

Type 19 Component Configuration

PREP Manual

Note: This is a supplement to the TRNSYS manuals. It describes the component configuration for Type 19 and a manual for PREP, the utility program used to calculate transfer functions used in Type 19.

Note that all the features in Type 19 are available in Type 56, which is easier to use thanks to its visual interface TRNBuild. Type 56 is the recommended model for most cases (except for very simple building loads modeled with Type 12 or Type 88).

Type 19 Component configuration

In order to describe a zone, it is necessary to specify characteristics of the internal space, external weather conditions, walls, windows, and doors. To facilitate this description, the parameters and inputs for this component are organized in separate lists according to type. In terms of the component description, the parameters and inputs may appear as single lists following single parameter and input cards or may be presented as separate lists, each with an individual parameter and input cards. The general form of the parameter and input cards is described in Volume 07, TRNEdit manual.

The first lists of parameters and inputs for the TYPE 19 pertain to the internal space and external conditions. These lists must appear first in the component description. For each surface in the zone, another set of parameters and inputs is necessary. There are five possibilities for surface types. They include transfer function representations for exterior walls, interior partitions, and walls separating zones at different temperatures. Coefficients for the standard walls, partitions, ceilings, or floors taken from the ASHRAE Handbook of Fundamentals (1) are in the file ASHRAE.COF and listed at the end of the component description. The user may choose from these lists or may provide the coefficients generated by the stand-alone program PREP for other constructions. A wall may also be modeled using a separate TRNSYS component with conduction through this wall provided as an input to the zone. The fifth type of surface available is a window. The user must specify the properties of the window, along with specifics concerning the illumination of the interior surfaces due to beam radiation passing through the window. A door or any other wall that has negligible thermal capacitance can be considered by specifying a transfer function wall

with one b and c coefficient and no d coefficients. In this case, both b_o and c_o should be set equal to the U value of the door or wall.

The last parameters that must be supplied define the geometry of the zone for radiation exchange calculations. There are three principal geometry modes. In the first mode, the program calculates view factors for a parallelepiped (box) geometry. There is a set of parameters that describe the size of the room and relative locations of wall surfaces. For each window or door, an additional set of parameters is necessary to describe its location on a wall. In the second geometry mode, the user specifies the number of entries required. A third geometry mode is 0. In this case, the program uses area ratios to determine view factors. Although this is not a correct procedure, it may be adequate when the inside surfaces are close in temperature and infrared energy exchange is not significant. When the geometry mode is specified as 0, no additional geometry parameters are required.

There are 10 standard outputs of the TYPE 19. Up to 10 additional surface dependent quantities may be specified as outputs using optional parameters that follow the geometry description. The first parameter specifies the number of additional outputs that are desired. For each output, two parameters are then required. The first one specifies the type of output desired as chosen (by number) from Table 3. The second parameter in this group of two is the surface number for which this quantity is desired. The additional outputs begin at the eleventh output and may range to the twentieth.

Table 3
Additional Output Options for Surface i

<u>Number</u>	<u>Output Description</u>
1	$T_{s,i}$ - temperature at inside surface ($^{\circ}$ C)
2	$T_{eq,i}$ - equivalent inside room temperature for surface i ($^{\circ}$ C)
3	S_i - absorbed radiative gains from solar, lights, and people for surface i ($\text{kJ/m}^2\text{-hr}$)
4	$\dot{Q}_{c,i}$ - energy convected to room from surface i (kJ/hr)
5	$\dot{Q}_{r,i}$ - radiative gains to surface i due to infrared exchange

ZONE PARAMETERS AND INPUTS

<u>PARAMETER NO.</u>	<u>DESCRIPTION</u>
1	Mode: 1 - energy rate control 2- temperature level control
2	V_a - zone volume of air (m^3)
3	K_1 - constant air change per hour
4	K_2 - proportionality constant for air change due to indoor - outdoor temperature difference ($(^\circ C)^{-1}$)
5	K_3 - proportionality constant for air change due to wind
6	Cap - capacitance of room air and furnishings
7	N - number of total surfaces comprising room description ($1 \leq N \leq 15$)
8	T_o - initial room temperature; also used for calculation of
9	ω_o - initial room humidity ratio (kg water/kg dry air)
<i>Mode 1 only:</i>	
10	T_{min} - set point temperature for heating ($^\circ C$)
11	T_{max} - set point temperature for cooling ($^\circ C$)
12	ω_{min} - set point humidity ratio for humidification (kg water/kg dry air)
13	ω_{max} - set point humidity ratio for dehumidification (kg water/kg dry air)

<u>INPUT NUMBER</u>	<u>DESCRIPTION</u>
1	T_a - ambient temperature ($^\circ C$)
2	ω_a - ambient humidity ratio (kg water/kg dry air)
3	T_v - temperature of ventilation flow stream ($^\circ C$)
4	$\dot{m}_v$ - mass flowrate of ventilation flow stream (kg/hr)
5	ω_v - humidity ratio of ventilation flow stream (kg water/kg dry air)
6	$\dot{\omega}_I$ - rate of moisture gain (other than people) (kg/hr)
7	N_{pepl} - number of people in zone
8	I_{act} - activity level of people (see Table 2)
9	$\dot{Q}_{IR}$ - radiative energy input due to lights, equipment, etc.
10	$\dot{Q}_{int}$ - sum of all other instantaneous heat gain to space
11	W - windspeed (m/s)

ASHRAE WALL PARAMETERS AND INPUTS

<u>PARAMETER NO.</u>	<u>DESCRIPTION</u>
1	Surface number: 1 to 15
2	Surface Type*: 1- Exterior wall 2- Interior partition 3- Wall separating zones
3	A - area (m ²)
4	ρ - reflectance of inner surface to solar
5	α - absorptance of exterior surface to solar radiation
6	I_{coef} - table number 1- standard ASHRAE roofs: Tables 6 and 7 2- standard ASHRAE exterior walls: Tables 8 and 9 3- standard ASHRAE partitions, floors, and ceilings: Tables 10 and 11 4- b, c, d coefficients entered using parameters following:
<i>for $I_{coef} < 4$:</i>	
7	N_{Table} - number of wall, roof, etc. from Table specified by I_{coef} †
<i>For $I_{coef} = 4$:</i>	
7	h_c - inside convection coefficient (kJ/hr-m ² -° C)
8	N_b - number of b coefficients
9	N_c - number of c coefficients
10	N_d - number of d coefficients
11	b_o - coefficient of current sol-air temperature (kJ/hr-m ² -° C)
.	.
.	.
.	.
$10 + N_b$	b_{N_b-1} - coefficient of the (N_b-1) th previous hours' sol-air temperature (kJ/hr-m ² -° C)
$11 + N_b$	C_o - coefficient of current equivalent zone air temperature (kJ/hr-m ² -° C)
.	.

* If $Par\ 2 < 0$, then parameters 4 through the last parameter are used from surface number $|Par\ 2|$. In this case, only parameters 1-3 should be specified.

† Tables can be found at the end of TYPE 19.

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.	.	
$10 + N_b + N_c$	C_{N_c-1}	- coefficient of the $(N_c - 1)^{th}$ previous hours' equivalent zone air temperature (kJ/hr-m ² -° C)
$11 + N_b + N_c$	d_1	- coefficient of previous hours' heat flux
.	.	
.	.	
.	.	
$10 + N_b + N_c + N_d$	d_{N_d}	- coefficient of the N_d^{th} previous hours' heat flux

INPUT NUMBERDESCRIPTION*Exterior wall:*

1	I_T	- incident radiation on exterior surface (kJ/m ² -hr)
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Wall separating zones:

1	T'_∞	- equivalent room temperature associated with adjacent zone (° C)
2	T'_z	- room temperature of adjacent zone (° C)
3	$(UA)_c$	- additional conductance for heat transfer between zones (kJ/hr-° C)

NON-ASHRAE WALL (CONDUCTION INPUT) PARAMETERS AND INPUTS

<u>PARAMETER NO.</u>	<u>DESCRIPTION</u>
1	Surface number - 1 to 15
2	Surface Type - Specify 4
3	A - area (m ²)
4	ρ - reflectance of inner surface for solar
5	$h_{c,i}$ - inside convection coefficient (kJ/hr-m ² -° C)
<u>INPUT NUMBER</u>	<u>DESCRIPTION</u>
1	$\dot{Q}$ - energy transfer into the zone at the inside surface of the wall (kJ/hr)

WINDOW

<u>PARAMETER NO.</u>		<u>DESCRIPTION</u>
1	Surface number	- 1 to 15
2	Surface Type	- Specify 5
3	A	- area (m^2)
4	WMODE	- Window Mode: 1 - transmitted solar and thermal energy calculated internally 2 - transmitted solar and thermal energy transfer provided as inputs
5	τ_d	- transmittance for diffuse solar radiation
6	$h_{c,i}$	- inside convection coefficient ($kJ/hr\cdot m^2\cdot ^\circ C$)
7	N_I	- number of surfaces on which transmitted beam radiation strikes
8	k	- first surface number of which beam of radiation strikes
.	.	
.	.	
.	.	
$7 + N_I$	n	- last surface number on which beam of radiation strikes

<u>INPUT NUMBER</u>	<u>DESCRIPTION</u>
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Window Mode 1:

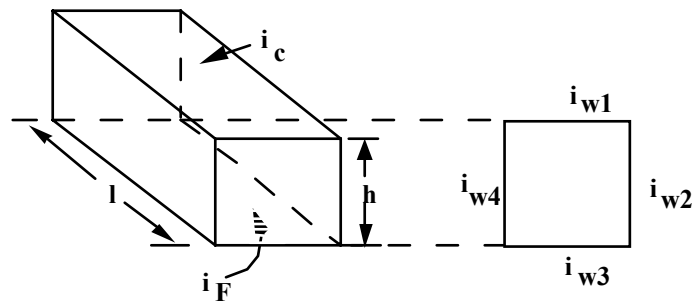
1	I_T	- total incident radiation ($kJ/m^2\cdot hr$)
2	I_{bT}	- incident beam radiation ($kJ/m^2\cdot hr$)
3	τ	- overall transmittance for solar radiation
4	U_g	- loss coefficient of window (+ night insulation) not including convection at the inside or outside surface ($kJ/hr\cdot m^2\cdot ^\circ C$)
5	f_k	- fraction of incoming beam radiation that strikes surface k
.	.	
.	.	
$4 + N_I$	f_n	- fraction of incoming beam radiation that strikes surface n

Window Mode 2:

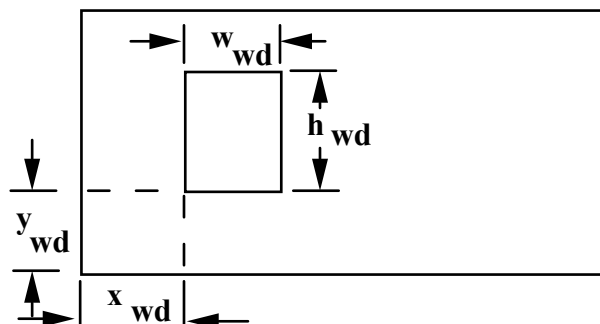
1	$\dot{Q}_s$	- total solar radiation passing through window (kJ/hr)
2	$\dot{Q}_{bs}$	- beam radiation passing through window (kJ/hr)
3	$\dot{Q}_{WT}$	- thermal energy gain through window (kJ/hr)
4	f_k	- fraction of incoming beam radiation that strikes surface k
.	.	
$3 + N_I$	f_n	- fraction of incoming beam radiation that strikes surface n

AREA RATIOS PARAMETERS

<u>PARAMETER NO.</u>	<u>DESCRIPTION</u>
1	Geometry mode: Specify 0

VIEW FACTORS PARAMETERS**Geometry Mode 1: Rectangular Parallelepiped**

<u>PARAMETER NO.</u>	<u>DESCRIPTION</u>
1	Geometry mode: Specify 1
2	h - height of walls (m)
3	w - width of enclosure (m)
4	l - length of enclosure (m)
5	i_{w1} - number of wall surface indicated in figure above
6	i_{w2} - number of wall surface indicated in figure above
7	i_{w3} - number of wall surface indicated in figure above
8	i_{w4} - number of wall surface indicated in figure above
9	i_f - surface number associated with floor
10	i_c - surface number associated with ceiling
11	N_{WD} - number of windows or doors on wall surfaces

