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RESIDENTIAL CODES WORKBOOK

prepared by:

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under the direction of:

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Atlanta, Georgia

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CODE MANUAL FOR PASSIVE SOLAR DESIGN SINGLE FAMILY RESIDENTIAL CONSTRUCTION

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INTRODUCTION

The Southern Solar Energy Center (SSEC) is one of four regional centers established by the Department of Energy to help industry commercialize economically viable solar applications.

One of the Center's most important missions is to work with the building community to promote energy efficient/solar building construction, and to remove barriers to solar use.

The nineteen jurisdictions which make up the SSEC region are: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, Virgin Islands, and West Virginia. Most of these jurisdictions and their incorporated municipalities enforce building and/or energy conservation codes, standards, and regulations which influence the use of passive solar energy techniques in residential building design.

This reference manual represents the first effort by the buildings program department of the SSEC to give builders within the region a practical tool to clarify the impact of building and energy codes on passive residential designs.

Building codes and their enforcement have a profound, and for the most part, beneficial effect on the quality and safety of homes. However, certain code regulations may unintentionally conflict with passive designs, which were not envisioned when the laws were created. As passive solar use gains wider acceptance, these conflicts will become more evident.

By sponsoring this study, the Southern Solar Energy Center is attempting to identify some of these problems in advance, thereby warning designers and builders of potential conflicts, while helping code officials and legislative groups to understand and give consideration to special passive solar designs.

The information contained within this guide will be updated periodically to keep builders informed of the latest changes in regulations and codes. These updates will also include a current listing of key code enforcement personnel and their attitudes toward passive design.

Development of similar reference manuals is planned for commercial buildings and multi-family construction.

We hope this document will be useful to the buildings community and will increase interest in building low energy/passive solar residences.

DESCRIPTION OF WORKBOOK

As is often the case with an emerging technology, there is some confusion surrounding the concept and application of passive solar systems. Because the success of this technology rests upon the cooperation of architects, builders, and code officials, it is essential that they all have an understanding of passive, both from a technical standpoint and as it relates to existing building codes in their particular areas.

Hopefully, as more data is made available, consideration will be given to adopting new codes which treat the special needs of passive solar systems. For the present, however, it is important that the builder be made aware of existing and emerging codes in the area of thermal specifications so that he might avoid potential conflicts while adhering to those requirements. The intent of this manual is to serve as a guide in furnishing that information.

The workbook is divided into three parts. Part I contains general information on types of passive solar techniques and a method for estimating passive solar performance.

Part II contains descriptions of the important codes and standards that are later referenced in Part III of the workbook. Each of the code descriptions lists the items in the code which could have a potential impact on a passive solar design and concludes with an overall analysis of the effect the code has on the use of such techniques.

Part III contains summaries of state and local codes and code agencies. In addition, the local summary contains the name of a contact in the enforcement agency to whom specific questions may be addressed. Included is a synopsis of statements made by the building official about the use of passive solar in his jurisdiction and descriptions of any related programs (such as those of utility companies). The last entry gives, briefly, the stated requirements to file for a building permit.

For builders, the key to using this manual is the local summary. Not only will it give them specific information about their locality, but it will also refer to the state and model codes which are summarized in Part II. It is important to remember that this manual is only a guide. The code descriptions are meant to point out areas which could have relevance to all passive solar design. Ultimately, of course, a builder must work with specific local codes and the people who enforce them. This workbook cannot be thought to cover all items for any single design, but it will enable the builder to anticipate problems and deal with them effectively.

GENERIC TYPES OF PASSIVE SOLAR DESIGN

With increasing numbers of successful applications, passive techniques are being recognized as possibly the most efficient ways of using solar energy. Passive solar systems utilize architectural elements to collect, store and distribute energy rather than the mechanical means of active systems. Very often building components serve two purposes - structural and thermal.

To assist in discussing these concepts with building officials, brief descriptions of the principal generic types of passive designs are listed below:

- 1) Direct Gain - A very simple and frequently used system requiring only large south-facing windows and some sort of thermal storage mass in the living space.

Sunlight enters the living space, strikes the thermal mass and the solar energy is converted into heat, much of which is absorbed by the mass.

When temperatures begin to drop, thermal energy stored in the mass begins to radiate into the space. Moveable insulation covering the window at night will reduce heat losses to the outside.

- 2) Thermal Storage Wall - The thermal storage in this system is directly behind the glazing. It can be either masonry (e.g., Trombe wall) or water (e.g., drum wall).

The sun strikes the thermal mass and is converted into thermal energy. When temperatures drop, that energy travels through the mass carrying heat into the living space by radiation and natural convection.

- 3) Attached Sunspace - This system operates essentially in the same manner as the thermal storage wall except that the space between the glazing and the thermal wall is much larger and can be used. This technique is often referred to as "greenhouse" or "solar "greenhouse".

- 4) Thermal Storage Roof - In this system, the thermal mass is located on the roof, but essentially the process is the same.

During the sunlight hours the mass on the roof (usually water) collects the thermal energy and stores it as heat.

At night insulation is placed over the thermal mass and the stored energy radiates into the space below.

This system can be reversed to provide cooling in the summer by simply covering the mass during the day and exposing it at night.

- 5) Convective Loop - In this system, the collector and thermal storage are separate units connected by piping or ducting. Circulation of a transfer medium (e.g., air) is by means of natural thermosiphon.

The sun striking the collector heats the transfer medium, which begins circulating through the loop by the natural convective process.

The thermal storage is heated by the transfer medium as it circulates through the loop.

PASSIVE PERFORMANCE ANALYSIS

To determine the approximate energy savings which can be expected from a passive solar design, the following calculation procedure can be used. This method simplifies many difficult computations and, as a result, a number of assumptions have been incorporated. The most important are listed below:

1. The system requires 45 BTU/°F of thermal storage for each SF of glazing - (e.g., 9 inches of water or 19 inches of concrete for a thermal storage wall).
2. The south facing glass is double glazed.
3. The temperature range in the building is allowed to fluctuate between 68°F and 75°F.
4. The night insulation has an "R" value of 9 and is drawn from 5pm to 8am.

With these assumptions the following procedure provides a quick estimating method.

1. Calculate the Building Skin Conductance. Using areas measured from plans and "U" values for typical ASHRAE calculations, compute the conductance through the building envelope, excluding the passive collector area.* (e.g., south window for direct gain, Trombe wall, etc.)

<u>SURFACE TYPE</u>	<u>AREA</u>	<u>"U" VALUE</u>	<u>A x U</u>
Walls*		x	=
Windows*		x	=
Roof		x	=
Floor		x	=

Building Skin Conductance = BTU/°F/HR

2. Calculate infiltration losses. Using standard ASHRAE methodology, compute the heat loss to changes in air inside the house:

<u>INTERIOR VOLUME</u>		<u>AIR CHANGE</u>		<u>CONSTANT**</u>	
Cubic feet	x	A/C	x	0.018	= BTU/°F/HR

** This constant is the product of the specific heat and the density of the air.

3. Determine the Building Loss Coefficient (BLC)

Sum up the building skin conductance and infiltration and multiply by 24 hours.

Building Skin Conductance	(BTU/°F/HR)
+Infiltration	(BTU/°F/HR)
Total	(BTU/°F/HR)
x 24	(HR)
	(BTU/DD)

4. Determine the Load Collector Ratio (LCR). This is done by dividing the Building Loss Coefficient (BLC) by the area of the passive solar collector. This area would be the actual aperture that the sun can come through:

$$\frac{\text{Building Loss Coefficient (BTU/DD)}}{\text{Solar Collector Area (SF)}} = \text{Load Collector Ratio (BTU/DD/SF)}$$

5. Having determined the Load Collector Ratio (LCR) go to Table 1 and locate the city closest to your location. Select the line with the passive solar system being utilized.

DG = for direct gain or attached sunspace
 DGNI = the above systems with night insulation
 TW = for thermal storage wall (masonry)
 TWNI = the above with night insulation
 WW = for thermal storage wall (water) or thermal storage roof
 WWNI = the above systems with night insulation

On the appropriate line find the LCR number you have calculated and read up to the Solar Heating Fraction (SHF). If the LCR is between the two numbers listed, interpolate to arrive at the proper SHF.

