.1	20.2	19.3	18.5	17.8	17.1	16.5	15.9	15.4	14.9	14.4	14.0	13.5	13.1	12.8	12.4	12.1	11.8	11.5
13.5	23.9	22.7	21.7	20.7	19.8	19.0	18.2	17.6	16.9	16.3	15.8	15.2	14.7	14.3	13.9	13.5	13.1	12.7	12.4	12.0	11.7
14.0	24.5	23.3	22.2	21.2	20.3	19.5	18.7	18.0	17.3	16.7	16.1	15.6	15.1	14.6	14.2	13.8	13.4	13.0	12.6	12.3	12.0
14.5	25.2	23.9	22.8	21.7	20.8	19.9	19.1	18.4	17.7	17.1	16.5	15.9	15.4	14.9	14.5	14.1	13.7	13.3	12.9	12.6	12.3
15.0	25.8	24.5	23.3	22.2	21.3	20.4	19.6	18.8	18.1	17.4	16.8	16.3	15.8	15.3	14.8	14.4	13.9	13.6	13.2	12.8	12.5
15.5	26.4	25.0	23.8	22.7	21.7	20.8	20.0	19.2	18.5	17.8	17.2	16.6	16.1	15.6	15.1	14.7	14.2	13.8	13.5	13.1	12.8
16.0	27.0	25.6	24.4	23.2	22.2	21.3	20.4	19.6	18.9	18.2	17.6	17.0	16.4	15.9	15.4	15.0	14.5	14.1	13.7	13.4	13.0
16.5	27.6	26.2	24.9	23.7	22.7	21.7	20.8	20.0	19.3	18.6	17.9	17.3	16.7	16.2	15.7	15.2	14.8	14.4	14.0	13.6	13.3
17.0	28.2	26.7	25.4	24.2	23.2	22.2	21.3	20.4	19.7	18.9	18.3	17.7	17.1	16.5	16.0	15.5	15.1	14.7	14.3	13.9	13.5
17.5	28.8	27.3	25.9	24.7	23.6	22.6	21.7	20.8	20.0	19.3	18.6	18.0	17.4	16.8	16.3	15.8	15.4	14.9	14.5	14.1	13.8
18.0	29.4	27.8	26.5	25.2	24.1	23.1	22.1	21.2	20.4	19.7	19.0	18.3	17.7	17.2	16.6	16.1	15.7	15.2	14.8	14.4	14.0
18.5	29.9	28.4	27.0	25.7	24.5	23.5	22.5	21.6	20.8	20.0	19.3	18.7	18.0	17.5	16.9	16.4	15.9	15.5	15.1	14.7	14.3
19.0	30.5	28.9	27.5	26.2	25.0	23.9	23.3	22.0	21.2	20.4	19.7	19.0	18.4	17.8	17.2	16.7	16.2	15.8	15.3	14.9	14.5
19.5	31.1	29.5	28.0	26.7	25.5	24.4	23.3	22.4	21.6	20.8	20.0	19.3	18.7	18.1	17.5	17.0	16.5	16.0	15.6	15.2	14.8
20.0	31.7	30.0	28.5	27.2	25.9	24.8	23.8	22.8	21.9	21.1	20.4	19.7	19.0	18.4	17.8	17.3	16.8	16.3	15.8	15.4	15.0
21.0	32.8	31.1	29.5	28.1	26.8	25.7	24.6	23.6	22.7	21.8	21.1	20.3	19.6	19.0	18.4	17.8	17.3	16.8	16.4	15.9	15.5
22.0	34.0	32.2	30.5	29.1	27.7	26.5	25.4	24.4	23.4	22.5	21.7	21.0	20.3	19.6	19.0	18.4	17.9	17.4	16.9	16.4	16.0

Climate Zone	Factor
1.14	1.04
2, 3	0.99
4, 5, 12	1.07
6-11, 13, 15	0.92
16	1.50

_____	_____		_____
Basic Energy Use x	CZ Factor.	=	BEU to Line 2a, DHW-1

Instructions: Multiply Basic Energy Use by appropriate Climate Zone Factor from table. **Do not interpolate.**

APPENDIX H

Glossary of Terms

Approved, as to a home energy rating provider or home energy rating system, means reviewed and approved by the Commission under Section 1675.

Certified, as to a home energy rater, means having been found by a certified home energy rating provider to have successfully completed the requirements established by that home energy rating provider.

Home Energy Rater means a person certified to perform the site inspection and data collection, diagnostic testing, and data entry and analysis required to produce a home energy rating.

Home Energy Rating means a representation on a 0 to 100 scale of the annual source energy efficiency of a building.

Home Energy Rating Provider means a person or entity ~~which~~that administers an approved home energy rating system.

Home Energy Rating System means a fixed set of procedures, utilizing specifically defined assumptions, measurements and calculations, which produces a home energy rating.

Low-Rise Residential Building means a building, other than a hotel/motel as defined in Title 24, Part 6, Section 101(b), of the California Code of Regulations, that is of occupancy group R-l and is three stories or less, or that is of occupancy group R-3, as those occupancy groups are defined in Title 24, Part 2, Section 1201, of the California Code of Regulations

APPENDIX I

Appendix I: Interior Mass Capacity

The *Interior Mass Capacity (IMC)* of a material is calculated by multiplying its *Area* times its *Unit Interior Mass Capacity (UIMC)* using Equation I-1. Tables 3-2a, 3-2b and 3-3 list the UIMCs for a number of thermal mass materials. This method allows for multiple mass types in both raised-floor and slab-on-grade construction.

The *Interior Mass Capacity* for the *Standard Design* shall be determined as 20 percent of the *Proposed Design's* conditioned slab floor as 3.5 inch thick exposed slab (UIMC=4.6), 80% of the conditioned slab as 3.5 inch thick rug-covered slab (UIMC=1.8), and 5% of the *Proposed Design's* conditioned nonslab floor area as exposed 2 inch thick concrete (UIMC=2.5). If the user does not specify a high mass design, the *Interior Mass Capacity* of the *Proposed Design* shall be the same as for the *Standard Design*. If the user specifies a high mass design with an *Interior Mass Capacity* greater than the high mass threshold, the user is allowed to model the mass specified in the *Proposed Design*. The high mass threshold *Interior Mass* Capacity is determined as 30% of the conditioned floor area as exposed slab (UIMC=4.6), 70% of the conditioned slab floor area as rug-covered slab (UIMC=1.8), and 15% of the conditioned nonslab floor area as 2 inch thick concrete (UIMC=2.5).

EQUATION NO. I-1
CALCULATION OF INTERIOR MASS CAPACITY

$$IMC = [(A_1 \times UIMC_1) + (A_2 \times UIMC_2) \ldots\ldots + (A_n \times UIMC_n)]$$

Where,

A_n = *Area of mass material n, and*

$UIMC_n$ = *Unit Interior Mass Capacity of mass material n*

Based on the UIMCs given above:

$$IMC_{threshold} = 2.64 \times CSA + 0.375 \times (CFA - CSA)$$

Where:

CSA = Conditioned Slab floor Area

CFA = total Conditioned Floor Area

Table 3-2a: Interior Mass UIMC Values:

Interior Mass[11] - Surfaces Exposed on One Side[13]

Material	Surface Condition	Mass Thickness (inches)	Unit Interior Mass Capacity
Concrete Slab-on-Grade and Raised Concrete Floors	Exposed[1]	2.00	3.6
		3.50	4.6
		6.00	5.1
	Covered[2]	2.00	1.6
		3.50	1.8
		6.00	1.9
Lightweight Concrete[9]	Exposed	0.75	1.0
		1.00	1.4
		1.50	2.0
		2.00	2.5
	Covered	0.75	0.9
		1.00	1.0
		1.50	1.2
		2.00	1.4
Solid Wood[9]	Exposed	1.50	1.2
		3.00	1.6
Tile[3,9]	Exposed	0.50	0.8
		1.00	1.7
		1.50	2.4
		2.00	3.0
Masonry[4,9]	Exposed	1.00	2.0
		2.00	2.7
		4.00	4.2
Adobe[9]	Exposed	4.00	3.8
		6.00	3.9
		8.00	3.9
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.1
	1.00" Gypsum	na	0.5
	0.88" Stucco	na	1.1
Masonry Infill[7]	0.50" Gypsum	3.50	1.3

Table 3-2 continued on next page.

Table 3-2b: Interior Mass UIMC Values:

Interior Mass[11] - Surfaces Exposed on Two Sides[5, 13]

Material	Surface Condition	Mass Thickness (inches)	Unit Interior Mass Capacity
Partial Grout Masonry[4]	Exposed[1]	4.00	6.9
		6.00	7.4
		8.00	7.4
Solid Grout Masonry[4,6]	Exposed	4.00	8.3
		6.00	9.2
		8.00	9.6
Adobe	Exposed	4.00	7.6
		12.00	7.8
		16.00	7.6
Solid Wood/ Logs	Exposed	3.00	3.3
		4.00	3.3
		6.00	3.3
		8.00	3.3
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.2
	1.00" Gypsum	na	0.9
	0.88" Stucco	na	2.1
Masonry Infill[7]	0.50" Gypsum	3.50	2.6

Notes follow Table 3-3.

Table 3-3: Exterior Wall Mass UIMC Values and Exterior Mass Factors[13]

Material	Surface Condition	Mass Thickness (inches)	Wall U-value	Unit Interior Mass Capacity	Exterior[8] Mass Factor
Partial Grout Masonry[4]	Exposed[1]	4.00	0.68	0.9	1.1
			0.58	1.0	1.0
		6.00	0.54	1.3	1.3
			0.44	1.5	1.1
		8.00	0.49	1.5	1.3
			0.38	1.7	1.2
	Furred[10]	4.00	0.40	0.5	0.9
			0.30	0.5	0.7
			0.20	0.5	0.5
			0.10	0.5	0.3
			0.08	0.5	0.2
		6.00	0.40	0.9	1.2
			0.30	0.6	1.0
			0.20	0.5	0.7
			0.10	0.5	0.4
			0.08	0.5	0.3
		8.00	0.30	0.8	1.0
			0.20	0.5	0.7
			0.10	0.5	0.4
			0.08	0.5	0.3
Solid Grout Masonry[4,6]	Exposed	4.00	0.79	1.0	1.4
		6.00	0.68	1.5	1.9
		8.00	0.62	1.8	2.1
	Furred[10]	4.00	0.40	0.5	1.0
			0.30	0.5	0.8
			0.20	0.5	0.6
			0.10	0.5	0.3
			0.08	0.5	0.3
		6.00	0.40	0.7	1.4
			0.30	0.5	1.1
			0.20	0.5	0.7
			0.10	0.5	0.4
			0.08	0.5	0.3
		8.00	0.40	0.8	1.5
			0.30	0.6	1.2
			0.20	0.5	0.8
			0.10	0.5	0.4
			0.08	0.5	0.3

Table 3-3 continued on next page

Table 3-3: Exterior Wall Mass UIMC Values and Exterior Mass Factors[13]

Material	Surface Condition	Mass Thickness (inches)	Wall U-value	Unit Interior Mass Capacity	Exterior[9] Mass Factor
Solid Wood/ Logs	Exposed[1]	3.00	0.22	0.7	0.5
		4.00	0.17	0.9	0.6
		6.00	0 .12	1.1	0.6
		8.00	0.093	1.2	0.4
		10.00	0.075	1.3	0.3
		12.00	0.063	1 .3	0.3
Wood Cavity Wall[12]	Exposed	3.00[12]	0.11	1.1	0.5
			0.065	1.3	0.3
			0.045	1.4	0.2
Adobe	Exposed	8.00	0.35	2.1	1.5
		16.00	0.21	2.8	0.8
		24.00	0.15	3.1	0.5
Masonry Veneer[4]	Framed Wall	4.00	0.10	na	0.3
			0.08	na	0.3
			0.06	na	0.2
Adobe Veneer	Framed Wall	4.00	0.10	na	0.4
			0.08	na	0.3
			0.06	na	0.2

Notes For Tables 3-2 and 3-3:

1. "Exposed" means that the mass is directly exposed to room air or covered with a conductive material such as ceramic tile.
2. "Covered" includes carpet, cabinets, closets or walls.
3. The indicated thickness includes both the tile and the mortar bed, when applicable.
4. Masonry includes brick, stone, concrete masonry units, hollow clay tile and other masonry.
5. The unit interior mass capacity for surfaces exposed on two sides is based on the area of one side only.
6. "Solid Grout Masonry" means that all the cells of the masonry units are filled with grout.
7. The indicated thickness for masonry infill is for the masonry material itself.
8. Use the Exterior Mass value for calculating Exterior Wall Mass.
9. Mass located inside exterior walls or ceilings may be considered interior mass (exposed one side) when it is insulated on the exterior with at least R-11 insulation, or a total resistance of R-9 including framing effects.
10. "Furred" means that 0.50-inch gypsum board is placed on the inside of the mass wall separated from the mass with insulation or an air space.
11. When mass types are layered, e.g. tile over slab-on-grade or lightweight concrete floor, only the mass type with the greatest interior mass capacity may be accounted for, based on the total thickness of both layers.
12. This wall consists of 3 inches of wood on each side of a cavity. The cavity may be insulated as indicated by the U-value column.
13. Values based on properties of materials listed in 1993 *ASHRAE Handbook of Fundamentals*.