Window or Door geometry (repeat as necessary)

<u>PARAMETER NO.</u>		<u>DESCRIPTION</u>
1	i_{wd} -	surface number associated with window or door
2	L_{wd} -	wall surface on which surface i_{wd} is located
3	x_{wd} -	horizontal distance from left edge of wall to left edge of surface i_{wd} as viewed from inside the enclosure (m)
4	y_{wd} -	vertical distance from bottom edge of wall to bottom edge of surface i_{wd} (m)
5	h_{wd} -	height of surface i_{wd} (m)
6	W_{wd} -	width of surface i_{wd} (m)

Geometry Mode 2: Enter View Factors

<u>PARAMETER NO.</u>		<u>DESCRIPTION</u>
1	Geometry Mode:	Specify 2
2	F_{12} -	view factor from surface 1 to surface 2
.	.	
.	.	
.	.	
N	F_{1N} -	view factor from surface 1 to surface N
N+1	F_{23} -	view factor from surface 2 to surface 3
.	.	
.	.	
.	.	
2N-2	F_{2N} -	view factor from surface 2 to surface N
.	.	
.	.	
.	.	
$N\frac{(N-1)}{2} + 1$	$F_{(N-1)N}$ -	view factor from surface N-1 to surface N_s

OPTIONAL OUTPUT PARAMETERS

<u>PARAMETER NO.</u>		<u>DESCRIPTION</u>
1	N_{out} -	number of additional outputs desired (between 1 and 10)
2	O_1 -	number from Table 3 corresponding to the type of quantity to be set as output 11.
3	I_1 -	surface number to which previous parameter refers
.	.	
.	.	
.	.	
$2*N_{out}$	$O_{N_{out}}$ -	number from Table 3 corresponding to the type of quantity to be set as output ($10 + N_{out}$)
$2*N_{out}+1$	$I_{N_{out}}$ -	surface to which previous parameter refers

OUTPUTS

<u>OUTPUT NUMBER</u>		<u>DESCRIPTION</u>
1	T_z -	zone temperature ($^{\circ}$ C)
2	ω_z -	zone humidity ratio (kg water/kg dry air)
3	$\dot{Q}_c$ -	room gains due to convection from all surfaces (kJ/hr)
4	$\dot{Q}_{spepl}$ -	sensible energy gains due to convection from people (kJ/hr)
5	$\dot{Q}_{infl}$ -	sensible infiltration gains (kJ/hr)
6	$\dot{Q}_v$ -	sensible gains due to ventilation flow stream (kJ/hr)
<i>Mode 1 only:</i>		
7	$\dot{Q}_{sens}$ -	sensible load (kJ/hr)
8	$\dot{Q}_{lat}$ -	latent load (kJ/hr)
9	$\dot{Q}_{c,max}$ -	maximum cooling load (kJ/hr)
10	$\dot{Q}_{H,max}$ -	maximum heating load (kJ/hr)
<i>Optional Outputs:</i>		
11		first optional output
.	.	
.	.	
.	.	
last		last optional output

Table 4
Thermal Properties and Code Numbers of Layers Used in Wall and Roof Descriptions
(English Units)

CODE	DESCRIPTION	L	k	ρ	Cp	R	Mass
A0	Outside Surface Resistance	0.0	0.0	0.0	0.0	0.33	0.0
A1	1 in. Stucco	0.0833	0.4	116.0	0.2	0.21	9.7
A2	4 in. Face Brick	0.333	0.77	125.0	0.22	0.43	41.7
A3	Steel Siding	0.005	26.0	480.0	0.1	0.00	2.4
A4	1/2 in. Slag	0.0417	0.11	70.0	0.4	0.38	2.2
A5	Outside Surface Resistance	0.0	0.0	0.0	0.0	0.33	0.0
A6	Finish	0.0417	0.24	78.0	0.26	0.17	3.3
A7	4 in. Face Brick	0.333	0.77	125.0	0.22	0.43	41.7
B1	Air Space Resistance	0.0	0.0	0.0	0.0	0.91	0.0
B2	1 in. Insulation	0.083	0.025	2.0	0.2	3.33	0.2
B3	2 in. Insulation	0.167	0.025	2.0	0.2	6.67	0.3
B4	3 in. Insulation	0.25	0.025	2.0	0.2	10.00	0.5
B5	1 in. Insulation	0.0833	0.025	5.7	0.2	3.33	0.5
B6	2 in. Insulation	0.167	0.025	5.7	0.2	6.67	1.0
B7	1 in. Wood	0.0833	0.07	37.0	0.6	10.0	3.1
B8	2.5 in. Wood	0.2083	0.07	37.0	0.6	2.98	7.7
B9	4 in. Wood	0.333	0.07	37.0	0.6	4.76	12.3
B10	2 in. Wood	0.167	0.07	37.0	0.6	2.39	6.2
B11	3 in. Wood	0.25	0.07	37.0	0.6	3.57	9.3
B12	3 in. Insulation	0.25	0.025	5.7	0.2	10.0	1.4
B13	4 in. Insulation	0.333	0.025	5.7	0.2	13.33	1.9
B14	5 in. Insulation	0.417	0.025	5.7	0.2	16.67	2.4
B15	6 in. Insulation	0.500	0.025	5.7	0.2	20.0	2.9
B16	0.15 in. Insulation	0.0126	0.025	5.7	0.2	0.50	0.1
B17	0.3 in. Insulation	0.0252	0.025	5.7	0.2	1.00	0.1
B18	0.45 in. Insulation	0.0379	0.025	5.7	0.2	1.50	0.2
B19	0.61 in. Insulation	0.0505	0.025	5.7	0.2	2.00	0.3
B20	0.76 in. Insulation	0.0631	0.025	5.7	0.2	2.50	0.4
B21	1.36 in. Insulation	0.1136	0.025	5.7	0.2	4.50	0.6
B22	1.67 in. Insulation	0.1388	0.025	5.7	0.2	5.50	0.8
B23	2.42 in. Insulation	0.2019	0.025	5.7	0.2	8.00	1.2
B24	2.73 in. Insulation	0.2272	0.025	5.7	0.2	9.00	1.3
B25	3.33 in. Insulation	0.2777	0.025	5.7	0.2	11.00	1.6
B26	3.64 in. Insulation	0.3029	0.025	5.7	0.2	12.00	1.7
B27	4.54 in. Insulation	0.3786	0.025	5.7	0.2	15.00	2.2
C1	4 in. Clay Tile	0.333	0.33	70.0	0.2	1.01	23.3
C2	4 in. Lightweight Concrete Block	0.333	0.22	38.0	0.2	1.51	12.7
C3	4 in. Heavyweight Concrete Block	0.333	0.47	61.0	0.2	0.71	20.3
C4	4 in. Common Brick	0.333	0.42	120.0	0.2	0.79	40.0
C5	4 in. Heavyweight Concrete	0.333	1.0	140.0	0.2	0.33	46.7
C6	8 in. Clay Tile	0.667	0.33	70.0	0.2	2.00	46.7
C7	8 in. Lightweight Concrete Block	0.667	0.33	38.0	0.2	2.00	25.3
C8	8 in. Heavyweight Concrete Block	0.667	0.6	61.0	0.2	1.11	40.7
C9	8 in. Common Brick	0.667	0.42	120.0	0.2	1.59	80.0
C10	8 in. Heavyweight Concrete	0.667	1.0	140.0	0.2	0.67	93.4

C11	12 in. Heavyweight Concrete	1.0		1.0	140.0	0.2	1.00140.0
C12	2 in. Heavyweight Concrete	0.167	1.0	140.0	0.2	0.17	23.3
C13	6 in. Heavyweight Concrete	0.5	1.0	140.0	0.2	0.5	70.0
C14	4 in. Lightweight Concrete	0.333	0.1	40.0	0.2	3.33	13.3
C15	6 in. Lightweight Concrete	0.5	0.1	40.0	0.2	5.00	20.0
C16	8 in. Lightweight Concrete	0.667	0.1	40.0	0.2	6.67	26.7
C17	8 in. Ltweight Conc. Blk (filled)	0.667	0.08	18.0	0.2	8.34	12.0
C18	8 in. Hvyweight Conc. Blk (filled)	0.667	0.34	53.0	0.2	1.96	35.4
C19	12 in. Ltweight Conc. Blk (filled)	1.000	0.08	19.0	0.2	12.50	19.0
C20	12 in. Hvyweight Conc. Blk (filled)	1.000	0.39	56.0	0.2	2.56	56.0
E0	Inside Surface Resistance	0.0	0.0	0.0	0.0	0.69	0.0
E1	3/4 in. Plaster or Gypsum	0.0625	0.42	100.0	0.2	0.15	6.3
E2	1/2 in. Slag or Stone	0.417	0.83	55.0	0.4	0.05	2.3
E3	3/8 in. Felt and Membrane	0.0313	0.11	70.0	0.4	00.29	2.2
E4	Ceiling Air Space	0.0	0.0	0.0	0.0	1.0	0.0
E5	Acoustic Tile	0.0625	0.035	30.0	0.2	1.79	1.9

L = thickness (ft)

 ρ = density (lb/ft³)R = thermal resistance (F-ft²-hr/BTU)

k = thermal conductivity (BTU/hr-ft-F)

Cp = specific heat (BTU/lbm-F)

Mass = unit mass (lb/ft²)

Table 5
Thermal Properties and Code Numbers of Layers Used in Wall and Roof Descriptions
(SI Units)

CODE	DESCRIPTION	L	k	ρ	Cp	R	Mass
A0	Outside Surface Resistance	0	0.000	0	0.00	0.059	0.00
A1	25 mm Stucco	25	0.692	1858	0.84	0.037	47.34
A2	100 mm Face Brick	100	1.333	2002	0.92	0.076	
	203.50						
A3	Steel Siding	2	44.998	76890.42	0.0	11.71	
A4	12 mm Slag	13	0.190	1121	1.67	0.067	10.74
A5	Outside Surface Resistance	0	0.000	0	0.00	0.059	0.00
A6	Finish	13	0.415	1249	1.09	0.031	16.10
A7	100 mm Face Brick	100	1.333	2002	0.92	0.076	
	203.50						
B1	Air Space Resistance	0	0.000	0	0.00	0.160	0.00
B2	25 mm Insulation	25	0.043	32	0.84	0.587	0.98
B3	50 mm Insulation	51	0.043	32	0.84	1.173	1.46
B4	75 mm Insulation	76	0.043	32	0.84	1.760	2.44
B5	25 mm Insulation	25	0.043	91	0.84	0.587	2.44
B6	50 mm Insulation	51	0.043	91	0.84	1.173	4.88
B7	25 mm Wood	25	0.121	593	2.51	1.760	15.13
B8	62 mm Wood	63	0.121	593	2.51	0.524	37.58
B9	100 mm Wood	101	0.121	593	0.51	0.837	60.02
B10	50 mm Wood	51	0.121	593	2.51	0.420	30.26
B11	75 mm Wood	76	0.121	593	2.51	0.628	45.38
B12	75 mm Insulation	76	0.043	91	0.84	1.760	6.83
B13	100 mm Insulation	100	0.043	91	0.84	2.347	9.27
B14	125 mm Insulation	125	0.043	91	0.84	2.933	11.71
B15	150 mm Insulation	150	0.043	91	0.84	3.520	14.15
B16	4 mm Insulation	4	0.043	91	0.84	0.088	0.49
B17	8 mm Insulation	8	0.043	91	0.84	0.176	0.49
B18	12 mm Insulation	12	0.043	91	0.84	0.264	0.98
B19	15 mm Insulation	15	0.043	91	0.84	0.352	1.46
B20	20 mm Insulation	20	0.043	91	0.84	0.440	1.95
B21	35 mm Insulation	35	0.043	91	0.84	0.792	2.93
B22	42 mm Insulation	42	0.043	91	0.84	0.968	3.90
B23	60 mm Insulation	62	0.043	91	0.84	1.408	5.86
B24	70 mm Insulation	70	0.043	91	0.84	1.584	6.34
B25	85 mm Insulation	85	0.043	91	0.84	1.936	7.81
B26	92 mm Insulation	92	0.043	91	0.84	2.112	8.30
B27	115 mm Insulation	115	0.043	91	0.84	2.640	10.74
C1	100 mm Clay Tile	100	0.571	1121	0.84	0.178	113.70
C2	100 mm Lightweight Concrete Block	100	0.381	609	0.84	0.266	61.98
C3	100 mm Heavyweight Concrete Block	100	0.813	977	0.84	0.125	99.06
C4	100 mm Common Brick	100	0.727	1922	0.84	0.140	195.20
C5	100 mm Heavyweight Concrete	100	1.731	2243	0.84	0.059	227.90
C6	200 mm Clay Tile	200	0.571	1121	0.84	0.352	227.90
C7	200 mm Lightweight Concrete Block	200	0.571	609	0.84	0.352	123.46
C8	200 mm Heavyweight Concrete Block	200	1.038	977	0.84	0.196	198.62
C9	200 mm Common Brick	200	0.727	1922	0.84	0.279	390.40
C10	200 mm Heavyweight Concrete	200	1.731	2243	0.84	0.117	455.79