Load Collector Ratio (LCR) _____ BTU/DD/SF

To interpolate - list the two numbers which bracket the load collector ratio you have calculated and find the difference between the two:

first number from table _____
 second number from table _____
 difference # 1 _____

-determine the difference between the LCR you have calculated and the first number from the table:

first number from table _____
 calculated LCR _____
 difference # 2 _____

-calculate the ratio between the two differences:

$\frac{\text{difference \# 2}}{\text{difference \# 1}} = \text{interval ratio}$

-determine the interval between the two SHF which correspond to the two LCR numbers from the tables:

SHF for first number from table: _____
 SHF for second number from table: _____
 difference # 3 _____

-using the interval ratio, determine the SHF interval which corresponds to the location of the calculated LCR between the two table numbers:

difference # 3 x interval ratio = $\frac{\text{SHF interval}}{\text{SHF for first table number} - \text{final SHF}}$
 _____ x _____ = _____
 + _____
 _____ final SHF

6. The Solar Heating Fraction (SHF) is the portion of the building envelope heat loss which is supplied by the passive solar system. To determine the amount of auxiliary heat required for the remainder of the heating load (Auxiliary Heating Fraction or 1-SHF) the following computation is utilized:

Annual Heating Load (AHL) =
 (Aux. Heat Fraction) x (Building Loss Coefficient) x
 (Heating Degree Days) *

- * For heating degree days use values obtained from the weather service closest to the site or the nearest city from the list included in the State summary in Part 3.

7. The AHL is the approximate quantity of energy for the entire year that is supplied by the auxiliary heating. In order to facilitate comparison between buildings and the guidelines presented later, the AHL is converted to BTU/SF/YR levels by dividing AHL by the floor area of the building being heated:

$$\text{Annual Energy Use Index (AEUI)} = \frac{\text{Annual Heating Load}}{\text{Building Floor Area}}$$

8. The form in which the proposed Building Energy Performance Standards (BEPS) are presented are also budgets of BTU/SF/YR. However, this BTU number is the actual consumption of energy supplied to the building and, therefore, must take into account the efficiency of the mechanical system.

To convert the AEUI to an energy budget:

$$\text{Energy Budget} = \frac{\text{Annual Energy Use Index}}{\text{Mechanical Plan Efficiency}^*}$$

- * The efficiency of the system can usually be obtained from the manufacturer or a local service company for the equipment being considered.

9. To arrive at an estimate of the annual fuel consumption in actual fuel units, simply divide the AHL (step 6) by the mechanical plan efficiency and the appropriate conversion factor listed below:

$$\text{Annual Fuel Requirement} = \frac{\text{Annual Heating Load}}{\text{Mechanical Plan Efficiency} \times \text{Conversion Factor}}$$

<u>FUEL UNITS</u>	<u>BTU'S</u>
1 gal. of heating oil	138,000 (average)
1 cu. ft. of gas	1,000 (average)
1 KWH of electricity	3,413

It should be reiterated that these calculations are for simple and quick estimates and should not be used as a final design tool. To produce effective passive solar systems, the designer must use precise computations along with the exact climatic data for the specific site.

To analyze a passive solar house, it always helps to have some guidelines by which to judge the performance. Past experience indicates that the following energy consumption levels are typical:

6-8 BTU/SF/DD - a well insulated house using conventional heat

3-4 BTU/SF/DD - a good passive solar house

1-2 BTU/SF/DD - an excellent passive solar house

These figures give a good indication of the type of performance that can be expected. A "good" passive solar house can save, on the average, 50 percent of the annual fuel consumption of a well insulated home with conventional heat. By converting these figures into energy budgets, the following table gives approximate heating loads for each listed degree day climate.

Energy Use Index (EUI) <u>MBTU/SF/YR</u>	Heating Degree Days									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Well insulated conv. house	6-8	12-16	18-24	24-32	30-40	36-48	42-56	48-64	54-72	60-80
Good passive solar house	3-4	6-8	9-12	12-16	15-20	18-24	21-28	24-32	27-36	30-40
Excellent passive solar house	1-2	2-4	3-6	4-8	5-10	6-12	7-14	8-16	9-18	10-20

Table 1.

		Solar Heating Fraction (SHF)									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Little Rock, AR 3219 DD 35° North Lat.	DG	269	140	84	53	33	19	---	---	---	
	DGNI	405	189	116	82	61	47	35	25	15	
	TW	232	112	67	44	30	21	14	9	---	
	TWNI	356	165	103	73	54	40	30	22	14	
	WW	239	108	66	46	33	24	17	11	---	
	WWNI	365	172	107	76	57	44	35	26	18	
Washington, DC 4224 DD 39° North Lat.	DG	226	115	67	40	23	---	---	---	---	
	DGNI	352	162	100	70	52	39	29	20	12	
	TW	180	85	50	32	21	13	8	---	---	
	TWNI	285	131	81	57	41	31	22	16	10	
	WW	179	79	47	32	22	15	9	---	---	
	WWNI	292	135	83	58	44	33	25	18	12	
Apalachicola, FL 1308 DD 30° North Lat.	DG	818	446	287	199	144	105	75	52	31	
	DGNI	1094	506	321	230	175	137	107	80	55	
	TW	635	313	194	133	95	70	51	36	24	
	TWNI	906	240	266	189	142	108	82	61	42	
	WW	700	322	204	145	110	85	65	48	32	
	WWNI	956	444	281	203	155	123	97	75	53	
Gainesville, FL 1239 DD 30° North Lat.	DG	858	467	301	210	152	111	81	56	34	
	DGNI	1146	524	335	241	184	145	113	84	58	
	TW	662	326	202	139	100	73	54	39	25	
	TWNI	943	435	276	197	148	113	86	64	44	
	WW	731	333	212	152	116	90	69	51	35	
	WWNI	1000	457	292	211	162	129	102	79	56	
Tallahassee, FL 1485 DD 30° North Lat.	DG	702	383	245	169	121	88	63	43	25	
	DGNI	952	439	276	199	151	119	92	69	47	
	TW	563	279	172	117	84	61	45	32	21	
	TWNI	809	376	237	169	127	97	73	54	37	
	WW	621	285	179	128	97	75	57	42	28	
	WWNI	857	397	249	180	138	109	87	67	48	
Tampa, FL 683 DD 28° North Lat.	DG	1403	803	534	381	281	210	157	114	75	
	DGNI	1743	871	570	416	322	256	201	153	107	
	TW	1059	548	351	245	179	134	100	73	49	
	TWNI	1443	717	467	339	258	199	152	114	80	
	WW	1147	573	374	272	210	166	129	98	69	
	WWNI	1520	760	500	365	283	227	182	141	102	

		Solar Heating Fraction (SHF)									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Atlanta, GA 2961 DD 34° North Lat.	DG	342	180	110	72	48	31	18	---	---	
	DGNI	501	230	142	100	75	58	43	31	20	
	TW	286	138	55	38	27	18	12	7	---	
	TWNI	431	198	123	87	64	48	36	26	17	
	WW	301	136	83	58	43	31	23	15	8	
	WWNI	448	207	129	91	69	54	42	32	22	
Lexington, KY 4683 DD 38° North Lat.	DG	151	71	36	---	---	---	---	---	---	
	DGNI	261	119	72	50	36	27	19	12	---	
	TW	148	70	40	25	16	10	5	---	---	
	TWNI	242	112	69	48	35	26	19	13	8	
	WW	143	63	36	24	16	10	---	---	---	
	WWNI	246	114	70	49	36	28	21	15	10	
Lake Charles, LA 1459 DD 30° North Lat.	DG	601	325	208	143	102	73	51	34	18	
	DGNI	817	377	239	173	132	102	79	59	39	
	TW	481	237	146	100	71	52	38	26	17	
	TWNI	695	322	204	146	109	83	63	46	32	
	WW	522	239	152	109	82	63	48	35	23	
	WWNI	730	338	214	155	119	94	74	57	40	
Shreveport, LA 2184 DD 32° North Lat.	DG	406	218	137	92	64	44	29	17	---	
	DGNI	573	266	167	120	91	71	54	40	26	
	TW	340	167	103	69	49	35	25	17	10	
	TWNI	500	234	148	105	79	60	45	33	22	
	WW	361	166	104	74	65	42	31	22	14	
	WWNI	524	245	154	111	85	67	53	40	28	
Greensboro, NC 3805 DD 36° North Lat.	DG	264	137	82	52	33	19	---	---	---	
	DGNI	399	184	114	81	60	46	34	24	15	
	TW	231	112	67	44	30	21	14	9	---	
	TWNI	354	165	103	72	54	40	30	22	14	
	WW	237	107	66	46	33	24	17	11	---	
	WWNI	367	170	107	75	57	44	35	26	18	
Hatteras, NC 2612 DD 35° North Lat.	DG	463	249	156	105	73	50	34	20	---	
	DGNI	652	302	190	134	101	78	59	43	28	
	TW	381	187	115	77	54	39	28	19	11	
	TWNI	560	261	164	115	86	65	49	36	24	
	WW	412	189	118	82	61	46	34	24	15	
	WWNI	588	274	173	123	93	73	57	43	30	

Solar Heating Fraction
(SHF)