APPENDIX J

							Climate Zone 1				Climate Zone 2			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.750	0.810	0.779	0.812	0.737	0.674	0.767	0.702
2	Attic	4.2	No	No		Yes	0.750	0.791	0.779	0.800	0.737	0.696	0.767	0.723
3	Attic	4.2	No	Yes		No	0.750	0.875	0.779	0.878	0.737	0.728	0.767	0.759
4	Attic	4.2	No	Yes		Yes	0.750	0.855	0.779	0.864	0.737	0.752	0.767	0.781
5	Attic	4.2	No	Yes	25%	No	0.773	0.877	0.795	0.879	0.762	0.754	0.783	0.776
6	Attic	4.2	No	Yes	25%	Yes	0.773	0.862	0.795	0.869	0.762	0.776	0.783	0.797
7	Attic	4.2	Yes	No		No	0.820	0.866	0.852	0.869	0.811	0.744	0.843	0.775
8	Attic	4.2	Yes	No		Yes	0.820	0.846	0.852	0.855	0.811	0.760	0.843	0.790
9	Attic	4.2	Yes	Yes		No	0.820	0.937	0.852	0.939	0.811	0.804	0.843	0.837
10	Attic	4.2	Yes	Yes		Yes	0.820	0.914	0.852	0.925	0.811	0.822	0.843	0.854
11	Attic	4.2	Yes	Yes	25%	No	0.846	0.938	0.869	0.941	0.838	0.832	0.861	0.856
12	Attic	4.2	Yes	Yes	25%	Yes	0.846	0.922	0.869	0.930	0.838	0.848	0.861	0.871
13	Attic	8.0	No	No		No	0.793	0.813	0.810	0.814	0.783	0.717	0.800	0.734
14	Attic	8.0	No	No		Yes	0.793	0.802	0.810	0.807	0.783	0.735	0.800	0.751
15	Attic	8.0	No	Yes		No	0.793	0.879	0.810	0.880	0.783	0.776	0.800	0.793
16	Attic	8.0	No	Yes		Yes	0.793	0.867	0.810	0.872	0.783	0.795	0.800	0.812
17	Attic	8.0	No	Yes	25%	No	0.807	0.880	0.819	0.881	0.797	0.790	0.810	0.803
18	Attic	8.0	No	Yes	25%	Yes	0.807	0.871	0.819	0.875	0.797	0.809	0.810	0.821
19	Attic	8.0	Yes	No		No	0.868	0.869	0.886	0.871	0.861	0.792	0.880	0.810
20	Attic	8.0	Yes	No		Yes	0.868	0.858	0.886	0.863	0.861	0.804	0.880	0.821
21	Attic	8.0	Yes	Yes		No	0.868	0.940	0.886	0.942	0.861	0.857	0.880	0.876
22	Attic	8.0	Yes	Yes		Yes	0.868	0.927	0.886	0.933	0.861	0.869	0.880	0.888
23	Attic	8.0	Yes	Yes	25%	No	0.883	0.941	0.896	0.942	0.877	0.873	0.891	0.887
24	Attic	8.0	Yes	Yes	25%	Yes	0.883	0.932	0.896	0.936	0.877	0.884	0.891	0.897
25	Crawlspace	4.2	No	No		No	0.755	0.833	0.783	0.828	0.743	0.709	0.772	0.726
26	Crawlspace	4.2	No	No		Yes	0.755	0.833	0.783	0.828	0.743	0.722	0.772	0.741
27	Crawlspace	4.2	No	Yes		No	0.755	0.900	0.783	0.895	0.743	0.767	0.772	0.785
28	Crawlspace	4.2	No	Yes		Yes	0.755	0.900	0.783	0.895	0.743	0.780	0.772	0.801
29	Crawlspace	4.2	No	Yes	25%	No	0.777	0.896	0.798	0.893	0.766	0.783	0.787	0.796
30	Crawlspace	4.2	No	Yes	25%	Yes	0.777	0.896	0.798	0.893	0.766	0.797	0.787	0.812
31	Crawlspace	4.2	Yes	No		No	0.824	0.889	0.855	0.884	0.815	0.781	0.847	0.799
32	Crawlspace	4.2	Yes	No		Yes	0.824	0.889	0.855	0.884	0.815	0.787	0.847	0.807
33	Crawlspace	4.2	Yes	Yes		No	0.824	0.962	0.855	0.956	0.815	0.844	0.847	0.864
34	Crawlspace	4.2	Yes	Yes		Yes	0.824	0.962	0.855	0.956	0.815	0.851	0.847	0.873
35	Crawlspace	4.2	Yes	Yes	25%	No	0.849	0.958	0.871	0.954	0.841	0.863	0.864	0.877
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.849	0.958	0.871	0.954	0.841	0.869	0.864	0.886
37	Crawlspace	8.0	No	No		No	0.797	0.827	0.813	0.824	0.787	0.739	0.804	0.749
38	Crawlspace	8.0	No	No		Yes	0.797	0.827	0.813	0.824	0.787	0.751	0.804	0.762
39	Crawlspace	8.0	No	Yes		No	0.797	0.894	0.813	0.891	0.787	0.798	0.804	0.809
40	Crawlspace	8.0	No	Yes		Yes	0.797	0.894	0.813	0.891	0.787	0.812	0.804	0.824
41	Crawlspace	8.0	No	Yes	25%	No	0.810	0.892	0.822	0.889	0.801	0.808	0.813	0.816
42	Crawlspace	8.0	No	Yes	25%	Yes	0.810	0.892	0.822	0.889	0.801	0.822	0.813	0.831
43	Crawlspace	8.0	Yes	No		No	0.870	0.883	0.888	0.880	0.864	0.814	0.882	0.825
44	Crawlspace	8.0	Yes	No		Yes	0.870	0.883	0.888	0.880	0.864	0.819	0.882	0.832
45	Crawlspace	8.0	Yes	Yes		No	0.870	0.955	0.888	0.952	0.864	0.880	0.882	0.892
46	Crawlspace	8.0	Yes	Yes		Yes	0.870	0.955	0.888	0.952	0.864	0.886	0.882	0.899
47	Crawlspace	8.0	Yes	Yes	25%	No	0.885	0.952	0.898	0.950	0.879	0.891	0.893	0.899
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.885	0.952	0.898	0.950	0.879	0.897	0.893	0.906
49	DuctsInEx12	4.2	No	No		No	0.837	0.816	0.837	0.816	0.829	0.761	0.827	0.760
50	DuctsInEx12	4.2	No	No		Yes	0.837	0.814	0.837	0.815	0.829	0.776	0.827	0.776
51	DuctsInEx12	4.2	No	Yes		No	0.837	0.882	0.837	0.882	0.829	0.823	0.827	0.821
52	DuctsInEx12	4.2	No	Yes		Yes	0.837	0.880	0.837	0.881	0.829	0.839	0.827	0.839
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.916	0.873	0.915	0.873	0.912	0.841	0.910	0.838
56	DuctsInEx12	4.2	Yes	No		Yes	0.916	0.871	0.915	0.872	0.912	0.848	0.910	0.848
57	DuctsInEx12	4.2	Yes	Yes		No	0.916	0.944	0.915	0.944	0.912	0.909	0.910	0.906
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.916	0.942	0.915	0.943	0.912	0.917	0.910	0.917
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.843	0.816	0.843	0.816	0.836	0.768	0.835	0.767
62	DuctsInEx12	8.0	No	No		Yes	0.843	0.815	0.843	0.816	0.836	0.782	0.835	0.782
63	DuctsInEx12	8.0	No	Yes		No	0.843	0.883	0.843	0.883	0.836	0.830	0.835	0.829
64	DuctsInEx12	8.0	No	Yes		Yes	0.843	0.881	0.843	0.882	0.836	0.845	0.835	0.845
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.923	0.873	0.923	0.874	0.920	0.848	0.919	0.847
68	DuctsInEx12	8.0	Yes	No		Yes	0.923	0.872	0.923	0.873	0.920	0.855	0.919	0.854
69	DuctsInEx12	8.0	Yes	Yes		No	0.923	0.944	0.923	0.944	0.920	0.917	0.919	0.916
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.923	0.943	0.923	0.944	0.920	0.924	0.919	0.924
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 3				Climate Zone 4			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.759	0.730	0.788	0.755	0.753	0.738	0.782	0.763
2	Attic	4.2	No	No		Yes	0.759	0.740	0.788	0.766	0.753	0.744	0.782	0.769
3	Attic	4.2	No	Yes		No	0.759	0.789	0.788	0.816	0.753	0.798	0.782	0.824
4	Attic	4.2	No	Yes		Yes	0.759	0.801	0.788	0.828	0.753	0.804	0.782	0.831
5	Attic	4.2	No	Yes	25%	No	0.782	0.809	0.803	0.830	0.776	0.817	0.797	0.837
6	Attic	4.2	No	Yes	25%	Yes	0.782	0.820	0.803	0.841	0.776	0.823	0.797	0.844
7	Attic	4.2	Yes	No		No	0.827	0.786	0.858	0.813	0.822	0.792	0.854	0.818
8	Attic	4.2	Yes	No		Yes	0.827	0.792	0.858	0.819	0.822	0.795	0.854	0.822
9	Attic	4.2	Yes	Yes		No	0.827	0.850	0.858	0.879	0.822	0.856	0.854	0.885
10	Attic	4.2	Yes	Yes		Yes	0.827	0.856	0.858	0.886	0.822	0.860	0.854	0.888
11	Attic	4.2	Yes	Yes	25%	No	0.852	0.871	0.875	0.893	0.848	0.877	0.871	0.898
12	Attic	4.2	Yes	Yes	25%	Yes	0.852	0.877	0.875	0.900	0.848	0.880	0.871	0.902
13	Attic	8.0	No	No		No	0.801	0.763	0.817	0.778	0.795	0.770	0.812	0.784
14	Attic	8.0	No	No		Yes	0.801	0.772	0.817	0.787	0.795	0.775	0.812	0.789
15	Attic	8.0	No	Yes		No	0.801	0.825	0.817	0.841	0.795	0.832	0.812	0.847
16	Attic	8.0	No	Yes		Yes	0.801	0.835	0.817	0.851	0.795	0.838	0.812	0.853
17	Attic	8.0	No	Yes	25%	No	0.814	0.837	0.826	0.848	0.809	0.843	0.821	0.855
18	Attic	8.0	No	Yes	25%	Yes	0.814	0.847	0.826	0.859	0.809	0.849	0.821	0.861
19	Attic	8.0	Yes	No		No	0.873	0.822	0.891	0.837	0.869	0.826	0.888	0.841
20	Attic	8.0	Yes	No		Yes	0.873	0.827	0.891	0.843	0.869	0.829	0.888	0.844
21	Attic	8.0	Yes	Yes		No	0.873	0.888	0.891	0.905	0.869	0.893	0.888	0.909
22	Attic	8.0	Yes	Yes		Yes	0.873	0.894	0.891	0.911	0.869	0.896	0.888	0.913
23	Attic	8.0	Yes	Yes	25%	No	0.887	0.901	0.900	0.914	0.884	0.905	0.898	0.917
24	Attic	8.0	Yes	Yes	25%	Yes	0.887	0.906	0.900	0.919	0.884	0.908	0.898	0.921
25	Crawlspace	4.2	No	No		No	0.764	0.762	0.792	0.777	0.758	0.770	0.786	0.784
26	Crawlspace	4.2	No	No		Yes	0.764	0.770	0.792	0.786	0.758	0.774	0.786	0.789
27	Crawlspace	4.2	No	Yes		No	0.764	0.824	0.792	0.840	0.758	0.832	0.786	0.848
28	Crawlspace	4.2	No	Yes		Yes	0.764	0.833	0.792	0.850	0.758	0.837	0.786	0.853
29	Crawlspace	4.2	No	Yes	25%	No	0.786	0.836	0.806	0.848	0.780	0.844	0.801	0.855
30	Crawlspace	4.2	No	Yes	25%	Yes	0.786	0.845	0.806	0.858	0.780	0.849	0.801	0.861
31	Crawlspace	4.2	Yes	No		No	0.830	0.819	0.861	0.835	0.826	0.824	0.857	0.840
32	Crawlspace	4.2	Yes	No		Yes	0.830	0.823	0.861	0.840	0.826	0.827	0.857	0.843
33	Crawlspace	4.2	Yes	Yes		No	0.830	0.885	0.861	0.903	0.826	0.891	0.857	0.908
34	Crawlspace	4.2	Yes	Yes		Yes	0.830	0.890	0.861	0.908	0.826	0.894	0.857	0.911
35	Crawlspace	4.2	Yes	Yes	25%	No	0.855	0.899	0.877	0.911	0.851	0.904	0.873	0.916
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.855	0.903	0.877	0.917	0.851	0.906	0.873	0.920
37	Crawlspace	8.0	No	No		No	0.804	0.782	0.820	0.791	0.799	0.789	0.816	0.797
38	Crawlspace	8.0	No	No		Yes	0.804	0.790	0.820	0.800	0.799	0.793	0.816	0.802
39	Crawlspace	8.0	No	Yes		No	0.804	0.846	0.820	0.855	0.799	0.853	0.816	0.862
40	Crawlspace	8.0	No	Yes		Yes	0.804	0.855	0.820	0.865	0.799	0.857	0.816	0.867
41	Crawlspace	8.0	No	Yes	25%	No	0.817	0.853	0.829	0.860	0.812	0.859	0.824	0.866
42	Crawlspace	8.0	No	Yes	25%	Yes	0.817	0.862	0.829	0.869	0.812	0.864	0.824	0.871
43	Crawlspace	8.0	Yes	No		No	0.875	0.841	0.893	0.850	0.872	0.845	0.890	0.854
44	Crawlspace	8.0	Yes	No		Yes	0.875	0.845	0.893	0.855	0.872	0.847	0.890	0.856
45	Crawlspace	8.0	Yes	Yes		No	0.875	0.909	0.893	0.919	0.872	0.914	0.890	0.923
46	Crawlspace	8.0	Yes	Yes		Yes	0.875	0.913	0.893	0.924	0.872	0.916	0.890	0.926
47	Crawlspace	8.0	Yes	Yes	25%	No	0.889	0.917	0.902	0.924	0.886	0.921	0.899	0.928
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.889	0.921	0.902	0.929	0.886	0.923	0.899	0.931
49	DuctsInEx12	4.2	No	No		No	0.843	0.799	0.843	0.800	0.839	0.804	0.839	0.806
50	DuctsInEx12	4.2	No	No		Yes	0.843	0.808	0.843	0.811	0.839	0.809	0.839	0.812
51	DuctsInEx12	4.2	No	Yes		No	0.843	0.863	0.843	0.865	0.839	0.869	0.839	0.871
52	DuctsInEx12	4.2	No	Yes		Yes	0.843	0.873	0.843	0.876	0.839	0.875	0.839	0.878
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.920	0.860	0.919	0.862	0.917	0.863	0.917	0.865
56	DuctsInEx12	4.2	Yes	No		Yes	0.920	0.865	0.919	0.868	0.917	0.866	0.917	0.869
57	DuctsInEx12	4.2	Yes	Yes		No	0.920	0.930	0.919	0.932	0.917	0.933	0.917	0.935
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.920	0.935	0.919	0.938	0.917	0.936	0.917	0.939
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.849	0.803	0.849	0.804	0.845	0.808	0.845	0.809
62	DuctsInEx12	8.0	No	No		Yes	0.849	0.811	0.849	0.813	0.845	0.812	0.845	0.814
63	DuctsInEx12	8.0	No	Yes		No	0.849	0.868	0.849	0.869	0.845	0.873	0.845	0.874
64	DuctsInEx12	8.0	No	Yes		Yes	0.849	0.877	0.849	0.879	0.845	0.878	0.845	0.880
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.926	0.865	0.926	0.866	0.924	0.867	0.924	0.868
68	DuctsInEx12	8.0	Yes	No		Yes	0.926	0.869	0.926	0.870	0.924	0.869	0.924	0.871
69	DuctsInEx12	8.0	Yes	Yes		No	0.926	0.935	0.926	0.936	0.924	0.937	0.924	0.939
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.926	0.939	0.926	0.941	0.924	0.940	0.924	0.941
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 5				Climate Zone 6			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.740	0.760	0.770	0.779	0.766	0.722	0.794	0.747
2	Attic	4.2	No	No		Yes	0.740	0.756	0.770	0.777	0.766	0.734	0.794	0.759
3	Attic	4.2	No	Yes		No	0.740	0.822	0.770	0.843	0.766	0.781	0.794	0.808
4	Attic	4.2	No	Yes		Yes	0.740	0.817	0.770	0.840	0.766	0.793	0.794	0.821
5	Attic	4.2	No	Yes	25%	No	0.765	0.837	0.786	0.853	0.788	0.801	0.809	0.822
6	Attic	4.2	No	Yes	25%	Yes	0.765	0.833	0.786	0.850	0.788	0.814	0.809	0.835
7	Attic	4.2	Yes	No		No	0.813	0.813	0.845	0.834	0.832	0.780	0.863	0.807
8	Attic	4.2	Yes	No		Yes	0.813	0.809	0.845	0.831	0.832	0.787	0.863	0.815
9	Attic	4.2	Yes	Yes		No	0.813	0.879	0.845	0.901	0.832	0.843	0.863	0.873
10	Attic	4.2	Yes	Yes		Yes	0.813	0.874	0.845	0.898	0.832	0.851	0.863	0.881
11	Attic	4.2	Yes	Yes	25%	No	0.840	0.895	0.863	0.912	0.856	0.866	0.879	0.888
12	Attic	4.2	Yes	Yes	25%	Yes	0.840	0.891	0.863	0.909	0.856	0.873	0.879	0.896
13	Attic	8.0	No	No		No	0.785	0.784	0.803	0.795	0.806	0.757	0.822	0.771
14	Attic	8.0	No	No		Yes	0.785	0.782	0.803	0.794	0.806	0.767	0.822	0.782
15	Attic	8.0	No	Yes		No	0.785	0.848	0.803	0.860	0.806	0.818	0.822	0.834
16	Attic	8.0	No	Yes		Yes	0.785	0.845	0.803	0.858	0.806	0.829	0.822	0.845
17	Attic	8.0	No	Yes	25%	No	0.799	0.856	0.812	0.866	0.819	0.830	0.831	0.842
18	Attic	8.0	No	Yes	25%	Yes	0.799	0.854	0.812	0.864	0.819	0.841	0.831	0.853
19	Attic	8.0	Yes	No		No	0.863	0.839	0.882	0.851	0.876	0.818	0.894	0.834
20	Attic	8.0	Yes	No		Yes	0.863	0.836	0.882	0.849	0.876	0.823	0.894	0.839
21	Attic	8.0	Yes	Yes		No	0.863	0.907	0.882	0.920	0.876	0.884	0.894	0.901
22	Attic	8.0	Yes	Yes		Yes	0.863	0.904	0.882	0.918	0.876	0.890	0.894	0.908
23	Attic	8.0	Yes	Yes	25%	No	0.878	0.916	0.892	0.926	0.890	0.897	0.903	0.910
24	Attic	8.0	Yes	Yes	25%	Yes	0.878	0.914	0.892	0.925	0.890	0.903	0.903	0.916
25	Crawlspace	4.2	No	No		No	0.746	0.790	0.774	0.800	0.770	0.755	0.797	0.770
26	Crawlspace	4.2	No	No		Yes	0.746	0.790	0.774	0.800	0.770	0.763	0.797	0.780
27	Crawlspace	4.2	No	Yes		No	0.746	0.854	0.774	0.864	0.770	0.816	0.797	0.832
28	Crawlspace	4.2	No	Yes		Yes	0.746	0.854	0.774	0.864	0.770	0.825	0.797	0.843
29	Crawlspace	4.2	No	Yes	25%	No	0.769	0.861	0.790	0.869	0.791	0.828	0.812	0.841
30	Crawlspace	4.2	No	Yes	25%	Yes	0.769	0.861	0.790	0.869	0.791	0.838	0.812	0.851
31	Crawlspace	4.2	Yes	No		No	0.817	0.843	0.849	0.854	0.835	0.813	0.865	0.830
32	Crawlspace	4.2	Yes	No		Yes	0.817	0.843	0.849	0.854	0.835	0.818	0.865	0.835
33	Crawlspace	4.2	Yes	Yes		No	0.817	0.912	0.849	0.923	0.835	0.879	0.865	0.897
34	Crawlspace	4.2	Yes	Yes		Yes	0.817	0.912	0.849	0.923	0.835	0.884	0.865	0.903
35	Crawlspace	4.2	Yes	Yes	25%	No	0.843	0.920	0.866	0.929	0.858	0.893	0.881	0.906
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.843	0.920	0.866	0.929	0.858	0.898	0.881	0.912
37	Crawlspace	8.0	No	No		No	0.789	0.802	0.806	0.808	0.809	0.776	0.825	0.785
38	Crawlspace	8.0	No	No		Yes	0.789	0.802	0.806	0.808	0.809	0.785	0.825	0.794
39	Crawlspace	8.0	No	Yes		No	0.789	0.867	0.806	0.873	0.809	0.839	0.825	0.849
40	Crawlspace	8.0	No	Yes		Yes	0.789	0.867	0.806	0.873	0.809	0.848	0.825	0.859
41	Crawlspace	8.0	No	Yes	25%	No	0.803	0.872	0.815	0.876	0.822	0.847	0.834	0.853
42	Crawlspace	8.0	No	Yes	25%	Yes	0.803	0.872	0.815	0.876	0.822	0.856	0.834	0.864
43	Crawlspace	8.0	Yes	No		No	0.866	0.857	0.884	0.863	0.878	0.837	0.895	0.847
44	Crawlspace	8.0	Yes	No		Yes	0.866	0.857	0.884	0.863	0.878	0.841	0.895	0.851
45	Crawlspace	8.0	Yes	Yes		No	0.866	0.926	0.884	0.933	0.878	0.905	0.895	0.915
46	Crawlspace	8.0	Yes	Yes		Yes	0.866	0.926	0.884	0.933	0.878	0.909	0.895	0.920
47	Crawlspace	8.0	Yes	Yes	25%	No	0.881	0.931	0.894	0.936	0.892	0.913	0.905	0.921
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.881	0.931	0.894	0.936	0.892	0.917	0.905	0.926
49	DuctsInEx12	4.2	No	No		No	0.831	0.811	0.830	0.813	0.848	0.793	0.848	0.794
50	DuctsInEx12	4.2	No	No		Yes	0.831	0.810	0.830	0.813	0.848	0.803	0.848	0.805
51	DuctsInEx12	4.2	No	Yes		No	0.831	0.877	0.830	0.879	0.848	0.858	0.848	0.859
52	DuctsInEx12	4.2	No	Yes		Yes	0.831	0.876	0.830	0.879	0.848	0.868	0.848	0.871
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.913	0.868	0.911	0.870	0.922	0.857	0.922	0.859
56	DuctsInEx12	4.2	Yes	No		Yes	0.913	0.867	0.911	0.869	0.922	0.862	0.922	0.865
57	DuctsInEx12	4.2	Yes	Yes		No	0.913	0.938	0.911	0.940	0.922	0.927	0.922	0.928
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.913	0.937	0.911	0.940	0.922	0.932	0.922	0.935
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.838	0.813	0.837	0.815	0.853	0.798	0.853	0.798
62	DuctsInEx12	8.0	No	No		Yes	0.838	0.813	0.837	0.814	0.853	0.807	0.853	0.808
63	DuctsInEx12	8.0	No	Yes		No	0.838	0.879	0.837	0.881	0.853	0.862	0.853	0.863
64	DuctsInEx12	8.0	No	Yes		Yes	0.838	0.879	0.837	0.880	0.853	0.872	0.853	0.874
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.920	0.870	0.920	0.872	0.928	0.862	0.928	0.863
68	DuctsInEx12	8.0	Yes	No		Yes	0.920	0.870	0.920	0.871	0.928	0.867	0.928	0.868
69	DuctsInEx12	8.0	Yes	Yes		No	0.920	0.941	0.920	0.942	0.928	0.932	0.928	0.933
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.920	0.941	0.920	0.942	0.928	0.937	0.928	0.938
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 7				Climate Zone 8			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.781	0.760	0.809	0.779	0.769	0.752	0.797	0.770
2	Attic	4.2	No	No		Yes	0.781	0.756	0.809	0.777	0.769	0.761	0.797	0.780
3	Attic	4.2	No	Yes		No	0.781	0.822	0.809	0.843	0.769	0.813	0.797	0.832
4	Attic	4.2	No	Yes		Yes	0.781	0.817	0.809	0.840	0.769	0.823	0.797	0.843
5	Attic	4.2	No	Yes	25%	No	0.802	0.837	0.823	0.853	0.791	0.827	0.811	0.842
6	Attic	4.2	No	Yes	25%	Yes	0.802	0.833	0.823	0.850	0.791	0.837	0.811	0.853
7	Attic	4.2	Yes	No		No	0.844	0.813	0.873	0.834	0.834	0.809	0.865	0.829
8	Attic	4.2	Yes	No		Yes	0.844	0.809	0.873	0.831	0.834	0.815	0.865	0.835
9	Attic	4.2	Yes	Yes		No	0.844	0.879	0.873	0.901	0.834	0.875	0.865	0.896
10	Attic	4.2	Yes	Yes		Yes	0.844	0.874	0.873	0.898	0.834	0.881	0.865	0.902
11	Attic	4.2	Yes	Yes	25%	No	0.866	0.895	0.888	0.912	0.858	0.891	0.881	0.906
12	Attic	4.2	Yes	Yes	25%	Yes	0.866	0.891	0.888	0.909	0.858	0.896	0.881	0.913
13	Attic	8.0	No	No		No	0.819	0.784	0.835	0.795	0.808	0.776	0.825	0.786
14	Attic	8.0	No	No		Yes	0.819	0.782	0.835	0.794	0.808	0.785	0.825	0.795
15	Attic	8.0	No	Yes		No	0.819	0.848	0.835	0.860	0.808	0.839	0.825	0.850
16	Attic	8.0	No	Yes		Yes	0.819	0.845	0.835	0.858	0.808	0.848	0.825	0.860
17	Attic	8.0	No	Yes	25%	No	0.831	0.856	0.843	0.866	0.821	0.847	0.833	0.855
18	Attic	8.0	No	Yes	25%	Yes	0.831	0.854	0.843	0.864	0.821	0.857	0.833	0.865
19	Attic	8.0	Yes	No		No	0.884	0.839	0.901	0.851	0.878	0.835	0.895	0.847
20	Attic	8.0	Yes	No		Yes	0.884	0.836	0.901	0.849	0.878	0.840	0.895	0.851
21	Attic	8.0	Yes	Yes		No	0.884	0.907	0.901	0.920	0.878	0.903	0.895	0.915
22	Attic	8.0	Yes	Yes		Yes	0.884	0.904	0.901	0.918	0.878	0.908	0.895	0.920
23	Attic	8.0	Yes	Yes	25%	No	0.897	0.916	0.910	0.926	0.892	0.912	0.905	0.921
24	Attic	8.0	Yes	Yes	25%	Yes	0.897	0.914	0.910	0.925	0.892	0.917	0.905	0.926
25	Crawlspace	4.2	No	No		No	0.784	0.790	0.811	0.800	0.773	0.775	0.800	0.786
26	Crawlspace	4.2	No	No		Yes	0.784	0.790	0.811	0.800	0.773	0.783	0.800	0.795
27	Crawlspace	4.2	No	Yes		No	0.784	0.854	0.811	0.864	0.773	0.838	0.800	0.850
28	Crawlspace	4.2	No	Yes		Yes	0.784	0.854	0.811	0.864	0.773	0.847	0.800	0.860
29	Crawlspace	4.2	No	Yes	25%	No	0.805	0.861	0.825	0.869	0.794	0.847	0.814	0.856
30	Crawlspace	4.2	No	Yes	25%	Yes	0.805	0.861	0.825	0.869	0.794	0.856	0.814	0.866
31	Crawlspace	4.2	Yes	No		No	0.845	0.843	0.875	0.854	0.837	0.833	0.867	0.845
32	Crawlspace	4.2	Yes	No		Yes	0.845	0.843	0.875	0.854	0.837	0.837	0.867	0.850
33	Crawlspace	4.2	Yes	Yes		No	0.845	0.912	0.875	0.923	0.837	0.901	0.867	0.913
34	Crawlspace	4.2	Yes	Yes		Yes	0.845	0.912	0.875	0.923	0.837	0.905	0.867	0.919
35	Crawlspace	4.2	Yes	Yes	25%	No	0.868	0.920	0.890	0.929	0.860	0.911	0.882	0.920
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.868	0.920	0.890	0.929	0.860	0.915	0.882	0.925
37	Crawlspace	8.0	No	No		No	0.821	0.802	0.837	0.808	0.811	0.790	0.828	0.796
38	Crawlspace	8.0	No	No		Yes	0.821	0.802	0.837	0.808	0.811	0.798	0.828	0.805
39	Crawlspace	8.0	No	Yes		No	0.821	0.867	0.837	0.873	0.811	0.854	0.828	0.861
40	Crawlspace	8.0	No	Yes		Yes	0.821	0.867	0.837	0.873	0.811	0.863	0.828	0.870
41	Crawlspace	8.0	No	Yes	25%	No	0.833	0.872	0.845	0.876	0.824	0.859	0.836	0.864
42	Crawlspace	8.0	No	Yes	25%	Yes	0.833	0.872	0.845	0.876	0.824	0.868	0.836	0.874
43	Crawlspace	8.0	Yes	No		No	0.885	0.857	0.903	0.863	0.879	0.849	0.897	0.856
44	Crawlspace	8.0	Yes	No		Yes	0.885	0.857	0.903	0.863	0.879	0.853	0.897	0.860
45	Crawlspace	8.0	Yes	Yes		No	0.885	0.926	0.903	0.933	0.879	0.918	0.897	0.926
46	Crawlspace	8.0	Yes	Yes		Yes	0.885	0.926	0.903	0.933	0.879	0.922	0.897	0.930
47	Crawlspace	8.0	Yes	Yes	25%	No	0.899	0.931	0.911	0.936	0.893	0.924	0.906	0.929
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.899	0.931	0.911	0.936	0.893	0.928	0.906	0.934
49	DuctsInEx12	4.2	No	No		No	0.858	0.811	0.859	0.813	0.850	0.801	0.850	0.802
50	DuctsInEx12	4.2	No	No		Yes	0.858	0.810	0.859	0.813	0.850	0.810	0.850	0.812
51	DuctsInEx12	4.2	No	Yes		No	0.858	0.877	0.859	0.879	0.850	0.866	0.850	0.868
52	DuctsInEx12	4.2	No	Yes		Yes	0.858	0.876	0.859	0.879	0.850	0.876	0.850	0.878
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.927	0.868	0.929	0.870	0.923	0.863	0.923	0.864
56	DuctsInEx12	4.2	Yes	No		Yes	0.927	0.867	0.929	0.869	0.923	0.867	0.923	0.869
57	DuctsInEx12	4.2	Yes	Yes		No	0.927	0.938	0.929	0.940	0.923	0.933	0.923	0.934
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.927	0.937	0.929	0.940	0.923	0.938	0.923	0.940
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.863	0.813	0.864	0.815	0.855	0.804	0.855	0.805
62	DuctsInEx12	8.0	No	No		Yes	0.863	0.813	0.864	0.814	0.855	0.813	0.855	0.814
63	DuctsInEx12	8.0	No	Yes		No	0.863	0.879	0.864	0.881	0.855	0.869	0.855	0.870
64	DuctsInEx12	8.0	No	Yes		Yes	0.863	0.879	0.864	0.880	0.855	0.879	0.855	0.880
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.932	0.870	0.933	0.872	0.929	0.866	0.929	0.867
68	DuctsInEx12	8.0	Yes	No		Yes	0.932	0.870	0.933	0.871	0.929	0.870	0.929	0.871
69	DuctsInEx12	8.0	Yes	Yes		No	0.932	0.941	0.933	0.942	0.929	0.937	0.929	0.937
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.932	0.941	0.933	0.942	0.929	0.941	0.929	0.942
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 9				Climate Zone 10			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.753	0.702	0.782	0.723	0.753	0.674	0.782	0.696
2	Attic	4.2	No	No		Yes	0.753	0.722	0.782	0.741	0.753	0.699	0.782	0.719
3	Attic	4.2	No	Yes		No	0.753	0.759	0.782	0.781	0.753	0.728	0.782	0.752
4	Attic	4.2	No	Yes		Yes	0.753	0.780	0.782	0.801	0.753	0.756	0.782	0.778
5	Attic	4.2	No	Yes	25%	No	0.776	0.778	0.797	0.794	0.776	0.749	0.797	0.766
6	Attic	4.2	No	Yes	25%	Yes	0.776	0.797	0.797	0.813	0.776	0.774	0.797	0.790
7	Attic	4.2	Yes	No		No	0.822	0.775	0.854	0.798	0.822	0.756	0.854	0.780
8	Attic	4.2	Yes	No		Yes	0.822	0.789	0.854	0.810	0.822	0.774	0.854	0.796
9	Attic	4.2	Yes	Yes		No	0.822	0.838	0.854	0.863	0.822	0.817	0.854	0.843
10	Attic	4.2	Yes	Yes		Yes	0.822	0.852	0.854	0.876	0.822	0.836	0.854	0.861
11	Attic	4.2	Yes	Yes	25%	No	0.848	0.859	0.871	0.876	0.848	0.841	0.871	0.859
12	Attic	4.2	Yes	Yes	25%	Yes	0.848	0.871	0.871	0.888	0.848	0.857	0.871	0.874
13	Attic	8.0	No	No		No	0.795	0.734	0.812	0.746	0.795	0.710	0.812	0.723
14	Attic	8.0	No	No		Yes	0.795	0.751	0.812	0.762	0.795	0.731	0.812	0.743
15	Attic	8.0	No	Yes		No	0.795	0.794	0.812	0.806	0.795	0.768	0.812	0.782
16	Attic	8.0	No	Yes		Yes	0.795	0.811	0.812	0.824	0.795	0.790	0.812	0.803
17	Attic	8.0	No	Yes	25%	No	0.809	0.804	0.821	0.814	0.809	0.780	0.821	0.790
18	Attic	8.0	No	Yes	25%	Yes	0.809	0.821	0.821	0.830	0.809	0.801	0.821	0.810
19	Attic	8.0	Yes	No		No	0.869	0.811	0.888	0.824	0.869	0.797	0.888	0.811
20	Attic	8.0	Yes	No		Yes	0.869	0.820	0.888	0.833	0.869	0.809	0.888	0.822
21	Attic	8.0	Yes	Yes		No	0.869	0.876	0.888	0.891	0.869	0.861	0.888	0.876
22	Attic	8.0	Yes	Yes		Yes	0.869	0.887	0.888	0.900	0.869	0.875	0.888	0.889
23	Attic	8.0	Yes	Yes	25%	No	0.884	0.888	0.898	0.898	0.884	0.875	0.898	0.885
24	Attic	8.0	Yes	Yes	25%	Yes	0.884	0.898	0.898	0.908	0.884	0.887	0.898	0.897
25	Crawlspace	4.2	No	No		No	0.758	0.728	0.786	0.741	0.758	0.701	0.786	0.715
26	Crawlspace	4.2	No	No		Yes	0.758	0.741	0.786	0.755	0.758	0.717	0.786	0.732
27	Crawlspace	4.2	No	Yes		No	0.758	0.787	0.786	0.801	0.758	0.758	0.786	0.773
28	Crawlspace	4.2	No	Yes		Yes	0.758	0.801	0.786	0.816	0.758	0.775	0.786	0.791
29	Crawlspace	4.2	No	Yes	25%	No	0.780	0.800	0.801	0.809	0.780	0.772	0.801	0.782
30	Crawlspace	4.2	No	Yes	25%	Yes	0.780	0.814	0.801	0.824	0.780	0.789	0.801	0.801
31	Crawlspace	4.2	Yes	No		No	0.826	0.802	0.857	0.816	0.826	0.784	0.857	0.799
32	Crawlspace	4.2	Yes	No		Yes	0.826	0.808	0.857	0.823	0.826	0.791	0.857	0.808
33	Crawlspace	4.2	Yes	Yes		No	0.826	0.867	0.857	0.882	0.826	0.848	0.857	0.864
34	Crawlspace	4.2	Yes	Yes		Yes	0.826	0.873	0.857	0.890	0.826	0.855	0.857	0.873
35	Crawlspace	4.2	Yes	Yes	25%	No	0.851	0.881	0.873	0.891	0.851	0.864	0.873	0.875
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.851	0.887	0.873	0.899	0.851	0.872	0.873	0.884
37	Crawlspace	8.0	No	No		No	0.799	0.750	0.816	0.757	0.799	0.727	0.816	0.735
38	Crawlspace	8.0	No	No		Yes	0.799	0.762	0.816	0.770	0.799	0.742	0.816	0.751
39	Crawlspace	8.0	No	Yes		No	0.799	0.811	0.816	0.818	0.799	0.786	0.816	0.794
40	Crawlspace	8.0	No	Yes		Yes	0.799	0.824	0.816	0.833	0.799	0.802	0.816	0.812
41	Crawlspace	8.0	No	Yes	25%	No	0.812	0.818	0.824	0.823	0.812	0.794	0.824	0.800
42	Crawlspace	8.0	No	Yes	25%	Yes	0.812	0.831	0.824	0.838	0.812	0.811	0.824	0.817
43	Crawlspace	8.0	Yes	No		No	0.872	0.826	0.890	0.834	0.872	0.813	0.890	0.822
44	Crawlspace	8.0	Yes	No		Yes	0.872	0.832	0.890	0.841	0.872	0.820	0.890	0.829
45	Crawlspace	8.0	Yes	Yes		No	0.872	0.893	0.890	0.902	0.872	0.879	0.890	0.888
46	Crawlspace	8.0	Yes	Yes		Yes	0.872	0.899	0.890	0.909	0.872	0.886	0.890	0.897
47	Crawlspace	8.0	Yes	Yes	25%	No	0.886	0.901	0.899	0.907	0.886	0.888	0.899	0.895
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.886	0.907	0.899	0.914	0.886	0.896	0.899	0.903
49	DuctsInEx12	4.2	No	No		No	0.839	0.766	0.839	0.764	0.839	0.745	0.839	0.743
50	DuctsInEx12	4.2	No	No		Yes	0.839	0.780	0.839	0.780	0.839	0.763	0.839	0.761
51	DuctsInEx12	4.2	No	Yes		No	0.839	0.828	0.839	0.826	0.839	0.806	0.839	0.803
52	DuctsInEx12	4.2	No	Yes		Yes	0.839	0.843	0.839	0.843	0.839	0.825	0.839	0.823
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.917	0.846	0.917	0.844	0.917	0.836	0.917	0.832
56	DuctsInEx12	4.2	Yes	No		Yes	0.917	0.853	0.917	0.852	0.917	0.844	0.917	0.842
57	DuctsInEx12	4.2	Yes	Yes		No	0.917	0.914	0.917	0.912	0.917	0.903	0.917	0.900
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.917	0.922	0.917	0.921	0.917	0.913	0.917	0.911
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.845	0.771	0.845	0.770	0.845	0.751	0.845	0.750
62	DuctsInEx12	8.0	No	No		Yes	0.845	0.784	0.845	0.784	0.845	0.768	0.845	0.767
63	DuctsInEx12	8.0	No	Yes		No	0.845	0.833	0.845	0.832	0.845	0.812	0.845	0.811
64	DuctsInEx12	8.0	No	Yes		Yes	0.845	0.848	0.845	0.847	0.845	0.830	0.845	0.829
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.924	0.851	0.924	0.850	0.924	0.842	0.924	0.841
68	DuctsInEx12	8.0	Yes	No		Yes	0.924	0.857	0.924	0.857	0.924	0.850	0.924	0.849
69	DuctsInEx12	8.0	Yes	Yes		No	0.924	0.920	0.924	0.919	0.924	0.911	0.924	0.909
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.924	0.927	0.924	0.926	0.924	0.919	0.924	0.918
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 11				Climate Zone 12			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.737	0.645	0.767	0.669	0.743	0.674	0.773	0.696
2	Attic	4.2	No	No		Yes	0.737	0.677	0.767	0.698	0.743	0.699	0.773	0.719
3	Attic	4.2	No	Yes		No	0.737	0.698	0.767	0.723	0.743	0.728	0.773	0.752
4	Attic	4.2	No	Yes		Yes	0.737	0.731	0.767	0.754	0.743	0.756	0.773	0.778
5	Attic	4.2	No	Yes	25%	No	0.762	0.721	0.783	0.739	0.767	0.749	0.789	0.766
6	Attic	4.2	No	Yes	25%	Yes	0.762	0.752	0.783	0.768	0.767	0.774	0.789	0.790
7	Attic	4.2	Yes	No		No	0.811	0.737	0.843	0.762	0.815	0.756	0.848	0.780
8	Attic	4.2	Yes	No		Yes	0.811	0.759	0.843	0.782	0.815	0.774	0.848	0.796
9	Attic	4.2	Yes	Yes		No	0.811	0.796	0.843	0.824	0.815	0.817	0.848	0.843
10	Attic	4.2	Yes	Yes		Yes	0.811	0.820	0.843	0.846	0.815	0.836	0.848	0.861
11	Attic	4.2	Yes	Yes	25%	No	0.838	0.822	0.861	0.841	0.842	0.841	0.865	0.859
12	Attic	4.2	Yes	Yes	25%	Yes	0.838	0.843	0.861	0.860	0.842	0.857	0.865	0.874
13	Attic	8.0	No	No		No	0.783	0.686	0.800	0.700	0.788	0.710	0.805	0.723
14	Attic	8.0	No	No		Yes	0.783	0.712	0.800	0.724	0.788	0.731	0.805	0.743
15	Attic	8.0	No	Yes		No	0.783	0.742	0.800	0.757	0.788	0.768	0.805	0.782
16	Attic	8.0	No	Yes		Yes	0.783	0.770	0.800	0.783	0.788	0.790	0.805	0.803
17	Attic	8.0	No	Yes	25%	No	0.797	0.756	0.810	0.766	0.802	0.780	0.814	0.790
18	Attic	8.0	No	Yes	25%	Yes	0.797	0.781	0.810	0.790	0.802	0.801	0.814	0.810
19	Attic	8.0	Yes	No		No	0.861	0.783	0.880	0.798	0.864	0.797	0.883	0.811
20	Attic	8.0	Yes	No		Yes	0.861	0.798	0.880	0.812	0.864	0.809	0.883	0.822
21	Attic	8.0	Yes	Yes		No	0.861	0.846	0.880	0.862	0.864	0.861	0.883	0.876
22	Attic	8.0	Yes	Yes		Yes	0.861	0.863	0.880	0.878	0.864	0.875	0.883	0.889
23	Attic	8.0	Yes	Yes	25%	No	0.877	0.861	0.891	0.872	0.880	0.875	0.893	0.885
24	Attic	8.0	Yes	Yes	25%	Yes	0.877	0.876	0.891	0.886	0.880	0.887	0.893	0.897
25	Crawlspace	4.2	No	No		No	0.743	0.674	0.772	0.689	0.749	0.701	0.777	0.715
26	Crawlspace	4.2	No	No		Yes	0.743	0.692	0.772	0.709	0.749	0.717	0.777	0.732
27	Crawlspace	4.2	No	Yes		No	0.743	0.729	0.772	0.745	0.749	0.758	0.777	0.773
28	Crawlspace	4.2	No	Yes		Yes	0.743	0.749	0.772	0.766	0.749	0.775	0.777	0.791
29	Crawlspace	4.2	No	Yes	25%	No	0.766	0.745	0.787	0.755	0.772	0.772	0.793	0.782
30	Crawlspace	4.2	No	Yes	25%	Yes	0.766	0.765	0.787	0.777	0.772	0.789	0.793	0.801
31	Crawlspace	4.2	Yes	No		No	0.815	0.766	0.847	0.783	0.819	0.784	0.851	0.799
32	Crawlspace	4.2	Yes	No		Yes	0.815	0.775	0.847	0.793	0.819	0.791	0.851	0.808
33	Crawlspace	4.2	Yes	Yes		No	0.815	0.829	0.847	0.846	0.819	0.848	0.851	0.864
34	Crawlspace	4.2	Yes	Yes		Yes	0.815	0.838	0.847	0.857	0.819	0.855	0.851	0.873
35	Crawlspace	4.2	Yes	Yes	25%	No	0.841	0.847	0.864	0.858	0.845	0.864	0.868	0.875
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.841	0.856	0.864	0.870	0.845	0.872	0.868	0.884
37	Crawlspace	8.0	No	No		No	0.787	0.704	0.804	0.712	0.792	0.727	0.808	0.735
38	Crawlspace	8.0	No	No		Yes	0.787	0.722	0.804	0.731	0.792	0.742	0.808	0.751
39	Crawlspace	8.0	No	Yes		No	0.787	0.761	0.804	0.770	0.792	0.786	0.808	0.794
40	Crawlspace	8.0	No	Yes		Yes	0.787	0.780	0.804	0.791	0.792	0.802	0.808	0.812
41	Crawlspace	8.0	No	Yes	25%	No	0.801	0.770	0.813	0.776	0.805	0.794	0.817	0.800
42	Crawlspace	8.0	No	Yes	25%	Yes	0.801	0.790	0.813	0.797	0.805	0.811	0.817	0.817
43	Crawlspace	8.0	Yes	No		No	0.864	0.800	0.882	0.809	0.867	0.813	0.885	0.822
44	Crawlspace	8.0	Yes	No		Yes	0.864	0.808	0.882	0.818	0.867	0.820	0.885	0.829
45	Crawlspace	8.0	Yes	Yes		No	0.864	0.865	0.882	0.875	0.867	0.879	0.885	0.888
46	Crawlspace	8.0	Yes	Yes		Yes	0.864	0.873	0.882	0.885	0.867	0.886	0.885	0.897
47	Crawlspace	8.0	Yes	Yes	25%	No	0.879	0.876	0.893	0.882	0.882	0.888	0.895	0.895
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.879	0.884	0.893	0.892	0.882	0.896	0.895	0.903
49	DuctsInEx12	4.2	No	No		No	0.829	0.725	0.827	0.721	0.833	0.745	0.832	0.743
50	DuctsInEx12	4.2	No	No		Yes	0.829	0.746	0.827	0.743	0.833	0.763	0.832	0.761
51	DuctsInEx12	4.2	No	Yes		No	0.829	0.784	0.827	0.779	0.833	0.806	0.832	0.803
52	DuctsInEx12	4.2	No	Yes		Yes	0.829	0.806	0.827	0.803	0.833	0.825	0.832	0.823
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.912	0.826	0.910	0.821	0.914	0.836	0.913	0.832
56	DuctsInEx12	4.2	Yes	No		Yes	0.912	0.836	0.910	0.833	0.914	0.844	0.913	0.842
57	DuctsInEx12	4.2	Yes	Yes		No	0.912	0.892	0.910	0.887	0.914	0.903	0.913	0.900
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.912	0.904	0.910	0.900	0.914	0.913	0.913	0.911
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.836	0.732	0.835	0.730	0.840	0.751	0.839	0.750
62	DuctsInEx12	8.0	No	No		Yes	0.836	0.751	0.835	0.750	0.840	0.768	0.839	0.767
63	DuctsInEx12	8.0	No	Yes		No	0.836	0.791	0.835	0.789	0.840	0.812	0.839	0.811
64	DuctsInEx12	8.0	No	Yes		Yes	0.836	0.812	0.835	0.811	0.840	0.830	0.839	0.829
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.920	0.834	0.919	0.831	0.921	0.842	0.921	0.841
68	DuctsInEx12	8.0	Yes	No		Yes	0.920	0.843	0.919	0.841	0.921	0.850	0.921	0.849
69	DuctsInEx12	8.0	Yes	Yes		No	0.920	0.901	0.919	0.898	0.921	0.911	0.921	0.909
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.920	0.911	0.919	0.909	0.921	0.919	0.921	0.918
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 13				Climate Zone 14			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.737	0.667	0.767	0.689	0.709	0.617	0.740	0.642
2	Attic	4.2	No	No		Yes	0.737	0.694	0.767	0.714	0.709	0.654	0.740	0.676
3	Attic	4.2	No	Yes		No	0.737	0.721	0.767	0.745	0.709	0.667	0.740	0.694
4	Attic	4.2	No	Yes		Yes	0.737	0.750	0.767	0.772	0.709	0.707	0.740	0.731
5	Attic	4.2	No	Yes	25%	No	0.762	0.742	0.783	0.759	0.736	0.693	0.758	0.711
6	Attic	4.2	No	Yes	25%	Yes	0.762	0.769	0.783	0.785	0.736	0.729	0.758	0.745
7	Attic	4.2	Yes	No		No	0.811	0.751	0.843	0.776	0.789	0.717	0.824	0.745
8	Attic	4.2	Yes	No		Yes	0.811	0.770	0.843	0.793	0.789	0.744	0.824	0.768
9	Attic	4.2	Yes	Yes		No	0.811	0.812	0.843	0.839	0.789	0.775	0.824	0.805
10	Attic	4.2	Yes	Yes		Yes	0.811	0.833	0.843	0.857	0.789	0.804	0.824	0.830
11	Attic	4.2	Yes	Yes	25%	No	0.838	0.836	0.861	0.854	0.820	0.804	0.844	0.824
12	Attic	4.2	Yes	Yes	25%	Yes	0.838	0.854	0.861	0.871	0.820	0.829	0.844	0.847
13	Attic	8.0	No	No		No	0.783	0.704	0.800	0.717	0.759	0.663	0.778	0.677
14	Attic	8.0	No	No		Yes	0.783	0.727	0.800	0.738	0.759	0.692	0.778	0.705
15	Attic	8.0	No	Yes		No	0.783	0.761	0.800	0.775	0.759	0.716	0.778	0.732
16	Attic	8.0	No	Yes		Yes	0.783	0.785	0.800	0.798	0.759	0.749	0.778	0.762
17	Attic	8.0	No	Yes	25%	No	0.797	0.774	0.810	0.784	0.775	0.731	0.789	0.742
18	Attic	8.0	No	Yes	25%	Yes	0.797	0.797	0.810	0.806	0.775	0.761	0.789	0.771
19	Attic	8.0	Yes	No		No	0.861	0.793	0.880	0.807	0.846	0.768	0.866	0.784
20	Attic	8.0	Yes	No		Yes	0.861	0.807	0.880	0.820	0.846	0.787	0.866	0.801
21	Attic	8.0	Yes	Yes		No	0.861	0.857	0.880	0.873	0.846	0.831	0.866	0.848
22	Attic	8.0	Yes	Yes		Yes	0.861	0.872	0.880	0.886	0.846	0.851	0.866	0.866
23	Attic	8.0	Yes	Yes	25%	No	0.877	0.871	0.891	0.882	0.864	0.848	0.878	0.859
24	Attic	8.0	Yes	Yes	25%	Yes	0.877	0.884	0.891	0.894	0.864	0.865	0.878	0.876
25	Crawlspace	4.2	No	No		No	0.743	0.695	0.772	0.708	0.716	0.647	0.746	0.663
26	Crawlspace	4.2	No	No		Yes	0.743	0.711	0.772	0.726	0.716	0.668	0.746	0.686
27	Crawlspace	4.2	No	Yes		No	0.743	0.751	0.772	0.766	0.716	0.700	0.746	0.717
28	Crawlspace	4.2	No	Yes		Yes	0.743	0.769	0.772	0.785	0.716	0.722	0.746	0.742
29	Crawlspace	4.2	No	Yes	25%	No	0.766	0.766	0.787	0.776	0.742	0.718	0.763	0.729
30	Crawlspace	4.2	No	Yes	25%	Yes	0.766	0.784	0.787	0.795	0.742	0.741	0.763	0.754
31	Crawlspace	4.2	Yes	No		No	0.815	0.780	0.847	0.795	0.796	0.748	0.829	0.766
32	Crawlspace	4.2	Yes	No		Yes	0.815	0.787	0.847	0.804	0.796	0.758	0.829	0.778
33	Crawlspace	4.2	Yes	Yes		No	0.815	0.843	0.847	0.860	0.796	0.809	0.829	0.828
34	Crawlspace	4.2	Yes	Yes		Yes	0.815	0.851	0.847	0.870	0.796	0.819	0.829	0.841
35	Crawlspace	4.2	Yes	Yes	25%	No	0.841	0.860	0.864	0.871	0.825	0.830	0.848	0.842
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.841	0.868	0.864	0.881	0.825	0.840	0.848	0.855
37	Crawlspace	8.0	No	No		No	0.787	0.721	0.804	0.729	0.765	0.681	0.782	0.690
38	Crawlspace	8.0	No	No		Yes	0.787	0.737	0.804	0.746	0.765	0.701	0.782	0.712
39	Crawlspace	8.0	No	Yes		No	0.787	0.780	0.804	0.788	0.765	0.736	0.782	0.746
40	Crawlspace	8.0	No	Yes		Yes	0.787	0.797	0.804	0.807	0.765	0.758	0.782	0.769
41	Crawlspace	8.0	No	Yes	25%	No	0.801	0.788	0.813	0.794	0.780	0.747	0.792	0.753
42	Crawlspace	8.0	No	Yes	25%	Yes	0.801	0.806	0.813	0.813	0.780	0.769	0.792	0.777
43	Crawlspace	8.0	Yes	No		No	0.864	0.810	0.882	0.819	0.850	0.787	0.870	0.797
44	Crawlspace	8.0	Yes	No		Yes	0.864	0.817	0.882	0.827	0.850	0.796	0.870	0.807
45	Crawlspace	8.0	Yes	Yes		No	0.864	0.876	0.882	0.885	0.850	0.850	0.870	0.861
46	Crawlspace	8.0	Yes	Yes		Yes	0.864	0.883	0.882	0.894	0.850	0.860	0.870	0.872
47	Crawlspace	8.0	Yes	Yes	25%	No	0.879	0.885	0.893	0.891	0.867	0.863	0.881	0.869
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.879	0.893	0.893	0.900	0.867	0.872	0.881	0.880
49	DuctsInEx12	4.2	No	No		No	0.829	0.740	0.827	0.737	0.810	0.705	0.807	0.699
50	DuctsInEx12	4.2	No	No		Yes	0.829	0.759	0.827	0.757	0.810	0.728	0.807	0.725
51	DuctsInEx12	4.2	No	Yes		No	0.829	0.800	0.827	0.797	0.810	0.762	0.807	0.756
52	DuctsInEx12	4.2	No	Yes		Yes	0.829	0.820	0.827	0.818	0.810	0.787	0.807	0.783
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.912	0.833	0.910	0.829	0.902	0.815	0.898	0.809
56	DuctsInEx12	4.2	Yes	No		Yes	0.912	0.842	0.910	0.840	0.902	0.827	0.898	0.823
57	DuctsInEx12	4.2	Yes	Yes		No	0.912	0.901	0.910	0.897	0.902	0.882	0.898	0.875
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.912	0.911	0.910	0.908	0.902	0.895	0.898	0.889
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.836	0.746	0.835	0.745	0.818	0.713	0.816	0.710
62	DuctsInEx12	8.0	No	No		Yes	0.836	0.764	0.835	0.763	0.818	0.735	0.816	0.733
63	DuctsInEx12	8.0	No	Yes		No	0.836	0.807	0.835	0.805	0.818	0.771	0.816	0.767
64	DuctsInEx12	8.0	No	Yes		Yes	0.836	0.826	0.835	0.825	0.818	0.795	0.816	0.792
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.920	0.840	0.919	0.838	0.911	0.825	0.909	0.821
68	DuctsInEx12	8.0	Yes	No		Yes	0.920	0.848	0.919	0.847	0.911	0.835	0.909	0.833
69	DuctsInEx12	8.0	Yes	Yes		No	0.920	0.908	0.919	0.906	0.911	0.892	0.909	0.888
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.920	0.917	0.919	0.916	0.911	0.903	0.909	0.900
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