C11	300 mm Heavyweight Concrete	300	1.731	2243	0.84	0.176	683.20
C12	50 mm Heavyweight Concrete	50	1.731	2243	0.84	0.029	113.70
C13	150 mm Heavyweight Concrete	150	1.731	2243	0.84	0.088	341.60
C14	100 mm Lightweight Concrete	100	0.173	641	0.84	0.587	64.90
C15	150 mm Lightweight Concrete	150	0.173	641	0.84	0.880	97.60
C16	200 mm Lightweight Concrete	200	0.173	641	0.84	1.173	130.30
C17	200 mm Ltweight Conc. Blk (filled)	200	0.138	288	0.84	1.467	58.56
C18	200 mm Hvyweight Conc. Blk (filled)	200	0.588	849	0.84	0.345	172.75
C19	300 mm Ltweight Conc. Blk (filled)	300	0.138	304	0.84	2.200	92.72
C20	300 mm Hvyweight Conc. Blk (filled)	300	0.675	897	0.84	0.451	273.28
E0	Inside Surface Resistance	0	0.000	0	0.00	0.121	0.00
E1	20 mm Plaster or Gypsum	20	0.727	1602	0.84	0.026	30.74
E2	12 mm Slag or Stone	12	1.436	881	1.67	0.009	11.22
E3	10 mm Felt and Membrane	10	0.190	1121	1.67	0.050	10.74
E4	Ceiling Air Space	0	0.000	0	0.00	0.176	0.00
E5	Acoustic Tile	19	0.061	481	0.84	0.314	9.27

L = thickness (mm)

ρ = density (kg/m³)

R = thermal resistance (m²-K/W)

k = thermal conductivity (W/m-K)

C_p = specific heat (kJ/kg-K)

Mass = unit mass (kg/m²)

Table 6
Available Roof Descriptions for Type 19 - Single Zone Model (English Units)

No.	DESCRIPTION	Code Numbers of Layers
1	Roof Terrace System A0,C12,B1,B6,E2,E3,C5,E4,E5,E0	
2	4 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B9,E4,E5,E0
3	2.5 in. Wood with 2 in. Insulation A0,E2,E3,B6,B8,E4,E5,E0	
4	1 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B7,E4,E5,E0
5	4 In. Wood with 1 in. Insulation	A0,E2,E3,B5,B9,E4,E5,E0
6	2.5 in. Wood with 1 in. Insulation A0,E2,E3,B5,B8,E4,E5,E0	
7	1 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B7,E4,E5,E0
8	8 in. Lightweight Concrete	A0,E2,E3,C16,E4,E5,E0
9	6 in. Lightweight Concrete	A0,E2,E3,C15,E4,E5,E0
10	4 in. Lightweight Concrete	A0,E2,E3,C14,E4,E5,E0
11	6 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C13,E4,E5,E0
12	4 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C5,E4,E5,E0
13	2 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C12,E4,E5,E0
14	6 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C13,E4,E5,E0
15	4 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C4,E4,E5,E0
16	2 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C12,E4,E5,E0
17	Steel Sheet with 2 in. Insulation	A0,E2,E3,B6,A3,E4,E5,E0
18	Steel Sheet with 1 in. Insulation	A0,E2,E3,B5,A3,E4,E5,E0
19	Roof Terrace System	A0,C12,B1,B6,E2,E3,C5,E0
20	4 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B9,E0
21	2.5 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B8,E0
22	1 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B7,E0
23	4 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B9,E0
24	2.5 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B8,E0
25	1 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B7,E0
26	8 in. Lightweight Concrete	A0,E2,E3,C16,E0
27	6 in. Lightweight Concrete	A0,E2,E3,C15,E0
28	4 in. Lightweight Concrete	A0,E2,E3,C14,E0
29	6 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C13,E0
30	4 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C5,E0
31	2 in. Heavyweight Concrete with 2 in. Insulation	A0,E2,E3,B6,C12,E0
32	6 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C13,E0
33	4 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C5,E0
34	2 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C12,E0
35	Steel Sheet with 2 in. Insulation	A0,E2,E3,B6,A3,E0
36	Steel Sheet with 1 in. Insulation	A0,E2,E3,B5,A3,E0
37	1 in. Wood with 5 in. Insulation	A0,E2,E3,B14,B7,E0
38	2.5 in. Wood with 5 in. Insulation	A0,E2,E3,B14,B8,E0
39	1 in. Wood with 6 in. Insulation	A0,E2,E3,B15,B7,E0
40	2.5 in. Wood with 6 in. Insulation	A0,E2,E3,B15,B8,E0
41	Steel Sheet with 1 in. Insulation	A0,E2,E3,B5,A3,E0
42	1 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B7,E0
43	4 in. Lightweight Concrete	A0,E2,E3,C14,E0
44	2 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C12,E0
45	1 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B7,E0
46	6 in. Lightweight Concrete	A0,E2,E3,C15,E0

47	2.5 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B8,E0
48	8 in. Lightweight Concrete	A0,E2,E3,C16,E0
49	4 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C5,E0
50	2.5 in. Wood with 2 in. Insulation	A0,E2,E3,B6,B8,E0
51	Roof Terrace System	A0,C12,B1,B6,E2,E3,C5,E0
52	6 in. Heavyweight Concrete with 1 in. Insulation	A0,E2,E3,B5,C13,E0
53	4 in. Wood with 1 in. Insulation	A0,E2,E3,B5,B9,E0
54	Steel Deck with 3.33 in. Insulation	A0,E2,E3,B25,A3,E0
55	Steel Deck with 5 in. Insulation	A0,E2,E3,B14,A3,E0
56	2 in. Heavyweight Concrete Deck with Suspending Ceiling	A0,E2,E3,C12,E4,E5,E0
57	Attic Roof with 6 in. Insulation	A0,B7,E4,B15,E1,E0
58	5 in. Insulation with 2 in. Heavyweight Concrete Deck	A0,E2,E3,C12,B14,E0
59	4 in. Heavyweight Concrete Deck with 0.3 in. Insulation	A0,E2,E3,B17,C5,E0
60	1.67 in. Insulation with 2 in. Heavyweight Concrete RTS	A0,C12,E2,E3,C12,B22,E0
61	0.15 in. Insulation with 6 in. Heavyweight Concrete Deck	A0,E2,E3,C13,B16,E0
62	3 in. Insul. with 4 in. L.W. Conc. Deck and Suspending Ceiling	A0,E2,E3,C14,B12,E4,E5,E0
63	6 in. L.W. Conc. Deck with 0.15 in. Insul. and Susp. Ceiling	A0,E2,E3,B16,C15,E4,E5,E0
64	4 in. Heavyweight Concrete Deck with 6 in. Insulation	A0,E2,E3,B15,C5,E0
65	6 in. H.W. Deck with 0.15 in. Insulation and 2 in. H.W. RTS	A0,C12,E2,E3,B16,C13,E0
66	6 in. Heavyweight Concrete Deck with 2 in. Insulation	A0,E2,E3,B6,C13,E0
67	2 in. L.W. Conc. Deck with 4 in. Insul. and Suspending Ceiling	A0,E2,E3,B13,C12,E4,E5,E0
68	1 in. Insul. with 4 in. H.W. Conc. Deck and Suspending Ceiling	A0,E2,E3,B6,C5,E4,E5,E0
69	6 in. H.W. Deck with 0.76 in. Insulation and Suspending Ceiling	A0,E2,E3,B20,C13,E4,E5,E0
70	6 in. Insul. with 4 in. L.W. Conc. Deck and Suspending Ceiling	A0,E2,E3,C14,B15,E4,E5,E0
71	2 in. H.W. Conc. Deck with 6 in. Insul. and 2 in. H.W. RTS	A0,C5,E2,E3,B15,C12,E0
72	4 in. H.W. Deck with 4.54 in. Insulation and 2 in. H.W. RTS	A0,C12,E2,E3,B27,C5,E0
73	1.36 in. Insulation with 8 in. Lightweight Concrete Deck	A0,E2,E3,C16,B21,E0
74	6 in. H.W. Deck with 3 in. Insulation and 2 in. H.W. RTS	A0,C12,E2,E3,B12,C13,E0
75	1.67 in. Insulation with 4 in. H.W. Deck and 6 in. H.W. RTS	A0,C13,E2,E3,C5,B22,E0
76	Susp. Ceiling, 2 in. H.W. Deck, 5 in. Insul., 2 in. H.W. RTS	A0,C12,E2,E3,B14,C12,E4,E5,E0
77	Susp. Ceiling, 4 in. H.W. Deck, 2 in. Insul., 2 in. H.W. RTS	A0,C12,B1,B6,E2,E3,C5,E4,E5,E0
78	6 in. H.W. Conc. Deck with 4 in. Insul. and Suspending Ceiling	A0,E2,E3,B13,C13,E4,E5,E0
79	6 in. Insul. with 6 in. L.W. Conc. Deck and Suspending Ceiling	A0,E2,E3,C15,B15,E4,E5,E0
80	6 in. H.W. Deck with 6 in. Insulation and 2 in. H.W. RTS	A0,C12,E2,E3,B15,C13,E0
81	4 in. Wood Deck with 5 in. Insulation	A0,E2,E3,B14,B9,E0
82	Susp. Ceiling, 2 in. H.W. Deck, 4 in. Insul., 4 in. H.W. RTS	A0,C5,E2,E3,B13,C12,E4,E5,E0
83	4 in. Wood Deck with 2 in. Insulation and Suspending Ceiling	A0,E2,E3,B6,B9,E4,E5,E0
84	4.54 in. Insulation with 6 in. H.W. Deck and 6 in. H.W. RTS	A0,C13,E2,E3,C13,B27,E0
85	Susp. Ceiling, 4 in. H.W. Deck, 0.76 in. Ins., 4 in. H.W. RTS	A0,C13,E2,E3,B20,C5,E4,E5,E0
86	Susp. Ceiling, 4 in. H.W. Deck, 4 in. Insul., 4 in. H.W. RTS	A0,C5,E2,E3,B13,C5,E4,E5,E0
87	Susp. Ceiling, 6 in. H.W. Deck, 2.42 in. Ins., 4 in. H.W. RTS	A0,C5,E2,E3,B23,C13,E4,E5,E0
88	4 in. H.W. Deck with 6 in. Insulation and 6 in. H.W. RTS	A0,C13,E2,E3,B15,C5,E0
89	6 in. H.W. Deck with 4.54 in. Insulation and 6 in. H.W. RTS	A0,C13,E2,E3,B27,C13,E0
90	Susp. Ceiling, 6 in. H.W. Deck, 6 in. Insul., 6 in. H.W. RTS	A0,C13,E2,E3,C13,B15,E4,E5,E0
91	4 in. H.W. Deck with 6 in. Insulation and Suspending Ceiling	A0,E2,E3,B15,B9,E4,E5,E0
92	Susp. Ceiling, 6 in. H.W. Deck, 0.76 in. Ins., 6 in. H.W. RTS	A0,C13,E2,E3,B20,C13,E4,E5,E0
93	Susp. Ceiling, 4 in. H.W. Deck, 3.64 in. Ins., 6 in. H.W. RTS	A0,C13,E2,E3,B26,C5,E4,E5,E0
94	Susp. Ceiling, 6 in. H.W. Deck, 2 in. Insul., 6 in. H.W. RTS	A0,C13,E2,E3,B6,C13,E4,E5,E0
95	Susp. Ceiling, 6 in. H.W. Deck, 5 in. Insul., 6 in. H.W. RTS	A0,C13,E2,E3,B14,C13,E4,E5,E0

Roofs 1 through 36 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 26, Chapter 25.