		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Raleigh, NC	DG	291	152	92	59	38	24	12	--	--
3393 DD	DGNI	432	200	124	87	66	51	38	27	17
36° North Lat.	TW	249	120	72	48	33	23	16	10	5
	TWNT	378	175	109	77	57	43	32	23	15
	WW	256	117	71	50	37	27	19	12	7
	WWNI	391	182	114	80	61	48	37	28	19
Oklahoma City, OK	DG	276	144	87	56	36	21	--	--	--
3725 DD	DGNI	412	192	119	84	63	48	36	26	16
35° North Lat.	TW	243	118	71	47	32	23	15	10	5
	TWNI	370	172	108	76	57	43	32	23	15
	WW	250	115	70	49	36	26	19	12	6
	WWNI	382	179	112	80	60	47	37	28	19
Charleston, SC	DG	507	276	174	118	83	58	40	25	--
2033 DD	DGNI	703	329	205	147	111	87	67	49	33
33° North Lat.	TW	407	202	124	84	59	43	31	21	13
	TWNI	594	279	176	124	93	71	53	39	27
	WW	442	204	127	90	67	52	39	28	18
	WWNI	624	295	184	132	100	79	63	48	34
Nashville, TN	DG	244	122	71	43	25	--	--	--	--
3578 DD	DGNI	384	172	104	72	53	40	30	20	12
36° North Lat.	TW	219	103	61	39	26	18	11	7	--
	TWNI	343	155	95	66	48	36	27	19	12
	WW	227	99	59	40	28	20	13	8	--
	WWNI	355	161	98	68	51	39	30	23	15
Oak Ridge, TN	DG	222	111	64	38	20	--	--	--	--
3817 DD	DGNI	352	160	97	68	50	38	28	19	11
36° North Lat.	TW	201	95	56	36	24	16	6	--	--
	TWNI	315	145	89	62	46	34	25	18	11
	WW	204	90	54	36	26	18	12	6	--
	WWNI	325	149	92	64	48	37	29	21	14
Brownsville, TX	DG	1309	741	493	351	258	192	142	101	65
600 DD	DGNI	1607	804	533	390	300	235	183	138	95
26° North Lat.	TW	976	506	324	226	165	123	91	66	44
	TWNI	1330	664	435	315	238	183	140	104	71
	WW	1052	526	348	254	194	151	117	88	60
	WWNI	1399	700	465	342	265	209	165	127	90

		Solar Heating Fraction (SHF)									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
El Paso, TX 2700 DD 32° North Lat.	DG	506	278	177	121	85	60	41	26	--	
	DGNI	688	331	209	150	114	88	68	50	33	
	TW	402	202	125	85	60	44	31	22	13	
	TWNI	582	279	178	126	94	72	54	40	27	
	WW	431	205	129	92	69	52	39	28	18	
	WWNI	608	295	187	134	103	80	63	48	34	
Fort Worth, TX 2405 DD 33° North Lat.	DG	424	231	146	98	68	47	31	19	--	
	DGNI	590	280	177	127	96	75	57	42	27	
	TW	344	171	106	71	50	36	26	18	10	
	TWNI	503	239	152	108	81	61	46	34	23	
	WW	364	171	108	76	57	43	32	23	14	
	WWNI	526	251	159	115	87	69	54	41	29	
Midland, TX 2591 DD 32° North Lat.	DG	449	246	156	106	74	51	35	21	--	
	DGNI	616	298	188	134	102	79	61	45	29	
	TW	362	182	113	76	54	39	28	19	12	
	TWNI	527	253	161	115	86	65	49	36	24	
	WW	385	184	115	82	61	47	35	25	16	
	WWNI	548	267	169	121	93	73	57	44	31	
San Antonio, TX 1546 DD 30° North Lat.	DG	644	351	224	155	110	79	56	38	21	
	DGNI	873	406	256	184	140	110	85	63	43	
	TW	501	248	154	104	75	54	40	28	18	
	TWNI	722	337	213	152	114	87	66	49	33	
	WW	547	253	159	114	86	66	50	37	24	
	WWNI	762	255	224	162	124	98	78	60	42	

Sample Problem

WORKSHEET FOR ESTIMATING PASSIVE SOLAR PERFORMANCE

A 72'x24' RANCH HOME IN ATLANTA WITH 309 SF OF WATER WALL WITH NIGHT INSULATION ON THE SOUTH FAÇADE. AN OIL BURNING FURNACE WILL PROVIDE THE AUXILIARY HEAT REQUIRED.

1) Building Skin Conductance

<u>Surface Type</u>	<u>Area</u>	<u>"U"</u>	<u>"A x U"</u>
WATER WALL	309	X	= NOT INCLUDED
OTHER WALL	1,107	X	= 77.5
WINDOWS	120	X	= 66.0
ROOF	1,728	X	= 86.4
FLOOR	1,728	X	= 86.4
		X	=

Building Skin Conductance = 316.3 BTU/°F/HR

2) Infiltration Loss

$$\frac{\text{Interior Volume}}{12,320 \text{ cf}} \times \frac{\text{Air Change}}{0.5} \times 0.018 = 110.9 \text{ (BTU/}^{\circ}\text{F/HR)}$$

3) Building Loss Coefficient (add #1 plus #2)=

<u>427.2</u>	BTU/°F/HR
<u>x 24</u>	HR
<u>10.253</u>	BTU/DD

4) Load Collector Ratio

$$\frac{\text{Building Loss Coefficient}}{\text{Solar Collector Area}} = \frac{10,253}{309} \frac{\text{BTU/DD}}{\text{SF}}$$

$$= 33.2 \frac{\text{BTU/DD}}{\text{SF}}$$

5) Load Collector Ratio (LCR) 33.2 BTU/DD/SF

First Table Number	<u>42</u>	First Table Number	<u>42.0</u>
Second Table Number	<u>- 32</u>	Calculated LCR	<u>- 33.2</u>
difference # 1	<u>10</u>	difference # 2	<u>8.8</u>

$\frac{\text{difference \# 2}}{\text{difference \# 1}} = \text{interval ratio}$

$$\frac{8.8}{10} = .88$$

SHF for first table number	<u>0.7</u>
SHF for second table number	<u>- 0.8</u>
difference # 3	<u>0.1</u>

difference #3 x interval ratio = $\frac{\text{SHF interval} + \text{SHF for first table number}}{\text{final SHF}}$

$$\begin{array}{rcl} .88 \times .1 & = & .088 \\ & + & .7 \\ \text{final SHF} & = & .788 \end{array}$$

6) Annual Heating Load (AHL)

(1-SHF) X BLC X DD = AHL

$$.212 \times 10.253 \times 2961 = 6,436,136 \text{ BTU/YR}$$

7) Annual Energy Use Index (AEUI)

$\frac{\text{AHL}}{\text{FA}} = \text{AEUI}$

$$\frac{6,436,136 \text{ BTU/YR}}{1,728 \text{ SF}} = 3,725 \text{ BTU/SF/YR}$$

8) Energy Budget (EB)

$$\frac{\text{AEUI}}{\text{Eff}} = \text{EB}$$

$$\frac{3,725 \text{ BTU/SF/YR}}{0.6} = \frac{6,208 \text{ BTU/SF/YR}}$$

9) Annual Fuel Requirement (AFR)

$$\frac{\text{AHL}}{\text{Eff} \times \text{CF}} = \text{AFR}$$

$$\frac{6,436,176 \text{ BTU/SF/YR}}{0.6 \times 138,000 \text{ BTU/gal.}} = \frac{78 \text{ gal. of oil}}$$

$$\frac{\text{BTU/SF/YR}}{\times 1,000 \text{ BTU/CF}} = \text{CF of gas}$$

$$\frac{\text{BTU/SF/YR}}{\times 3,413 \text{ BTU/KWH}} = \text{KWH of elect.}$$

WORKSHEET FOR ESTIMATING PASSIVE SOLAR PERFORMANCE1) Building Skin Conductance

<u>Surface Type</u>	<u>Area</u>	<u>"U"</u>	<u>A x U</u>
		x	=
		x	=
		x	=
		x	=
		x	=
		x	=
		x	=

Building Skin Conductance = BTU/°F/HR

2) Infiltration Loss

Interior Volume Air Change
 _____ x _____ x 0.018 = _____ (BTU/°F/HR)

3) Building Loss Coefficient (add #1 plus #2)=

_____ BTU/°F/HR
 _____ x 24 HR
 _____ BTU/DD

4) Load Collector Ratio

Building Loss Coefficient = _____ BTU/DD
Solar Collector Area SF
 = _____ BTU/DD/SF

5) Load Collector Ratio (LCR) _____ BTU/DD/SF

First Table Number	_____	First Table Number	_____
Second Table Number	- _____	Calculated LCR	- _____
difference # 1	_____	difference # 2	_____

$\frac{\text{difference \# 2}}{\text{difference \# 1}} = \text{interval ratio}$

_____ = _____

SHF for first table number _____
SHF for second table number _____
difference # 3 _____

difference #3 x interval ratio = $\frac{\text{SHF interval} + \text{SHF for first table number}}{\text{final SHF}}$

_____ x _____ = _____
final SHF = _____

6) Annual Heating Load (AHL)

(1-SHF) X BLC X DD = AHL

_____ x _____ x _____ = _____ BTU/YR

7) Annual Energy Use Index (AEUI)

$\frac{\text{AHL}}{\text{FA}} = \text{AEUI}$

_____ $\frac{\text{BTU/YR}}{\text{SF}}$ = _____ BTU/SF/YR

8) Energy Budget (EB)

$$\frac{AEUI}{Eff} = EB$$

$$\frac{\text{BTU/SF/YR}}{\text{BTU/SF/YR}} =$$

9) Annual Fuel Requirement (AFR)

$$\frac{AHL}{Eff \times CF} = AFR$$

$$\frac{\text{BTU/SF/YR}}{X 138,000 \text{ BTU/gal.}} = \text{gal. of oil}$$

$$\frac{\text{BTU/SF/YR}}{X 1,000 \text{ BTU/CF}} = \text{CF of gas}$$

$$\frac{\text{BTU/SF/YR}}{X 3,413 \text{ BTU/KWH}} = \text{KWH of elect.}$$

CODES AND STANDARDS

A majority of states, municipalities, and territories included in this manual enforce or reference building and/or energy codes and standards.