							Climate Zone 15				Climate Zone 16			
							One Story		Two Story		One Story		Two Story	
Case	Duct Location	Duct R-value	Duct Sealing	Duct Design	Area Reduction	Radiant Barrier	Heating	Cooling	Heating	Cooling	Heating	Cooling	Heating	Cooling
1	Attic	4.2	No	No		No	0.743	0.596	0.773	0.622	0.686	0.730	0.719	0.755
2	Attic	4.2	No	No		Yes	0.743	0.637	0.773	0.660	0.686	0.740	0.719	0.766
3	Attic	4.2	No	Yes		No	0.743	0.644	0.773	0.672	0.686	0.789	0.719	0.816
4	Attic	4.2	No	Yes		Yes	0.743	0.689	0.773	0.713	0.686	0.801	0.719	0.828
5	Attic	4.2	No	Yes	25%	No	0.767	0.672	0.789	0.690	0.716	0.809	0.739	0.830
6	Attic	4.2	No	Yes	25%	Yes	0.767	0.712	0.789	0.728	0.716	0.820	0.739	0.841
7	Attic	4.2	Yes	No		No	0.815	0.703	0.848	0.731	0.773	0.786	0.809	0.813
8	Attic	4.2	Yes	No		Yes	0.815	0.733	0.848	0.758	0.773	0.792	0.809	0.819
9	Attic	4.2	Yes	Yes		No	0.815	0.760	0.848	0.791	0.773	0.850	0.809	0.879
10	Attic	4.2	Yes	Yes		Yes	0.815	0.793	0.848	0.819	0.773	0.856	0.809	0.886
11	Attic	4.2	Yes	Yes	25%	No	0.842	0.791	0.865	0.811	0.805	0.871	0.831	0.893
12	Attic	4.2	Yes	Yes	25%	Yes	0.842	0.818	0.865	0.836	0.805	0.877	0.831	0.900
13	Attic	8.0	No	No		No	0.788	0.645	0.805	0.660	0.742	0.763	0.761	0.778
14	Attic	8.0	No	No		Yes	0.788	0.678	0.805	0.691	0.742	0.772	0.761	0.787
15	Attic	8.0	No	Yes		No	0.788	0.697	0.805	0.713	0.742	0.825	0.761	0.841
16	Attic	8.0	No	Yes		Yes	0.788	0.733	0.805	0.747	0.742	0.835	0.761	0.851
17	Attic	8.0	No	Yes	25%	No	0.802	0.713	0.814	0.724	0.759	0.837	0.772	0.848
18	Attic	8.0	No	Yes	25%	Yes	0.802	0.746	0.814	0.756	0.759	0.847	0.772	0.859
19	Attic	8.0	Yes	No		No	0.864	0.758	0.883	0.775	0.835	0.822	0.856	0.837
20	Attic	8.0	Yes	No		Yes	0.864	0.779	0.883	0.794	0.835	0.827	0.856	0.843
21	Attic	8.0	Yes	Yes		No	0.864	0.819	0.883	0.837	0.835	0.888	0.856	0.905
22	Attic	8.0	Yes	Yes		Yes	0.864	0.842	0.883	0.858	0.835	0.894	0.856	0.911
23	Attic	8.0	Yes	Yes	25%	No	0.880	0.837	0.893	0.849	0.854	0.901	0.868	0.914
24	Attic	8.0	Yes	Yes	25%	Yes	0.880	0.857	0.893	0.868	0.854	0.906	0.868	0.919
25	Crawlspace	4.2	No	No		No	0.749	0.627	0.777	0.644	0.695	0.762	0.726	0.777
26	Crawlspace	4.2	No	No		Yes	0.749	0.650	0.777	0.669	0.695	0.770	0.726	0.786
27	Crawlspace	4.2	No	Yes		No	0.749	0.678	0.777	0.696	0.695	0.824	0.726	0.840
28	Crawlspace	4.2	No	Yes		Yes	0.749	0.703	0.777	0.723	0.695	0.833	0.726	0.850
29	Crawlspace	4.2	No	Yes	25%	No	0.772	0.698	0.793	0.709	0.723	0.836	0.744	0.848
30	Crawlspace	4.2	No	Yes	25%	Yes	0.772	0.723	0.793	0.737	0.723	0.845	0.744	0.858
31	Crawlspace	4.2	Yes	No		No	0.819	0.735	0.851	0.753	0.780	0.819	0.815	0.835
32	Crawlspace	4.2	Yes	No		Yes	0.819	0.746	0.851	0.767	0.780	0.823	0.815	0.840
33	Crawlspace	4.2	Yes	Yes		No	0.819	0.795	0.851	0.815	0.780	0.885	0.815	0.903
34	Crawlspace	4.2	Yes	Yes		Yes	0.819	0.806	0.851	0.829	0.780	0.890	0.815	0.908
35	Crawlspace	4.2	Yes	Yes	25%	No	0.845	0.817	0.868	0.829	0.811	0.899	0.835	0.911
36	Crawlspace	4.2	Yes	Yes	25%	Yes	0.845	0.829	0.868	0.844	0.811	0.903	0.835	0.917
37	Crawlspace	8.0	No	No		No	0.792	0.664	0.808	0.673	0.747	0.782	0.766	0.791
38	Crawlspace	8.0	No	No		Yes	0.792	0.686	0.808	0.697	0.747	0.790	0.766	0.800
39	Crawlspace	8.0	No	Yes		No	0.792	0.717	0.808	0.728	0.747	0.846	0.766	0.855
40	Crawlspace	8.0	No	Yes		Yes	0.792	0.742	0.808	0.754	0.747	0.855	0.766	0.865
41	Crawlspace	8.0	No	Yes	25%	No	0.805	0.729	0.817	0.735	0.764	0.853	0.776	0.860
42	Crawlspace	8.0	No	Yes	25%	Yes	0.805	0.754	0.817	0.762	0.764	0.862	0.776	0.869
43	Crawlspace	8.0	Yes	No		No	0.867	0.777	0.885	0.787	0.839	0.841	0.859	0.850
44	Crawlspace	8.0	Yes	No		Yes	0.867	0.787	0.885	0.799	0.839	0.845	0.859	0.855
45	Crawlspace	8.0	Yes	Yes		No	0.867	0.840	0.885	0.851	0.839	0.909	0.859	0.919
46	Crawlspace	8.0	Yes	Yes		Yes	0.867	0.851	0.885	0.864	0.839	0.913	0.859	0.924
47	Crawlspace	8.0	Yes	Yes	25%	No	0.882	0.853	0.895	0.860	0.858	0.917	0.871	0.924
48	Crawlspace	8.0	Yes	Yes	25%	Yes	0.882	0.864	0.895	0.872	0.858	0.921	0.871	0.929
49	DuctsInEx12	4.2	No	No		No	0.833	0.689	0.832	0.683	0.795	0.799	0.791	0.800
50	DuctsInEx12	4.2	No	No		Yes	0.833	0.716	0.832	0.711	0.795	0.808	0.791	0.811
51	DuctsInEx12	4.2	No	Yes		No	0.833	0.745	0.832	0.738	0.795	0.863	0.791	0.865
52	DuctsInEx12	4.2	No	Yes		Yes	0.833	0.774	0.832	0.769	0.795	0.873	0.791	0.876
53	DuctsInEx12	4.2	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
54	DuctsInEx12	4.2	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
55	DuctsInEx12	4.2	Yes	No		No	0.914	0.808	0.913	0.800	0.894	0.860	0.889	0.862
56	DuctsInEx12	4.2	Yes	No		Yes	0.914	0.821	0.913	0.816	0.894	0.865	0.889	0.868
57	DuctsInEx12	4.2	Yes	Yes		No	0.914	0.873	0.913	0.865	0.894	0.930	0.889	0.932
58	DuctsInEx12	4.2	Yes	Yes		Yes	0.914	0.888	0.913	0.882	0.894	0.935	0.889	0.938
59	DuctsInEx12	4.2	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60	DuctsInEx12	4.2	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
61	DuctsInEx12	8.0	No	No		No	0.840	0.698	0.839	0.695	0.804	0.803	0.802	0.804
62	DuctsInEx12	8.0	No	No		Yes	0.840	0.723	0.839	0.720	0.804	0.811	0.802	0.813
63	DuctsInEx12	8.0	No	Yes		No	0.840	0.755	0.839	0.751	0.804	0.868	0.802	0.869
64	DuctsInEx12	8.0	No	Yes		Yes	0.840	0.782	0.839	0.779	0.804	0.877	0.802	0.879
65	DuctsInEx12	8.0	No	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	DuctsInEx12	8.0	No	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
67	DuctsInEx12	8.0	Yes	No		No	0.921	0.818	0.921	0.814	0.905	0.865	0.902	0.866
68	DuctsInEx12	8.0	Yes	No		Yes	0.921	0.830	0.921	0.827	0.905	0.869	0.902	0.870
69	DuctsInEx12	8.0	Yes	Yes		No	0.921	0.885	0.921	0.880	0.905	0.935	0.902	0.936
70	DuctsInEx12	8.0	Yes	Yes		Yes	0.921	0.897	0.921	0.894	0.905	0.939	0.902	0.941
71	DuctsInEx12	8.0	Yes	Yes	25%	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
72	DuctsInEx12	8.0	Yes	Yes	25%	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

