DEVELOPMENT OF A REVISED *COOLING AND HEATING LOAD CALCULATION MANUAL*

J.D. Spitler, Ph.D., P.E.

F.C. McQuiston, Ph.D., P.E.
Member ASHRAE

K.L. Lindsey

ABSTRACT

This paper describes the new ASHRAE Cooling and Heating Load Calculation Manual, *developed as part of ASHRAE RP-626, with emphasis placed on new techniques and data. Much of the new material in the manual is based on recent ASHRAE research, such as RP-472. A comprehensive review of the literature was made to ensure that all data in the manual were the latest available.*

Three load calculation methods are covered by the new manual: the transfer function method (TFM), the cooling load temperature difference/solar cooling load/cooling load factor (CLTD/SCL/CLF) method, and the total equivalent temperature difference/time averaging (TETD/TA) method. The CLTD/SCL/CLF method is a revised version of the CLTD/CLF method. These revisions are described in a companion paper.

A significant new feature of the manual is the inclusion of electronic tables on diskette for both the TFM and the CLTD/SCL/CLF methods. In addition, the manual has been reorganized for easier use.

INTRODUCTION

Cooling and heating load estimates are the basis for designing the environmental control system for a building. Therefore, it is essential that a reasonably accurate prediction of the peak load and the time it occurs be obtained for each room and zone and for the building. The basic methodology for computing loads is the transfer function method (TFM) described in the *1989 ASHRAE Handbook —Fundamentals (ASHRAE 1989).* Alternative procedures, such as the cooling load temperature difference/cooling load factor (CLTD/CLF) method and the total equivalent temperature difference/time averaging (TETD/TA) method, are simplified approaches intended for hand calculation.

The TETD/TA method had its beginning in the 1960s and was initially a hand calculation procedure with two steps required to obtain a cooling load. First, the heat gains were computed using the TETD for walls and roofs. Second, an averaging technique was employed to transform heat gain into cooling load. As a manual procedure, this was quite tedious and, as a result, the second step was often not done. The result was an inaccurate and usually very conservative load estimate. As the digital computer came into popular use, the TETD/TA method became more computer-oriented, with all the tedious work automated. However, this change left a very large group without a convenient manual procedure.

To fill this need, ASHRAE Research Project 138 (Rudoy and Duran 1975) was initiated and subsequently the GRP-158 *Cooling and Heating Load Calculation Manual* (ASHRAE 1979) was published. The methodology in GRP-158 is known as the CLTD/CLF procedure. Briefly, the method predicts cooling loads in a convenient one-step process that does not require many assumptions on the part of the user and is easy to understand. All three of the procedures presented above are described in the *1989 ASHRAE Handbook—Fundamentals* with some discussion of advantages and disadvantages.

ASHRAE Research Project 359, completed in 1984 (Sowell and Chiles 1985), revealed some limitations of the applicability of the CLTD/CLF factors given in GRP-158. The research revealed that factors not taken into account in the original work could significantly affect the results.

ASHRAE Research Project 472, completed in 1988 (Sowell 1988; Harris and McQuiston 1988), resulted in new categorization schemes for walls, roofs, and zones, as well as normalized conduction transfer function (CTF) coefficients and weighting factors that corresponded to the categorization schemes. The data base of weighting factors developed was much too large to be used in printed form. However, the widespread availability of personal computers allows the possibility of distributing the data on diskette.

The results of ASHRAE Research Projects 359 and 472 represented the possibility of substantial improvement in load calculation techniques and data compared to those contained in GRP-158. Other research that impacted load calculation techniques or data had also been published since the development of GRP-158—particularly in the areas of

Jeffrey D. Spitler is an assistant professor, **Faye C. McQuiston** is a professor emeritus, and **Kirk L. Lindsey** is a graduate student in the School of Mechanical and Aerospace Engineering at Oklahoma State University, Stillwater.

solar radiation, appliance heat gains, and material properties. Furthermore, access of engineers to personal computers had drastically improved since 1979, which made possible the use of more sophisticated load calculation techniques.

The above factors taken together suggested the need for a new load calculation manual. ASHRAE Research Project 626 focused on three areas: revision of the load calculation manual, revision of the CLTD/CLF method, and development of software that could access the data developed by RP-472. This paper describes the new load calculation manual (McQuiston and Spitler 1992). A companion paper (Spitler et al. 1993) describes the revision of the CLTD/CLF method. A third paper describes the software developed to access the RP-472 data (Falconer et al. 1993).