These codes and standards often impose restrictions on passive solar designs by prescribing the use and performance of the construction materials.

Most of these codes, however, contain equivalency clauses which give the passive solar designer/builder more flexibility by allowing the performance of his design to be compared with that of a reference building which complies with the prescriptive nature of the code.

The following pages summarize the elements of the predominant codes currently enforced in the SSEC jurisdictions which are critical to the passive solar designer/builder.

The state, local, and territorial descriptions which follow in Part III reference one or more of these codes and standards. This allows the user of this manual to identify quickly and comply with the constraints of the code for the area in which the passive solar house is to be built.

Energy Conservation in New Building Design, ASHRAE Standard 90-75

Issued by: The American Society of Heating, Refrigerating,
and Air-Conditioning Engineers, Inc.
345 East 47th Street
New York, New York 10017

ASHRAE 90-75 is the first national technical standard aimed specifically at reducing energy consumption in buildings. As such, it provides the technical basis for subsequent legal models used in all 19 jurisdictions. It prescribes performance levels for individual building components, but has provisions for evaluation of alternate designs.

POINTS OF IMPORTANCE:

Paragraph 4.2.4.1 - Specifically states that trade-offs are allowed between U_o values of assemblies (i.e., roof/ceiling, walls, etc.) as long as the overall heat gain/loss for the entire building envelope remains the same.

Paragraph 4.3.2.1 - Establishes an overall "U" value requirement for walls, windows, and doors. In comparison with a standard counterpart, a passive solar design would call for larger areas of glazing on the south facade. In addition to the added cost of more glass, there is the additional expense of more insulation necessary to bring the overall "U" value down to that of the standard design.

Paragraph 10 - Describes the requirements to show equivalency of an alternate design. The basis for comparison must be a building designed according to the criteria in sections 4 through 9 and of the same size and usage as the alternate design.

Paragraph 10.4.1 - Exempts single family detached housing from the requirements for full year simulation calculations. Instead, a registered engineer may substitute simplified degree day calculations or similar methods.

Paragraph 11 - States the requirements for demonstrating the equivalency of a building utilizing non-depleting energy sources. It credits solar energy passing through windows with the following restrictions:

- a) Moveable insulation of some sort is required and must meet the performance required in section 4.

b) The window must be shaded whenever cooling is required.

It requires that an energy analysis prove the alternate design to be equally or more energy conservative than a design following prescribed standards.

It exempts from full year simulation calculations residential structures of less than 20,000 square feet which use non-depleting sources for a "significant portion of their total annual energy usage." Instead, verification is required from a registered engineer attesting to the percentage supplied by the non-depleting sources.

ANALYSIS:

While the basic standard penalizes the passive solar design economics by increasing initial costs for extra insulation in the building envelope, it does allow consideration of alternate designs under paragraphs 10 and 11. Even so, there would still be the added expense of more design and documentation required to demonstrate the alternate's equivalency. Perhaps most important, though, is the requirement that in order to gain credit for solar gain through windows there must be moveable insulation. While this is a good design procedure for passive solar, many systems have been built without it. As a result, care must be taken on this point whenever dealing with codes based on this standard.

ASHRAE 90-75 Component Performance Requirements	HEATING DEGREE DAYS									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U" VALUES</u>										
Roof, w/ attic	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
Roof, cathedral ceiling	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
U _o - wall, window, door	0.29	0.28	0.26	0.25	0.23	0.22	0.20	0.19	0.17	0.16
Floor, over unheated space	0.32	0.25	0.18	0.11	0.08	0.08	0.08	0.08	0.08	0.08
<u>"R" VALUES</u>										
Heated Slab	3.3	4.0	4.8	5.5	6.3	7.0	7.8	8.5	9.3	10.0
Unheated Slab	-	-	2.9	3.5	4.2	4.9	5.5	6.2	6.8	7.5
<u>INFILTRATION</u>										
Windows CFM/Lin.Ft.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Door CFM/Sq.Ft.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Sliding Door CFM/Sq.Ft.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Notes:

1. Pipe and Duct Insulation:
For insulation requirements for ducts and pipes see Table 5.1 (page 26)
2. Equipment Efficiency
Criteria for Coefficients of Performance (COP) and Energy Efficiency Ratings (EER) are listed in Chapter 6.

Notes:

3. **Caulking and Weatherstripping**

Paragraph 4.5.4 requires caulking and weatherstripping for all openings in the exterior envelope.

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed. Interpolation may produce inaccuracies; therefore, any actual design work should always refer to the code itself.

Addendum to Energy Conservation in New Building Design,
ASHRAE 90-75: (Section 12) Annual Fuel and Energy Resource
Determination

Issued by: The American Society of Heating, Refrigerating,
and Air-Conditioning Engineers, Inc.
345 East 47th Street
New York, New York 10017

Because of organizational procedures this section was published in February of 1977 as a separate companion document to ASHRAE Standard 90-75. However, it was done with the intention that it be incorporated into ASHRAE 90-75R, a revision still to be adopted.

ANALYSIS:

This section contains the format required to determine annual resource requirements. Integral to it is the use of Resource Utilization Factors (RUF) which incorporate into the consumption figures the resources required to bring energy to the site. These factors are subject to constant change and, therefore, are not actually part of the standard, but rather attachments to it. Although not specifically intended, the format does allow the inclusion of solar contribution, and this section would be of great benefit in documenting equivalency of a passive solar design. Unfortunately, this addendum was issued after the NCSBCS Model Code for Energy Conservation in New Buildings and, therefore, has not been included in the code. However, because it is an ASHRAE procedure, it will probably be acceptable to most building officials.

Energy Conservation in New Building Design ASHRAE 90-75R

Issued by: The American Society of Heating, Refrigerating
and Air-Conditioning Engineers, Inc.
345 East 47th Street
New York, New York 10017

and: Illuminating Engineering Society
of North America
345 East 47th Street
New York, New York 10017

ASHRAE 90-75R, the draft revision to ASHRAE 90-75, is still in the comment phase of the review process.

POINTS OF IMPORTANCE:

The most significant proposed change from the original ASHRAE 90-75 is the addition of Section 12.0, "Annual Fuel and Energy Resource Determination." Other prospective changes to the first eleven sections are relatively minor and will be listed below and in the following table.

Section 4.3 - Some "U" values change, but the methods of calculation and the impact on passive solar design are the same.

Section 10 - Alternate designs for buildings of less than 10,000 square feet (previously 20,000 square feet) whose mechanical systems do not heat and cool simultaneously (e.g., some dual duct systems) are exempted from providing annual simulations.

ANALYSIS:

The revision to the first eleven sections has very little impact on passive solar designs. There is a slight economic penalty due to higher first costs (for materials) or higher design fees (for documentation of alternate designs). However, the Annual Fuel and Energy Resource Determination may have a favorable impact in that a building's entire energy requirement and utilization will be analyzed and compared with other sources of energy. In this light, passive solar will certainly be viewed more favorably.

Standard 90-75R is still in draft form and there is no assurance that any of the changes will be kept in the final version. The present plans are for the revision to be issued in three volumes:

- 90.1 - Sections 1 through 9
- 90.2 - Sections 10 and 11
- 90.3 - Section 12

To this date, the comment phase has been closed for only 90.1 (June 10, 1979), and the publication date of the final results is still unknown.