	Input Assumptions for Duct System							
CASE CODE	Supply duct Locatrion	Return duct Location	Total duct Leakage,%	ACCA Design	Radiant Barrier	Supply duct R Value	Return duct R value	Duct Surface Area Reduction
1001	attic	attic	22	no	no	4.2	4.2	0
1002	attic	attic	22	no	no	8	4.2	0
1003	attic	attic	22	no	no	4.2	8	0
1004	attic	attic	8	no	no	4.2	4.2	0
1005	attic	attic	8	no	no	8	4.2	0
1006	attic	attic	8	no	no	4.2	8	0
1007	attic	attic	8	yes	no	4.2	4.2	0
1008	attic	attic	8	yes	yes	4.2	4.2	0
1009	attic	attic	8	yes	yes	8	8	0
1010	attic	attic	22	no	yes	4.2	4.2	0
1011	attic	attic	22	no	no	8	8	0
1012	attic	attic	22	yes	no	4.2	4.2	0
1013	attic	attic	8	no	no	8	8	0
1014	attic	attic	8	no	no	8	4.2	0
1015	attic	attic	8	no	no	4.2	8	0
1016	attic	attic	8	yes	yes	4.2	4.2	0
1017	attic	attic	8	yes	no	4.2	4.2	50%
1018	attic	attic	8	yes	no	4.2	4.2	25%
1019	attic	attic	8	no	no	4.2	4.2	50%
1020	attic	attic	22	no	no	4.2	4.2	50%
1021	attic	attic	8	no	no	4.2	4.2	25%
1022	attic	attic	22	no	no	4.2	4.2	25%
1023	attic	crawlspace	22	no	no	4.2	4.2	0
1024	attic	crawlspace	22	no	no	8	4.2	0
1025	attic	crawlspace	22	no	no	4.2	8	0
1026	attic	crawlspace	8	no	no	4.2	4.2	0
1027	attic	crawlspace	8	no	no	8	4.2	0
1028	attic	crawlspace	8	no	no	4.2	8	0
1029	attic	crawlspace	8	yes	no	4.2	4.2	0
1030	attic	crawlspace	8	yes	yes	4.2	4.2	0
1031	attic	crawlspace	8	yes	yes	8	8	0
1032	attic	crawlspace	22	no	yes	4.2	4.2	0
1033	attic	crawlspace	22	no	no	8	8	0
1034	attic	crawlspace	22	yes	no	4.2	4.2	0
1035	attic	crawlspace	8	no	no	8	8	0
1036	attic	crawlspace	8	no	no	8	4.2	0

CASE CODE	Input Assumptions for Duct System							
	Supply duct Location	Return duct Location	Total duct Leakage,%	ACCA Design	Radiant Barrier	Supply duct R Value	Return duct R value	Duct Surface Area Reduction
1037	attic	crawlspace	8	no	no	4.2	8	0
1038	attic	crawlspace	8	yes	yes	4.2	4.2	0
1039	attic	crawlspace	8	yes	no	4.2	4.2	50%
1040	attic	crawlspace	8	yes	no	4.2	4.2	25%
1041	attic	crawlspace	8	no	no	4.2	4.2	50%
1042	attic	crawlspace	22	no	no	4.2	4.2	50%
1043	attic	crawlspace	8	no	no	4.2	4.2	25%
1044	attic	crawlspace	22	no	no	4.2	4.2	25%
1045	conditioned space	attic	22	no	no	4.2	4.2	0
1046	conditioned space	attic	8	no	no	4.2	4.2	0
1047	conditioned space	attic	8	yes	no	4.2	4.2	0
1048	conditioned space	attic	8	yes	no	8	8	0
1049	conditioned space	attic	8	yes	yes	8	8	0
1050	conditioned space	attic	22	no	yes	8	8	0
1051	conditioned space	attic	22	yes	yes	8	8	0
1052	conditioned space	attic	22	no	no	8	8	0
1053	conditioned space	attic	22	yes	no	4.2	4.2	0
1054	crawlspace	crawlspace	22	no	no	4.2	4.2	0
1055	crawlspace	crawlspace	8	no	no	4.2	4.2	0
1056	crawlspace	crawlspace	8	yes	no	4.2	4.2	0
1057	crawlspace	crawlspace	8	yes	no	4.2	8	0
1058	crawlspace	crawlspace	8	yes	no	8	4.2	0
1059	crawlspace	crawlspace	8	yes	no	8	8	0
1060	crawlspace	crawlspace	22	yes	no	4.2	4.2	0
1061	crawlspace	crawlspace	22	no	no	8	8	0
1062	crawlspace	crawlspace	22	no	no	4.2	8	0
1063	crawlspace	crawlspace	22	no	no	8	4.2	0
1064	crawlspace	crawlspace	22	no	no	4.2	4.2	50%
1065	crawlspace	crawlspace	22	no	no	4.2	4.2	25%
1066	crawlspace	crawlspace	22	yes	no	4.2	4.2	50%
1067	crawlspace	crawlspace	8	no	no	4.2	4.2	50%
1068	crawlspace	crawlspace	8	no	no	8	8	50%
1069	crawlspace	crawlspace	8	no	no	8	8	25%
1070	crawlspace	attic	22	no	no	4.2	4.2	0
1071	crawlspace	attic	8	no	no	4.2	4.2	0
1072	crawlspace	attic	8	yes	no	4.2	4.2	0

	Input Assumptions for Duct System							
CASE CODE	Supply duct Location	Return duct Location	Total duct Leakage,%	ACCA Design	Radiant Barrier	Supply duct R Value	Return duct R value	Duct Surface Area Reduction
1073	crawlspace	attic	8	yes	no	4.2	8	0
1074	crawlspace	attic	8	yes	no	8	4.2	0
1075	crawlspace	attic	8	yes	no	8	8	0
1076	crawlspace	attic	22	yes	no	4.2	4.2	0
1077	crawlspace	attic	22	no	no	8	8	0
1078	crawlspace	attic	22	no	no	8	4.2	0
1079	crawlspace	attic	22	no	no	4.2	8	0
1080	crawlspace	attic	22	no	no	4.2	4.2	50%
1081	crawlspace	attic	22	no	no	4.2	4.2	25%
1082	crawlspace	attic	22	yes	no	4.2	4.2	50%
1083	crawlspace	attic	8	no	no	4.2	4.2	50%
1084	crawlspace	attic	8	no	no	8	8	50%
1085	crawlspace	attic	8	no	no	8	8	25%
1086	conditioned space	crawlspace	22	no	no	4.2	4.2	0
1087	conditioned space	crawlspace	8	no	no	4.2	4.2	0
1088	conditioned space	crawlspace	8	no	no	8	8	0
1089	conditioned space	crawlspace	8	yes	no	4.2	4.2	0
1090	conditioned space	crawlspace	8	yes	no	8	8	0
1091	conditioned space	crawlspace	22	yes	no	4.2	4.2	0
1092	conditioned space	crawlspace	22	yes	no	8	8	0
1093	conditioned space	crawlspace	22	no	no	8	8	0
1094	basement	basement	22	no	no	4.2	4.2	0
1095	basement	basement	22	no	no	8	8	0
1096	basement	basement	8	no	no	4.2	4.2	0
1097	basement	basement	8	yes	no	4.2	4.2	0
1098	basement	basement	8	yes	no	8	8	0
1099	basement	basement	22	yes	no	4.2	4.2	0
1100	basement	basement	22	no	no	4.2	4.2	50%
1101	basement	basement	8	no	no	4.2	4.2	50%
1102	conditioned space	basement	22	no	no	4.2	4.2	0
1103	conditioned space	basement	8	no	no	4.2	4.2	0
1104	conditioned space	basement	8	yes	no	4.2	4.2	0
1105	conditioned space	basement	8	yes	no	8	8	0
1106	conditioned space	basement	8	no	no	8	8	0
1107	conditioned space	basement	22	yes	no	8	8	0
1108	conditioned space	basement	22	yes	no	4.2	4.2	0

CASE CODE	Climate Zone 1				Climate Zone 2			
	1 Story		2 Story		1 Story		2 Story	
	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.756	0.810	0.785	0.812	0.743	0.674	0.773	0.702
1002	0.796	0.813	0.812	0.814	0.786	0.715	0.801	0.729
1003	0.758	0.810	0.788	0.812	0.745	0.676	0.777	0.706
1004	0.825	0.866	0.856	0.869	0.815	0.744	0.848	0.775
1005	0.869	0.869	0.886	0.871	0.862	0.790	0.879	0.805
1006	0.827	0.866	0.860	0.869	0.818	0.746	0.852	0.780
1007	0.825	0.937	0.856	0.939	0.815	0.804	0.848	0.837
1008	0.825	0.914	0.856	0.925	0.815	0.822	0.848	0.854
1009	0.871	0.927	0.889	0.933	0.864	0.869	0.883	0.888
1010	0.756	0.791	0.785	0.800	0.743	0.696	0.773	0.723
1011	0.798	0.813	0.815	0.814	0.788	0.717	0.805	0.734
1012	0.756	0.875	0.785	0.878	0.743	0.728	0.773	0.759
1013	0.871	0.869	0.889	0.871	0.864	0.792	0.883	0.810
1014	0.869	0.869	0.886	0.871	0.862	0.790	0.879	0.805
1015	0.827	0.866	0.860	0.869	0.818	0.746	0.852	0.780
1016	0.825	0.914	0.856	0.925	0.815	0.822	0.848	0.854
1017	0.876	0.941	0.890	0.942	0.869	0.861	0.883	0.875
1018	0.850	0.938	0.873	0.941	0.842	0.832	0.865	0.856
1019	0.876	0.870	0.890	0.871	0.869	0.797	0.883	0.810
1020	0.802	0.813	0.816	0.814	0.792	0.721	0.805	0.733
1021	0.850	0.868	0.873	0.870	0.842	0.770	0.865	0.792
1022	0.779	0.811	0.800	0.813	0.767	0.697	0.789	0.718
1023	0.758	0.811	0.785	0.812	0.746	0.717	0.773	0.702
1024	0.798	0.814	0.812	0.814	0.788	0.760	0.801	0.729
1025	0.760	0.811	0.788	0.812	0.748	0.717	0.777	0.706
1026	0.826	0.867	0.856	0.869	0.817	0.765	0.848	0.775
1027	0.870	0.870	0.886	0.871	0.864	0.812	0.879	0.805
1028	0.828	0.867	0.860	0.869	0.820	0.765	0.852	0.780
1029	0.826	0.937	0.856	0.939	0.817	0.827	0.848	0.837
1030	0.826	0.915	0.856	0.925	0.817	0.838	0.848	0.854
1031	0.872	0.928	0.889	0.933	0.866	0.884	0.883	0.888
1032	0.758	0.792	0.785	0.800	0.746	0.726	0.773	0.723
1033	0.800	0.814	0.815	0.814	0.790	0.760	0.805	0.734
1034	0.758	0.877	0.785	0.878	0.746	0.775	0.773	0.759
1035	0.872	0.870	0.889	0.871	0.866	0.812	0.883	0.810
1036	0.870	0.870	0.886	0.871	0.864	0.812	0.879	0.805

CASE CODE	Climate Zone 1				Climate Zone 2			
	1 Story		2 Story		1 Story		2 Story	
	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.828	0.867	0.860	0.869	0.820	0.765	0.852	0.780
1038	0.826	0.915	0.856	0.925	0.817	0.838	0.848	0.854
1039	0.877	0.941	0.890	0.942	0.871	0.885	0.883	0.875
1040	0.851	0.939	0.873	0.941	0.844	0.856	0.865	0.856
1041	0.877	0.870	0.890	0.871	0.871	0.818	0.883	0.810
1042	0.804	0.814	0.816	0.814	0.795	0.766	0.805	0.733
1043	0.851	0.869	0.873	0.870	0.844	0.791	0.865	0.792
1044	0.781	0.812	0.800	0.813	0.770	0.741	0.789	0.718
1045	0.902	0.862	0.900	0.862	0.895	0.819	0.893	0.817
1046	0.949	0.890	0.947	0.890	0.946	0.872	0.943	0.869
1047	0.949	0.962	0.947	0.962	0.946	0.942	0.943	0.939
1048	0.950	0.962	0.949	0.962	0.947	0.944	0.946	0.942
1049	0.950	0.962	0.949	0.962	0.947	0.950	0.946	0.948
1050	0.903	0.862	0.902	0.862	0.895	0.833	0.894	0.833
1051	0.903	0.931	0.902	0.931	0.895	0.901	0.894	0.900
1052	0.903	0.862	0.902	0.862	0.895	0.820	0.894	0.819
1053	0.902	0.931	0.900	0.931	0.895	0.886	0.893	0.883
1054	0.761	0.833	0.787	0.813	0.749	0.750	0.775	0.704
1055	0.828	0.889	0.857	0.869	0.820	0.800	0.849	0.776
1056	0.828	0.962	0.857	0.940	0.820	0.865	0.849	0.839
1057	0.830	0.962	0.861	0.940	0.822	0.865	0.854	0.844
1058	0.871	0.955	0.887	0.942	0.865	0.899	0.880	0.871
1059	0.873	0.955	0.890	0.942	0.867	0.899	0.884	0.877
1060	0.761	0.900	0.787	0.879	0.749	0.811	0.775	0.761
1061	0.801	0.827	0.816	0.815	0.792	0.779	0.807	0.735
1062	0.762	0.833	0.790	0.813	0.751	0.750	0.779	0.708
1063	0.800	0.827	0.813	0.815	0.791	0.779	0.803	0.731
1064	0.806	0.826	0.817	0.815	0.797	0.783	0.807	0.735
1065	0.783	0.829	0.802	0.814	0.773	0.766	0.791	0.719
1066	0.806	0.893	0.817	0.882	0.797	0.847	0.807	0.795
1067	0.878	0.882	0.891	0.872	0.872	0.836	0.884	0.810
1068	0.902	0.879	0.910	0.873	0.898	0.853	0.905	0.831
1069	0.888	0.881	0.900	0.872	0.882	0.842	0.894	0.821
1070	0.758	0.832	0.787	0.813	0.746	0.707	0.775	0.704
1071	0.826	0.889	0.857	0.869	0.818	0.779	0.849	0.776
1072	0.826	0.961	0.857	0.940	0.818	0.843	0.849	0.839

CASE	Climate Zone 1				Climate Zone 2			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.828	0.961	0.861	0.940	0.820	0.845	0.854	0.844
1074	0.870	0.954	0.887	0.942	0.864	0.876	0.880	0.871
1075	0.872	0.954	0.890	0.942	0.866	0.879	0.884	0.877
1076	0.758	0.899	0.787	0.879	0.746	0.765	0.775	0.761
1077	0.800	0.826	0.816	0.815	0.790	0.737	0.807	0.735
1078	0.798	0.826	0.813	0.815	0.788	0.735	0.803	0.731
1079	0.760	0.832	0.790	0.813	0.748	0.709	0.779	0.708
1080	0.804	0.825	0.817	0.815	0.794	0.739	0.807	0.735
1081	0.781	0.828	0.802	0.814	0.770	0.723	0.791	0.719
1082	0.804	0.892	0.817	0.882	0.794	0.799	0.807	0.795
1083	0.877	0.882	0.891	0.872	0.870	0.815	0.884	0.810
1084	0.901	0.879	0.910	0.873	0.897	0.834	0.905	0.831
1085	0.887	0.881	0.900	0.872	0.881	0.823	0.894	0.821
1086	0.903	0.863	0.980	0.907	0.897	0.863	0.980	0.907
1087	0.950	0.891	0.980	0.907	0.947	0.891	0.980	0.907
1088	0.951	0.891	0.980	0.907	0.948	0.891	0.980	0.907
1089	0.950	0.963	0.980	0.980	0.947	0.963	0.980	0.980
1090	0.951	0.963	0.980	0.980	0.948	0.963	0.980	0.980
1091	0.903	0.933	0.980	0.980	0.897	0.933	0.980	0.980
1092	0.904	0.933	0.980	0.980	0.897	0.933	0.980	0.980
1093	0.904	0.863	0.980	0.907	0.897	0.863	0.980	0.907
1094	0.786	0.859	0.814	0.853	0.808	0.815	0.835	0.825
1095	0.821	0.849	0.839	0.846	0.839	0.824	0.856	0.830
1096	0.847	0.907	0.876	0.898	0.862	0.860	0.890	0.868
1097	0.847	0.981	0.876	0.971	0.862	0.930	0.890	0.939
1098	0.886	0.968	0.903	0.963	0.897	0.939	0.913	0.945
1099	0.786	0.929	0.814	0.922	0.808	0.882	0.835	0.892
1100	0.824	0.847	0.839	0.845	0.843	0.825	0.857	0.831
1101	0.889	0.894	0.903	0.890	0.901	0.870	0.914	0.875
1102	0.905	0.869	0.906	0.872	0.919	0.869	0.921	0.872
1103	0.950	0.893	0.949	0.894	0.956	0.893	0.956	0.894
1104	0.950	0.965	0.949	0.966	0.956	0.965	0.956	0.966
1105	0.951	0.965	0.951	0.966	0.957	0.965	0.957	0.966
1106	0.951	0.893	0.951	0.894	0.957	0.893	0.957	0.894
1107	0.905	0.940	0.907	0.942	0.919	0.940	0.921	0.942
1108	0.905	0.940	0.906	0.942	0.919	0.940	0.921	0.942