DESCRIPTION OF THE MANUAL

The manual contains ten chapters, five appendices, and computer software. Table 1 summarizes the content of each chapter and appendix. The software portion of the manual includes three interactive programs: TFMTAB, CLTDTAB, and SHADE. TFMTAB provides access to the data base so that users can determine conductive transfer function coefficients based on wall or roof parameters and weighting factors based on room parameters. CLTDTAB generates custom CLTD, SCL, and CLF tables. SHADE generates custom shadow tables. Also available are C and FORTRAN source codes for the data base access subroutines.

This paper describes the individual chapters in the manual, with the exception of the chapter on the CLTD/SCL/CLF method. The CLTD/SCL/CLF method is described in a companion paper (Spitler et al. 1993). The emphasis here is on material that was not previously included in GRP-158 or *Fundamentals*.

TABLE 1
Contents of Cooling and Heating Load Calculation Manual

Chapter	Topic
1	Introduction
2	The Transfer Function Method
3	Weather and Design Conditions
4	Heat Transmission Coefficients and Property Data
5	Internal Heat Gain
6	Infiltration
7	Heating Load
8	CLTD/SCL/CLF Method
9	The TETD/TA Method
10	Air Systems, Loads, IAQ and Psychrometrics
Appendix	**Topic**
A	The Transfer Function Method
B	Heat Transmission Factors
C	The CLTD/SCL/CLF Method
D	Psychrometric Processes - Basic Principles
E	Software Installation and Use

The Transfer Function Method (Chapter 2 and Appendix A)

Although the transfer function method described by chapter 2 of the manual is essentially the same as described previously in the *1989 ASHRAE Handbook—Fundamentals* (ASHRAE 1989), the data used by the method and the techniques used to access the data have been substantially revised. In fact, much of the impetus for a new load calculation manual came from improved data and techniques developed as part of RP-472. The data and techniques relate to conductive transfer function (CTF) coefficients and room weighting factors (WF), sometimes called room transfer function (RTF) coefficients.

CTF Coefficients Prior to the publication of the 1989 *Fundamentals*, CTF coefficients were tabulated for a number of typical constructions. If the engineer using the transfer function method needed CTF coefficients for a construction not listed in the tables, a similar construction was chosen or a computer program referenced by the handbook was used. However, there were no guidelines for choosing a similar construction.

As part of ASHRAE RP-472, Harris and McQuiston (1988) developed a new set of typical walls and roofs with

TABLE 2
Wall R-Value Range Definitions

R-value Range (R)	R-values ($hr\text{-}ft^2\text{-}F/Btu$)
1	0.00 - 2.00
2	2.00 - 2.50
3	2.50 - 3.00
4	3.00 - 3.50
5	3.50 - 4.00
6	4.00 - 4.75
7	4.75 - 5.50
8	5.50 - 6.50
9	6.50 - 7.75
10	7.75 - 9.00
11	9.00 - 10.75
12	10.75 - 12.75
13	12.75 - 15.00
14	15.00 - 17.50
15	17.50 - 20.00
16	20.00 - 23.00
17	23.00 - 27.00

TABLE 3
Principal Wall Materials

Material Number	Layer Code	Description
1	A1, A3, A6, or E1	1 in.Stucco, Steel Siding, Finish, Or Gypsum
2	A2 or A7	4 in. Face Brick
3	B7	1 in. Wood
4	B10	2 in. Wood
5	B9	4 in. Wood
6	C1	4 in. Clay Tile
7	C2	4 in. LW Concrete Block
8	C3	4 in. HW Concrete Block
9	C4	4 in. Common Brick
10	C5	4 in. HW Conc
11	C6	8 in. Clay Tile
12	C7	8 in. LW Concrete Block
13	C8	8 in. HW Concrete Block
14	C9	8 in. Common Brick
15	C10	8 in. HW Concrete
16	C11	12 in. HW Concrete
17	C12	2 in. HW Concrete
18	C13	6 in. HW Concrete
19	C14	4 in. LW Concrete
20	C15	6 in. LW Concrete
21	C16	8 in. LW Concrete
22	C17	8 in. LW Concrete Block (Filled)
23	C18	8 in. HW Concrete Block (Filled)
24	C19	12 in. LW Concrete Block (Filled)
25	C20	12 in. HW Concrete Block (Filled)