ASHRAE 90-75R Component Performance Requirement	Heating Degree Days									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U" VALUES</u>										
Roof w/ attic	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03
Roof cathedral ceiling	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Uo - wall, window, door	0.29	0.26	0.24	0.21	0.19	0.18	0.17	0.16	0.15	0.14
Floor, over unheated space	0.32	0.25	0.18	0.11	0.08	0.08	0.08	0.08	0.08	0.08
Floor exposed to exterior	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03
<u>"R" VALUES</u>										
Heated Slab	3.4	4.1	4.9	5.6	6.4	7.1	7.9	8.6	9.4	10.1
Unheated Slab			2.9	3.6	4.3	4.9	5.6	6.3	7.0	7.6
<u>INFILTRATION</u>										
Window CFM/lin.ft	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Door CFM/lin.ft	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sliding door CFM/sq. ft.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
*Section added as part of revision										

Notes:

1. Pipe and Duct Insulation:
For insulation requirements for ducts and pipes see Table 5.1 (page 19)
2. Equipment Efficiency
Criteria for Coefficients of Performance (COP) and Energy Efficiency Ratings (EER) are listed in Chapter 6.

Notes:

3. Caulking and Weatherstripping

Paragraph 4.5.4 requires caulking and weatherstripping for all openings in the exterior envelope.

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed. Interpolation may produce inaccuracies; therefore, any actual design work should always refer to the code itself.

BOCA

BOCA Basic Building Code

The BOCA Basic Building Code/1978 - 7th Edition

Issued by: Building Officials & Code Administrators
International, Inc.
1313 East 60th Street
Chicago, Illinois 60637
(312) 947-2580

Model building regulations for the protection of public health, safety and welfare that are issued every three years.

POINTS OF IMPORTANCE:

Section 109.4 - Reads: "The building official may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the intent of the provisions of this code..."

This section allows the building official to approve any alternate material or method as long as it is proven to achieve the same effect as the code and is shown not to be hazardous.

Section 506 - Establishes the requirements for having in every "habitable and occupiable room" a minimum glazing area of 8 percent of the floor area, $\frac{1}{2}$ of which must be operable to provide for natural ventilation.

Section 506.4 - States: "In place of the means for natural light and ventilation herein prescribed, alternate arrangements of windows, louvres, or other methods and devices that will provide the equivalent minimum performance requirements, shall be permitted...."

Section 857.5 - Establishes the wind loads and thickness requirements for glass installed in vertical walls.

Section 925.3 - States the restrictions for skylights:

- a. Wired glass (unless over a vent shaft or enclosed stair)
- b. Single panel not to exceed 720 sq. in.
- c. No dimension to exceed 48 in.

These restrictions do not apply to glass block skylights or greenhouses.

Section 1902-1905 - Sets forth the restrictions for use of light, transmitting plastic glazing, exterior wall panels, roof panels, or skylights.

Article 20 - Energy Conservation

The building envelope requirements are the same as those stated in ASHRAE 90-75 except that the requirements for mechanical equipment efficiencies are not included.

ANALYSIS:

There are no provisions which would prohibit solar features. Section 109.4, the light and ventilation section, as well as the energy conservation article, both have clauses which allow consideration of alternate designs. There is some restriction on the use of plastic, but this constraint applies more to a material component than to passive solar itself.

Building Energy Performance Standards

Building Energy Performance Standards (BEPS)

(Advance Notice of Proposed Rulemaking - November 21, 1979)

Issued by: Department of Energy
Washington, D. C.

These standards, which are still in the development process, are the result of Title III of the Energy Conservation and Production Act (P.L. 94-385). Originally, HUD, and now DOE, was asked to develop building performance standards to improve energy efficiency and encourage the use of non-depletable energy sources.

POINTS OF IMPORTANCE:

Section IV.D.4 - Explains the development of the standards for single family residences. The proposal is to use the National Association of Home Builders (NAHB) Thermal Performance Guidelines (TPG) to determine a "floating energy budget" based on local conditions. Once the energy budget is established, the designer/builder is then free to choose methods, processes, and materials, as long as the final design stays within the delineated energy budget.

Section V.B.4.a. (2) - Contains tables for average design energy consumption for single family homes as per NAHB/TPG. They are broken down into seven climatic zones as described in the accompanying figure.

Appendix I - Contains the preliminary standards format.

part 435.8.18 and .19 - Describes the procedure to establish an energy budget utilizing the NAHB/TPG. Essentially, the ASHRAE modified degree day method is used for heating and the ASHRAE equivalent full-load hours method for cooling.

part 435.9 - Contains the proposed procedure for evaluating the energy performance of a structure. Allows the use of any technique listed in "Bibliography on Available Computer Programs in the General Area of Heating, Refrigerating, Air-Conditioning and Ventilating," AHSRAE 1975.

ANALYSIS:

The proposed performance standards depend entirely on the NAHB/TPG for their energy budgets. Since these guidelines do not allow for the consideration of passive solar techniques, procedures for alternate designs would have to be used. This requires determining the budget for an equivalent conventional house. Most builders would require the assistance of an architect or engineer for these calculations, and the procedure is not well suited to the evaluation of passive solar contributions. As a result, a computer simulation would probably be necessary, at a cost which is prohibitive to many builders.

BEPS - DOE Average Performance Budget MBTU/SF/YR	CLIMATIC ZONE									
	1	2	3	4	5	6	7	8	9	10
Single Family Detached										
Gas	110	106	100	81	50	55	79			
Oil	72	62	74	55	N/A	43	N/A			
Electric	32	28	31	29	21	29	29			

* N/A - Fuel not reported used in that climatic zone.

Notes:

The values listed in these tables are for estimating and comparative purposes only. As such the numbers are for the specific degree days listed. Interpolation may produce inaccuracies and therefore any actual design work should always refer to the code itself.

Thermal Performance Standards

Issued by: Farmers Home Administration, USDA
Washington, D. C.

These standards prescribe the minimum requirements for all Rural Housing (RH) loan and grant programs.

POINTS OF IMPORTANCE:

Section III.A. - Gives the minimum insulation requirements for building components (walls, floors, ceilings, etc.)

Section III.C. - States that housing designs not in compliance with Section III.A. are acceptable if the design can be proven equivalent through the use of the overall heat transmittance (U_o) for walls and ceiling. Another method of demonstrating compliance is to show equivalent performance of the overall structure using documentation based on the current ASHRAE Handbook of Fundamentals or some other universally accepted engineering procedure.

Section IV.A. - Provides several general design recommendations, including plantings, orientation of entry door, configuration, and glazing. Included is a table which provides approximate overhang widths to control solar gain during non-heating periods.

ANALYSIS:

These guidelines do not prohibit the use of passive solar techniques. However, deterrents include higher initial costs for more insulation and glass, and the added expense of documenting equivalent energy consumption.

TPS- FmHA Component Performance Requirements	Heating Degree Day									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U" VALUES</u>										
Ceilings	.05	.04	.03	.03	.03	.03	.026	.026		
Walls	.08	.07	.05	.05	.05	.05	.05	.05		
Floors	.08	.07	.05	.05	.05	.05	.05	.05		
Glazing	1.13	.69	.69	.69	.47	.47	.47	.47		
Storm doors			* yes	* yes	yes	yes	yes	yes		
FOUNDATION WALLS- For Heated basement (Non-habitable living area) or heated crawl space										
Walls					.17	.10	.10	.10		
Glazing **	1.13	1.13	1.13	1.13	1.13	.69	.69	.69		
<u>"R" VALUES</u>										
Heated Slab	3.5	4.0	4.8	5.5	6.3	7.0	7.8	8.5	9.2	10.0
Unheated Slab		2.5	2.8	3.5	4.2	4.8	5.5	6.2	6.8	7.5

*If door has hollow core or over 25% glass

**Glazing in heated basement limited to 5%

TPS-FmHA Component Performance Requirements	Heating Degree Day									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U_O" VALUES</u>										
Walls	.24	.20	.18	.16	.14	.13	.11	.11	.11	.11
Ceiling	.05	.045	.04	.036	.031	.026	.026	.026	.026	.026
<u>INFILTRATION</u>										
Doors CFM/lin. ft.	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Windows CFM/lin. ft.	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Sliding doors CFM/SF	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5

Note:

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed. Interpolation may produce inaccuracies and therefore any actual design work should always refer to the code itself,

HUD Minimum Property Standards

HUD Minimum Property Standards for One- and Two-Family Dwellings (Volume 1)

Issued by: U.S. Department of Housing and Urban Development
Washington, D.C.

These standards set the minimum level of quality in construction acceptable to HUD. Any project wishing to take advantage of a HUD program must meet these standards.

POINTS OF IMPORTANCE:

Section 101-1 - States, "These standards are intended to encourage the use of new or innovative technologies, methods or materials. However, in all cases, equivalency with the standards must be demonstrated.

Section 403 - "Light and Ventilation" - Gives the minimum requirements for natural light and ventilation. The minimum for most spaces is 10 percent of the floor area, with $\frac{1}{2}$ operable for natural ventilation. Table 4-3-1 lists all of the specific requirements.

Section 508-5 & 6 - States the requirements for metal and wood windows.

Section 508-8 - States the requirements for glazing. The area to thickness chart is shown in Figure 5.8.1.