Roofs 37 through 40 are taken from the 1981 and 1985 ASHRAE Handbook of Fundamentals, Table 28, Ch 26.

Roofs 41 through 53 are taken from the 1989 ASHRAE Handbook of Fundamentals, Table 28, Chapter 26.

Roofs 54 through 95 are taken from the 1989 ASHRAE Handbook of Fundamentals, Table 13, Chapter 26.

Table 7
Available Roof Descriptions for Type 19 - Single Zone Model (SI Units)

No.	DESCRIPTION	Code Numbers of Layers
1	Roof Terrace System A0,C12,B1,B6,E2,E3,C5,E4,E5,E0	
2	100 mm Wood with 50 mm Insulation A0,E2,E3,B6,B9,E4,E5,E0	
3	63 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B8,E4,E5,E0
4	25 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B7,E4,E5,E0
5	100 mm Wood with 25 mm Insulation A0,E2,E3,B5,B9,E4,E5,E0	
6	63 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B8,E4,E5,E0
7	25 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B7,E4,E5,E0
8	200 mm Lightweight Concrete	A0,E2,E3,C16,E4,E5,E0
9	150 mm Lightweight Concrete	A0,E2,E3,C15,E4,E5,E0
10	100 mm Lightweight Concrete	A0,E2,E3,C14,E4,E5,E0
11	150 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C13,E4,E5,E0
12	100 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C5,E4,E5,E0
13	50 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C12,E4,E5,E0
14	150 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C13,E4,E5,E0
15	100 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C4,E4,E5,E0
16	50 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C12,E4,E5,E0
17	Steel Sheet with 50 mm Insulation	A0,E2,E3,B6,A3,E4,E5,E0
18	Steel Sheet with 25 mm Insulation	A0,E2,E3,B5,A3,E4,E5,E0
19	Roof Terrace System	A0,C12,B1,B6,E2,E3,C5,E0
20	100 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B9,E0
21	63 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B8,E0
22	25 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B7,E0
23	100 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B9,E0
24	63 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B8,E0
25	25 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B7,E0
26	200 mm Lightweight Concrete	A0,E2,E3,C16,E0
27	150 mm Lightweight Concrete	A0,E2,E3,C15,E0
28	100 mm Lightweight Concrete	A0,E2,E3,C14,E0
29	150 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C13,E0
30	100 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C5,E0
31	50 mm Heavyweight Concrete with 50 mm Insulation	A0,E2,E3,B6,C12,E0
32	150 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C13,E0
33	100 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C5,E0
34	50 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C12,E0
35	Steel Sheet with 50 mm Insulation	A0,E2,E3,B6,A3,E0
36	Steel Sheet with 25 mm Insulation	A0,E2,E3,B5,A3,E0
37	25 mm Wood with 125 mm Insulation	A0,E2,E3,B14,B7,E0
38	63 mm Wood with 125 mm Insulation	A0,E2,E3,B14,B8,E0
39	25 mm Wood with 150 mm Insulation	A0,E2,E3,B15,B7,E0
40	63 mm Wood with 150 mm Insulation	A0,E2,E3,B15,B8,E0
41	Steel Sheet with 25 mm Insulation	A0,E2,E3,B5,A3,E0
42	25 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B7,E0
43	100 mm Lightweight Concrete	A0,E2,E3,C14,E0
44	50 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C12,E0
45	25 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B7,E0
46	150 mm Lightweight Concrete	A0,E2,E3,C15,E0

47	63 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B8,E0
48	200 mm Lightweight Concrete	A0,E2,E3,C16,E0
49	100 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C5,E0
50	63 mm Wood with 50 mm Insulation	A0,E2,E3,B6,B8,E0
51	Roof Terrace System	A0,C12,B1,B6,E2,E3,C5,E0
52	150 mm Heavyweight Concrete with 25 mm Insulation	A0,E2,E3,B5,C13,E0
53	100 mm Wood with 25 mm Insulation	A0,E2,E3,B5,B9,E0
54	Steel Deck with 85 mm Insulation	A0,E2,E3,B25,A3,E0
55	Steel Deck with 125 mm Insulation	A0,E2,E3,B14,A3,E0
56	50 mm Heavyweight Concrete Deck with Suspending Ceiling	A0,E2,E3,C12,E4,E5,E0
57	Attic Roof with 150 mm Insulation	A0,B7,E4,B15,E1,E0
58	125 mm Insulation with 50 mm Heavyweight Concrete Deck	A0,E2,E3,C12,B14,E0
59	100 mm Heavyweight Concrete Deck with 8 mm Insulation	A0,E2,E3,B17,C5,E0
60	40 mm Insulation with 50 mm Heavyweight Concrete RTS	A0,C12,E2,E3,C12,B22,E0
61	4 mm Insulation with 150 mm Heavyweight Concrete Deck	A0,E2,E3,C13,B16,E0
62	75 mm Insul. with 100 mm L.W. Conc. Deck and Susp. Ceiling	A0,E2,E3,C14,B12,E4,E5,E0
63	150 mm L.W. Conc. Deck with 4 mm Insul. and Susp. Ceiling	A0,E2,E3,B16,C15,E4,E5,E0
64	100 mm Heavyweight Concrete Deck with 150 mm Insulation	A0,E2,E3,B15,C5,E0
65	150 mm H.W. Deck with 4 mm Insul. and 50 mm H.W. RTS	A0,C12,E2,E3,B16,C13,E0
66	150 mm Heavyweight Concrete Deck with 50 mm Insulation	A0,E2,E3,B6,C13,E0
67	50 mm L.W. Conc. Deck with 100 mm Ins. and Susp. Ceiling	A0,E2,E3,B13,C12,E4,E5,E0
68	25 mm Ins. with 100 mm H.W. Conc. Deck and Susp. Ceiling	A0,E2,E3,B6,C5,E4,E5,E0
69	150 mm H.W. Deck with 20 mm Insulation and Susp. Ceiling	A0,E2,E3,B20,C13,E4,E5,E0
70	150 mm Ins. w/ 100 mm L.W. Conc. Deck and Susp. Ceiling	A0,E2,E3,C14,B15,E4,E5,E0
71	50 mm H.W. Con. Dck w/ 150 mm Ins. and 50 mm H.W. RTS	A0,C5,E2,E3,B15,C12,E0
72	100 mm H.W. Deck with 115 mm Ins. and 50 mm H.W. RTS	A0,C12,E2,E3,B27,C5,E0
73	35 mm Insulation with 200 mm L.W. Concrete Deck	A0,E2,E3,C16,B21,E0
74	150 mm H.W. Deck with 75 mm Insul. and 50 mm H.W. RTS	A0,C12,E2,E3,B12,C13,E0
75	40 mm Insul. w/ 100 mm H.W. Deck and 150 mm H.W. RTS	A0,C13,E2,E3,C5,B22,E0
76	Sus. Ceil., 50 mm H.W. Dck, 125 mm Ins., 50 mm H.W. RTS	A0,C12,E2,E3,B14,C12,E4,E5,E0
77	Sus. Ceil., 100 mm H.W. Dck, 50 mm Ins., 50 mm H.W. RTS	A0,C12,B1,B6,E2,E3,C5,E4,E5,E0
78	150 mm H.W. Conc. Deck with 100 mm Ins. and Susp. Ceiling	A0,E2,E3,B13,C13,E4,E5,E0
79	150 mm Ins. w/ 150 mm L.W. Conc. Deck and Susp. Ceiling	A0,E2,E3,C15,B15,E4,E5,E0
80	150 mm H.W. Deck with 150 mm Ins. and 50 mm H.W. RTS	A0,C12,E2,E3,B15,C13,E0
81	100 mm Wood Deck with 125 mm Insulation	A0,E2,E3,B14,B9,E0
82	Sus. Ceil., 50 mm H.W. Dk, 100 mm Ins., 100 mm H.W. RTS	A0,C5,E2,E3,B13,C12,E4,E5,E0
83	100 mm Wood Deck with 50 mm Insulation and Sus. Ceiling	A0,E2,E3,B6,B9,E4,E5,E0
84	115 mm Ins. with 150 mm H.W. Deck and 150 mm H.W. RTS	A0,C13,E2,E3,C13,B27,E0
85	Sus. Ceil., 100 mm H.W. Dk, 20 mm Ins., 100 mm H.W. RTS	A0,C13,E2,E3,B20,C5,E4,E5,E0
86	Sus. Ceil., 100 mm H.W. Dk, 100 mm Ins., 100 mm H.W. RTS	A0,C5,E2,E3,B13,C5,E4,E5,E0
87	Susp. Ceil., 150 mm H.W. Dk, 60 mm Ins., 100 mm H.W. RTS	A0,C5,E2,E3,B23,C13,E4,E5,E0
88	100 mm H.W. Deck with 150 mm Ins. and 150 mm H.W. RTS	A0,C13,E2,E3,B15,C5,E0
89	150 mm H.W. Deck with 115 mm Ins. and 150 mm H.W. RTS	A0,C13,E2,E3,B27,C13,E0
90	Sus. Ceil., 150 mm H.W. Dk, 150 mm Ins., 150 mm H.W. RTS	A0,C13,E2,E3,C13,B15,E4,E5,E0
91	100 mm H.W. Deck with 150 mm Ins. and Suspending Ceiling	A0,E2,E3,B15,B9,E4,E5,E0
92	Sus. Ceil., 150 mm H.W. Dk, 20 mm Ins., 150 mm H.W. RTS	A0,C13,E2,E3,B20,C13,E4,E5,E0
93	Sus. Ceil., 100 mm H.W. Dk, 90 mm Ins., 150 mm H.W. RTS	A0,C13,E2,E3,B26,C5,E4,E5,E0
94	Sus. Ceil., 150 mm H.W. Dk, 50 mm Ins., 150 mm H.W. RTS	A0,C13,E2,E3,B6,C13,E4,E5,E0
95	Sus. Ceil., 150 mm H.W. Dk, 125 mm Ins., 150 mm H.W. RTS	A0,C13,E2,E3,B14,C13,E4,E5,E0

Roofs 1 through 36 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 26, Chapter 25.

Roofs 37 through 40 are taken from the 1981 and 1985 ASHRAE Handbook of Fundamentals, Table 28, Chr 26.

Roofs 41 through 53 are taken from the 1989 ASHRAE Handbook of Fundamentals, Table 28, Chapter 26.

Roofs 54 through 95 are taken from the 1989 ASHRAE Handbook of Fundamentals, Table 13, Chapter 26.