CASE	Climate Zone 3				Climate Zone 4			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.766	0.730	0.794	0.755	0.759	0.738	0.788	0.763
1002	0.804	0.763	0.820	0.777	0.799	0.769	0.814	0.783
1003	0.767	0.731	0.796	0.756	0.761	0.738	0.791	0.763
1004	0.832	0.786	0.863	0.813	0.827	0.792	0.858	0.818
1005	0.874	0.821	0.891	0.836	0.871	0.826	0.887	0.841
1006	0.833	0.786	0.865	0.814	0.829	0.792	0.862	0.819
1007	0.832	0.850	0.863	0.879	0.827	0.856	0.858	0.885
1008	0.832	0.856	0.863	0.886	0.827	0.860	0.858	0.888
1009	0.876	0.894	0.894	0.911	0.873	0.896	0.891	0.913
1010	0.766	0.740	0.794	0.766	0.759	0.744	0.788	0.769
1011	0.806	0.763	0.822	0.778	0.801	0.770	0.817	0.784
1012	0.766	0.789	0.794	0.816	0.759	0.798	0.788	0.824
1013	0.876	0.822	0.894	0.837	0.873	0.826	0.891	0.841
1014	0.874	0.821	0.891	0.836	0.871	0.826	0.887	0.841
1015	0.833	0.786	0.865	0.814	0.829	0.792	0.862	0.819
1016	0.832	0.856	0.863	0.886	0.827	0.860	0.858	0.888
1017	0.881	0.893	0.895	0.908	0.877	0.898	0.892	0.912
1018	0.856	0.871	0.879	0.893	0.852	0.877	0.875	0.898
1019	0.881	0.826	0.895	0.840	0.877	0.831	0.892	0.844
1020	0.810	0.767	0.824	0.780	0.805	0.774	0.818	0.786
1021	0.856	0.806	0.879	0.826	0.852	0.811	0.875	0.831
1022	0.788	0.749	0.809	0.767	0.782	0.756	0.803	0.774
1023	0.767	0.741	0.794	0.755	0.761	0.745	0.788	0.763
1024	0.806	0.774	0.820	0.777	0.801	0.776	0.814	0.783
1025	0.768	0.741	0.796	0.756	0.763	0.745	0.791	0.763
1026	0.833	0.792	0.863	0.813	0.829	0.795	0.858	0.818
1027	0.875	0.827	0.891	0.836	0.872	0.829	0.887	0.841
1028	0.835	0.792	0.865	0.814	0.830	0.795	0.862	0.819
1029	0.833	0.856	0.863	0.879	0.829	0.860	0.858	0.885
1030	0.833	0.858	0.863	0.886	0.829	0.861	0.858	0.888
1031	0.877	0.895	0.894	0.911	0.874	0.897	0.891	0.913
1032	0.767	0.743	0.794	0.766	0.761	0.746	0.788	0.769
1033	0.807	0.774	0.822	0.778	0.802	0.776	0.817	0.784
1034	0.767	0.801	0.794	0.816	0.761	0.805	0.788	0.824
1035	0.877	0.827	0.894	0.837	0.874	0.829	0.891	0.841
1036	0.875	0.827	0.891	0.836	0.872	0.829	0.887	0.841

CASE	Climate Zone 3				Climate Zone 4			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.835	0.792	0.865	0.814	0.830	0.795	0.862	0.819
1038	0.833	0.858	0.863	0.886	0.829	0.861	0.858	0.888
1039	0.882	0.899	0.895	0.908	0.878	0.901	0.892	0.912
1040	0.857	0.877	0.879	0.893	0.853	0.880	0.875	0.898
1041	0.882	0.832	0.895	0.840	0.878	0.834	0.892	0.844
1042	0.811	0.778	0.824	0.780	0.807	0.780	0.818	0.786
1043	0.857	0.811	0.879	0.826	0.853	0.814	0.875	0.831
1044	0.789	0.760	0.809	0.767	0.784	0.762	0.803	0.774
1045	0.908	0.852	0.906	0.852	0.904	0.857	0.902	0.857
1046	0.952	0.886	0.950	0.885	0.950	0.888	0.948	0.888
1047	0.952	0.958	0.950	0.957	0.950	0.960	0.948	0.960
1048	0.952	0.958	0.952	0.958	0.951	0.960	0.950	0.960
1049	0.952	0.962	0.952	0.962	0.951	0.962	0.950	0.962
1050	0.908	0.861	0.907	0.861	0.904	0.862	0.904	0.862
1051	0.908	0.930	0.907	0.930	0.904	0.931	0.904	0.931
1052	0.908	0.852	0.907	0.852	0.904	0.857	0.904	0.857
1053	0.908	0.921	0.906	0.921	0.904	0.926	0.902	0.926
1054	0.769	0.771	0.795	0.757	0.763	0.774	0.790	0.764
1055	0.834	0.823	0.863	0.814	0.830	0.827	0.859	0.819
1056	0.834	0.890	0.863	0.880	0.830	0.894	0.859	0.886
1057	0.836	0.890	0.866	0.881	0.832	0.894	0.863	0.886
1058	0.876	0.914	0.892	0.905	0.873	0.915	0.888	0.910
1059	0.878	0.914	0.895	0.906	0.875	0.916	0.892	0.910
1060	0.769	0.834	0.795	0.818	0.763	0.837	0.790	0.826
1061	0.808	0.791	0.824	0.779	0.804	0.793	0.819	0.785
1062	0.770	0.771	0.798	0.758	0.765	0.774	0.792	0.765
1063	0.807	0.791	0.821	0.778	0.802	0.793	0.816	0.785
1064	0.813	0.794	0.825	0.781	0.808	0.796	0.820	0.788
1065	0.791	0.783	0.810	0.769	0.785	0.785	0.805	0.776
1066	0.813	0.859	0.825	0.844	0.808	0.861	0.820	0.852
1067	0.882	0.848	0.896	0.840	0.879	0.850	0.893	0.845
1068	0.906	0.860	0.913	0.854	0.903	0.861	0.911	0.857
1069	0.891	0.852	0.904	0.846	0.889	0.854	0.901	0.849
1070	0.767	0.761	0.795	0.757	0.761	0.768	0.790	0.764
1071	0.833	0.818	0.863	0.814	0.829	0.824	0.859	0.819
1072	0.833	0.884	0.863	0.880	0.829	0.890	0.859	0.886

CASE	Climate Zone 3				Climate Zone 4			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.834	0.885	0.866	0.881	0.830	0.891	0.863	0.886
1074	0.875	0.908	0.892	0.905	0.872	0.912	0.888	0.910
1075	0.877	0.909	0.895	0.906	0.874	0.913	0.892	0.910
1076	0.767	0.822	0.795	0.818	0.761	0.831	0.790	0.826
1077	0.807	0.781	0.824	0.779	0.802	0.787	0.819	0.785
1078	0.806	0.781	0.821	0.778	0.801	0.787	0.816	0.785
1079	0.768	0.761	0.798	0.758	0.763	0.769	0.792	0.765
1080	0.812	0.784	0.825	0.781	0.807	0.790	0.820	0.788
1081	0.789	0.772	0.810	0.769	0.784	0.779	0.805	0.776
1082	0.812	0.847	0.825	0.844	0.807	0.854	0.820	0.852
1083	0.882	0.843	0.896	0.840	0.878	0.847	0.893	0.845
1084	0.905	0.855	0.913	0.854	0.903	0.858	0.911	0.857
1085	0.891	0.848	0.904	0.846	0.888	0.851	0.901	0.849
1086	0.908	0.863	0.980	0.907	0.905	0.863	0.980	0.907
1087	0.952	0.891	0.980	0.907	0.950	0.891	0.980	0.907
1088	0.953	0.891	0.980	0.907	0.951	0.891	0.980	0.907
1089	0.952	0.963	0.980	0.980	0.950	0.963	0.980	0.980
1090	0.953	0.963	0.980	0.980	0.951	0.963	0.980	0.980
1091	0.908	0.933	0.980	0.980	0.905	0.933	0.980	0.980
1092	0.909	0.933	0.980	0.980	0.905	0.933	0.980	0.980
1093	0.909	0.863	0.980	0.907	0.905	0.863	0.980	0.907
1094	0.813	0.821	0.839	0.828	0.808	0.825	0.835	0.831
1095	0.843	0.826	0.860	0.832	0.839	0.829	0.856	0.833
1096	0.866	0.866	0.893	0.872	0.862	0.870	0.890	0.875
1097	0.866	0.936	0.893	0.943	0.862	0.940	0.890	0.945
1098	0.899	0.943	0.915	0.947	0.897	0.945	0.913	0.948
1099	0.813	0.887	0.839	0.895	0.808	0.891	0.835	0.898
1100	0.847	0.827	0.861	0.832	0.843	0.829	0.857	0.834
1101	0.903	0.873	0.917	0.876	0.901	0.875	0.914	0.878
1102	0.922	0.869	0.924	0.872	0.919	0.869	0.921	0.872
1103	0.958	0.893	0.958	0.894	0.956	0.893	0.956	0.894
1104	0.958	0.965	0.958	0.966	0.956	0.965	0.956	0.966
1105	0.958	0.965	0.959	0.966	0.957	0.965	0.957	0.966
1106	0.958	0.893	0.959	0.894	0.957	0.893	0.957	0.894
1107	0.922	0.940	0.924	0.942	0.919	0.940	0.922	0.942
1108	0.922	0.940	0.924	0.942	0.919	0.940	0.921	0.942

CASE	Climate Zone 5				Climate Zone 6			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.747	0.760	0.776	0.779	0.772	0.722	0.800	0.747
1002	0.788	0.784	0.804	0.795	0.810	0.756	0.825	0.770
1003	0.749	0.760	0.779	0.779	0.773	0.723	0.802	0.749
1004	0.818	0.813	0.850	0.834	0.837	0.780	0.867	0.807
1005	0.864	0.839	0.880	0.851	0.878	0.817	0.894	0.832
1006	0.820	0.813	0.854	0.834	0.838	0.781	0.869	0.809
1007	0.818	0.879	0.850	0.901	0.837	0.843	0.867	0.873
1008	0.818	0.874	0.850	0.898	0.837	0.851	0.867	0.881
1009	0.866	0.904	0.885	0.918	0.879	0.890	0.897	0.908
1010	0.747	0.756	0.776	0.777	0.772	0.734	0.800	0.760
1011	0.790	0.784	0.807	0.795	0.811	0.757	0.827	0.771
1012	0.747	0.822	0.776	0.843	0.772	0.781	0.800	0.808
1013	0.866	0.839	0.885	0.851	0.879	0.818	0.897	0.834
1014	0.864	0.839	0.880	0.851	0.878	0.817	0.894	0.832
1015	0.820	0.813	0.854	0.834	0.838	0.781	0.869	0.809
1016	0.818	0.874	0.850	0.898	0.837	0.851	0.867	0.881
1017	0.871	0.911	0.885	0.923	0.884	0.889	0.898	0.903
1018	0.844	0.895	0.867	0.912	0.860	0.866	0.883	0.888
1019	0.871	0.843	0.885	0.853	0.884	0.822	0.898	0.835
1020	0.795	0.788	0.808	0.798	0.815	0.761	0.829	0.773
1021	0.844	0.828	0.867	0.843	0.860	0.801	0.883	0.821
1022	0.770	0.774	0.792	0.789	0.793	0.745	0.814	0.760
1023	0.749	0.762	0.776	0.779	0.773	0.738	0.800	0.747
1024	0.791	0.786	0.804	0.795	0.810	0.772	0.825	0.770
1025	0.751	0.762	0.779	0.779	0.774	0.738	0.802	0.749
1026	0.820	0.814	0.850	0.834	0.838	0.788	0.867	0.807
1027	0.865	0.840	0.880	0.851	0.879	0.824	0.894	0.832
1028	0.822	0.814	0.854	0.834	0.839	0.788	0.869	0.809
1029	0.820	0.880	0.850	0.901	0.838	0.852	0.867	0.873
1030	0.820	0.875	0.850	0.898	0.838	0.855	0.867	0.881
1031	0.867	0.905	0.885	0.918	0.880	0.893	0.897	0.908
1032	0.749	0.758	0.776	0.777	0.773	0.741	0.800	0.760
1033	0.793	0.786	0.807	0.795	0.812	0.772	0.827	0.771
1034	0.749	0.824	0.776	0.843	0.773	0.797	0.800	0.808
1035	0.867	0.840	0.885	0.851	0.880	0.824	0.897	0.834
1036	0.865	0.840	0.880	0.851	0.879	0.824	0.894	0.832

CASE	Climate Zone 5				Climate Zone 6			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.822	0.814	0.854	0.834	0.839	0.788	0.869	0.809
1038	0.820	0.875	0.850	0.898	0.838	0.855	0.867	0.881
1039	0.872	0.912	0.885	0.923	0.885	0.897	0.898	0.903
1040	0.846	0.896	0.867	0.912	0.861	0.874	0.883	0.888
1041	0.872	0.843	0.885	0.853	0.885	0.830	0.898	0.835
1042	0.797	0.789	0.808	0.798	0.816	0.777	0.829	0.773
1043	0.846	0.829	0.867	0.843	0.861	0.809	0.883	0.821
1044	0.773	0.775	0.792	0.789	0.794	0.757	0.814	0.760
1045	0.896	0.862	0.895	0.862	0.911	0.848	0.910	0.847
1046	0.947	0.890	0.944	0.890	0.953	0.884	0.952	0.883
1047	0.947	0.962	0.944	0.962	0.953	0.956	0.952	0.955
1048	0.948	0.962	0.947	0.962	0.954	0.956	0.953	0.955
1049	0.948	0.962	0.947	0.962	0.954	0.960	0.953	0.960
1050	0.897	0.862	0.896	0.862	0.912	0.857	0.911	0.857
1051	0.897	0.931	0.896	0.931	0.912	0.926	0.911	0.926
1052	0.897	0.862	0.896	0.862	0.912	0.848	0.911	0.847
1053	0.896	0.931	0.895	0.931	0.911	0.916	0.910	0.915
1054	0.752	0.790	0.778	0.781	0.774	0.768	0.801	0.749
1055	0.822	0.843	0.851	0.834	0.838	0.820	0.867	0.808
1056	0.822	0.912	0.851	0.902	0.838	0.887	0.867	0.874
1057	0.824	0.912	0.856	0.902	0.840	0.887	0.870	0.876
1058	0.867	0.926	0.882	0.921	0.879	0.911	0.895	0.900
1059	0.869	0.926	0.886	0.921	0.880	0.912	0.897	0.902
1060	0.752	0.854	0.778	0.844	0.774	0.831	0.801	0.810
1061	0.795	0.802	0.809	0.797	0.813	0.790	0.828	0.773
1062	0.754	0.790	0.782	0.781	0.775	0.768	0.803	0.750
1063	0.793	0.802	0.806	0.797	0.812	0.790	0.826	0.771
1064	0.799	0.804	0.810	0.799	0.817	0.793	0.830	0.775
1065	0.775	0.797	0.794	0.790	0.796	0.780	0.815	0.762
1066	0.799	0.869	0.810	0.864	0.817	0.857	0.830	0.837
1067	0.873	0.859	0.886	0.854	0.885	0.847	0.899	0.836
1068	0.899	0.865	0.906	0.863	0.908	0.859	0.916	0.850
1069	0.884	0.861	0.896	0.857	0.894	0.851	0.907	0.842
1070	0.749	0.788	0.778	0.781	0.773	0.753	0.801	0.749
1071	0.820	0.843	0.851	0.834	0.837	0.813	0.867	0.808
1072	0.820	0.911	0.851	0.902	0.837	0.878	0.867	0.874

CASE	Climate Zone 5				Climate Zone 6			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.822	0.911	0.856	0.902	0.838	0.879	0.870	0.876
1074	0.865	0.925	0.882	0.921	0.879	0.903	0.895	0.900
1075	0.867	0.925	0.886	0.921	0.880	0.904	0.897	0.902
1076	0.749	0.852	0.778	0.844	0.773	0.814	0.801	0.810
1077	0.792	0.801	0.809	0.797	0.812	0.775	0.828	0.773
1078	0.791	0.801	0.806	0.797	0.811	0.774	0.826	0.771
1079	0.751	0.788	0.782	0.781	0.774	0.754	0.803	0.750
1080	0.797	0.803	0.810	0.799	0.817	0.777	0.830	0.775
1081	0.773	0.795	0.794	0.790	0.795	0.765	0.815	0.762
1082	0.797	0.868	0.810	0.864	0.817	0.840	0.830	0.837
1083	0.872	0.858	0.886	0.854	0.885	0.839	0.899	0.836
1084	0.898	0.865	0.906	0.863	0.907	0.852	0.916	0.850
1085	0.883	0.860	0.896	0.857	0.894	0.844	0.907	0.842
1086	0.898	0.863	0.980	0.907	0.911	0.863	0.980	0.907
1087	0.948	0.891	0.980	0.907	0.953	0.891	0.980	0.907
1088	0.949	0.891	0.980	0.907	0.954	0.891	0.980	0.907
1089	0.948	0.963	0.980	0.980	0.953	0.963	0.980	0.980
1090	0.949	0.963	0.980	0.980	0.954	0.963	0.980	0.980
1091	0.898	0.933	0.980	0.980	0.911	0.933	0.980	0.980
1092	0.899	0.933	0.980	0.980	0.912	0.933	0.980	0.980
1093	0.899	0.863	0.980	0.907	0.912	0.863	0.980	0.907
1094	0.796	0.838	0.823	0.839	0.817	0.817	0.844	0.826
1095	0.829	0.836	0.846	0.838	0.847	0.824	0.864	0.830
1096	0.854	0.884	0.882	0.884	0.869	0.861	0.896	0.869
1097	0.854	0.956	0.882	0.955	0.869	0.931	0.896	0.940
1098	0.891	0.954	0.908	0.954	0.902	0.940	0.918	0.945
1099	0.796	0.906	0.823	0.907	0.817	0.883	0.844	0.893
1100	0.833	0.836	0.847	0.838	0.851	0.825	0.865	0.831
1101	0.894	0.882	0.908	0.882	0.906	0.871	0.919	0.875
1102	0.911	0.869	0.913	0.872	0.925	0.869	0.927	0.872
1103	0.953	0.893	0.952	0.894	0.959	0.893	0.959	0.894
1104	0.953	0.965	0.952	0.966	0.959	0.965	0.959	0.966
1105	0.954	0.965	0.954	0.966	0.959	0.965	0.960	0.966
1106	0.954	0.893	0.954	0.894	0.959	0.893	0.960	0.894
1107	0.911	0.940	0.914	0.942	0.925	0.940	0.927	0.942
1108	0.911	0.940	0.913	0.942	0.925	0.940	0.927	0.942

CASE	Climate Zone 7				Climate Zone 8			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.788	0.760	0.815	0.779	0.775	0.752	0.803	0.770
1002	0.823	0.784	0.838	0.795	0.812	0.775	0.828	0.785
1003	0.788	0.760	0.816	0.779	0.776	0.752	0.805	0.770
1004	0.848	0.813	0.878	0.834	0.839	0.809	0.869	0.829
1005	0.887	0.839	0.903	0.851	0.880	0.835	0.896	0.846
1006	0.849	0.813	0.879	0.834	0.840	0.810	0.871	0.830
1007	0.848	0.879	0.878	0.901	0.839	0.875	0.869	0.896
1008	0.848	0.874	0.878	0.898	0.839	0.881	0.869	0.902
1009	0.888	0.904	0.905	0.918	0.881	0.908	0.898	0.920
1010	0.788	0.756	0.815	0.777	0.775	0.761	0.803	0.780
1011	0.824	0.784	0.839	0.795	0.813	0.776	0.830	0.786
1012	0.788	0.822	0.815	0.843	0.775	0.813	0.803	0.832
1013	0.888	0.839	0.905	0.851	0.881	0.835	0.898	0.847
1014	0.887	0.839	0.903	0.851	0.880	0.835	0.896	0.846
1015	0.849	0.813	0.879	0.834	0.840	0.810	0.871	0.830
1016	0.848	0.874	0.878	0.898	0.839	0.881	0.869	0.902
1017	0.893	0.911	0.907	0.923	0.886	0.907	0.900	0.917
1018	0.870	0.895	0.892	0.912	0.862	0.891	0.884	0.906
1019	0.893	0.843	0.907	0.853	0.886	0.839	0.900	0.848
1020	0.828	0.788	0.842	0.798	0.818	0.779	0.831	0.788
1021	0.870	0.828	0.892	0.843	0.862	0.824	0.884	0.839
1022	0.808	0.774	0.828	0.789	0.796	0.765	0.817	0.779
1023	0.788	0.762	0.815	0.779	0.776	0.762	0.803	0.770
1024	0.823	0.786	0.838	0.795	0.813	0.786	0.828	0.785
1025	0.788	0.762	0.816	0.779	0.777	0.762	0.805	0.770
1026	0.849	0.814	0.878	0.834	0.840	0.814	0.869	0.829
1027	0.887	0.840	0.903	0.851	0.880	0.840	0.896	0.846
1028	0.850	0.814	0.879	0.834	0.841	0.814	0.871	0.830
1029	0.849	0.880	0.878	0.901	0.840	0.880	0.869	0.896
1030	0.849	0.875	0.878	0.898	0.840	0.882	0.869	0.902
1031	0.888	0.905	0.905	0.918	0.881	0.909	0.898	0.920
1032	0.788	0.758	0.815	0.777	0.776	0.764	0.803	0.780
1033	0.823	0.786	0.839	0.795	0.814	0.786	0.830	0.786
1034	0.788	0.824	0.815	0.843	0.776	0.824	0.803	0.832
1035	0.888	0.840	0.905	0.851	0.881	0.840	0.898	0.847
1036	0.887	0.840	0.903	0.851	0.880	0.840	0.896	0.846

CASE	Climate Zone 7				Climate Zone 8			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.850	0.814	0.879	0.834	0.841	0.814	0.871	0.830
1038	0.849	0.875	0.878	0.898	0.840	0.882	0.869	0.902
1039	0.892	0.912	0.907	0.923	0.886	0.912	0.900	0.917
1040	0.870	0.896	0.892	0.912	0.863	0.896	0.884	0.906
1041	0.892	0.843	0.907	0.853	0.886	0.844	0.900	0.848
1042	0.828	0.789	0.842	0.798	0.818	0.789	0.831	0.788
1043	0.870	0.829	0.892	0.843	0.863	0.829	0.884	0.839
1044	0.808	0.775	0.828	0.789	0.797	0.776	0.817	0.779
1045	0.920	0.862	0.920	0.862	0.913	0.852	0.912	0.852
1046	0.957	0.890	0.957	0.890	0.954	0.886	0.953	0.886
1047	0.957	0.962	0.957	0.962	0.954	0.958	0.953	0.958
1048	0.958	0.962	0.957	0.962	0.955	0.958	0.954	0.958
1049	0.958	0.962	0.957	0.962	0.955	0.962	0.954	0.962
1050	0.921	0.862	0.920	0.862	0.913	0.861	0.913	0.861
1051	0.921	0.931	0.920	0.931	0.913	0.931	0.913	0.930
1052	0.921	0.862	0.920	0.862	0.913	0.853	0.913	0.852
1053	0.920	0.931	0.920	0.931	0.913	0.921	0.912	0.921
1054	0.788	0.790	0.815	0.781	0.777	0.784	0.804	0.771
1055	0.849	0.843	0.878	0.834	0.840	0.838	0.870	0.830
1056	0.849	0.912	0.878	0.902	0.840	0.905	0.870	0.897
1057	0.849	0.912	0.879	0.902	0.842	0.905	0.872	0.898
1058	0.887	0.926	0.903	0.921	0.881	0.923	0.897	0.915
1059	0.888	0.926	0.905	0.921	0.882	0.923	0.899	0.916
1060	0.788	0.854	0.815	0.844	0.777	0.848	0.804	0.834
1061	0.824	0.802	0.840	0.797	0.815	0.799	0.831	0.787
1062	0.789	0.790	0.817	0.781	0.778	0.784	0.806	0.772
1063	0.823	0.802	0.839	0.797	0.814	0.799	0.829	0.787
1064	0.829	0.804	0.843	0.799	0.820	0.801	0.833	0.789
1065	0.808	0.797	0.829	0.790	0.798	0.793	0.818	0.780
1066	0.829	0.869	0.843	0.864	0.820	0.866	0.833	0.853
1067	0.893	0.859	0.907	0.854	0.887	0.856	0.901	0.849
1068	0.913	0.865	0.922	0.863	0.909	0.864	0.917	0.858
1069	0.900	0.861	0.913	0.857	0.895	0.859	0.908	0.853
1070	0.788	0.788	0.815	0.781	0.776	0.774	0.804	0.771
1071	0.848	0.843	0.878	0.834	0.839	0.833	0.870	0.830
1072	0.848	0.911	0.878	0.902	0.839	0.900	0.870	0.897