Section 607-3 - "Building Insulation" - This section gives the insulation levels required for building components and the requirements for performance criteria for alternate designs. The recommended "U" values for individual components are listed in Table 6-71. Note #4 limits the amount of glass in the gross area of the exterior wall to 15 percent, except when it can be demonstrated that the daily winter solar gain exceeds the 24-hour heat loss through the glass. Windows must also be shaded from solar gain during the summer. The criteria for alternate designs take the form of an overall coefficient (U_o) which allows trade-offs between "U" values of various components.

Paragraph 607-3.5 specifically states that passive solar contributions can be considered for alternative designs as long as analysis of their performance is compared with an equivalent design using the recommended "U" values.

Section 615-3.1 and 4.2 - These sections give the acceptable form for heat loss and heat gain calculations.

ANALYSIS:

These standards are precise in the thermal requirements and do not deal with passive solar as a standard construction technique, thereby requiring extra documentation to prove equivalent energy conservation. However, passive solar techniques are specifically mentioned, and this may help builders in getting approval for such systems. But performance of a passive solar design must be evaluated and compared to an equivalent conventional design. This may cause difficulty, since preparation of such an analysis could be costly.

HUD - MPS Component Performance Requirements	HEATING DEGREE DAYS									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U" VALUE - Individual Component</u>										
Ceilings ER	.050	.040	.030	.030	.030	.026	.026			
FF	.050	.050	.040	.030	.030	.030	.026			
Walls ER	.08	.07	.05	.05	.05	.05	.05			
FF	.08	.08	.08	.07	.07	.07	.05			
Floors ER	-	-	.07	.05	.05	.05	.05			
FF	-	-	-	.07	.07	.07	.05			
Windows ER	1.13	.69	.69	.69	.47	.47	.47			
FF	1.13	1.13	1.13	.69	.69	.69	.47			
Sliding Glass Doors ER	1.13	.69	.69	.69	.69	.69	.69			
FF	1.13	1.13	1.13	.69	.69	.69	.69			
Storm Doors ER	NO	NO*	NO*	NO*	YES	YES	YES			
FF	NO	NO	NO	NO*	NO*	NO*	YES			
Walls of heated Bsmt or crl sp	-	-	0.17	0.17	0.10	0.10	0.10	0.10	0.10	

* Storm door required if primary door has hollow core or over 25 percent glass.

Note: HUD/MPS specifies separate U-values for electric resistance heat (ER) and heat pump or fossil fuel heat (FF).

HUD - MPS Component Performance Requirements	Heating Degree Days									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
"U" VALUE - Overall Coefficient										
U _o Gross Wall ER	.24	.175	.16	.145	.125	.11	.11	.11	.11	
FF	.26	.235	.22	.20	.175	.11	.11	.11	.11	
U _o Gross Ceiling ER	.05	.042	.038	.033	.026	.026	.026	.026	.026	
FF	.05	.05	.05	.044	.033	.026	.026	.026	.026	

Notes:

HUD/MPS specifies separate U-values for electric resistance heat (ER) and Heat Pump or Fossil Fuel Heat (FF)

1) Caulking and Weatherstripping -

Section 607-4 requires caulking of all openings in the building envelope, all junctions between major components (e.g., wall to floor) and joints between dissimilar materials.

Section 608-2.2 and -4.1 requires weatherstripping for all doors and windows.

2) Slab Edge Insulation - The heat loss from the perimeter of concrete slabs-on-ground shall not exceed the following:

42 BTUh for unheated slabs
50 BTUh for heated slabs

This can be achieved with insulation ranging from R = 2.5 to R = 5.0 (see Table 6-7.4 for precise values).

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed, and interpolation may produce inaccuracies. Any actual design work should always be done by referring to the code itself.

HUD Solar Standards

Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems (Volume 5)
(1977 edition)

Issued by: U. S. Department of Housing and Urban Development
Washington, D. C.

These standards are a supplement to HUD's Minimum Property Standards dealing specifically with aspects of planning and design which utilize solar heating and domestic hot water systems.

POINTS OF IMPORTANCE:

Section S-1010-1 - Allows variation for new materials and technologies. However, equivalence with these standards or HUD/MPS, in terms of performance and structure, must be demonstrated.

Section S-401-1 - States that passive solar building components shall be constructed so that there is no interference with their normal building functions.

Section S-403-3 - States that if an attic or other structural space is used as part of a passive solar system and other methods of controlling condensation are used, the requirements for venting these spaces may be waived.

Section S-405 - States that no solar energy system shall increase the fire hazard in a building or interfere with safe egress.

Section S-508-7.3 - States the specifications for screens which both shade the windows and keep out insects.

Section S-515-2.4 - Lists the specifications for absorptive coatings on collector surfaces.

Section S-515-2.6 - Lists the specifications for reflective and anti-reflective surfaces.

Section S-515-3 - Lists the specifications for energy transport systems, both liquid and air.

Section S-515-8 - States the specifications for heat transfer fluids.

Section S-515-11 - States the requirements for insulation and moisture protection.

Section S-600-2 - Restates the acceptability of alternate construction methods which are demonstrated to be equivalent to stated standards.

Section S-600-3 - States that an operating and maintenance manual must be provided to the homeowner for solar heating and domestic hot water systems.

Section S-600-6 - States that using any solar system shall not reduce the building's safety and health requirements.

Section S-607-3.1 - States the areas of application for building insulation.

Section S-607-3.2 - States that "U" values for insulation may be traded off to improve the overall thermal performance of a building.

Section S-615-1 - "Thermal Design"

S-615-1.2 - Requires that the auxiliary thermal energy subsystem provide 100 percent backup for the solar energy system.

S-615-1.3 - Describes the minimum system capacity requirements for space heating. The commentary for S-615-1.3.2.a recognizes that the calculation procedures these standards contain are inappropriate for passive systems, and allows the use of "other approved methods" for sizing and designing such systems.

Section 615-1.4 - Describes the minimum capacity requirements for domestic hot water systems.

Section 615-1.6 - Describes the environmental design conditions for passive solar systems, including the allowable temperature fluctuations for interior spaces.

Section S-615-2.2.5 - States the acceptable performance of passive thermosiphon systems.

Section S-615-7 - "Thermal Storage" describes the acceptable characteristics of various thermal storage systems.

ANALYSIS:

These standards were intended primarily for active solar heating

and domestic hot water systems. However, passive systems are mentioned throughout, and although none of the calculations address this system type, the standards do allow the use of "other approved methods." If adhered to, the requirements stated in this document would result in a well-design passive solar system. In addition, there are many sections not specifically mentioned under "Points of Importance" which address active system components but apply equally well to passive components (e.g., ducting, piping, valves, etc.). These standards, while mechanically excellent, are somewhat conservative in that they require the auxilliary system to be large enough to supply 100 percent of the heating load with absolutely no solar contribution. This requirement for a double system may be discouraging to some builders and will hopefully be revised.

NAHB

NAHB Thermal Performance Guidelines

NAHB Thermal Performance Guidelines for One- and Two-Family Dwellings (1978 Edition)

Issued by: The National Association of Home Builders
15th and M Streets, NW
Washington, DC 20005

These industry guidelines are intended to provide builders with a simple, easy-to-use manual for building cost-effective, energy conservative homes. There are component performance standards based on climatic data, local costs, and mechanical system efficiency.

POINTS OF IMPORTANCE:

p13 - building section #5 - Requires that any exterior wall have insulation. This may present a problem if a building official interprets as an exterior wall a Trombe Wall, which would not satisfy the requirement without moveable insulation.

p14 - building section #6 - Requires triple glazing in areas where the energy index is over 3,750. The energy index is an adjusted combination of the heating and cooling indices. It takes into consideration the local climatic data (both heating and cooling), local cost of energy, and mechanical system efficiencies.

ANALYSIS:

These guidelines are an easy-to-use manual for builders of conventional homes. However, unlike ASHRAE 90-75 and the model codes, there are no provisions for "alternate design" methods, nor is there an overall coefficient (U_o) procedure that allows trade-offs between components. In addition, the calculations used are based on several assumptions: a 7-year payback; a 10 percent annual increase in cost of energy; and a 9 percent alternate investment rate.

The procedures for modifying these assumptions are cumbersome and have no provisions for contributions by solar or other non-depletable energy sources.