TABLE 4
Wall Mass Location Parameter

Mass Location Parameter	Mass Location
1	Mass In
2	Mass Integral
3	Mass Out

TABLE 5
Secondary Wall Materials

Number	Symbol	Description
1	A1	1 in. stucco
1	E1	3/4 in. plaster or gypsum
2	A3	steel siding
2	A6	finish
3	A2	4 in. face brick
3	A7	4 in. face brick

corresponding CTF coefficients and a methodology to categorize any arbitrary wall such that its response could be accurately represented by unnormalized CTF coefficients from one of the typical walls or roofs. The categorization procedure for walls is based on four parameters: primary wall material, secondary wall material, R-value, and mass location. Possible levels of each parameter are given in Tables 2 through 5.

The categorization procedure for roofs is also based on four parameters: principal roof material, R-value range, mass location, and the presence of a suspended ceiling. Possible levels of the first three parameters are given in Tables 6 through 8.

TABLE 6
Roof R-Value Range Definitions

R-value Range (R)	R-values (hr-ft^2-F/Btu)
1	0.00 - 5.00
2	5.00 - 10.00
3	10.00 - 15.00
4	15.00 - 20.00
5	20.00 - 25.00
6	25.00 - 30.00

Harris and McQuiston used a heuristic technique to determine a corresponding wall or roof type for each reasonable permutation of the parameters. The results can be seen in Tables 12, 15, 16, and 17 in chapter 26 of the *1989 Fundamentals*. Based on the four wall or roof parameters, the corresponding typical wall or roof can readily be determined using such tables in printed or electronic form.

Once the corresponding wall or roof type has been determined, its CTF coefficients must be unnormalized by multiplying the *b* and *c* coefficients by the ratio of the U-factor for the actual wall to the U-factor of the typical wall.

The primary improvements in the new load calculation manual are the computer subroutines that implement the categorization scheme developed by Harris and McQuiston (1988). The text of the chapter assumes that the CTF coefficients will be determined using the subroutines. The subroutines are described in Appendix A of the *Cooling and Heating Load Calculation Manual*.

In addition, an interactive program called TFMTAB, capable of determining CTF coefficients based on the four

TABLE 7
Principal Roof Materials

Material Number	Layer Code	Description
1	B7	1 in. Wood
2	B8	2.5 in. Wood
3	B9	4 in. Wood
4	C5	4 in. HW Conc
5	C12	2 in. HW Conc
6	C13	6 in. HW Conc
7	C14	4 in. LW Conc
8	C15	6 in. LW Conc
9	C16	8 in. LW Conc
10	A3	Steel Deck
11	B7 & E4	Attic Ceiling Combination
12	C12 - C12	2 in. HW Conc - 2 in. HW Conc (RTS)
13	C12 - C5	2 in.HW Conc - 4 in.HW Conc (RTS)
14	C12 - C13	2 in. HW Conc - 6 in.HW Conc (RTS)
15	C5 - C12	4 in.HW Conc - 2 in. HW Conc (RTS)
16	C5 - C5	4 in.HW Conc - 4 in.HW Conc (RTS)
17	C5 - C13	4 in.HW Conc - 6 in.HW Conc (RTS)
18	C13 - C12	6 in. HW Conc - 2 in. HW Conc (RTS)
19	C13 - C5	6 in.HW Conc - 4 in.HW Conc (RTS)
20	C13 - C13	6 in. HW Conc - 6 in.HW Conc (RTS)

RTS - Roof Terrace System : First Material is outer Layer, Second Material Is Inner Layer.

TABLE 8
Roof Mass Location Parameter

Mass Location Parameter	Mass Location
1	Mass In
2	Mass Integral
3	Mass Out

parameters, is also included. The TFMTAB program was developed by Sowell and is described in Appendix A of the *Cooling and Heating Load Calculation Manual.*

Weighting Factors Previously, users of the transfer function method relied on a very small set of tables, such as Tables 21 and 22 in chapter 26 of the *1989 Fundamentals*, to determine room weighting factors. The weighting factors in these tables could only reflect a relatively small number of parameters.

As part of RP-472, Sowell (1988a, 1988b, 1988c) developed a large data base of zone weighting factors, as well as a categorization system utilizing 14 parameters. The 14 parameters and their levels are shown in Table 9. The allowable permutations of the 14 parameters resulted in more than 200,000 different zones, each with different weighting factors. To further reduce the size of the data base, Sowell grouped zones with similar responses together. This made the data base of manageable size for a microcomputer.