CASE	Climate Zone 7				Climate Zone 8			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.849	0.911	0.879	0.902	0.841	0.901	0.872	0.898
1074	0.887	0.925	0.903	0.921	0.880	0.917	0.897	0.915
1075	0.888	0.925	0.905	0.921	0.881	0.918	0.899	0.916
1076	0.788	0.852	0.815	0.844	0.776	0.837	0.804	0.834
1077	0.824	0.801	0.840	0.797	0.815	0.789	0.831	0.787
1078	0.824	0.801	0.839	0.797	0.814	0.789	0.829	0.787
1079	0.789	0.788	0.817	0.781	0.777	0.774	0.806	0.772
1080	0.829	0.803	0.843	0.799	0.819	0.791	0.833	0.789
1081	0.808	0.795	0.829	0.790	0.797	0.782	0.818	0.780
1082	0.829	0.868	0.843	0.864	0.819	0.855	0.833	0.853
1083	0.893	0.858	0.907	0.854	0.886	0.851	0.901	0.849
1084	0.913	0.865	0.922	0.863	0.909	0.859	0.917	0.858
1085	0.900	0.860	0.913	0.857	0.895	0.854	0.908	0.853
1086	0.919	0.863	0.980	0.907	0.913	0.863	0.980	0.907
1087	0.957	0.891	0.980	0.907	0.954	0.891	0.980	0.907
1088	0.957	0.891	0.980	0.907	0.955	0.891	0.980	0.907
1089	0.957	0.963	0.980	0.980	0.954	0.963	0.980	0.980
1090	0.957	0.963	0.980	0.980	0.955	0.963	0.980	0.980
1091	0.919	0.933	0.980	0.980	0.913	0.933	0.980	0.980
1092	0.920	0.933	0.980	0.980	0.913	0.933	0.980	0.980
1093	0.920	0.863	0.980	0.907	0.913	0.863	0.980	0.907
1094	0.819	0.824	0.845	0.830	0.818	0.821	0.844	0.829
1095	0.848	0.828	0.865	0.833	0.848	0.827	0.864	0.832
1096	0.870	0.869	0.897	0.874	0.870	0.867	0.896	0.873
1097	0.870	0.940	0.897	0.945	0.870	0.937	0.896	0.944
1098	0.902	0.945	0.918	0.948	0.902	0.944	0.918	0.947
1099	0.819	0.891	0.845	0.897	0.818	0.889	0.844	0.896
1100	0.852	0.829	0.866	0.833	0.851	0.828	0.866	0.833
1101	0.906	0.875	0.920	0.878	0.906	0.874	0.920	0.877
1102	0.926	0.869	0.928	0.872	0.925	0.869	0.927	0.872
1103	0.959	0.893	0.960	0.894	0.959	0.893	0.959	0.894
1104	0.959	0.965	0.960	0.966	0.959	0.965	0.959	0.966
1105	0.960	0.965	0.960	0.966	0.959	0.965	0.960	0.966
1106	0.960	0.893	0.960	0.894	0.959	0.893	0.960	0.894
1107	0.926	0.940	0.928	0.942	0.925	0.940	0.928	0.942
1108	0.926	0.940	0.928	0.942	0.925	0.940	0.927	0.942

CASE	Climate Zone 9				Climate Zone 10			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.759	0.702	0.788	0.723	0.759	0.674	0.788	0.696
1002	0.799	0.732	0.814	0.743	0.799	0.708	0.814	0.718
1003	0.761	0.704	0.791	0.726	0.761	0.676	0.791	0.700
1004	0.827	0.775	0.858	0.798	0.827	0.756	0.858	0.780
1005	0.871	0.809	0.887	0.820	0.871	0.794	0.887	0.805
1006	0.829	0.777	0.862	0.802	0.829	0.759	0.862	0.785
1007	0.827	0.838	0.858	0.863	0.827	0.817	0.858	0.843
1008	0.827	0.853	0.858	0.876	0.827	0.837	0.858	0.861
1009	0.873	0.887	0.891	0.900	0.873	0.875	0.891	0.889
1010	0.759	0.722	0.788	0.742	0.759	0.699	0.788	0.720
1011	0.801	0.734	0.817	0.746	0.801	0.710	0.817	0.723
1012	0.759	0.759	0.788	0.781	0.759	0.728	0.788	0.752
1013	0.873	0.811	0.891	0.824	0.873	0.797	0.891	0.811
1014	0.871	0.809	0.887	0.820	0.871	0.794	0.887	0.805
1015	0.829	0.777	0.862	0.802	0.829	0.759	0.862	0.785
1016	0.827	0.853	0.858	0.876	0.827	0.837	0.858	0.861
1017	0.877	0.880	0.892	0.890	0.877	0.864	0.892	0.874
1018	0.852	0.859	0.875	0.876	0.852	0.841	0.875	0.859
1019	0.877	0.814	0.892	0.823	0.877	0.800	0.892	0.809
1020	0.805	0.737	0.818	0.746	0.805	0.713	0.818	0.722
1021	0.852	0.794	0.875	0.810	0.852	0.778	0.875	0.794
1022	0.782	0.719	0.803	0.734	0.782	0.695	0.803	0.709
1023	0.761	0.745	0.788	0.723	0.761	0.718	0.788	0.696
1024	0.801	0.776	0.814	0.743	0.801	0.754	0.814	0.718
1025	0.763	0.745	0.791	0.726	0.763	0.719	0.791	0.700
1026	0.829	0.795	0.858	0.798	0.829	0.777	0.858	0.780
1027	0.872	0.829	0.887	0.820	0.872	0.815	0.887	0.805
1028	0.830	0.795	0.862	0.802	0.830	0.778	0.862	0.785
1029	0.829	0.860	0.858	0.863	0.829	0.840	0.858	0.843
1030	0.829	0.868	0.858	0.876	0.829	0.851	0.858	0.861
1031	0.874	0.901	0.891	0.900	0.874	0.889	0.891	0.889
1032	0.761	0.751	0.788	0.742	0.761	0.728	0.788	0.720
1033	0.802	0.776	0.817	0.746	0.802	0.754	0.817	0.723
1034	0.761	0.805	0.788	0.781	0.761	0.777	0.788	0.752
1035	0.874	0.829	0.891	0.824	0.874	0.816	0.891	0.811
1036	0.872	0.829	0.887	0.820	0.872	0.815	0.887	0.805

CASE	Climate Zone 9				Climate Zone 10			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.830	0.795	0.862	0.802	0.830	0.778	0.862	0.785
1038	0.829	0.868	0.858	0.876	0.829	0.851	0.858	0.861
1039	0.878	0.902	0.892	0.890	0.878	0.887	0.892	0.874
1040	0.853	0.881	0.875	0.876	0.853	0.863	0.875	0.859
1041	0.878	0.834	0.892	0.823	0.878	0.821	0.892	0.809
1042	0.807	0.780	0.818	0.746	0.807	0.759	0.818	0.722
1043	0.853	0.814	0.875	0.810	0.853	0.799	0.875	0.794
1044	0.784	0.762	0.803	0.734	0.784	0.738	0.803	0.709
1045	0.904	0.820	0.902	0.818	0.904	0.802	0.902	0.799
1046	0.950	0.872	0.948	0.870	0.950	0.864	0.948	0.861
1047	0.950	0.943	0.948	0.941	0.950	0.935	0.948	0.931
1048	0.951	0.944	0.950	0.943	0.951	0.936	0.950	0.934
1049	0.951	0.950	0.950	0.949	0.951	0.943	0.950	0.942
1050	0.904	0.834	0.904	0.823	0.904	0.818	0.904	0.817
1051	0.904	0.901	0.904	0.901	0.904	0.885	0.904	0.884
1052	0.904	0.821	0.904	0.820	0.904	0.803	0.904	0.801
1053	0.904	0.887	0.902	0.885	0.904	0.867	0.902	0.864
1054	0.763	0.769	0.790	0.724	0.763	0.744	0.790	0.698
1055	0.830	0.821	0.859	0.799	0.830	0.804	0.859	0.781
1056	0.830	0.887	0.859	0.864	0.830	0.869	0.859	0.845
1057	0.832	0.887	0.863	0.868	0.832	0.870	0.863	0.850
1058	0.873	0.912	0.888	0.887	0.873	0.898	0.888	0.871
1059	0.875	0.912	0.892	0.891	0.875	0.899	0.892	0.877
1060	0.763	0.831	0.790	0.783	0.763	0.804	0.790	0.754
1061	0.804	0.790	0.819	0.747	0.804	0.769	0.819	0.724
1062	0.765	0.769	0.792	0.727	0.765	0.745	0.792	0.702
1063	0.802	0.790	0.816	0.744	0.802	0.769	0.816	0.720
1064	0.808	0.793	0.820	0.747	0.808	0.772	0.820	0.723
1065	0.785	0.781	0.805	0.736	0.785	0.758	0.805	0.710
1066	0.808	0.858	0.820	0.808	0.808	0.835	0.820	0.782
1067	0.879	0.847	0.893	0.824	0.879	0.835	0.893	0.810
1068	0.903	0.859	0.911	0.839	0.903	0.849	0.911	0.828
1069	0.889	0.851	0.901	0.832	0.889	0.840	0.901	0.820
1070	0.761	0.727	0.790	0.724	0.761	0.700	0.790	0.698
1071	0.829	0.801	0.859	0.799	0.829	0.783	0.859	0.781
1072	0.829	0.866	0.859	0.864	0.829	0.847	0.859	0.845

CASE	Climate Zone 9				Climate Zone 10			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.830	0.868	0.863	0.868	0.830	0.849	0.863	0.850
1074	0.872	0.891	0.888	0.887	0.872	0.875	0.888	0.871
1075	0.874	0.893	0.892	0.891	0.874	0.878	0.892	0.877
1076	0.761	0.786	0.790	0.783	0.761	0.756	0.790	0.754
1077	0.802	0.748	0.819	0.747	0.802	0.725	0.819	0.724
1078	0.801	0.747	0.816	0.744	0.801	0.723	0.816	0.720
1079	0.763	0.728	0.792	0.727	0.763	0.702	0.792	0.702
1080	0.807	0.750	0.820	0.747	0.807	0.727	0.820	0.723
1081	0.784	0.738	0.805	0.736	0.784	0.713	0.805	0.710
1082	0.807	0.811	0.820	0.808	0.807	0.785	0.820	0.782
1083	0.878	0.827	0.893	0.824	0.878	0.814	0.893	0.810
1084	0.903	0.841	0.911	0.839	0.903	0.830	0.911	0.828
1085	0.888	0.833	0.901	0.832	0.888	0.821	0.901	0.820
1086	0.905	0.863	0.980	0.907	0.905	0.846	0.980	0.907
1087	0.950	0.891	0.980	0.907	0.950	0.884	0.980	0.907
1088	0.951	0.891	0.980	0.907	0.951	0.884	0.980	0.907
1089	0.950	0.963	0.980	0.980	0.950	0.955	0.980	0.980
1090	0.951	0.963	0.980	0.980	0.951	0.956	0.980	0.980
1091	0.905	0.933	0.980	0.980	0.905	0.915	0.980	0.980
1092	0.905	0.933	0.980	0.980	0.905	0.915	0.980	0.980
1093	0.905	0.863	0.980	0.907	0.905	0.846	0.980	0.907
1094	0.817	0.817	0.843	0.826	0.821	0.811	0.847	0.822
1095	0.847	0.824	0.863	0.830	0.850	0.821	0.866	0.829
1096	0.869	0.862	0.895	0.869	0.872	0.856	0.898	0.866
1097	0.869	0.932	0.895	0.940	0.872	0.926	0.898	0.936
1098	0.901	0.940	0.917	0.945	0.903	0.937	0.919	0.943
1099	0.817	0.883	0.843	0.893	0.821	0.878	0.847	0.889
1100	0.850	0.825	0.865	0.831	0.854	0.823	0.868	0.830
1101	0.905	0.871	0.919	0.875	0.908	0.868	0.921	0.873
1102	0.924	0.869	0.926	0.872	0.927	0.869	0.929	0.872
1103	0.959	0.893	0.959	0.894	0.960	0.893	0.960	0.894
1104	0.959	0.965	0.959	0.966	0.960	0.965	0.960	0.966
1105	0.959	0.965	0.960	0.966	0.960	0.965	0.961	0.966
1106	0.959	0.893	0.960	0.894	0.960	0.893	0.961	0.894
1107	0.925	0.940	0.927	0.942	0.927	0.940	0.930	0.942
1108	0.924	0.940	0.926	0.942	0.927	0.940	0.929	0.942

CASE	Climate Zone 11				Climate Zone 12			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.743	0.645	0.773	0.669	0.750	0.674	0.779	0.696
1002	0.786	0.683	0.801	0.694	0.791	0.708	0.806	0.718
1003	0.745	0.648	0.777	0.675	0.751	0.676	0.782	0.700
1004	0.815	0.737	0.848	0.762	0.820	0.756	0.852	0.780
1005	0.862	0.779	0.879	0.790	0.866	0.794	0.882	0.805
1006	0.818	0.740	0.852	0.769	0.822	0.759	0.856	0.785
1007	0.815	0.796	0.848	0.824	0.820	0.817	0.852	0.843
1008	0.815	0.821	0.848	0.846	0.820	0.837	0.852	0.861
1009	0.864	0.863	0.883	0.878	0.868	0.875	0.886	0.889
1010	0.743	0.677	0.773	0.698	0.750	0.699	0.779	0.720
1011	0.788	0.686	0.805	0.700	0.793	0.710	0.810	0.723
1012	0.743	0.698	0.773	0.723	0.750	0.728	0.779	0.752
1013	0.864	0.783	0.883	0.798	0.868	0.797	0.886	0.811
1014	0.862	0.779	0.879	0.790	0.866	0.794	0.882	0.805
1015	0.818	0.740	0.852	0.769	0.822	0.759	0.856	0.785
1016	0.815	0.821	0.848	0.846	0.820	0.837	0.852	0.861
1017	0.869	0.849	0.883	0.859	0.872	0.864	0.887	0.874
1018	0.842	0.822	0.865	0.841	0.846	0.841	0.869	0.859
1019	0.869	0.785	0.883	0.795	0.872	0.800	0.887	0.809
1020	0.792	0.689	0.805	0.698	0.797	0.713	0.811	0.722
1021	0.842	0.761	0.865	0.778	0.846	0.778	0.869	0.794
1022	0.767	0.667	0.789	0.683	0.773	0.695	0.795	0.709
1023	0.746	0.692	0.773	0.669	0.752	0.718	0.779	0.696
1024	0.788	0.731	0.801	0.694	0.793	0.754	0.806	0.718
1025	0.748	0.693	0.777	0.675	0.754	0.719	0.782	0.700
1026	0.817	0.759	0.848	0.762	0.822	0.777	0.852	0.780
1027	0.864	0.801	0.879	0.790	0.867	0.815	0.882	0.805
1028	0.820	0.760	0.852	0.769	0.824	0.778	0.856	0.785
1029	0.817	0.820	0.848	0.824	0.822	0.840	0.852	0.843
1030	0.817	0.835	0.848	0.846	0.822	0.851	0.852	0.861
1031	0.866	0.876	0.883	0.878	0.869	0.889	0.886	0.889
1032	0.746	0.705	0.773	0.698	0.752	0.728	0.779	0.720
1033	0.790	0.732	0.805	0.700	0.795	0.754	0.810	0.723
1034	0.746	0.748	0.773	0.723	0.752	0.777	0.779	0.752
1035	0.866	0.803	0.883	0.798	0.869	0.816	0.886	0.811
1036	0.864	0.801	0.879	0.790	0.867	0.815	0.882	0.805

CASE	Climate Zone 11				Climate Zone 12			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.820	0.760	0.852	0.769	0.824	0.778	0.856	0.785
1038	0.817	0.835	0.848	0.846	0.822	0.851	0.852	0.861
1039	0.871	0.873	0.883	0.859	0.874	0.887	0.887	0.874
1040	0.844	0.846	0.865	0.841	0.847	0.863	0.869	0.859
1041	0.871	0.808	0.883	0.795	0.874	0.821	0.887	0.809
1042	0.795	0.737	0.805	0.698	0.799	0.759	0.811	0.722
1043	0.844	0.783	0.865	0.778	0.847	0.799	0.869	0.794
1044	0.770	0.714	0.789	0.683	0.776	0.738	0.795	0.709
1045	0.895	0.783	0.893	0.780	0.898	0.802	0.896	0.799
1046	0.946	0.857	0.943	0.853	0.948	0.864	0.945	0.861
1047	0.946	0.926	0.943	0.922	0.948	0.935	0.945	0.931
1048	0.947	0.928	0.946	0.925	0.949	0.936	0.947	0.934
1049	0.947	0.936	0.946	0.934	0.949	0.943	0.947	0.942
1050	0.895	0.803	0.894	0.801	0.899	0.818	0.898	0.817
1051	0.895	0.868	0.894	0.866	0.899	0.885	0.898	0.884
1052	0.895	0.784	0.894	0.783	0.899	0.803	0.898	0.801
1053	0.895	0.847	0.893	0.843	0.898	0.867	0.896	0.864
1054	0.749	0.719	0.775	0.671	0.755	0.744	0.781	0.698
1055	0.820	0.787	0.849	0.764	0.824	0.804	0.853	0.781
1056	0.820	0.851	0.849	0.826	0.824	0.869	0.853	0.845
1057	0.822	0.852	0.854	0.833	0.826	0.870	0.857	0.850
1058	0.865	0.884	0.880	0.856	0.868	0.899	0.883	0.871
1059	0.867	0.885	0.884	0.863	0.870	0.899	0.887	0.877
1060	0.749	0.777	0.775	0.725	0.755	0.804	0.781	0.754
1061	0.792	0.748	0.807	0.701	0.797	0.769	0.812	0.724
1062	0.751	0.720	0.779	0.677	0.757	0.745	0.784	0.702
1063	0.791	0.747	0.803	0.695	0.795	0.769	0.808	0.720
1064	0.797	0.751	0.807	0.699	0.801	0.772	0.812	0.723
1065	0.773	0.735	0.791	0.685	0.778	0.758	0.796	0.710
1066	0.797	0.812	0.807	0.756	0.801	0.835	0.812	0.782
1067	0.872	0.822	0.884	0.795	0.875	0.835	0.888	0.810
1068	0.898	0.839	0.905	0.817	0.900	0.849	0.907	0.828
1069	0.882	0.829	0.894	0.808	0.885	0.840	0.897	0.820
1070	0.746	0.673	0.775	0.671	0.752	0.700	0.781	0.698
1071	0.818	0.765	0.849	0.764	0.822	0.783	0.853	0.781
1072	0.818	0.827	0.849	0.826	0.822	0.847	0.853	0.845

CASE	Climate Zone 11				Climate Zone 12			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.820	0.831	0.854	0.833	0.824	0.849	0.857	0.850
1074	0.864	0.860	0.880	0.856	0.867	0.875	0.883	0.871
1075	0.866	0.864	0.884	0.863	0.869	0.878	0.887	0.877
1076	0.746	0.727	0.775	0.725	0.752	0.756	0.781	0.754
1077	0.790	0.702	0.807	0.701	0.795	0.725	0.812	0.724
1078	0.788	0.699	0.803	0.695	0.793	0.723	0.808	0.720
1079	0.748	0.675	0.779	0.677	0.754	0.702	0.784	0.702
1080	0.794	0.703	0.807	0.699	0.799	0.727	0.812	0.723
1081	0.770	0.688	0.791	0.685	0.775	0.713	0.796	0.710
1082	0.794	0.760	0.807	0.756	0.799	0.785	0.812	0.782
1083	0.870	0.800	0.884	0.795	0.874	0.814	0.888	0.810
1084	0.897	0.819	0.905	0.817	0.899	0.830	0.907	0.828
1085	0.881	0.809	0.894	0.808	0.884	0.821	0.897	0.820
1086	0.897	0.830	0.980	0.907	0.900	0.846	0.980	0.907
1087	0.947	0.877	0.980	0.907	0.948	0.884	0.980	0.907
1088	0.948	0.877	0.980	0.907	0.949	0.884	0.980	0.907
1089	0.947	0.948	0.980	0.980	0.948	0.955	0.980	0.980
1090	0.948	0.948	0.980	0.980	0.949	0.956	0.980	0.980
1091	0.897	0.897	0.980	0.980	0.900	0.915	0.980	0.980
1092	0.897	0.898	0.980	0.980	0.901	0.915	0.980	0.980
1093	0.897	0.830	0.980	0.907	0.901	0.846	0.980	0.907
1094	0.816	0.811	0.843	0.822	0.816	0.817	0.842	0.824
1095	0.846	0.821	0.863	0.828	0.846	0.823	0.862	0.829
1096	0.868	0.855	0.895	0.865	0.868	0.859	0.895	0.867
1097	0.868	0.924	0.895	0.935	0.868	0.928	0.895	0.938
1098	0.901	0.936	0.917	0.943	0.901	0.938	0.917	0.944
1099	0.816	0.876	0.843	0.888	0.816	0.880	0.842	0.891
1100	0.850	0.822	0.864	0.829	0.849	0.824	0.864	0.830
1101	0.905	0.867	0.919	0.873	0.905	0.869	0.918	0.874
1102	0.924	0.869	0.926	0.872	0.924	0.869	0.926	0.872
1103	0.959	0.893	0.959	0.894	0.958	0.893	0.959	0.894
1104	0.959	0.965	0.959	0.966	0.958	0.965	0.959	0.966
1105	0.959	0.965	0.960	0.966	0.959	0.965	0.959	0.966
1106	0.959	0.893	0.960	0.894	0.959	0.893	0.959	0.894
1107	0.924	0.940	0.927	0.942	0.924	0.940	0.926	0.942
1108	0.924	0.940	0.926	0.942	0.924	0.940	0.926	0.942

CASE	Climate Zone 13				Climate Zone 14			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.743	0.667	0.773	0.689	0.715	0.617	0.746	0.642
1002	0.786	0.702	0.801	0.712	0.762	0.659	0.777	0.669
1003	0.743	0.669	0.777	0.694	0.718	0.621	0.752	0.649
1004	0.815	0.751	0.848	0.776	0.794	0.717	0.828	0.745
1005	0.862	0.790	0.879	0.801	0.846	0.764	0.863	0.776
1006	0.818	0.754	0.852	0.781	0.797	0.721	0.835	0.753
1007	0.815	0.812	0.848	0.839	0.794	0.775	0.828	0.805
1008	0.815	0.833	0.848	0.857	0.794	0.805	0.828	0.831
1009	0.864	0.872	0.883	0.886	0.849	0.851	0.870	0.866
1010	0.743	0.694	0.773	0.714	0.715	0.654	0.746	0.676
1011	0.788	0.704	0.805	0.717	0.765	0.663	0.783	0.677
1012	0.743	0.721	0.773	0.745	0.715	0.667	0.746	0.694
1013	0.864	0.793	0.883	0.807	0.849	0.768	0.870	0.784
1014	0.862	0.790	0.879	0.801	0.846	0.764	0.863	0.776
1015	0.818	0.754	0.852	0.781	0.797	0.721	0.835	0.753
1016	0.815	0.833	0.848	0.857	0.794	0.805	0.828	0.831
1017	0.869	0.860	0.883	0.871	0.854	0.834	0.868	0.843
1018	0.842	0.836	0.865	0.854	0.824	0.804	0.848	0.824
1019	0.869	0.796	0.883	0.805	0.854	0.771	0.868	0.780
1020	0.792	0.707	0.805	0.716	0.769	0.665	0.782	0.674
1021	0.842	0.773	0.865	0.790	0.824	0.744	0.848	0.762
1022	0.767	0.687	0.789	0.702	0.741	0.643	0.764	0.658
1023	0.746	0.712	0.773	0.689	0.720	0.666	0.746	0.642
1024	0.788	0.748	0.801	0.712	0.766	0.709	0.777	0.669
1025	0.748	0.713	0.777	0.694	0.722	0.668	0.752	0.649
1026	0.817	0.772	0.848	0.776	0.797	0.740	0.828	0.745
1027	0.864	0.812	0.879	0.801	0.849	0.787	0.863	0.776
1028	0.820	0.773	0.852	0.781	0.800	0.743	0.835	0.753
1029	0.817	0.835	0.848	0.839	0.797	0.800	0.828	0.805
1030	0.817	0.847	0.848	0.857	0.797	0.819	0.828	0.831
1031	0.866	0.886	0.883	0.886	0.852	0.864	0.870	0.866
1032	0.746	0.722	0.773	0.714	0.720	0.682	0.746	0.676
1033	0.790	0.749	0.805	0.717	0.769	0.711	0.783	0.677
1034	0.746	0.770	0.773	0.745	0.720	0.720	0.746	0.694
1035	0.866	0.813	0.883	0.807	0.852	0.790	0.870	0.784
1036	0.864	0.812	0.879	0.801	0.849	0.787	0.863	0.776