NAHB - TPG Component Performance Requirements	Energy Index									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"R" Value</u>										
Ceiling	19	19	19	30	30	30	38	38		
Rigid Deck	10	10	10	12.5	15	15	17.5	20		
Frame wall	12	12	12	14	18	18	18	18		
Masonry wall	3	3	11	11	11	11	11	11		
Floor, over open space		11	11	19	19	19	22	22		
Floor over vented crawl space	11	11	19	19	19	19	22	22		
Floor over unvented crawl space		11	11	11	19	19	19	19		
Slab edge	5	5	5	7.5	7.5	10	10	10		
Perimeter wall unvented crawl		11	11	11	19	19	19	19		
Foundation exposed greater 47"			3A	3A	3A	3B	3B	3B		
Foundation exposed 24"-48"			3A	3B	3B	3B	3B	11B		
Foundation exposed less 24"			3B	3B	3B	3B	11B	11B		

A - Insulation extends to 24" below exterior grade

B - Insulation extends to basement floor

NAHB - TPG Component Performance Requirements	Energy Index									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
"R" VALUE FOR DUCT INSULATION										
In attic	6	8	10	12	14	14	14	14		
In vented crawl space	6	8	10	12	14	14	14	14		
In unvented crawl space, wall insul.		4	4	4	4	4	6	6		
In unvented crawl space, floor insul.		4	4	6	6	8	8	8		
In insulated basement	4	6	6	8	8	8	8	8		
Windows and patio doors	SG	SG	DG	TG	TG	TG	TG	TG		
Glass area of doors req. storm					2/3	1/3	1/3	1/3		

SF - Single glaze

DG - Double glaze

TG - Triple glaze

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed. Interpolation may produce inaccuracies and, therefore, any actual design work should always refer to the code itself.

NCSBCS Model Energy Code

Code for Energy Conservation in New Building Construction (December, 1977)

Jointly prepared by: National Conference of States on
Building Codes and Standards, Inc.
(NCSBCS)

Building Officials & Code Adminis-
trators International, Inc. (BOCA)

International Conference of
Building Officials (ICBO)

Southern Building Code Congress
International, Inc. (SBCC)

This code was the product of a contract between the U. S. Department of Energy (DoE) and the National Conference of States on Building Codes and Standards, Inc. (NCSBCS). The intention was to produce a model code based on ASHRAE Standard 90-75 that could be easily adopted by local building code officials.

POINTS OF IMPORTANCE:

Section 103.0 - States that this code should not "prevent the use of any material, method of construction, design or insulating system" as long as the building official is convinced that it meets the intent of the code.

Section 4 - Building Design by System Analysis and Design of Building Utilizing Non-Depletable Energy Sources.

This section describes the procedure for proving compliance of alternate designs. Such designs must have energy consumption equal to conventional designs, calculated according to the component performance method used in ASHRAE 90-75.

Section 402 - Describes the requirements for systems analysis. Requires that, using ASHRAE 90-75 guidelines, the energy consumption of a house of similar size and functional arrangements be developed for use as the "standard" against which the alternate design is compared.

Section 402.5 - States that residential buildings do not have to use a computer simulation of system performance for the required comparisons.

Section 403 - Describes the requirements necessary regarding energy consumption calculations when energy derived from non-depletable sources is used.

Section 403.2 - Excludes from full year energy analysis residential construction of less than 20,000 square feet and construction which receives at least 30 percent of its total annual energy from non-depletable sources.

Section 5 - Building Design by Component Performance Approach Guidelines as stated in ASHRAE 90-75.

Section 502.5 - States the component performance requirements for all residential buildings. In comparison with a standard counterpart, a passive solar design would call for larger areas of glazing on the south facade. In addition to the increase in cost due to more glass, there is the expense of added insulation to bring the overall "U" value down to that of the standard design.

Section 6 - Building Design by Acceptable Practice

This section gives examples of component construction which would satisfy the requirements of Section 5.

ANALYSIS:

Since this model code is based on ASHRAE 90-75 its impact on passive solar design is much the same. The code does not prohibit any aspects of passive solar design and contains sections which allow evaluation of alternate techniques. However, there is an economic discouragement in that the standard guidelines increase the first cost for materials for the alternative design, and there is an additional expense for documenting equivalent energy consumption.

NCSBCS Component Performance Requirements	Heating Degree Days									
	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
<u>"U" - VALUES</u>										
Roof w/attic	0.05	0.5	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04
Roof Cathedral Ceiling	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
"Uo" wall , window, door	0.29	0.28	0.26	0.25	0.23	0.22	0.20	0.19	0.17	0.16
Floor, over un-heated space	0.32	0.25	0.18	0.11	0.08	0.08	0.08	0.08	0.08	0.08
<u>"R" - VALUES</u>										
Heated Slab	3.3	4.0	4.8	5.5	6.3	7.0	7.8	8.5	9.3	10.0
Unheated Slab			2.9	3.5	4.2	4.9	5.5	6.2	6.9	7.5
<u>INFILTRATION</u>										
Window CFM/ lin.ft.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Door CFM/sq.ft.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Sliding Door CFM/sq.ft.	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Notes:

1. Pipe and Duct Insulation:
For insulation requirements for ducts and pipes see table 5-8 (page 40) of NCSBCS document.
2. Equipment Efficiency
Criteria for Coefficients of Performance (COP) and Energy Efficiency Ratings (EER) are listed in Section 503.0 Building Mechanical Systems

Notes:

3. Caulking and Weatherstripping

Section 502.4.c requires caulking and weatherstripping for all openings in the exterior envelope.

The values listed in these tables are for estimating and comparative purposes only. As such, the numbers are for the specific degree days listed. Interpolation may produce inaccuracies; therefore, any actual design work should always refer to the code itself.

NBC

National Building Code

The National Building Code (1976 edition)

Issued by: American Insurance Association
Engineering and Safety Service
85 John Street
New York, New York 10038

Model code containing regulations for all facets of building construction, operation, and demolition.

POINTS OF IMPORTANCE:

Section 100.7 - States that any material or method of construction is acceptable if the building official is convinced that specific provisions or the intent of the code are met.

Section 382.3 - Means of egress - requires that each habitable room have at least one window with a clear opening of 20" in width, 24" in height, and a minimum area of 5.7 square feet. The bottom sash must not be higher than 4 feet above the floor. Such a window is not required for rooms having 2 doors providing separate means of egress of a door which discharges at or near grade or to an exterior stairway/ramp which discharges at grade.

Section 382.7 - Requires that dwellings must be able to maintain 68°F in habitable rooms.

Section 530.8 - Describes the requirements for constructing and attaching exterior solar screens to exterior walls of a building.

Section 601.2 - Requires that every habitable room in a dwelling unit have a minimum of one operable window for natural light and ventilation. Section 601.4 states the same requirement for a habitable room partially below grade.

Section 603.1 - States the minimum areas of glazing as 10 percent of floor area, 10 square feet minimum.

Section 603.3 - Requires that 50 percent of area stated in 603.1 be operable for natural ventilation.

Section 604.1 - States that the natural lighting and ventilation requirements can be met by skylights.

Appendix E - Contains the requirements for heat-producing appliances, heating, ventilating, air-conditioning, and blower and exhaust systems. These sections would be of particular importance to auxiliary heat systems.

ANALYSIS:

There is nothing in the code which would prohibit the use of passive solar. Section 100.7 specifically allows consideration of any novel or innovative techniques. However, there are some specific requirements for glass and sun screens which have to be accommodated, and there are restrictions on the use of glazing other than glass. The one last item of importance is the section requiring 68°F to be maintained in habitable rooms. This would tend to result in larger auxiliary systems to ensure compliance.

One and Two Family Dwelling Code

One and Two Family Dwelling Code (1975 edition)

Issued by: American Insurance Association
Building Officials and Code Administrators
International, Inc.
International Conference of Building Officials
Southern Building Code Congress International

This code is a compilation of data from the model codes issued by the groups listed above dealing with construction of one and two family dwellings of not more than three stories in height.

POINTS OF IMPORTANCE:

Section R-108 - This section allows "the use of any material or method of construction not specifically prescribed by this Code" as long as it is proven to the building official that it meets the intended design criteria.

Section R-203 - Openings in exterior walls within 3 feet of the property line are not permitted.

Section R-204 - All habitable rooms (spaces) require:

- 1) Glazed area not less than 10 square feet nor less than 1/10 of floor area
- 2) Glazed area must be operable - not less than 1/10 of floor area.

Mechanical ventilation can substitute if it produces 2 air changes per hour.

Section R-209 - Prescribes the glazing thickness requirements for window areas (Table 2-B).

ANALYSIS:

This code really has no section which prevents or even hinders the use of any passive designs. In addition, there is Section R-108 which allows consideration of alternate designs.

SBCC Standard Building Code

Standard Building Code - 1979 Edition

Issued by: Southern Building Code Congress
International, Inc.
Birmingham, Alabama 35222

A model code to provide minimum requirements for safeguarding life, health, and public welfare, and for the protection of property.

POINTS OF IMPORTANCE:

Section 103.6 - Reads: "The provisions of this code are not intended to prevent the use of any material, or method of construction not specifically prescribed by the code..."

States that as long as the intent of the code is satisfied without endangering health and safety, then the building official can approve any novel or innovative design or material.

Section 502 - Prescribes metal frames for greenhouses over 35 feet high. It allows any sort of construction for ones of less than 400 square feet and 15 feet in height, but does place restrictions on the use of wood frames.

Section 2001 - Requires that every "habitable room" have the following minimums:

Glass openings for natural light - 8 percent of floor area

Clear opening for natural ventilation - 4 percent of floor area

"Skylights, vents, louvres or mechanical ventilation may be substituted for windows, as required herein,..."