Table 8
Available Wall Descriptions for Type 19 - Single Zone Model
(English Units)

No.	DESCRIPTION	Code Numbers of Layers
1	4 in. Face Brick, 2 in. Insulation, 4 in. L.W. Concrete Block	A0,A2,B3,C2,E1,E0
2	4 in. Lightweight	A0,C14,E1,E0
3	4 in. Face Brick, Air space, 8 in. Common Brick	A0,A2,B1,C9,E1,E0
4	4 in. Face Brick, Air Space, 8 in. Heavyweight Concrete Block	A0,A2,B1,C8,E1,E0
5	4 in. Face Brick, Air Space, 8 in. Lightweight Concrete Block	A0,A2,B1,C7,E1,E0
6	4 in. Face Brick, Air Space, 8 in. Clay Tile	A0,A2,B1,C6,E1,E0
7	4 in. Face Brick, Air Space, 2 in. Heavyweight Concrete	A0,A2,B1,C12,E1,E0
8	4 in. Face Brick, Air Space, 4 in. Common Brick	A0,A2,B1,C4,E1,E0
9	4 in. Face Brick, Air Space, 4 in. Heavyweight Concrete Block	A0,A2,B1,C3,E1,E0
10	4 in. Face Brick, Air Space, 4 in. Lightweight Concrete Block	A0,A2,B1,C2,E1,E0
11	12 in. Heavyweight Concrete	A0,A1,C11,E1,E0
12	8 in. Heavyweight Concrete with 2 in. Insulation	A0,A1,C10,B6,E1,E0
13	8 in. Heavyweight Concrete with 1 in. Insulation	A0,A1,C10,B5,E1,E0
14	8 in. Heavyweight Concrete with Air Space	A0,A1,C10,B1,E1,E0
15	8 in. Heavyweight Concrete	A0,A1,C10,E1,E0
16	4 in. Face Brick, 8 in. Common Brick, 1 in. Insulation	A0,A2,C9,B2,E1,E0
17	4 in. Face Brick, 8 in. Common Brick, Air Space	A0,A2,C9,B1,E1,E0
18	Wall with 4 in. Face Brick, Air Space and 4 in. L.W. Block	A0,A7,B1,C14,E0
19	Wall with Fiberglass Insulation and Stucco Outside Finish	A0,A6,B4,A6,E0,
20	Two-sided Brick Wall	A0,A7,B1,A2,E0
21	Brick Wall, 8 in. Concrete Block and No Air Space	A0,A7,C7,A6,E0
22	Brick Wall with 4 in. Concrete Block	A0,A7,B1,C3,A6,E0
23	Brick Wall with 8 in. Concrete Block	A0,A7,B1,C8,A6,E0
24	Brick Wall with 6 in. Concrete Block	A0,A7,B1,C15,A6,E0
25	Frame Wall with 4 in. Brick Veneer	A0,A7,B6,A6,E0
26	Frame Wall	A0,A6,B6,A6,E0
27	Metal Curtain Wall with 3 in. Insulation	A0,A3,B12,A3,E0
28	Metal Curtain Wall with 2 in. Insulation	A0,A3,B6,A3,E0
29	Metal Curtain Wall with 1 in. Insulation	A0,A3,B5,A3,E0
30	Wall 12 in. Concrete with 2 in. Insulation on the Outside	A0,A3,B6,C11,A6,E0
31	Wall 8 in. Concrete with 2 in. Insulation on the Outside	A0,A3,B6,C10,A6,E0
32	Wall 4 in. Concrete with 2 in. Insulation on the Outside	A0,A3,B6,C5,A6,E0
33	Wall 12 in. Concrete with 2 in. Insulation on the Inside	A0,C11,B6,A6,E0
34	Wall 8 in. Concrete with 2 in. Insulation on the Inside	A0,C10,B6,A6,E0
35	Wall 4 in. Concrete with 2 in. Insulation on the Inside	A0,C5,B6,A6,E0
36	Frame Wall with 3 in. Insulation	A0,A1,B1,B4,E1,E0
37	Frame Wall with 2 in. Insulation	A0,A1,B1,B3,E1,E0
38	Frame Wall with 1 in. Insulation	A0,A1,B1,B2,E1,E0
39	Frame Wall without Insulation	A0,A1,B1,E1,E0
40	2 in. Insulation with 12 in. Heavyweight Concrete	A0,A1,B3,C11,E1,E0
41	2 in. Insulation with 8 in. Heavyweight Concrete	A0,A1,B3,C10,E1,E0
42	2 in. Insulation with 8 in. Common Brick	A0,A1,B3,C9,E1,E0
43	2 in. Insulation with 8 in. Heavyweight Concrete Block	A0,A1,B3,C8,E1,E0
44	2 in. Insulation with 8 in. Lightweight Concrete Block	A0,A1,B3,C7,E1,E0

45	2 in. Insulation with 8 in. Clay Tile	A0,A1,B3,C6,E1,E0
46	2 in. Insulation with 4 in. Heavyweight Concrete	A0,A1,B3,C5,E1,E0
47	2 in. Insulation with 4 in. Common Brick	A0,A1,B3,C4,E1,E0
48	2 in. Insulation with 4 in. Heavyweight Concrete Block	A0,A1,B3,C3,E1,E0
49	2 in. Insulation with 4 in. Lightweight Block	A0,A1,B3,C2,E1,E0
50	2 in. Insulation with 4 in. Clay Tile	A0,A1,B3,C1,E1,E0
51	4 in. Face Brick, 2 in. Insulation, 12 in. Heavyweight Concrete	A0,A2,B3,C11,E1,E0
52	4 in. Face Brick, 2 in. Insulation, 8 in. Heavyweight Concrete	A0,A2,B3,C10,E1,E0
53	4 in. Face Brick, 2 in. Insulation, 12 in. Common Brick	A0,A2,B3,C9,E1,E0
54	4 in. Face Brick, Air Space, 12 in. Heavyweight Concrete	A0,A2,B1,C11,E1,E0
55	4 in. Face Brick, Air Space, 8 in. Heavyweight Concrete	A0,A2,B1,C10,E1,E0
56	4 in. Face Brick, 2 in. Insulation, 8 in. H.W. Concrete Block	A0,A2,B3,C8,E1,E0
57	4 in. Face Brick, 2 in. Insulation, 8 in. L.W. Concrete Block	A0,A2,B3,C7,E1,E0
58	2 in. Face Brick, 2 in. Insulation, 8 in. Clay Tile	A0,A2,B3,C6,E1,E0
59	4 in. Face Brick, 2 in. Insulation, 4 in. Heavyweight Concrete	A0,A2,B3,C5,E1,E0
60	4 in. Face Brick, 2 in. Insulation, 4 in. Common Brick	A0,A2,B3,C4,E1,E0
61	4 in. Face Brick, 2 in. Insulation, 4 in. H.W. Concrete Brick	A0,A2,B3,C3,E1,E0
62	4 in. Face Brick with 8 in. Common Brick	A0,A2,C9,E1,E0
63	8 in. Heavyweight Concrete Block with 1 in. Insulation	A0,A1,C8,B2,E1,E0
64	8 in. Heavyweight Concrete Block	A0,A1,C8,E1,E0
65	8 in. Lightweight Concrete Block with Insulation	A0,A1,C7,B2,E1,E0
66	8 in. Lightweight Concrete Block	A0,A1,C7,E1,E0
67	4 in. Face Brick, 8 in. Clay Tile, 1 in. Insulation	A0,A2,C6,B2,E1,E0
68	4 in. Face Brick, 8 in. Clay Tile, Air Space	A0,A2,C6,B1,E1,E0
69	4 in. Face Brick with 8 in. Clay Tile	A0,A2,C6,E1,E0
70	8 in. Clay Tile with 1 in. Insulation	A0,A1,C6,B2,E1,E0
71	8 in. Clay Tile with Air Space	A0,A1,C6,B1,E1,E0
72	8 in. Clay Tile	A0,A1,C6,E1,E0
73	4 in. Heavyweight Concrete with 2 in. Insulation	A0,A1,C5,B3,E1,E0
74	4 in. Heavyweight Concrete with 1 in. Insulation	A0,A1,C5,B2,E1,E0
75	4 in. Heavyweight Concrete with Air Space	A0,A1,C5,B1,E1,E0
76	4 in. Heavyweight Concrete	A0,A1,C5,E1,E0
77	4 in. Face Brick, 4 in. Common Brick, 1 in. Insulation	A0,A2,C4,B2,E1,E0
78	4 in. Face Brick, 4 in. Common Brick, Air Space	A0,A2,C4,B1,E1,E0
79	4 in. Face Brick with 4 in. Common Brick	A0,A2,C4,E1,E0
80	4 in. Common Brick	A0,A1,C4,E1,E0
81	4 in. Heavyweight Concrete Block	A0,A1,C3,E1,E0
82	4 in. Face Brick, 4 in. L.W. Concrete Block, 1 in. Insulation	A0,A2,C2,B2,E1,E0
83	4 in. Face Brick, 4 in. Lightweight Concrete Block, Air Space	A0,A2,C2,B1,E1,E0
84	4 in. Face Brick, 4 in. Lightweight Concrete Block	A0,A2,C2,E1,E0
85	4 in. Lightweight Concrete Block and 1 in. Insulation	A0,A1,C2,B2,E1,E0
86	4 in. Lightweight Concrete Block and Air Space	A0,A1,C2,B1,E1,E0
87	4 in. Lightweight Concrete Block	A0,A1,C2,E1,E0
88	4 in. Face Brick, 4 in. Clay Tile, 1 in. Insulation	A0,A2,C1,B2,E1,E0
89	4 in. Face Brick, 4 in. Clay Tile, Air Space	A0,A2,C1,B1,E1,E0
90	4 in. Face Brick and 4 in. Clay Tile	A0,A2,C1,E1,E0
91	4 in. Clay Tile and 1 in. Insulation	A0,A1,C1,B2,E1,E0
92	4 in. Clay Tile and Air Space	A0,A1,C1,B1,E1,E0
93	4 in. Clay Tile	A0,A1,C1,E1,E0
94	Sheet Metal with 1 in. Insulation	A0,A3,B2,B1,A3,E0
95	Sheet Metal with 2 in. Insulation	A0,A3,B3,B1,A3,E0
96	Sheet Metal with 3 in. Insulation	A0,A3,B4,B1,A3,E0
97	Frame Wall with 4 in. Insulation on Outside	A0,A1,B1,B13,E1,E0
98	Frame Wall with 5 in. Insulation	A0,A1,B1,B14,E1,E0