Chapter 2 of the *Cooling and Heating Load Calculation Manual* emphasizes the meaning of the 14 parameters, and gives guidance for parameter selection. As part of RP-626, software was developed to retrieve weighting factors from the data base. This software is described in Appendix A of the *Cooling and Heating Load Calculation Manual* and in a paper by Falconer et al. (1993).

Solar Heat Gain The coverage of solar heat gain has been modified from previous ASHRAE material in two respects: the coefficients used to determine incident solar radiation and solar heat gain through fenestration.

The *A*, *B*, and *C* coefficients in the ASHRAE solar model have been revised as suggested by Machler and Iqbal (1985). The revised model coefficients reflect the fact that the accepted solar constant has changed from 419.0 Btu/h·ft^2 (1322 W/m^2) to 433.3 Btu/h·ft^2 (1367 W/m^2). The revised coefficients also improve the accuracy of the ASHRAE model, particularly during winter. The new coefficients are given in Table 10.

Previously, solar heat gain factors (SHGF) were used to predict total solar heat gain, including both transmitted and absorbed components. A set of v and w coefficients (weighting factors) was used with the room transfer function equation to convert the solar heat gain to cooling load. These coefficients were selected from a table such as Table 22 in chapter 26 of the *1989 Fundamentals*.

When the new weighting-factor data base was created for ASHRAE RP-472, decisions were made that resulted in treating the transmitted and absorbed components of solar heat gain separately for purposes of conversion to cooling load. This is described by Sowell (1988a). Therefore, one necessary revision to the existing TFM method has been to split the transmitted and absorbed components that went into the SHGF. The separate components are named transmitted solar heat gain factor (TSHGF) and absorbed solar heat gain factor (ASHGF). They are defined as follows:

$$\text{TSHGF} = I_D \sum_{j=0}^{5} t_j [\cos\theta]^j + I_d \, 2\sum_{j=0}^{5} t_j/(j+2), \quad (1)$$

$$\text{ASHGF} = I_D \sum_{j=0}^{5} a_j [\cos\theta]^j + I_d \cdot 2\sum_{j=0}^{5} a_j/(j+2), \quad (2)$$

TABLE 9
Zone Parametric Level Definitions

No.	Parameter	Meaning	Levels (given in normal order)
1	ZG	Zone Geometry	100 ft. x 20 ft., 15 ft x 15 ft. 100 ft x 100 ft.
2	ZH	Zone Height	8 ft, 10 ft. 20 ft
3	NW	Num. Ext. Walls	1, 2, 3, 4, 0
4	IS	Interior Shade	100, 50, 0 percent
5	FN	Furniture	With, Without
6	EC	Ext. Wall Cons.	1, 2, 3, 4
7	PT	Partition Type	5/8 in. Gyp-Air-5/8 in. Gyp, 8 in. Conc. Blk.
8	ZL	Zone Location	Single-story, Top flr, Bot. flr, Mid flr.
9	MF	Mid Flr Type	8 in. Conc., 2.5 in. Conc., 1 in. Wood
10	ST	Slab Type	Mid flr Type, 4 in slab on 12 in soil
11	CT	Ceiling Type	3/4 in Acoustic tile & Air space, w/o ceiling
12	RT	Roof Type	1,2,3,4
13	FC	Floor Covering	Carpet with rubber pad, vinyl tile
14	GL	Glass Percent	10, 50, 90

Note: Parameter 10, slab type is redundant because it's value is controlled by parameters 8 and Therefore, there are effectively only 13 parameters.

TABLE 10
Solar Data for the 21st Day of Each Month

	Equation of Time, min.	Declination, degrees	A Btu/hr-ft²	B (Dimensionless Ratios)	C
Jan	-11.2	-20.0	381.2	0.141	0.103
Feb	-13.9	-10.8	376.4	0.142	0.104
Mar	-7.5	0.0	369.1	0.149	0.109
Apr	1.1	11.6	358.3	0.164	0.120
May	3.3	20.0	350.7	0.177	0.130
June	-1.4	23.45	346.3	0.185	0.137
July	-6.2	20.6	346.6	0.186	0.138
Aug	-2.4	12.3	351.0	0.182	0.134
Sep	7.5	0.0	360.2	0.165	0.121
Oct	15.4	-10.5	369.7	0.152	0.111
Nov	13.8	-19.8	377.3	0.142	0.106
Dec	1.6	-23.45	381.8	0.141	0.103

*A, B, C coefficients are based on research by Machler and Iqbal (1985)

TABLE 11
Coefficients for DSA Glass for Calculation of Transmittance and Absorptance

i	a_j	t_j
0	0.01154	-0.00885
1	0.77674	2.71235
2	-3.94657	-0.62062
3	8.57881	-7.07329
4	-8.38135	9.75995
5	3.01188	-3.89922

where

I_D = direct (beam) radiation (Btu/h·ft²),
I_d = diffuse radiation (Btu/h·ft²),
θ = incidence angle,
t_j, a_j = coefficients from Table 11.