CASE	Climate Zone 13				Climate Zone 14			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.820	0.773	0.852	0.781	0.800	0.743	0.835	0.753
1038	0.817	0.847	0.848	0.857	0.797	0.819	0.828	0.831
1039	0.871	0.884	0.883	0.871	0.856	0.859	0.868	0.843
1040	0.844	0.859	0.865	0.854	0.826	0.829	0.848	0.824
1041	0.871	0.818	0.883	0.805	0.856	0.794	0.868	0.780
1042	0.795	0.753	0.805	0.716	0.773	0.715	0.782	0.674
1043	0.844	0.795	0.865	0.790	0.826	0.767	0.848	0.762
1044	0.770	0.732	0.789	0.702	0.746	0.690	0.764	0.658
1045	0.895	0.797	0.893	0.794	0.878	0.765	0.875	0.761
1046	0.946	0.862	0.943	0.859	0.939	0.849	0.935	0.844
1047	0.946	0.932	0.943	0.929	0.939	0.917	0.935	0.912
1048	0.947	0.934	0.946	0.932	0.940	0.920	0.938	0.917
1049	0.947	0.941	0.946	0.940	0.940	0.929	0.938	0.927
1050	0.895	0.814	0.894	0.813	0.879	0.787	0.878	0.786
1051	0.895	0.880	0.894	0.879	0.879	0.851	0.878	0.849
1052	0.895	0.798	0.894	0.797	0.879	0.766	0.878	0.764
1053	0.895	0.862	0.893	0.859	0.878	0.827	0.875	0.822
1054	0.749	0.738	0.775	0.691	0.724	0.694	0.749	0.644
1055	0.820	0.800	0.849	0.777	0.801	0.770	0.831	0.746
1056	0.820	0.864	0.849	0.840	0.801	0.832	0.831	0.807
1057	0.822	0.865	0.854	0.846	0.804	0.835	0.838	0.816
1058	0.865	0.895	0.880	0.867	0.851	0.870	0.865	0.840
1059	0.867	0.896	0.884	0.874	0.854	0.872	0.871	0.849
1060	0.749	0.798	0.775	0.747	0.724	0.750	0.749	0.696
1061	0.792	0.764	0.807	0.719	0.772	0.727	0.785	0.679
1062	0.751	0.738	0.779	0.696	0.727	0.696	0.755	0.651
1063	0.791	0.763	0.803	0.714	0.769	0.725	0.780	0.671
1064	0.797	0.767	0.807	0.717	0.776	0.730	0.784	0.675
1065	0.773	0.752	0.791	0.704	0.750	0.712	0.767	0.659
1066	0.797	0.829	0.807	0.775	0.776	0.789	0.784	0.730
1067	0.872	0.832	0.884	0.806	0.859	0.810	0.870	0.781
1068	0.898	0.847	0.905	0.825	0.888	0.830	0.894	0.806
1069	0.882	0.838	0.894	0.817	0.871	0.818	0.882	0.795
1070	0.746	0.693	0.775	0.691	0.719	0.645	0.749	0.644
1071	0.818	0.779	0.849	0.777	0.798	0.747	0.831	0.746
1072	0.818	0.842	0.849	0.840	0.798	0.808	0.831	0.807

CASE	Climate Zone 13				Climate Zone 14			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.820	0.845	0.854	0.846	0.801	0.812	0.838	0.816
1074	0.864	0.871	0.880	0.867	0.849	0.845	0.865	0.840
1075	0.866	0.875	0.884	0.874	0.852	0.849	0.871	0.849
1076	0.746	0.749	0.775	0.747	0.719	0.698	0.749	0.696
1077	0.790	0.720	0.807	0.719	0.768	0.679	0.785	0.679
1078	0.788	0.717	0.803	0.714	0.765	0.676	0.780	0.671
1079	0.748	0.695	0.779	0.696	0.722	0.649	0.755	0.651
1080	0.794	0.721	0.807	0.717	0.772	0.680	0.784	0.675
1081	0.770	0.707	0.791	0.704	0.745	0.663	0.767	0.659
1082	0.794	0.779	0.807	0.775	0.772	0.735	0.784	0.730
1083	0.870	0.810	0.884	0.806	0.856	0.786	0.870	0.781
1084	0.897	0.827	0.905	0.825	0.886	0.809	0.894	0.806
1085	0.881	0.818	0.894	0.817	0.869	0.797	0.882	0.795
1086	0.897	0.842	0.980	0.907	0.882	0.813	0.980	0.907
1087	0.947	0.882	0.980	0.907	0.940	0.869	0.980	0.907
1088	0.948	0.882	0.980	0.907	0.942	0.871	0.980	0.907
1089	0.947	0.953	0.980	0.980	0.940	0.940	0.980	0.980
1090	0.948	0.954	0.980	0.980	0.942	0.941	0.980	0.980
1091	0.897	0.910	0.980	0.980	0.882	0.879	0.980	0.980
1092	0.897	0.911	0.980	0.980	0.883	0.880	0.980	0.980
1093	0.897	0.842	0.980	0.907	0.883	0.814	0.980	0.907
1094	0.813	0.814	0.840	0.824	0.804	0.811	0.832	0.823
1095	0.844	0.823	0.860	0.830	0.836	0.822	0.853	0.829
1096	0.866	0.859	0.893	0.868	0.860	0.857	0.888	0.866
1097	0.866	0.929	0.893	0.938	0.860	0.926	0.888	0.936
1098	0.899	0.938	0.916	0.944	0.895	0.937	0.912	0.943
1099	0.813	0.880	0.840	0.891	0.804	0.878	0.832	0.890
1100	0.847	0.824	0.862	0.830	0.840	0.823	0.855	0.830
1101	0.903	0.869	0.917	0.874	0.899	0.868	0.913	0.874
1102	0.922	0.869	0.924	0.872	0.917	0.869	0.918	0.872
1103	0.958	0.893	0.958	0.894	0.955	0.893	0.955	0.894
1104	0.958	0.965	0.958	0.966	0.955	0.965	0.955	0.966
1105	0.958	0.965	0.959	0.966	0.956	0.965	0.956	0.966
1106	0.958	0.893	0.959	0.894	0.956	0.893	0.956	0.894
1107	0.922	0.940	0.925	0.942	0.917	0.940	0.919	0.942
1108	0.922	0.940	0.924	0.942	0.917	0.940	0.918	0.942

CASE	Climate Zone 15				Climate Zone 16			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1001	0.750	0.596	0.779	0.622	0.693	0.730	0.725	0.755
1002	0.791	0.640	0.806	0.651	0.743	0.763	0.759	0.777
1003	0.751	0.600	0.782	0.630	0.696	0.731	0.732	0.756
1004	0.820	0.703	0.852	0.731	0.778	0.786	0.813	0.813
1005	0.866	0.753	0.882	0.765	0.834	0.821	0.851	0.836
1006	0.822	0.708	0.856	0.741	0.782	0.786	0.821	0.814
1007	0.820	0.760	0.852	0.791	0.778	0.850	0.813	0.879
1008	0.820	0.793	0.852	0.819	0.778	0.856	0.813	0.886
1009	0.868	0.842	0.886	0.858	0.838	0.894	0.859	0.911
1010	0.750	0.637	0.779	0.660	0.693	0.740	0.725	0.766
1011	0.793	0.645	0.810	0.660	0.747	0.763	0.766	0.778
1012	0.750	0.644	0.779	0.672	0.693	0.789	0.725	0.816
1013	0.868	0.758	0.886	0.775	0.838	0.822	0.859	0.837
1014	0.866	0.753	0.882	0.765	0.834	0.821	0.851	0.836
1015	0.822	0.708	0.856	0.741	0.782	0.786	0.821	0.814
1016	0.820	0.793	0.852	0.819	0.778	0.856	0.813	0.886
1017	0.872	0.822	0.887	0.832	0.842	0.893	0.856	0.908
1018	0.846	0.791	0.869	0.811	0.810	0.871	0.835	0.893
1019	0.872	0.760	0.887	0.769	0.842	0.826	0.856	0.840
1020	0.797	0.647	0.811	0.655	0.751	0.767	0.764	0.780
1021	0.846	0.731	0.869	0.750	0.810	0.806	0.835	0.826
1022	0.773	0.621	0.795	0.639	0.721	0.749	0.744	0.767
1023	0.752	0.646	0.779	0.622	0.699	0.741	0.725	0.755
1024	0.793	0.692	0.806	0.651	0.749	0.774	0.759	0.777
1025	0.754	0.649	0.782	0.630	0.702	0.741	0.732	0.756
1026	0.822	0.727	0.852	0.731	0.782	0.792	0.813	0.813
1027	0.867	0.777	0.882	0.765	0.837	0.827	0.851	0.836
1028	0.824	0.729	0.856	0.741	0.785	0.792	0.821	0.814
1029	0.822	0.786	0.852	0.791	0.782	0.856	0.813	0.879
1030	0.822	0.807	0.852	0.819	0.782	0.858	0.813	0.886
1031	0.869	0.855	0.886	0.858	0.841	0.895	0.859	0.911
1032	0.752	0.665	0.779	0.660	0.699	0.743	0.725	0.766
1033	0.795	0.694	0.810	0.660	0.753	0.774	0.766	0.778
1034	0.752	0.699	0.779	0.672	0.699	0.801	0.725	0.816
1035	0.869	0.780	0.886	0.775	0.841	0.827	0.859	0.837
1036	0.867	0.777	0.882	0.765	0.837	0.827	0.851	0.836

CASE	Climate Zone 15				Climate Zone 16			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1037	0.824	0.729	0.856	0.741	0.785	0.792	0.821	0.814
1038	0.822	0.807	0.852	0.819	0.782	0.858	0.813	0.886
1039	0.874	0.848	0.887	0.832	0.846	0.899	0.856	0.908
1040	0.847	0.817	0.869	0.811	0.813	0.877	0.835	0.893
1041	0.874	0.784	0.887	0.769	0.846	0.832	0.856	0.840
1042	0.799	0.699	0.811	0.655	0.757	0.778	0.764	0.780
1043	0.847	0.755	0.869	0.750	0.813	0.811	0.835	0.826
1044	0.776	0.672	0.795	0.639	0.728	0.760	0.744	0.767
1045	0.898	0.751	0.896	0.746	0.865	0.852	0.861	0.852
1046	0.948	0.843	0.945	0.837	0.933	0.886	0.928	0.885
1047	0.948	0.911	0.945	0.905	0.933	0.958	0.928	0.957
1048	0.949	0.914	0.947	0.910	0.935	0.958	0.932	0.958
1049	0.949	0.924	0.947	0.921	0.935	0.962	0.932	0.962
1050	0.899	0.776	0.898	0.774	0.867	0.861	0.865	0.861
1051	0.899	0.839	0.898	0.837	0.867	0.930	0.865	0.930
1052	0.899	0.753	0.898	0.750	0.867	0.852	0.865	0.852
1053	0.898	0.812	0.896	0.807	0.865	0.921	0.861	0.921
1054	0.755	0.675	0.781	0.624	0.705	0.771	0.729	0.757
1055	0.824	0.757	0.853	0.733	0.787	0.823	0.817	0.814
1056	0.824	0.819	0.853	0.792	0.787	0.890	0.817	0.880
1057	0.826	0.821	0.857	0.803	0.790	0.890	0.825	0.881
1058	0.868	0.859	0.883	0.828	0.840	0.914	0.853	0.905
1059	0.870	0.862	0.887	0.839	0.844	0.914	0.861	0.906
1060	0.755	0.730	0.781	0.674	0.705	0.834	0.729	0.818
1061	0.797	0.711	0.812	0.661	0.756	0.791	0.769	0.779
1062	0.757	0.678	0.784	0.632	0.708	0.771	0.730	0.758
1063	0.795	0.709	0.808	0.653	0.753	0.791	0.762	0.778
1064	0.801	0.714	0.812	0.657	0.760	0.794	0.766	0.781
1065	0.778	0.695	0.796	0.640	0.732	0.783	0.748	0.769
1066	0.801	0.772	0.812	0.710	0.760	0.859	0.766	0.844
1067	0.875	0.800	0.888	0.770	0.848	0.848	0.858	0.840
1068	0.900	0.822	0.907	0.797	0.880	0.860	0.885	0.854
1069	0.885	0.810	0.897	0.786	0.862	0.852	0.873	0.846
1070	0.752	0.625	0.781	0.624	0.698	0.761	0.729	0.757
1071	0.822	0.734	0.853	0.733	0.783	0.818	0.817	0.814
1072	0.822	0.793	0.853	0.792	0.783	0.884	0.817	0.880

CASE	Climate Zone 15				Climate Zone 16			
	1 Story		2 Story		1 Story		2 Story	
CODE	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%	Heating,%	Cooling,%
1073	0.824	0.798	0.857	0.803	0.787	0.885	0.825	0.881
1074	0.867	0.833	0.883	0.828	0.837	0.908	0.853	0.905
1075	0.869	0.839	0.887	0.839	0.841	0.909	0.861	0.906
1076	0.752	0.676	0.781	0.674	0.698	0.822	0.729	0.818
1077	0.795	0.662	0.812	0.661	0.750	0.781	0.769	0.779
1078	0.793	0.658	0.808	0.653	0.747	0.781	0.762	0.778
1079	0.754	0.629	0.784	0.632	0.702	0.761	0.736	0.758
1080	0.799	0.662	0.812	0.657	0.754	0.784	0.766	0.781
1081	0.775	0.644	0.796	0.640	0.726	0.772	0.748	0.769
1082	0.799	0.716	0.812	0.710	0.754	0.847	0.766	0.844
1083	0.874	0.776	0.888	0.770	0.845	0.843	0.858	0.840
1084	0.899	0.800	0.907	0.797	0.878	0.855	0.885	0.854
1085	0.884	0.788	0.897	0.786	0.859	0.848	0.873	0.846
1086	0.900	0.801	0.980	0.907	0.870	0.863	0.980	0.907
1087	0.948	0.864	0.980	0.907	0.935	0.891	0.980	0.907
1088	0.949	0.866	0.980	0.907	0.937	0.891	0.980	0.907
1089	0.948	0.934	0.980	0.980	0.935	0.963	0.980	0.980
1090	0.949	0.936	0.980	0.980	0.937	0.963	0.980	0.980
1091	0.900	0.866	0.980	0.980	0.870	0.933	0.980	0.980
1092	0.901	0.867	0.980	0.980	0.872	0.933	0.980	0.980
1093	0.901	0.802	0.980	0.907	0.872	0.863	0.980	0.907
1094	0.827	0.800	0.853	0.815	0.772	0.845	0.801	0.844
1095	0.855	0.815	0.872	0.824	0.809	0.841	0.827	0.841
1096	0.876	0.843	0.902	0.858	0.837	0.892	0.867	0.889
1097	0.876	0.912	0.902	0.927	0.837	0.964	0.867	0.961
1098	0.907	0.929	0.922	0.938	0.878	0.959	0.896	0.957
1099	0.827	0.865	0.853	0.881	0.772	0.914	0.801	0.912
1100	0.859	0.817	0.874	0.826	0.812	0.840	0.827	0.840
1101	0.911	0.861	0.924	0.869	0.882	0.886	0.896	0.885
1102	0.931	0.869	0.934	0.872	0.896	0.869	0.897	0.872
1103	0.962	0.893	0.962	0.894	0.946	0.893	0.945	0.894
1104	0.962	0.965	0.962	0.966	0.946	0.965	0.945	0.966
1105	0.962	0.965	0.963	0.966	0.947	0.965	0.947	0.966
1106	0.962	0.893	0.963	0.894	0.947	0.893	0.947	0.894
1107	0.931	0.940	0.934	0.942	0.896	0.940	0.898	0.942
1108	0.931	0.940	0.934	0.942	0.896	0.940	0.897	0.942

APPENDIX K

Procedures for Determining Required Refrigerant Charge and Adequate Airflow for Split System Space Cooling Systems without Thermostatic Expansion Valves

1. Overview

Failure to maintain proper refrigerant charge or proper airflow across the coil reduces the seasonal energy efficiency for an air conditioner (whether a cooling only air conditioner or a heat pump). In addition, excessive refrigerant charge can cause premature compressor failure, while insufficient refrigerant charge allows compressors to overheat. Very low airflow can result in icing of the coil and compressor failure.

To help avoid these problems and to provide a compliance credit for correctly installed systems, this appendix describes procedures for determining if a residential split system space cooling system has the required refrigerant charge and adequate airflow across the evaporator coil. The applicability of these procedures have the following limitations:

- The procedures detailed in this appendix only apply to ducted split system central air conditioners and ducted split system central heat pumps that do not have thermostatic expansion valves (TXVs).
- As an alternative to the procedures detailed in this appendix, systems may substitute a TXV installed and confirmed through field verification and diagnostic testing.
- The procedures detailed in this appendix do not apply to single packaged systems.

Note that the procedures detailed in this appendix are intended to be used after the HVAC installer has installed and charged the system in accordance with the manufacturer's specifications.

The installer shall install and charge the air conditioner and heat pump equipment in accordance with the manufacturer's instructions and specifications for the specific model equipment installed. The installer shall certify to the builder, building official and HERS rater that they have followed these instruction and specifications prior to proceeding with the procedures in this appendix.

For dwelling units with multiple systems, this procedure must be applied to each system separately.

This appendix defines two procedures, the Standard Charge and Airflow Measurement procedure in Section 2 and the Alternate Charge and Airflow Measurement procedure in Section 3. The Standard procedure shall be used when the outdoor air temperature is 55°F or above and shall always be used for HERS rater verification. HVAC installers who must complete system installation when the outdoor temperature is below 55°F shall use the Alternate procedure.

The following sections document the instrumentation needed, the required instrumentation calibration, the measurement procedure, and the calculations required for each procedure. Note: Wherever thermocouples appear in this document, thermisters can be used instead with the same requirements applying to thermisters as to thermocouples.

2. Standard Charge and Airflow Measurement Procedure

This section specifies the Standard charge and airflow measurement procedure. Under this procedure, required refrigerant charge is calculated using the *Superheat Charging Method* and adequate airflow across the evaporator coil is calculated using the *Temperature Split Method*.

The Standard procedure detailed in this section shall be completed when the outdoor temperature is 55°F or higher after the HVAC installer has installed and charged the system in accordance with the manufacturer's specifications. All HERS rater verifications are required to use this Standard procedure.

2.1 Minimum Qualifications for this Procedure

Persons carrying out this procedure need to be qualified to perform the following:

- Obtain accurate pressure/temperature readings from refrigeration manifold gauges.
- Obtain accurate temperature readings from thermometer and thermocouple set up.
- Check calibration of refrigerant gauges using a known reference pressure and thermometer/thermocouple set up using a known reference temperature.
- Determine best location for temperature measurements in ducting system and on refrigerant lineset.
- Calculate the measured superheat and temperature split.
- Determine the correct level of superheat and temperature split required, based on the conditions present at the time of the test.
- Determine if measured values are reasonable.

2.2 Instrumentation Specifications

Instrumentation for the procedures described in this section shall conform to the following specifications.

2.2.1 Digital Thermometer

Digital thermometer must have thermocouple compatibility (type K and J) and Celsius or Fahrenheit readout with:

- Accuracy: ±(0.1% of reading + 1.3º F)
- Resolution: 0.2º F

2.2.2 Thermocouples

Measurements require five (5) heavy duty beaded low-mass wire thermocouples and one (1) cotton wick for measuring wet-bulb temperatures.

2.2.3 Refrigerant Manifold Gauge Set

A standard multiport refrigerant manifold gauge with an accuracy of plus or minus 3% shall be used.

2.3 Calibration

The accuracy of instrumentation shall be maintained using the following procedures. A sticker with the calibration check date shall be affixed to each instrument calibrated.

2.3.1 Thermometer/Thermocouple Field Calibration Procedure

Thermometers/thermocouples shall be calibrated monthly to ensure that they are reading accurate temperatures. The following procedure shall be used to check thermometer/thermocouple calibration.

Step 1. Fill an insulated cup (foam) with crushed ice. The ice shall completely fill the cup. Add water to fill the cup.

Step 2. Insert two thermocouples into the center of the ice bath and attach them to the digital thermometer.

Step 3. Let the temperatures stabilize. The temperatures shall be 32°F (+/- 1°F). If the temperature is off by more than 1°F make corrections according to the manufacturer's instructions. Any thermocouples that are off by more than 3°F shall be replaced.

Step 4. Switch the thermocouples and ensure that the temperatures read on T1 and T2 are still within +/- 1°F of 32°F.

Step 5. Affix sticker with calibration check date onto thermocouple.

Step 6. Repeat the process for all thermocouples.

2.3.2 Refrigerant Gauge Field Check Procedure

Refrigerant gauges shall be checked monthly to ensure that the gauges are reading the correct pressures and corresponding temperatures. The following procedure shall be used to check gauge calibration.

Step 1. Place a refrigerant cylinder in a stable environment and let it sit for 4 hours minimum to stabilize to the ambient conditions.

Step 2. Attach a thermocouple to the refrigerant cylinder using duct tape so that there is good contact between the cylinder and the thermocouple.

Step 3. Insulate the thermocouple connection to the cylinder (closed cell pipe insulation can be taped over the end of the thermocouple to provide the insulation).

Step 4. Zero the low side compound gauge with all ports open to atmospheric pressure (no hoses attached).

Step 5. Re-install the hose and attach the low side gauge to the refrigerant cylinder.

Step 6. Read the temperature of the thermocouple.

Step 7. Using a pressure/temperature chart for the refrigerant, look up the pressure that corresponds to the temperature measured.

Step 8. If gauge does not read the correct pressure corresponding to the temperature, the gauge is out of calibration and needs to be replaced or returned to the manufacturer for calibration.

Step 9. Repeat the process in steps 4 through 8 for the high side gauge.

Step 10. Affix sticker with calibration check date onto refrigerant gauge.

2.4 Charge and Airflow Measurements

The following procedure shall be used to obtain measurements necessary to adjust required refrigerant charge and adequate airflow as described in the following sections.

Step 1. Establish a return air dry bulb temperature sufficiently high that the return air dry bulb temperature will be not less than 70°F prior to the measurements at the end of the 15 minute period in step 2.

Step 2. Turn the cooling system on and let it run for 15 minutes to stabilize temperatures and pressures before taking any measurements. While the system is stabilizing, proceed with setting up the temperature measurements.

Step 3. Connect the refrigerant gauge manifold to the suction line service valve.

Step 4. Attach a thermocouple to the suction line near the suction line service valve. Be sure the sensor is in direct contact with the line and is well insulated from air temperature.

Step 5. Attach a thermocouple to measure the condenser (entering) air dry-bulb temperature. The sensor shall be placed so that it records the average condenser air entering temperature and is shaded from direct sun.

Step 6. Be sure that all cabinet panels that affect airflow are in place before making measurements. The thermocouple sensors shall remain attached to the system until the final charge is determined.

Step 7. Place wet-bulb thermocouple in water to ensure it is saturated when needed. **Do not get the dry-bulb thermocouples wet.**

Step 8. Insert the dry-bulb thermocouple in the supply plenum at the center of the airflow.

Step 9. At 12 minutes, insert a dry-bulb thermocouple and a wet-bulb thermocouple into the return plenum at the center of the airflow.

Step 10. At 15 minutes when the return plenum temperatures have stabilized, using the thermocouples already in place, measure and record the return (evaporator entering) air dry-bulb temperature ($T_{return, db}$) and the return (evaporator entering) air wet-bulb temperature ($T_{return, wb}$).

Step 11. Using the dry-bulb thermocouple already in place, measure and record the supply (evaporator leaving) air dry-bulb temperature ($T_{supply, db}$).