99	Frame Wall with 6 in. Insulation	A0,A1,B15,E1,E0
100	Brick Wall with 8 in. L.W. Conc. Block with Loose Insulation	A0,A7,B1,C17,A6,E0
101	Brick Wall with 8 in. H.W. Conc. Block with Loose Insulation	A0,A7,B1,C18,A6,E0
102	Brick Wall with 12 in. L.W. Conc. Block with Loose Insulation	A0,A7,B1,C19,A6,E0
103	Brick Wall with 12 in. H.W. Conc. Block with Loose Insulation	A0,A7,B1,C20,A6,E0
104	Steel Siding with 4 in. Insulation	A0,A3,B13,B1,A3,E0
105	Frame Wall with 5 in. Insulation	A0,A1,B14,E1,E0
106	4 in. Heavyweight Concrete Block with 1 in. Insulation	A0,A6,B5,C3,E0
107	2 in. Insulation with 2 in. Heavyweight Concrete	A0,C12,B6,E1,E0
108	1.36 in. Insulation with 8 in. Lightweight Concrete Block	A0,C7,B21,A6,E0
109	1 in. Insulation with 4 in. Heavyweight Concrete	A0,A1,C5,B2,E1,E0
110	4 in. Heavyweight Concrete with 2 in. Insulation	A0,A3,B3,C5,A6,E0
111	Face Brick and 2 in. Heavyweight Concrete with 1 in. Insulation	A0,A6,B5,C12,A2,E0
112	6 in. Insulation with 2 in. Wood	A0,B10,B15,A6,E0
113	4 in. L.W. Concrete Block with 1 in. Insulation and Face Brick	A0,A2,B5,C2,E1,E0
114	8 in. Heavyweight Concrete Block with 2 in. Insulation	A0,A1,B6,C8,E1,E0
115	8 in. Heavyweight Concrete	A0,A1,C10,B1,E1,E0
116	Face Brick and 4 in. H.W. Concrete with 0.61 in. Insulation	A0,A6,B19,C5,A2,E0
117	Face Brick and Face Brick with 2 in. Insulation	A0,A6,B6,A2,A2,E0
118	8 in. Lightweight Concrete Block (filled) and Face Brick	A0,A7,B1,C17,A6,E0
119	8 in. Heavyweight Concrete Block (filled) and Face Brick	A0,A7,B1,C18,A6,E0
120	Face Brick and 4 in. L.W. Concrete Block with 6 in. Insulation	A0,B15,C2,A2,E0
121	3.33 in. Insulation with 8 in. Common Brick	A0,C9,B25,A6,E0
122	8 in. Common Brick with 2 in. Insulation	A0,A6,B6,C9,E0
123	12 in. Heavyweight Concrete with 0.61 in. Insulation	A0,A6,B19,C11,E0
124	12 in. Heavyweight Concrete with 12 in. Insulation	A0,A1,B6,C11,E0
125	4 in. Lightweight Concrete with 6 in. Insulation and Face Brick	A0,A2,B15,C14,E0
126	6 in. Insulation with 8 in. Lightweight Concrete Block	A0,A2,C7,B15,E1,E0
127	12 in. Heavyweight Concrete Block (filled) and Face Brick	A0,A7,B1,C20,A6,E0
128	Face Brick and 6 in. L.W. Concrete Block with 3 in. Insulation	A0,A6,B12,C15,A2,E0
129	Face Brick and 8 in. Clay Tile with 2 in. Insulation	A0,A6,B6,C6,A2,E0
130	5 in. Insulation with 12 in. Heavyweight Concrete	A0,A1,C11,B14,E1,E0
131	12 in. Heavyweight Concrete with 4 in. Insulation	A0,A1,B13,C11,E1,E0
132	Face Brick and 12 in. H.W. Concrete with 1 in. Insulation	A0,A6,B5,C11,A2,E0
133	0.61 in. Ins. with 12 in. L.W. Block Conc.(filled) and Face Brick	A0,A2,C19,B19,E1,E0
134	6 in. Insulation with 6 in. Lightweight Concrete and Face Brick	A0,A2,C15,B15,E1,E0
135	2.42 in. Insulation with Face Brick	A0,A2,B9,B23,E1,E0
136	Face Brick and 8 in. Clay Tile with 6 in. Insulation	A0,A6,B15,C6,A2,E0
137	12 in. H.W. Concrete with 1.36 in. Insulation and Face Brick	A0,A2,B21,C11,E0
138	5 in. Insulation with 12 in. H.W. Concrete and Face Brick	A0,A2,C11,B14,E1,E0
139	Face Brick and 12 in. H.W. Concrete with 3.33 in. Insulation	A0,A6,B25,C11,A2,E0
140	3.33 in. Insul. with 12 in. L.W. Block (filled) and Face Brick	A0,A2,C19,B25,E1,E0
141	6 in. Insulation with 12 in. H.W. Block (filled) and Face Brick	A0,A2,C20,B15,E1,E0
142	Face Brick and 8 in. Lightweight Concrete with 5 in. Insulation	A0,A6,B14,C16,A2,E0
143	Face Brick, 12 in. H.W. Block (filled) and 6 in. Insulation	A0,A6,B15,C20,A2,E0
144	12 in. H.W. Concrete with 5 in. Insulation and Face Brick	A0,A2,B14,C11,E1,E0

Walls 1 through 96 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 27, Chapter 25.

Walls 97 through 103 are taken from the 1981 and 1985 ASHRAE Handbook of Fundamentals, Table 29, Chapter 26.

Walls 104 through 144 are taken from the 1993 ASHRAE Handbook of Fundamentals, Table 18, Chapter 26.

Table 9
Available Wall Descriptions for Type 19 - Single Zone Model
(SI Units)

No.	DESCRIPTION	Code Numbers of Layers
1	100 mm Face Brick, 50 mm Insul., 100 mm L.W. Conc. Block	A0,A2,B3,C2,E1,E0
2	100 mm Lightweight	A0,C14,E1,E0
3	100 mm Face Brick, Air space, 200 mm Common Brick	A0,A2,B1,C9,E1,E0
4	100 mm Face Brick, Air Space, 200 mm H.W. Concrete Block	A0,A2,B1,C8,E1,E0
5	100 mm Face Brick, Air Space, 200 mm L.W. Concrete Block	A0,A2,B1,C7,E1,E0
6	100 mm Face Brick, Air Space, 200 mm Clay Tile	A0,A2,B1,C6,E1,E0
7	100 mm Face Brick, Air Space, 50 mm Heavyweight Concrete	A0,A2,B1,C12,E1,E0
8	100 mm Face Brick, Air Space, 100 mm Common Brick	A0,A2,B1,C4,E1,E0
9	100 mm Face Brick, Air Space, 100 mm H.W. Concrete Block	A0,A2,B1,C3,E1,E0
10	100 mm Face Brick, Air Space, 100 mm L.W. Concrete Block	A0,A2,B1,C2,E1,E0
11	300 mm Heavyweight Concrete	A0,A1,C11,E1,E0
12	200 mm Heavyweight Concrete with 50 mm Insulation	A0,A1,C10,B6,E1,E0
13	200 mm Heavyweight Concrete with 25 mm Insulation	A0,A1,C10,B5,E1,E0
14	200 mm Heavyweight Concrete with Air Space	A0,A1,C10,B1,E1,E0
15	200 mm Heavyweight Concrete	A0,A1,C10,E1,E0
16	100 mm Face Brick, 200 mm Common Brick, 50 mm Insulation	A0,A2,C9,B2,E1,E0
17	100 mm Face Brick, 200 mm Common Brick, Air Space	A0,A2,C9,B1,E1,E0
18	Wall with 100 mm Face Brick, Air Space, 100 mm L.W. Block	A0,A7,B1,C14,E0
19	Wall with Fiberglass Insulation and Stucco Outside Finish	A0,A6,B4,A6,E0,
20	Two-sided Brick Wall	A0,A7,B1,A2,E0
21	Brick Wall, 200 mm Concrete Block and No Air Space	A0,A7,C7,A6,E0
22	Brick Wall with 100 mm Concrete Block	A0,A7,B1,C3,A6,E0
23	Brick Wall with 200 mm Concrete Block	A0,A7,B1,C8,A6,E0
24	Brick Wall with 150 mm Concrete Block	A0,A7,B1,C15,A6,E0
25	Frame Wall with 100 mm Brick Veneer	A0,A7,B6,A6,E0
26	Frame Wall	A0,A6,B6,A6,E0
27	Metal Curtain Wall with 75 mm Insulation	A0,A3,B12,A3,E0
28	Metal Curtain Wall with 50 mm Insulation	A0,A3,B6,A3,E0
29	Metal Curtain Wall with 25 mm Insulation	A0,A3,B5,A3,E0
30	Wall 300 mm Concrete with 50 mm Insulation on the Outside	A0,A3,B6,C11,A6,E0
31	Wall 200 mm Concrete with 50 mm Insulation on the Outside	A0,A3,B6,C10,A6,E0
32	Wall 100 mm Concrete with 50 mm Insulation on the Outside	A0,A3,B6,C5,A6,E0
33	Wall 300 mm Concrete with 50 mm Insulation on the Inside	A0,C11,B6,A6,E0
34	Wall 200 mm Concrete with 50 mm Insulation on the Inside	A0,C10,B6,A6,E0
35	Wall 100 mm Concrete with 50 mm Insulation on the Inside	A0,C5,B6,A6,E0
36	Frame Wall with 75 mm Insulation	A0,A1,B1,B4,E1,E0
37	Frame Wall with 50 mm Insulation	A0,A1,B1,B3,E1,E0
38	Frame Wall with 25 mm Insulation	A0,A1,B1,B2,E1,E0
39	Frame Wall without Insulation	A0,A1,B1,E1,E0
40	50 mm Insulation with 300 mm Heavyweight Concrete	A0,A1,B3,C11,E1,E0
41	50 mm Insulation with 200 mm Heavyweight Concrete	A0,A1,B3,C10,E1,E0
42	50 mm Insulation with 200 mm Common Brick	A0,A1,B3,C9,E1,E0
43	50 mm Insulation with 200 mm Heavyweight Concrete Block	A0,A1,B3,C8,E1,E0
44	50 mm Insulation with 200 mm Lightweight Concrete Block	A0,A1,B3,C7,E1,E0
45	50 mm Insulation with 200 mm Clay Tile	A0,A1,B3,C6,E1,E0
46	50 mm Insulation with 100 mm Heavyweight Concrete	A0,A1,B3,C5,E1,E0
47	50 mm Insulation with 100 mm Common Brick	A0,A1,B3,C4,E1,E0

48	50 mm Insulation with 100 mm Heavyweight Concrete Block	A0,A1,B3,C3,E1,E0
49	50 mm Insulation with 100 mm Lightweight Block	A0,A1,B3,C2,E1,E0
50	50 mm Insulation with 100 mm Clay Tile	A0,A1,B3,C1,E1,E0
51	100 mm Face Brick, 50 mm Insulation, 300 mm H.W. Concrete	A0,A2,B3,C11,E1,E0
52	100 mm Face Brick, 50 mm Insulation, 200 mm H.W. Concrete	A0,A2,B3,C10,E1,E0
53	100 mm Face Brick, 50 mm Insulation, 300 mm Common Brick	A0,A2,B3,C9,E1,E0
54	100 mm Face Brick, Air Space, 300 mm Heavyweight Concrete	A0,A2,B1,C11,E1,E0
55	100 mm Face Brick, Air Space, 200 mm Heavyweight Concrete	A0,A2,B1,C10,E1,E0
56	100 mm Face Brick, 50 mm Insul., 200 mm H.W. Conc. Block	A0,A2,B3,C8,E1,E0
57	100 mm Face Brick, 50 mm Insul., 200 mm L.W. Conc. Block	A0,A2,B3,C7,E1,E0
58	50 mm Face Brick, 50 mm Insulation, 200 mm Clay Tile	A0,A2,B3,C6,E1,E0
59	100 mm Face Brick, 50 mm Insulation, 100 mm H.W. Concrete	A0,A2,B3,C5,E1,E0
60	100 mm Face Brick, 50 mm Insulation, 100 mm Common Brick	A0,A2,B3,C4,E1,E0
61	100 mm Face Brick, 50 mm Insul., 100 mm H.W. Concrete Brick	A0,A2,B3,C3,E1,E0
62	100 mm. Face Brick with 200 mm Common Brick	A0,A2,C9,E1,E0
63	200 mm Heavyweight Concrete Block with 100 mm Insulation	A0,A1,C8,B2,E1,E0
64	200 mm Heavyweight Concrete Block	A0,A1,C8,E1,E0
65	200 mm Lightweight Concrete Block with Insulation	A0,A1,C7,B2,E1,E0
66	200 mm Lightweight Concrete Block	A0,A1,C7,E1,E0
67	100 mm Face Brick, 200 mm Clay Tile, 100 mm Insulation	A0,A2,C6,B2,E1,E0
68	100 mm Face Brick, 200 mm Clay Tile, Air Space	A0,A2,C6,B1,E1,E0
69	100 mm Face Brick with 200 mm Clay Tile	A0,A2,C6,E1,E0
70	200 mm Clay Tile with 100 mm Insulation	A0,A1,C6,B2,E1,E0
71	200 mm Clay Tile with Air Space	A0,A1,C6,B1,E1,E0
72	200 mm Clay Tile	A0,A1,C6,E1,E0
73	100 mm Heavyweight Concrete with 50 mm Insulation	A0,A1,C5,B3,E1,E0
74	100 mm Heavyweight Concrete with 25 mm Insulation	A0,A1,C5,B2,E1,E0
75	100 mm Heavyweight Concrete with Air Space	A0,A1,C5,B1,E1,E0
76	100 mm Heavyweight Concrete	A0,A1,C5,E1,E0
77	100 mm Face Brick, 100 mm Common Brick, 25 mm Insulation	A0,A2,C4,B2,E1,E0
78	100 mm Face Brick, 100 mm Common Brick, Air Space	A0,A2,C4,B1,E1,E0
79	100 mm Face Brick with 100 mm Common Brick	A0,A2,C4,E1,E0
80	100 mm Common Brick	A0,A1,C4,E1,E0
81	100 mm Heavyweight Concrete Block	A0,A1,C3,E1,E0
82	100 mm Face Brick, 100 mm L.W. Concr. Block, 25 mm Insul.	A0,A2,C2,B2,E1,E0
83	100 mm Face Brick, 100 mm L.W. Concrete Block, Air Space	A0,A2,C2,B1,E1,E0
84	100 mm Face Brick, 100 mm Lightweight Concrete Block	A0,A2,C2,E1,E0
85	100 mm Lightweight Concrete Block and 25 mm Insulation	A0,A1,C2,B2,E1,E0
86	100 mm Lightweight Concrete Block and Air Space	A0,A1,C2,B1,E1,E0
87	100 mm Lightweight Concrete Block	A0,A1,C2,E1,E0
88	100 mm Face Brick, 100 mm Clay Tile, 25 mm Insulation	A0,A2,C1,B2,E1,E0
89	100 mm Face Brick, 100 mm Clay Tile, Air Space	A0,A2,C1,B1,E1,E0
90	100 mm Face Brick and 100 mm Clay Tile	A0,A2,C1,E1,E0
91	100 mm Clay Tile and 25 mm Insulation	A0,A1,C1,B2,E1,E0
92	100 mm Clay Tile and Air Space	A0,A1,C1,B1,E1,E0
93	100 mm Clay Tile	A0,A1,C1,E1,E0
94	Sheet Metal with 25 mm Insulation	A0,A3,B2,B1,A3,E0
95	Sheet Metal with 50 mm Insulation	A0,A3,B3,B1,A3,E0
96	Sheet Metal with 75 mm Insulation	A0,A3,B4,B1,A3,E0
97	Frame Wall with 100 mm Insulation on Outside	A0,A1,B1,B13,E1,E0
98	Frame Wall with 125 mm Insulation	A0,A1,B1,B14,E1,E0
99	Frame Wall with 150 mm Insulation	A0,A1,B15,E1,E0
100	Brick Wall with 200 mm L.W. Conc. Block with Loose Insul.	A0,A7,B1,C17,A6,E0
101	Brick Wall with 200 mm H.W. Conc. Block with Loose Insul.	A0,A7,B1,C18,A6,E0