The transmitted solar heat gain (TSHG) is given by

$$\text{TSHG} = \text{TSHGF} \times SC \times A \tag{3}$$

where

SC = shading coefficient,
A = area.

Absorbed solar heat gain is given by

$$\text{ASHG} = \text{ASHGF} \times \text{SC} \times N_i \times A \tag{4}$$

where

N_i = inward flowing fraction of absorbed solar heat gain.

The separate application of the shading coefficient to both transmitted solar heat gain and absorbed solar heat gain is an approximation. Shading coefficients are determined experimentally as the ratio between total (transmitted and absorbed) solar heat gain from a specific fenestration type to total solar heat gain from double-strength sheet glass (DSA). Separate shading coefficients are not available.

Correction of Weighting Factors for Nonstandard Radiant/Convective Splits The weighting factors used for people and equipment are based on the heat gain being 70% radiative and 30% convective. The weighting factors for lighting are based on the heat gain being 59% radiative and 41% convective. Should the actual split be significantly different, it may be worthwhile for the user to correct the weighting factors. A procedure for modifying the weighting factors, developed by Sowell (1991), is given in Appendix A of the load calculation manual.

The procedure is based on the Z-transfer function:

$$5K(z) = \frac{v_o + v_1 z^{-1} + v_2 z^{-2}}{1 + w_1 z^{-1} + w_2 z^{-2}} . \tag{5}$$

The Z-transfer function can be modified to account for a different radiant convective split:

$$K'(z) = \left[\frac{r}{r_1}\right] K(z) + \left[1 - \frac{r}{r_1}\right] \tag{6}$$

where

$K'(z)$ = modified Z-transfer function,
r = actual radiative fraction,
r_1 = radiative fraction used to develop the weighting factors.

The fraction, r/r_1, represents the reduced (or increased) contribution of radiative heat gain to the cooling load. The quantity $(1 - r/r_1)$ represents the increased (or reduced) contribution of convective heat gain to the cooling load.

Combining Equations 5 and 6, a set of modified weighting factors can be developed as follows:

$$v_0' = \left[\frac{r}{r_1}\right] v_0 + \left[1 - \frac{r}{r_1}\right] , \tag{7}$$

$$v_1' = \left[\frac{r}{r_1}\right] v_1 + \left[1 - \frac{r}{r_1}\right] w_1 , \tag{8}$$

$$v_2' = \left[\frac{r}{r_1}\right] v_2 + \left[1 - \frac{r}{r_1}\right] w_2 , \tag{9}$$

where v'_0, v'_1, and v'_2 represent the modified weighting factors. The values for w_1 and w_2 remain the same.

Weather and Design Conditions (Chapter 3)

Revisions to this chapter were directed toward updating the design temperature tables to the latest available data from the current *Fundamentals* (1989) and addition of design temperature data required for underground walls and floors.

Design temperatures for use in computing cooling loads for the months of October through May are occasionally of interest. The data in the GRP-158 manual were from an unknown source. Therefore, new data were derived from Weather Year for Energy Calculations (WYEC) bin data (Degelman 1984) for 51 cities. Using the bin data, approximate 2.5% design temperatures were determined for each city for the months of October through May.

More emphasis was placed on explanation of the basis for the given design temperatures, and the designer is repeatedly warned to treat the design temperatures as guidelines and to seek information on local conditions, particularly where severe weather conditions may be encountered.

Heat Transmission Coefficients and Property Data (Chapter 4 and Appendix B)

This chapter and Appendix D are complementary. Appendix D discusses the various modes of heat transfer and the combination of all by using the concept of thermal resistance. The use of the overall heat transfer coefficient, U, and its relation to thermal resistance is discussed. Applications in summer and winter and to above-grade and below-grade walls are described.