Step 12. Using the refrigerant gauge already attached, measure and record the evaporator saturation temperature ($T_{evaporator, sat}$) from the low side gauge.

Step 13. Using the dry-bulb thermocouple already in place, measure and record the suction line temperature ($T_{suction, db}$).

Step 14. Using the dry-bulb thermocouple already in place, measure and record the condenser (entering) air dry-bulb temperature ($T_{condenser, db}$).

The above measurements shall be used to adjust refrigerant charge and airflow as described in following sections.

2.5 Refrigerant Charge Calculations

The Superheat Charging Method is used only for non-TXV systems equipped with fixed metering devices. These include capillary tubes and piston-type metering devices. The following steps describe the calculations to determine if the system meets the required refrigerant charge using the measurements described in section 2.4. If a system fails, then remedial actions must be taken. If the refrigerant charge is changed and the airflow has been previously tested and shown to pass, then the airflow shall be re-tested. Be sure to complete Steps 1 and 2 of Section 2.4 before re-testing the airflow. Both the airflow and charge must be re-tested until they both sequentially pass.

Step 1. Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature.

Actual Superheat = $T_{suction,\ db} - T_{evaporator,\ sat}$.

Step 2. Determine the Target Superheat using Table K-1 using the return air wet-bulb temperature ($T_{return,\ wb}$) and condenser air dry-bulb temperature ($T_{condenser,\ db}$).

Step 3. If a dash mark is read from Table K-1, the target superheat is less than 5°F, then the system **does not pass** the required refrigerant charge criteria, usually because outdoor conditions are too hot and dry. One of the following adjustments is needed until a target superheat value can be obtained from Table K-1 by either 1) turning on the space heating system and/or opening the windows to warm up indoor temperature; or 2) retest at another time when conditions are different. After adjustments, repeat the measurement procedure as often as necessary to establish the target superheat. Allow system to stabilize for 15 minutes before completing the measurement procedure again.

Step 4. Calculate the difference between actual superheat and target superheat (Actual Superheat - Target Superheat)

Step 5. If the difference is between minus 5 and plus 5°F, then the system **passes** the required refrigerant charge criteria.

Step 6. If the difference is greater than plus 5°F, then the system **does not pass** the required refrigerant charge criteria and the installer shall add refrigerant. After the refrigerant has been added, turn the system on and allow it to stabilize for 15 minutes before completing the measurement procedure again. Adjust refrigerant charge and repeat the measurement procedure as many times as necessary to pass the test.

Step 7. If the difference is between –5 and -100°F, then the system **does not pass** the required refrigerant charge criteria, the installer shall remove refrigerant. After the refrigerant has been removed, turn the system on and allow it to stabilize for 15 minutes before completing the measurement procedure again. Adjust refrigerant charge and repeat the measurement as many times as necessary to pass the test.

Table K-1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser,db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return,wb}$)																										
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
55	8.8	10.1	11.5	12.8	14.2	15.6	17.1	18.5	20.0	21.5	23.1	24.6	26.2	27.8	29.4	31.0	32.4	33.8	35.1	36.4	37.7	39.0	40.2	41.5	42.7	43.9	45.0
56	8.6	9.9	11.2	12.6	14.0	15.4	16.8	18.2	19.7	21.2	22.7	24.2	25.7	27.3	28.9	30.5	31.8	33.2	34.6	35.9	37.2	38.5	39.7	41.0	42.2	43.4	44.6
57	8.3	9.6	11.0	12.3	13.7	15.1	16.5	17.9	19.4	20.8	22.3	23.8	25.3	26.8	28.3	29.9	31.3	32.6	34.0	35.3	36.7	38.0	39.2	40.5	41.7	43.0	44.2
58	7.9	9.3	10.6	12.0	13.4	14.8	16.2	17.6	19.0	20.4	21.9	23.3	24.8	26.3	27.8	29.3	30.7	32.1	33.5	34.8	36.1	37.5	38.7	40.0	41.3	42.5	43.7
59	7.5	8.9	10.2	11.6	13.0	14.4	15.8	17.2	18.6	20.0	21.4	22.9	24.3	25.7	27.2	28.7	30.1	31.5	32.9	34.3	35.6	36.9	38.3	39.5	40.8	42.1	43.3
60	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4	23.8	25.2	26.6	28.1	29.6	31.0	32.4	33.7	35.1	36.4	37.8	39.1	40.4	41.6	42.9
61	6.5	7.9	9.3	10.7	12.1	13.5	14.9	16.3	17.7	19.1	20.5	21.9	23.3	24.7	26.1	27.5	29.0	30.4	31.8	33.2	34.6	35.9	37.3	38.6	39.9	41.2	42.4
62	6.0	7.4	8.8	10.2	11.7	13.1	14.5	15.9	17.3	18.7	20.1	21.4	22.8	24.2	25.5	27.0	28.4	29.9	31.3	32.7	34.1	35.4	36.8	38.1	39.4	40.7	42.0
63	5.3	6.8	8.3	9.7	11.1	12.6	14.0	15.4	16.8	18.2	19.6	20.9	22.3	23.6	25.0	26.4	27.8	29.3	30.7	32.2	33.6	34.9	36.3	37.7	39.0	40.3	41.6
64	-	6.1	7.6	9.1	10.6	12.0	13.5	14.9	16.3	17.7	19.0	20.4	21.7	23.1	24.4	25.8	27.3	28.7	30.2	31.6	33.0	34.4	35.8	37.2	38.5	39.9	41.2
65	-	5.4	7.0	8.5	10.0	11.5	12.9	14.3	15.8	17.1	18.5	19.9	21.2	22.5	23.8	25.2	26.7	28.2	29.7	31.1	32.5	33.9	35.3	36.7	38.1	39.4	40.8
66	-		6.3	7.8	9.3	10.8	12.3	13.8	15.2	16.6	18.0	19.3	20.7	22.0	23.2	24.6	26.1	27.6	29.1	30.6	32.0	33.4	34.9	36.3	37.6	39.0	40.4
67	-	-	5.5	7.1	8.7	10.2	11.7	13.2	14.6	16.0	17.4	18.8	20.1	21.4	22.7	24.1	25.6	27.1	28.6	30.1	31.5	33.0	34.4	35.8	37.2	38.6	39.9
68	-	-	-	6.3	8.0	9.5	11.1	12.6	14.0	15.5	16.8	18.2	19.5	20.8	22.1	23.5	25.0	26.5	28.0	29.5	31.0	32.5	33.9	35.3	36.8	38.1	39.5
69	-	-	-	5.5	7.2	8.8	10.4	11.9	13.4	14.8	16.3	17.6	19.0	20.3	21.5	22.9	24.4	26.0	27.5	29.0	30.5	32.0	33.4	34.9	36.3	37.7	39.1
70	-	-	-	-	6.4	8.1	9.7	11.2	12.7	14.2	15.7	17.0	18.4	19.7	20.9	22.3	23.9	25.4	27.0	28.5	30.0	31.5	33.0	34.4	35.9	37.3	38.7
71	-	-	-	-	5.6	7.3	8.9	10.5	12.1	13.6	15.0	16.4	17.8	19.1	20.3	21.7	23.3	24.9	26.4	28.0	29.5	31.0	32.5	34.0	35.4	36.9	38.3
72	-	-	-	-	-	6.4	8.1	9.8	11.4	12.9	14.4	15.8	17.2	18.5	19.7	21.2	22.8	24.3	25.9	27.4	29.0	30.5	32.0	33.5	35.0	36.5	37.9
73	-	-	-	-	-	5.6	7.3	9.0	10.7	12.2	13.7	15.2	16.6	17.9	19.2	20.6	22.2	23.8	25.4	26.9	28.5	30.0	31.5	33.1	34.6	36.0	37.5
74	-	-	-	-	-	-	6.5	8.2	9.9	11.5	13.1	14.5	15.9	17.3	18.6	20.0	21.6	23.2	24.8	26.4	28.0	29.5	31.1	32.6	34.1	35.6	37.1
75	-	-	-	-	-	-	5.6	7.4	9.2	10.8	12.4	13.9	15.3	16.7	18.0	19.4	21.1	22.7	24.3	25.9	27.5	29.1	30.6	32.2	33.7	35.2	36.7
76	-	-	-	-	-	-	-	6.6	8.4	10.1	11.7	13.2	14.7	16.1	17.4	18.9	20.5	22.1	23.8	25.4	27.0	28.6	30.1	31.7	33.3	34.8	36.3
77	-	-	-	-	-	-	-	5.7	7.5	9.3	11.0	12.5	14.0	15.4	16.8	18.3	20.0	21.6	23.2	24.9	26.5	28.1	29.7	31.3	32.8	34.4	36.0
78	-	-	-	-	-	-	-	-	6.7	8.5	10.2	11.8	13.4	14.8	16.2	17.7	19.4	21.1	22.7	24.4	26.0	27.6	29.2	30.8	32.4	34.0	35.6
79	-	-	-	-	-	-	-	-	5.9	7.7	9.5	11.1	12.7	14.2	15.6	17.1	18.8	20.5	22.2	23.8	25.5	27.1	28.8	30.4	32.0	33.6	35.2
80	-	-	-	-	-	-	-	-	-	6.9	8.7	10.4	12.0	13.5	15.0	16.6	18.3	20.0	21.7	23.3	25.0	26.7	28.3	29.9	31.6	33.2	34.8
81	-	-	-	-	-	-	-	-	-	6.0	7.9	9.7	11.3	12.9	14.3	16.0	17.7	19.4	21.1	22.8	24.5	26.2	27.9	29.5	31.2	32.8	34.4
82	-	-	-	-	-	-	-	-	-	5.2	7.1	8.9	10.6	12.2	13.7	15.4	17.2	18.9	20.6	22.3	24.0	25.7	27.4	29.1	30.7	32.4	34.0
83	-	-	-	-	-	-	-	-	-	-	6.3	8.2	9.9	11.6	13.1	14.9	16.6	18.4	20.1	21.8	23.5	25.2	26.9	28.6	30.3	32.0	33.7
84	-	-	-	-	-	-	-	-	-	-	5.5	7.4	9.2	10.9	12.5	14.3	16.1	17.8	19.6	21.3	23.0	24.8	26.5	28.2	29.9	31.6	33.3
85	-	-	-	-	-	-	-	-	-	-	-	6.6	8.5	10.3	11.9	13.7	15.5	17.3	19.0	20.8	22.6	24.3	26.0	27.8	29.5	31.2	32.9
86	-	-	-	-	-	-	-	-	-	-	-	5.8	7.8	9.6	11.3	13.2	15.0	16.7	18.5	20.3	22.1	23.8	25.6	27.3	29.1	30.8	32.6
87	-	-	-	-	-	-	-	-	-	-	-	5.0	7.0	8.9	10.6	12.6	14.4	16.2	18.0	19.8	21.6	23.4	25.1	26.9	28.7	30.4	32.2
88	-	-	-	-	-	-	-	-	-	-	-	-	6.3	8.2	10.0	12.0	13.9	15.7	17.5	19.3	21.1	22.9	24.7	26.5	28.3	30.1	31.8
89	-	-	-	-	-	-	-	-	-	-	-	-	5.5	7.5	9.4	11.5	13.3	15.1	17.0	18.8	20.6	22.4	24.3	26.1	27.9	29.7	31.5
90	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.8	14.6	16.5	18.3	20.1	22.0	23.8	25.6	27.5	29.3	31.1

Table K-1: Target Superheat (Suction Line Temperature - Evaporator Saturation Temperature) (continued)

Condenser Air Dry-Bulb Temperature (°F) ($T_{condenser,db}$)	Return Air Wet-Bulb Temperature (°F) ($T_{return,wb}$)																										
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
91	-	-	-	-	-	-	-	-	-	-	-	-	-	6.1	8.1	10.3	12.2	14.1	15.9	17.8	19.7	21.5	23.4	25.2	27.1	28.9	30.8
92	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	7.5	9.8	11.7	13.5	15.4	17.3	19.2	21.1	22.9	24.8	26.7	28.5	30.4
93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	9.2	11.1	13.0	14.9	16.8	18.7	20.6	22.5	24.4	26.3	28.2	30.1
94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.7	10.6	12.5	14.4	16.3	18.2	20.2	22.1	24.0	25.9	27.8	29.7
95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.6	8.1	10.0	12.0	13.9	15.8	17.8	19.7	21.6	23.6	25.5	27.4	29.4
96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.5	9.5	11.4	13.4	15.3	17.3	19.2	21.2	23.2	25.1	27.1	29.0
97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	8.9	10.9	12.9	14.9	16.8	18.8	20.8	22.7	24.7	26.7	28.7
98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	8.4	10.4	12.4	14.4	16.4	18.3	20.3	22.3	24.3	26.3	28.3
99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.8	7.9	9.9	11.9	13.9	15.9	17.9	19.9	21.9	24.0	26.0	28.0
100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.3	7.3	9.3	11.4	13.4	15.4	17.5	19.5	21.5	23.6	25.6	27.7
101	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8	8.8	10.9	12.9	15.0	17.0	19.1	21.1	23.2	25.3	27.3
102	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.3	10.4	12.4	14.5	16.6	18.6	20.7	22.8	24.9	27.0
103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	7.8	9.9	11.9	14.0	16.1	18.2	20.3	22.4	24.5	26.7
104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	7.2	9.3	11.5	13.6	15.7	17.8	19.9	22.1	24.2	26.3
105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7	8.8	11.0	13.1	15.2	17.4	19.5	21.7	23.8	26.0
106	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.3	10.5	12.6	14.8	17.0	19.1	21.3	23.5	25.7
107	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.7	7.9	10.0	12.2	14.4	16.6	18.7	21.0	23.2	25.4
108	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	7.4	9.5	11.7	13.9	16.1	18.4	20.6	22.8	25.1
109	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.9	9.1	11.3	13.5	15.7	18.0	20.2	22.5	24.7
110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.4	8.6	10.8	13.1	15.3	17.6	19.9	22.1	24.4
111	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.9	8.1	10.4	12.6	14.9	17.2	19.5	21.8	24.1
112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4	7.6	9.9	12.2	14.5	16.8	19.1	21.5	23.8
113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.2	9.5	11.8	14.1	16.4	18.8	21.1	23.5
114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.7	9.0	11.4	13.7	16.1	18.4	20.8	23.2
115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	8.6	10.9	13.3	15.7	18.1	20.5	22.9

2.6 Adequate Airflow Calculations

The temperature split method is designed to provide an efficient check to see if airflow is above the required minimum. The following steps describe the calculations using the measurement procedure described in section 2.4. If a system fails, then remedial actions must be taken. If the airflow is changed and the refrigerant charge has previously been tested and shown to pass, then the refrigerant charge shall be re-tested. Be sure to complete Steps 1 and 2 of Section 2.4 before re-testing the refrigerant charge. Both the airflow and charge must be re-tested until they both sequentially pass.

Step 1. Calculate the Actual Temperature Split as the return air dry-bulb temperature minus the supply air dry-bulb temperature. Actual Temperature Split = $T_{return, db} - T_{supply, db}$

Step 2. Determine the Target Temperature Split from Table K-2 using the return air wet-bulb temperature ($T_{return, wb}$) and return air dry-bulb temperature ($T_{return, db}$).

Step 3. If a dash mark is read from Table K-2, then there probably was an error in the measurements because the conditions in this part of the table would be extremely unusual. If this happens, re-measure the temperatures. If re-measurement results in a dash mark, complete one of the alternate airflow measurements in Section 3.4 below.

Step 4. Calculate the difference between target and actual temperature split (Actual Temperature Split-Target Temperature Split). If the difference is within plus 3°F and minus 3°F, then the system **passes** the adequate airflow criteria.

Step 5. If the difference is greater than plus 3°F, then the system **does not pass** the adequate airflow criteria and the airflow shall be increased by the installer. Increasing airflow can be accomplished by eliminating restrictions in the duct system, increasing blower speed, cleaning filters, or opening registers. After corrective measures are taken, repeat measurement procedure as often as necessary to establish adequate airflow range. Allow system to stabilize for 15 minutes before repeating measurement procedure.

Step 6. If the difference is between minus 3°F and minus 100°F, then the measurement procedure shall be repeated making sure that temperatures are measured at the center of the airflow.

Step 7. If the re-measured difference is between plus 3°F and minus 3°F the system **passes** the adequate airflow criteria. If the re-measured difference is between minus 3°F and minus 100°F, the system passes, but it is likely that the capacity is low on this system (it is possible, but unlikely, that airflow is higher than average).

Table K-2: Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

Return Air Dry–Bulb (°F) ($T_{return, db}$)	Return Air Wet-Bulb (°F) ($T_{return, wb}$)																										
	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
70	20.9	20.7	20.6	20.4	20.1	19.9	19.5	19.1	18.7	18.2	17.7	17.2	16.5	15.9	15.2	14.4	13.7	12.8	11.9	11.0	10.0	9.0	7.9	6.8	5.7	4.5	3.2
71	21.4	21.3	21.1	20.9	20.7	20.4	20.1	19.7	19.3	18.8	18.3	17.7	17.1	16.4	15.7	15.0	14.2	13.4	12.5	11.5	10.6	9.5	8.5	7.4	6.2	5.0	3.8
72	21.9	21.8	21.7	21.5	21.2	20.9	20.6	20.2	19.8	19.3	18.8	18.2	17.6	17.0	16.3	15.5	14.7	13.9	13.0	12.1	11.1	10.1	9.0	7.9	6.8	5.6	4.3
73	22.5	22.4	22.2	22.0	21.8	21.5	21.2	20.8	20.3	19.9	19.4	18.8	18.2	17.5	16.8	16.1	15.3	14.4	13.6	12.6	11.7	10.6	9.6	8.5	7.3	6.1	4.8
74	23.0	22.9	22.8	22.6	22.3	22.0	21.7	21.3	20.9	20.4	19.9	19.3	18.7	18.1	17.4	16.6	15.8	15.0	14.1	13.2	12.2	11.2	10.1	9.0	7.8	6.6	5.4
75	23.6	23.5	23.3	23.1	22.9	22.6	22.2	21.9	21.4	21.0	20.4	19.9	19.3	18.6	17.9	17.2	16.4	15.5	14.7	13.7	12.7	11.7	10.7	9.5	8.4	7.2	5.9
76	24.1	24.0	23.9	23.7	23.4	23.1	22.8	22.4	22.0	21.5	21.0	20.4	19.8	19.2	18.5	17.7	16.9	16.1	15.2	14.3	13.3	12.3	11.2	10.1	8.9	7.7	6.5
77	-	24.6	24.4	24.2	24.0	23.7	23.3	22.9	22.5	22.0	21.5	21.0	20.4	19.7	19.0	18.3	17.5	16.6	15.7	14.8	13.8	12.8	11.7	10.6	9.5	8.3	7.0
78	-	-	-	24.7	24.5	24.2	23.9	23.5	23.1	22.6	22.1	21.5	20.9	20.2	19.5	18.8	18.0	17.2	16.3	15.4	14.4	13.4	12.3	11.2	10.0	8.8	7.6
79	-	-	-	-	-	24.8	24.4	24.0	23.6	23.1	22.6	22.1	21.4	20.8	20.1	19.3	18.5	17.7	16.8	15.9	14.9	13.9	12.8	11.7	10.6	9.4	8.1
80	-	-	-	-	-	-	25.0	24.6	24.2	23.7	23.2	22.6	22.0	21.3	20.6	19.9	19.1	18.3	17.4	16.4	15.5	14.4	13.4	12.3	11.1	9.9	8.7
81	-	-	-	-	-	-	-	25.1	24.7	24.2	23.7	23.1	22.5	21.9	21.2	20.4	19.6	18.8	17.9	17.0	16.0	15.0	13.9	12.8	11.7	10.4	9.2
82	-	-	-	-	-	-	-	-	25.2	24.8	24.2	23.7	23.1	22.4	21.7	21.0	20.2	19.3	18.5	17.5	16.6	15.5	14.5	13.4	12.2	11.0	9.7
83	-	-	-	-	-	-	-	-	-	25.3	24.8	24.2	23.6	23.0	22.3	21.5	20.7	19.9	19.0	18.1	17.1	16.1	15.0	13.9	12.7	11.5	10.3
84	-	-	-	-	-	-	-	-	-	25.9	25.3	24.8	24.2	23.5	22.8	22.1	21.3	20.4	19.5	18.6	17.6	16.6	15.6	14.4	13.3	12.1	10.8

3. Alternate Charge and Airflow Measurement Procedure

This section specifies the Alternate charge and airflow measurement procedure. Under this procedure, the required refrigerant charge is calculated using the *Weigh-In Charging Method* and adequate airflow across the evaporator coil is calculated using the *Measured Airflow Method*.

HVAC installers who must complete system installation verification when the outdoor temperature is below 55°F shall use this Alternate procedure in conjunction with installing and charging the system in accordance with the manufacturer's specifications. HERS Raters shall not use this procedure to verify compliance.

Split system air conditioners come from the factory already charged with the standard charge indicated on the name plate. The manufacturer supplies the charge proper for the application based on their standard liquid line length. It is the responsibility of the HVAC installer to ensure that the charge is correct for each air conditioner and to adjust the charge based on liquid line length different from the manufacturer's standard.

3.1 Minimum Qualifications for this Procedure

HVAC installation technicians need to be qualified to perform the following:

- Transfer and recovery of refrigerant (including a valid Environmental Protection Agency (EPA) certification for transition and recovery of refrigerant).
- Accurately weigh the amount of refrigerant added or removed using an electronic scale.
- Calculate the refrigerant charge adjustment needed to compensate for non-standard lineset lengths/diameters based on the actual lineset length/diameter and the manufacturer's specifications for adjusting refrigerant charge for non-standard lineset lengths/diameters.

3.2 Instrumentation Specifications

Instrumentation for the procedures described in this section shall conform to the following specifications.

3.2.1 Digital Charging Scale

The digital scale used to weigh in refrigerant must have a range of .5 oz to at least 1200 oz (75 lb.). The scale's accuracy must be ± 0.25 oz.

3.3 Weigh-In Method

The following procedure shall be used by the HVAC installer to charge the system with the correct refrigerant charge.

Step 1. Obtain manufacturer's standard liquid line length and charge adjustment for alternate liquid line lengths.

Step 2. Measure and record the actual liquid line length (L_{actual}).

Step 3. Record the manufacturer's standard liquid line length ($L_{standard}$).

Step 4. Calculate the difference between actual and standard liquid line lengths ($L_{actual} - L_{standard}$).

Step 5. Record the manufacturer's adjustment for liquid line length difference per foot (A_{length}).

Step 6. Calculate the amount of refrigerant to add or remove and document the calculations on the CF-6R.

Step 7. Weigh in or remove the correct amount of refrigerant

3.4 Airflow Measurement

The airflow across the indoor evaporator coil shall be measured using one of the 2 methods described Appendix F - Standard Procedure for Determining the Seasonal Energy Efficiencies of Residential Air Distribution Systems:

Section 4.3.7.2.1 Diagnostic Fan Flow Using Flow Hood

Section 4.3.7.2.2 Diagnostic Fan Flow Using Plenum Pressure Matching

3.5 Adequate Airflow Calculation

The measured airflow method is used to provide a check to see if airflow is above the required minimum of 385 CFM per nominal ton of capacity (assumes coil is dry). The following steps describe the calculations using the measurement procedure described in Section 3.4. If a system fails, then remedial actions must be taken. The airflow must be re-tested until it passes.

Step 1. Record the measured airflow ($F_{measured}$) obtained from the measurement procedures described in Section 3.4.

Step 2. Obtain and record the rated cooling capacity ($C_{cooling}$) in Btu.

Step 3. Calculate the required airflow as the product of the rated cooling capacity in Btu times 0.032.

Step 4. Compare the airflow measured according to section 3.4 with the required airflow.

Step 5. If the measured airflow is greater than the required airflow, then the system **passes** the adequate airflow criteria.

Step 6. If the measured airflow is less than the required airflow, the system does not pass the adequate airflow criteria and the airflow shall be increased by the installer. Increasing airflow can be accomplished by eliminating restrictions in the duct system, increasing blower speed, cleaning filters, or opening registers. After corrective measures are taken, repeat measurement procedure.