102	Brick Wall with 300 mm L.W. Conc. Block with Loose Insul.	A0,A7,B1,C19,A6,E0
103	Brick Wall with 300 mm H.W. Conc. Block with Loose Insul.	A0,A7,B1,C20,A6,E0
104	Steel Siding with 100 mm Insulation	A0,A3,B13,B1,A3,E0
105	Frame Wall with 125 mm Insulation	A0,A1,B14,E1,E0
106	100 mm Heavyweight Concrete Block with 25 mm Insulation	A0,A6,B5,C3,E0
107	50 mm Insulation with 50 mm. Heavyweight Concrete	A0,C12,B6,E1,E0
108	35 mm Insulation with 200 mm Lightweight Concrete Block	A0,C7,B21,A6,E0
109	25 mm Insulation with 100 mm Heavyweight Concrete	A0,A1,C5,B2,E1,E0
110	100 mm Heavyweight Concrete with 50 mm Insulation	A0,A3,B3,C5,A6,E0
111	Face Brick and 50 mm H.W. Concrete with 25 mm Insulation	A0,A6,B5,C12,A2,E0
112	150 mm Insulation with 50 mm Wood	A0,B10,B15,A6,E0
113	100 mm L.W. Conc. Block with 25 mm Insul. and Face Brick	A0,A2,B5,C2,E1,E0
114	200 mm Heavyweight Concrete Block with 50 mm Insulation	A0,A1,B6,C8,E1,E0
115	200 mm Heavyweight Concrete	A0,A1,C10,B1,E1,E0
116	Face Brick and 100 mm H.W. Concrete with 15 mm Insulation	A0,A6,B19,C5,A2,E0
117	Face Brick and Face Brick with 50 mm Insulation	A0,A6,B6,A2,A2,E0
118	200 mm Lightweight Concrete Block (filled) and Face Brick	A0,A7,B1,C17,A6,E0
119	200 mm Heavyweight Concrete Block (filled) and Face Brick	A0,A7,B1,C18,A6,E0
120	Face Brick and 100 mm L.W. Conc. Block with 150 mm Insul.	A0,B15,C2,A2,E0
121	85 mm Insulation with 200 mm Common Brick	A0,C9,B25,A6,E0
122	200 mm Common Brick with 50 mm Insulation	A0,A6,B6,C9,E0
123	300 mm Heavyweight Concrete with 15 mm Insulation	A0,A6,B19,C11,E0
124	300 mm Heavyweight Concrete with 300 mm Insulation	A0,A1,B6,C11,E0
125	100 mm L.W. Concrete with 150 mm Insulation and Face Brick	A0,A2,B15,C14,E0
126	150 mm Insulation with 200 mm Lightweight Concrete Block	A0,A2,C7,B15,E1,E0
127	300 mm Heavyweight Concrete Block (filled) and Face Brick	A0,A7,B1,C20,A6,E0
128	Face Brick and 150 mm L.W. Conc. Block with 75 mm Insul.	A0,A6,B12,C15,A2,E0
129	Face Brick and 200 mm Clay Tile with 50 mm Insulation	A0,A6,B6,C6,A2,E0
130	125 mm Insulation with 300 mm Heavyweight Concrete	A0,A1,C11,B14,E1,E0
131	300 mm Heavyweight Concrete with 100 mm Insulation	A0,A1,B13,C11,E1,E0
132	Face Brick and 300 mm H.W. Concrete with 25 mm Insulation	A0,A6,B5,C11,A2,E0
133	15 mm Ins. with 300 mm L.W. Block Conc.(filled) w/ Face Brick	A0,A2,C19,B19,E1,E0
134	150 mm Insulation with 150 mm L.W. Concrete and Face Brick	A0,A2,C15,B15,E1,E0
135	60 mm Insulation with Face Brick	A0,A2,B9,B23,E1,E0
136	Face Brick and 200 mm Clay Tile with 150 mm Insulation	A0,A6,B15,C6,A2,E0
137	300 mm H.W. Concrete with 35 mm Insulation and Face Brick	A0,A2,B21,C11,E0
138	125 mm Insulation with 300 mm H.W. Concrete and Face Brick	A0,A2,C11,B14,E1,E0
139	Face Brick and 300 mm H.W. Concrete with 85 mm Insulation	A0,A6,B25,C11,A2,E0
140	85 mm Insul. with 300 mm L.W. Block (filled) and Face Brick	A0,A2,C19,B25,E1,E0
141	150 mm Insul. with 300 mm H.W. Block (filled) and Face Brick	A0,A2,C20,B15,E1,E0
142	Face Brick and 200 mm L.W. Concrete with 125 mm Insulation	A0,A6,B14,C16,A2,E0
143	Face Brick, 300 mm H.W. Block (filled) and 150 mm Insulation	A0,A6,B15,C20,A2,E0
144	300 mm H.W. Concrete with 125 mm Insulation and Face Brick	A0,A2,B14,C11,E1,E0

Walls 1 through 96 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 27, Chapter 25.

Walls 97 through 103 are taken from the 1981 and 1985 ASHRAE Handbook of Fundamentals, Table 29, Chapter 26.

Walls 104 through 144 are taken from the 1993 ASHRAE Handbook of Fundamentals, Table 18, Chapter 26.

Table 10
Available Interior Partition, Floor, and Ceiling Descriptions for Type 19 - Single Zone
Model(English Units)

No.	DESCRIPTION	Code Numbers of Layers
1	4 in. Clay Tile with 0.75 in. Plaster	E0,E1,C1,E1,E0
2	4 in. Lightweight Concrete Block with 0.75 in. Plaster	E0,E1,C2,E1,E0
3	4 in. Heavyweight Concrete Block with 0.75 in. Plaster	E0,E1,C3,E1,E0
4	4 in. Common Brick with 0.75 in. Plaster	E0,E1,C4,E1,E0
5	4 in. Heavyweight Concrete with 0.75 in. Plaster	E0,E1,C5,E1,E0
6	8 in. Clay Tile with 0.75 in. Plaster	E0,E1,C6,E1,E0
7	8 in. Lightweight Concrete Block, Plastered Both Sides	E0,E1,C7,E1,E0
8	8 in. Heavyweight Concrete Block, Plastered Both Sides	E0,E1,C8,E1,E0
9	8 in. Common Brick, Plastered Both Sides	E0,E1,C9,E1,E0
10	8 in. Heavy Concrete, Plastered Both Sides	E0,E1,C10,E1,E0
11	12 in. Heavy Concrete, Plastered Both Sides	E0,E1,C11,E1,E0
12	4 in. Clay Tile	E0,C1,E0
13	4 in. Lightweight Concrete Block	E0,C2,E0
14	4 in. Heavyweight Concrete Block	E0,C3,E0
15	4 in. Common Brick	E0,C4,E0
16	4 in. Heavyweight Concrete	E0,C5,E0
17	8 in. Clay Tile	E0,C6,E0
18	8 in. Lightweight Concrete Block	E0,C7,E0
19	8 in. Heavyweight Concrete Block	E0,C8,E0
20	8 in. Common Brick	E0,C9,E0
21	8 in. Heavyweight Concrete	E0,C10,E0
22	12 in. Heavyweight Concrete	E0,C11,E0
23	Frame, Partition with 0.75 in. Gypsum Board	E0,E1,B1,E1,E0
24	1 in. Wood	E0,B7,E0
25	2 in. Wood	E0,B10,E0
26	3 in. Wood	E0,B11,E0
27	4 in. Wood	E0,B9,E0
28	Frame, Partition with 1 in. Wood	E0,B7,B1,B7,E0
29	2 in. Furniture	E0,B10,B1,B10,E0
30	3 in. Furniture	E0,B11,B1,B11,E0
31	2 in. Heavyweight Concrete Floor Deck	E0,A5,C12,E0
32	4 in. Heavyweight Concrete Floor Deck	E0,A5,C5,E0
33	4 in. Lightweight Concrete Floor Deck	E0,A5,C2,E0
34	8 in. Heavyweight Concrete Floor Deck	E0,A5,C10,E0
35	8 in. Lightweight Concrete Floor Deck	E0,A5,C7,E0
36	2 in. Wood Deck	E0,A5,B10,E0
37	3 in. Wood Deck	E0,A5,B11,E0
38	2 in. Heavyweight Concrete Deck with False Ceiling	E0,A5,C10,E4,E5,E0
39	4 in. Heavyweight Concrete Deck with False Ceiling	E0,A5,C5,E4,E5,E0
40	4 in. Lightweight Concrete Deck with False Ceiling	E0,A5,C2,E4,E5,E0
41	8 in. Heavyweight Concrete Deck with False Ceiling	E0,A5,C10,E4,E5,E0
42	8 in. Lightweight Concrete Deck with False Ceiling	E0,A5,C7,E4,E5,E0
43	2 in. Wood Deck with False Ceiling	E0,A5,B10,E4,E5,E0
44	3 in. Wood Deck with False Ceiling	E0,A5,B11,E4,E5,E0
45	12 in. Heavyweight Concrete Deck with False Ceiling	E0,A5,C11,E4,E5,E0
46	4 in. Wood Deck with False Ceiling	E0,A5,B9,E4,E5,E0
47	Steel Deck with False Ceiling	E0,A5,A3,E4,E5,E0

Interiors 1 through 47 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 29, Chapter 25.