The data in chapter 4 are largely unchanged but were all checked against the current *Handbook* for timeliness. The basic tables of thermal properties were updated to the current version. The tables of thermal resistance for surfaces and air spaces were unchanged. However, more emphasis was placed on the fact that convection and radiation are combined in these data. Current data for attics and ceiling spaces replace out-of-date data. Thermal resistance and U-factors for doors and fenestration were updated from new data in the 1989 *Handbook* and transmission data for underground floors and walls and slabs on grade were updated.

Internal Heat Gain (Chapter 5)

Discussion of the various aspects of the three general sources of internal heat gain was expanded beyond that given in the old calculation manual with emphasis on the split between radiative and convective heat transfer. Some modest revisions to the table of heat gain from occupants were made based on the current *Handbook*. An effort was made to explain how to handle lights and the various ways they may be installed and ventilated. Further discussion of this problem is given in chapter 8. A concerted effort was made to explain the estimation of heat gain from motors and equipment depending on how they are connected and located with respect to the conditioned space. All the old tables related to appliances were replaced and new data for office and hospital equipment were added. The new and revised data were the result of ASHRAE Research Project 391 by Alereza and Breen (1984). ASHRAE RP-391 involved an extensive survey of appliance and equipment manufacturers to determine representative internal heat gains.

Infiltration (Chapter 6)

The literature search did not reveal any significant information that could be used to refine the existing material given in the old manual except some new data for wind pressure coefficients found in the 1989 *Fundamentals*. Therefore, the material given in the old manual was reorganized in an effort to make it more understandable and useful with the new wind pressure coefficient data added. Alternative approaches are discussed for both high-rise and low-rise structures.

Heating Load (Chapter 7)

This chapter has no new material, but all procedures related to heating load have been drawn together in one chapter. A new calculation sheet was developed for manual load calculation. The problem of estimating the temperature in an adjacent unheated space is also discussed.

The TETD/TA Method (Chapter 9)

The total equivalent temperature difference/time averaging method (TETD/TA) was introduced in the 1967 *Fundamentals*. This chapter of the manual contains essentially the same method previously described. However, there is a new set of decrement factor and time lag data. Decrement factor and time lag were determined for each of the representative walls and roofs developed as part of RP-472. Therefore, a user of the TETD/TA method determines the appropriate wall or roof type in the same manner as a user of the TFM or CLTD/SCL/CLF method. Once the wall or roof type has been determined, the time lag and decrement factor can be determined from Tables 9.2 and 9.3 of the manual. Other than these improved data, the method remains unchanged.

Air Systems, Loads, IAQ, and Psychrometrics (Chapter 10 and Appendix D)

Chapter 10 and Appendix D are closely related. The chapter contains the information needed by a designer on a daily basis, while the appendix gives in-depth coverage of the thermodynamic principles involved. All the basic processes are covered with examples. The effect of variable atmospheric pressure (or elevation) is emphasized. Processes involving work and lost pressure are clearly discussed, and the relation between lost pressure and temperature rise due to a fan is developed. A complete discussion of the problem of heat transfer to or from the air distribution system is presented.

The material in chapter 10 is classical in nature, generally using relations based on sea level conditions. However, Appendix D is referenced regularly when allowances for nonstandard conditions may be in order. A brief discussion of indoor air quality is included because of the relation to ventilation and outdoor air. ASHRAE Standard 62 is referenced. A discussion of the behavior of cooling/heating coils is included to aid the designer in the psychrometric analysis. Special situations are discussed, such as hot and dry climates where evaporative cooling may be used to advantage. Off-design conditions are discussed, and examples of all the common systems are included. The psychrometric chart is used extensively, and many figures are provided to enhance understanding.

CONCLUSIONS

A new heating and cooling load calculation manual has been developed, which incorporates the results of a great deal of research. The important features include:

1. A complete new set of electronically accessible weighting factor and conductive transfer function coefficients for use with the transfer function method. The accuracy of the TFM has been greatly improved by a vast increase in the number of zone types for which weighting factors are available, as well as a new method and new data for determining wall and roof CTF coefficients.
2. A substantial revision of the CLTD/CLF method called the CLTD/SCL/CLF method. The method can be used with printed tables included in the manual or custom computer-generated tables produced with the software

included with the manual.

3. A description of the TETD/TA method with improved data for calculating the TETDs.
4. Revised and updated data for solar radiation; weather; material properties; heat transmission for underground walls, floors, and slabs; and appliance heat gain.

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