Table 11
Available Interior Partition, Floor, and Ceiling Descriptions for
Type 19 - Single Zone Model (SI Units)

No.	DESCRIPTION	Code Numbers of Layers
1	100 mm Clay Tile with 20 mm Plaster	E0,E1,C1,E1,E0
2	100 mm Lightweight Concrete Block with 20 mm Plaster	E0,E1,C2,E1,E0
3	100 mm Heavyweight Concrete Block with 20 mm Plaster	E0,E1,C3,E1,E0
4	100 mm Common Brick with 20 mm Plaster	E0,E1,C4,E1,E0
5	100 mm Heavyweight Concrete with 20 mm Plaster	E0,E1,C5,E1,E0
6	200 mm Clay Tile with 20 mm Plaster	E0,E1,C6,E1,E0
7	200 mm Lightweight Concrete Block, Plastered Both Sides	E0,E1,C7,E1,E0
8	200 mm Heavyweight Concrete Block, Plastered Both Sides	E0,E1,C8,E1,E0
9	200 mm Common Brick, Plastered Both Sides	E0,E1,C9,E1,E0
10	200 mm Heavy Concrete, Plastered Both Sides	E0,E1,C10,E1,E0
11	300 mm Heavy Concrete, Plastered Both Sides	E0,E1,C11,E1,E0
12	100 mm Clay Tile	E0,C1,E0
13	100 mm Lightweight Concrete Block	E0,C2,E0
14	100 mm Heavyweight Concrete Block	E0,C3,E0
15	100 mm Common Brick	E0,C4,E0
16	100 mm Heavyweight Concrete	E0,C5,E0
17	200 mm Clay Tile	E0,C6,E0
18	200 mm Lightweight Concrete Block	E0,C7,E0
19	200 mm Heavyweight Concrete Block	E0,C8,E0
20	200 mm Common Brick	E0,C9,E0
21	200 mm Heavyweight Concrete	E0,C10,E0
22	300 mm Heavyweight Concrete	E0,C11,E0
23	Frame, Partition with 20 mm Gypsum Board	E0,E1,B1,E1,E0
24	25 mm Wood	E0,B7,E0
25	50 mm Wood	E0,B10,E0
26	75 mm Wood	E0,B11,E0
27	100 mm Wood	E0,B9,E0
28	Frame, Partition with 25 mm Wood	E0,B7,B1,B7,E0
29	50 mm Furniture	E0,B10,B1,B10,E0
30	75 mm Furniture	E0,B11,B1,B11,E0
31	50 mm Heavyweight Concrete Floor Deck	E0,A5,C12,E0
32	100 mm Heavyweight Concrete Floor Deck	E0,A5,C5,E0
33	100 mm Lightweight Concrete Floor Deck	E0,A5,C2,E0
34	200 mm Heavyweight Concrete Floor Deck	E0,A5,C10,E0
35	200 mm Lightweight Concrete Floor Deck	E0,A5,C7,E0
36	50 mm Wood Deck	E0,A5,B10,E0
37	75 mm Wood Deck	E0,A5,B11,E0
38	50 mm Heavyweight Concrete Deck with False Ceiling	E0,A5,C10,E4,E5,E0
39	100 mm Heavyweight Concrete Deck with False Ceiling	E0,A5,C5,E4,E5,E0
40	100 mm Lightweight Concrete Deck with False Ceiling	E0,A5,C2,E4,E5,E0
41	200 mm Heavyweight Concrete Deck with False Ceiling	E0,A5,C10,E4,E5,E0
42	200 mm Lightweight Concrete Deck with False Ceiling	E0,A5,C7,E4,E5,E0
43	50 mm Wood Deck with False Ceiling	E0,A5,B10,E4,E5,E0
44	75 mm Wood Deck with False Ceiling	E0,A5,B11,E4,E5,E0
45	300 mm Heavyweight Concrete Deck with False Ceiling	E0,A5,C11,E4,E5,E0
46	100 mm Wood Deck with False Ceiling	E0,A5,B9,E4,E5,E0
47	Steel Deck with False Ceiling	E0,A5,A3,E4,E5,E0

Interiors 1 through 47 are taken from the 1977 ASHRAE Handbook of Fundamentals, Table 29, Chapter 25.

References

1. ASHRAE, Handbook of Fundamentals (1977, 81, 85, 89, 93).
2. Madsen, J.M., "Modeling Heat Transfer in Rooms Using Transfer Function Methods," M.S. Thesis, University of Wisconsin-Madison (1982).
3. McAdams, W.H., Heat Transmission, 3rd Edition, McGraw-Hill, New York (1954).
Beckman, W.A., "The Solution of Heat Transfer Problems on a Digital Computer," Solar Energy, 13, 3 (1971).

PREP Manual

PREP is located in %TRNSYS16%\Tools\Prep (%TRNSYS16% is your installation directory)

1 INTRODUCTION

In this chapter, an interactive program included with the TRNSYS package is described. PREP is available for generating transfer function coefficients for walls or roofs for use with the TYPE 19 Zone Model (See here above). However, PREP was written to be a general transfer function coefficient generating program and is not specific to Type 19.

2 PREP

PREP can be used interactively or in a batch mode to generate transfer function coefficients for walls or roofs. Outputs from the program are the b, c, and d coefficients. PREP is adapted from the z-transfer function program of Mitalas and Arsenault (1).

When PREP is used to generate transfer functions for TYPE 19, several points need to be kept in mind: Transfer function coefficients used with TRNSYS TYPE 19 should not include radiative resistance at the inside surface. If standard ASHRAE layer codes are used, it should be noted that the standard inside surface resistance (E_0) includes both convective and radiative resistance. Because TYPE 19 handles radiation separately, only the inside surface convective resistance should be included*. The appropriate value for the inside surface convective resistance is $0.1044 \text{ m}^2\text{-}^\circ \text{C-hr/kJ}$ ($2.134 \text{ hr-ft}^2\text{-F/Btu}$). This value should also be specified in the parameter list of TYPE 19, as it will be used for calculating sol-air temperatures. The standard external surface resistance (A_0) is fine: the wind speed, given as an input to TYPE 19, is used only to calculate the sol-air temperature. This discussion does not apply to TYPE 56, which uses surface-to-surface transfer coefficients.

If used interactively, PREP is self-documenting. The user is prompted for details pertaining to each layer comprising the wall. The user may enter material properties, or code numbers from Table 8, Chapter 25, of the 1977 ASHRAE Fundamentals; Table 8, Chapter 26 of the 1981 Fundamentals; Table 8, Chapter 26 of the 1985 Fundamentals; Table 11, Chapter 26 of the 1989 Fundamentals, or Tables 4-5 from this manual. The wall description begins at the outside surface and proceeds to the inside.

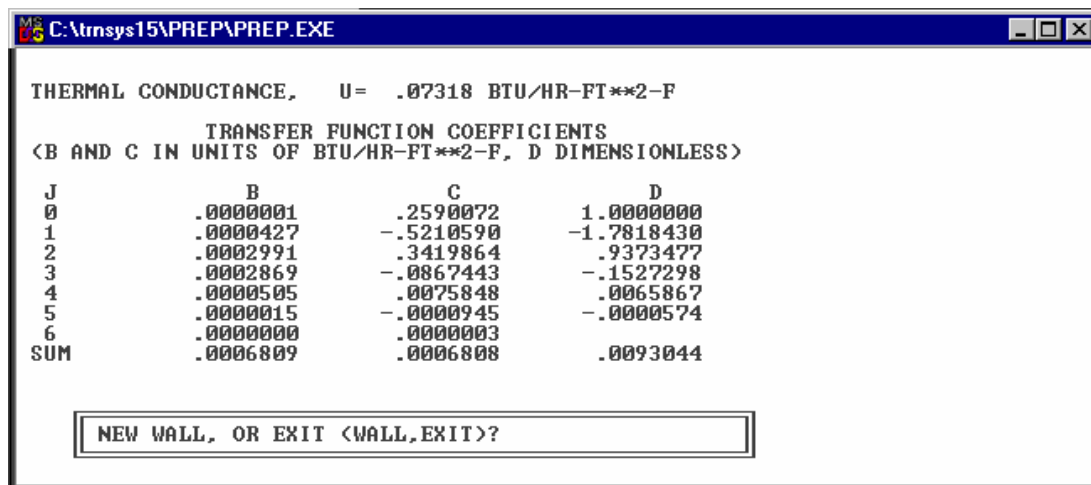
PREP produces two output files for each wall that is run. The first (trnsfn.dat) is a

* This modification has already been taken into account in the ASHRAE.COF file of standard walls, etc.

text file containing all the coefficients in standard columnar format. The second (fortype19.dat) contains the same transfer function coefficients but in a more readable format

Example: It is sometimes difficult to be sure that the coefficients generated by PREP are correct. So as an example of using PREP, we will verify the first entry in the ASHRAE.COF file.

1. Launch the PREP program by double clicking on the prep.exe file in %TRNSYS16%\Tools\Prep.
2. Make sure that Caps Lock is on and type "NO" when PREP asks if you want instructions.
3. The ASHRAE.COF file is in English units, so type "ENG"
4. Next, PREP will ask how many layers there are to be in the wall. We are going to generate the first wall (a roof really) in ASHRAE.COF so refer to Table 4.8.3.6 in the Type19 description for the roof at hand. There are 10 layers in the first roof
5. For each material PREP will ask you two questions; first, is this material an air gap or a material and second, what is the code number. Type, in sequence:
 - AIR A0
 - MAT C12
 - AIR B1
 - MAT B6
 - MAT E2
 - MAT E3
 - MAT C5
 - AIR E4
 - MAT E5
 - AIR 2.134
6. Next PREP will ask you to confirm that the wall is correct; Type "NO" for no changes
7. PREP will then generate and display the coefficients. It should look like the following:



```

C:\trnsys15\PREP\PREP.EXE

THERMAL CONDUCTANCE,   U=  .07318 BTU/HR-FT**2-F

      TRANSFER FUNCTION COEFFICIENTS
<B AND C IN UNITS OF BTU/HR-FT**2-F, D DIMENSIONLESS>

J      B      C      D
0      .0000001  .2590072  1.0000000
1      .0000427  -.5210590  -1.7818430
2      .0002991  .3419864  .9373477
3      .0002869  -.0867443  -.1527298
4      .0000505  .0075848  .0065867
5      .0000015  -.0000945  -.0000574
6      .0000000  .0000003  .0000000
SUM      .0006809  .0006808  .0093044

NEW WALL, OR EXIT <WALL,EXIT??>
  
```

8. Now open the file ASHRAE.COF and verify that the data in the first entry matches the data generated by PREP. An entry in the ASHRAE.COF file has the following syntax. On the first line are two numbers. The first number is the number of b and c coefficients that follow. The second number is the number of d coefficients given. Then the coefficients are listed in the following order:

b0 b1 ... bn c0 c1 ... cn d1 d2 ... dn

In batch mode, the first data item must be the word BATCH. The next data entry specifies the set of units to be used. SI is for metric (kJ, m, kg, ° C). The data following this describes the layers comprising each wall to be considered. This data is summarized in Table 12.

TABLE 12
Necessary Data for Each Wall in Batch Mode

Data Item	Data entry	Description
1	N	The number of layers comprising the wall. Includes convective resistance at the inside or outside surface.
	$1 < N < 20$	
2	AIR or MAT	Layer 1 type. AIR denotes a massless layer such as a convective (air) resistance only. MAT is for a massive (materials) layer.
3	Resistance (if AIR), ASHRAE code number or thickness, conductivity, density and specific heat (if MAT)	Properties associated with Layer 1. If an ASHRAE code number is not used then a resistance is necessary for massless layers, while for massive layers, the thickness, conductivity, density and specific heat are required.
...		
2N	AIR or MAT	Layer N type
2N+1	Resistance (if AIR), ASHRAE code number or thickness, conductivity, density and specific heat (if MAT)	Properties associated with layer N.

The data entries are read in free format. The data items should be separated by spaces or commas. Any number of walls may be considered in a batch analysis. The program continues to look for data as appears in Table 12 until the word EXIT is encountered. This signals an end to the input data.

Reference

1. Mitalas, G.P and Arseneault, J.G., "FORTRAN IV Program to Calculate z-Transfer Functions for the Calculation of Thermal Performance of Buildings", National Research Council of Canada, DBR Computer Program No. 33 (1982).