Chapter 26 - Specifies required thicknesses and area limitations for glass installed in vertical walls - Table 2706.

Appendix J - Refers to the NCSBCS Model Code for Energy Conservation.

ANALYSIS:

The code places essentially two restrictions on the use of a passive system:

Greenhouses with wooden frames must be 5 feet from any adjacent structure.

There are some limitations on how plastic can be used.

These limitations are rather minor, dealing with materials rather than design. However, Section 103.6 opens the possibility to use other than standard techniques as long as health, safety, and welfare are protected. In the end, it is the building official who will have to be convinced.

UBC

Uniform Building Code

Uniform Building Code (1979 Edition)

Issued by: International Conference of Building Officials
5360 South Workman Mill Road
Whittier, California 90601

Model regulations for building design and construction methods.

POINTS OF IMPORTANCE:

Section 105 - Reads: "The provisions of this code are not intended to prevent the use of any material or method of construction not specifically prescribed by this code, provided any alternative has been approved and its use authorized by the building official."

This clause allows the building official to approve passive solar designs even if they do not conform exactly to the code. The only provision is that effectiveness of the alternate design must be at least equal to conventional and present no threat to health and safety.

Section 1205 - Provides that every habitable room must have:

Glazing for light - 10 percent of floor area, minimum
of 10 square feet

Opening for ventilation - 5 percent of floor area,
minimum of 5 square feet

In lieu of the natural ventilation, mechanical ventilation must provide 2 air changes per hour with 20 percent outside air.

Section 3401 - States that skylight frames must be of noncombustible material and specifies requirements for the type of glass that can be used. For greenhouses less than 20 feet in height, the use of ordinary glass and wood frames is allowed.

Section 5203-5207 - Gives the limitations and requirements for using light transmitting plastic in exterior wall panels, glazing, and skylights.

Section 5212 - States that approved plastics may be used in place of plain glass in greenhouses.

Section 5403 - Gives the area limitations for the use of glass and glazing.

Appendix - Chapter 53: Energy Conservation in New Building Construction

Refers directly to NCSBCS Code for Energy Conservation in New Building Construction

ANALYSIS:

There is a slight restriction on how plastics can be used, but otherwise there are no restrictions on the use of passive solar techniques. With the alternate methods and design section (#105), novel or innovative designs can be accepted under the code.

JURISDICTION SUMMARIES

The following section summarizes code-specific information for selected county and city code jurisdictions which are considered to be areas of major building activity. Also included is a summary of information of statewide code policies in the nineteen SSEC jurisdictions.

Included in the format is information of greatest relevance to potential builders/designers of passive solar homes, such as building compliance requirements and means for finding additional information.

Building Code: State Building Code

Reference Code: Standard Building Code (SBCC)

**State
Enforcement
Agency:** State Building Commission
State Office Building
501 Dexter Avenue
Montgomery, AL 36104
(205) 832-3404

Energy Code: Appendix "J"

Reference Code: Standard Building Code (SBCC)

**State
Administrative
Agency:** Alabama Energy Management Board
State Capital
Montgomery, AL 36130
(205) 832-5010

**Enforcement
Level:** State Building Commission

Comments: The State Building Code, including Appendix "J", applies only to state funded construction. However, local municipalities and counties have been encouraged to adopt the SBCC model. The Alabama Energy Management Board is involved in code development only in that it is attempting to get the state legislature to adopt an energy code which would be enforced statewide, thereby complying with the forthcoming federal regulations. As of this writing the state legislature is still in session.

Heating Degree Days

Birmingham	2551
Huntsville	3070
Mobile	1560
Montgomery	2291

**Local
Enforcement
Official:**

Mr. Myron Sasser
Director of Inspection Services
Room 207/City Hall
710 20th Street North
Birmingham, AL 35203
(205) 254-2000

Building Code:

Reference Code:

Standard Building Code (SBCC)

Energy Code:

None

Reference Code:

Comments:

None

**Statement About
Passive Solar:**

They have had no experience with such designs but do not feel there would be a problem as long as they meet the building code requirements.

Related Programs: None

**Requirements
to File:**

Plan Review - Plans and specifications

Calculations - If construction is out of the ordinary

Certifications - None

Inspections - Footing, framing, mechanical, and final

Fees - Building permit based on cost of construction. Mechanical based on quantity of fixture/input energy

Other -

Building Code: None

Reference Code:

**State
Enforcement
Agency:**

Energy Code: None

Reference Code:

**State
Administrative
Agency:**

State Energy Office
960 Plaza West Building
Little Rock, AR 72205
(501) 371-1379

**Enforcement
Level:**

Comments:

State Energy Office is working on developing an energy code based on the NCSBCS model, but passage is not imminent. Although there is no state building code, some of the larger municipalities do have codes. In the city of Fort Smith, a conflict over the use of plastic in a greenhouse design was resolved after testing was done by the local fire department.

Heating Degree Days

Fort Smith	3292
Little Rock	3219
Texarkana	2533

**Local
Enforcement
Official:**

Roy G. Beard
Little Rock Building Department
701 W. Markum Street
Little Rock, AR 72201
(501) 371-4825

Building Code:

Reference Code:

Standard Building Code (SBCC)
1969 Edition and 1979 Amendments

Energy Code:

None

Reference Code:

Comments:

Adoption of the 1979 Southern Standard Building Code is expected in the near future, but date is still uncertain.

**Statement About
Passive Solar:**

Only structural aspects are considered at present, although several solar systems have been installed in the city.

Related Programs: None

**Requirements
to File:**

Plan Review - One copy, 2 survey plans

Calculations - None, other than structural calculation.

Certifications - None

Inspections - Footing, framing, and final

Fees - Permit fee @ 2¢ per square foot/roof

Other - The building department retains one copy of the survey/plot plan.

DISTRICT OF COLUMBIA

Building Code: District of Columbia Building Code

Reference Code:

**State
Enforcement
Agency:** Building Department
614 H Street, NW
Room 203
Washington, DC 20001
(202) 724-8943 Ralph E. Spencer

Energy Code: None

Reference Code:

**State
Administrative
Agency:** Department of Housing & Community Development
1325 G Street, NW
Washington, DC 20005
(202) 724-8721

**Enforcement
Level:** (Anticipated to be by the Building Department)

Comments: D.C. Energy Conservation Code is being evaluated at present by the Housing and Economic Development Committee and the D.C. City Council. The proposed code is based on the NCSBCS Model Code for Energy Conservation in New Building Construction.

Heating Degree Days - 4224

**Statement About
Passive Solar:**

The Building Department will accept anything as long as health and safety aspects are within code requirements.

Related Programs:

Potomac Electric Power Co. has a voluntary program of energy audits which, as of now, does not have the capacity to incorporate contributions from solar systems. They have begun an internal program to upgrade the level of information about solar systems and, hopefully, will incorporate solar into the audit program. Washington Gas & Light had recently been refused by the Public Service Commission an increase in rates for buildings which use gas as an auxiliary for heat pumps. The commission felt that the utility had not justified its claim that gas consumption in such installations resulted in a continual operating loss for them.

**Requirements
to File:**

Plan Review - 4 sets of construction drawings

Calculations - None

Certifications - Over 1,000 square feet or 2 stories, an architect's statement certifying that work complies with code requirements

Inspections - Foundation, framing, and final

Fees - Based on cubic feet. Renovation fees based on cost of the project.

Other - None

DELAWARE

Building Code: None

Reference Code:

**State
Enforcement
Agency:** State Fire Marshal
P. O. Box 109
Dover, DE 19901
(302) 678-4393

Energy Code: None

Reference Code:

**State
Administrative
Agency:** Governor's Energy Office
Townsend Building
Dover, DE 19901
(302) 678-5644

**Enforcement
Level:**

Comments: There are no building or energy codes at the state level. All such codes are handled, instead, at the county level. The State Fire Marshal enforces the NFPA Fire Codes for construction other than 1 & 2 family residences.

Heating Degree Days

Wilmington 4930

**Local
Enforcement
Official:**

Robert Hubbard
Building Commissioner
City of Wilmington
Licenses and Inspection/5th Floor
Wilmington, DE 19801
(302) 571-4356

Building Code:

Reference Code: BOCA Basic Building Code (1975 ed.)

Energy Code:

None

Reference Code:

Comments:

A review committee has been established to evaluate solar systems and to develop procedures for the analysis of materials and designs. The committee includes the local power authorities, city and county officials, builders, developers, and designers.

**Statement About
Passive Solar:**

Building Department encourages energy conservation. Frame construction is permitted only with a one-hour fire rating for single family homes. Any material or design not covered by the code is directed to a Board of Appeals composed of an architect, engineer, the building commissioner, and a permit official. Thus far, so solar applications, either passive or active, have been reviewed by the department.

Related Programs:

None

**Requirements
to File:**

Plan Review - 2 sets of plans and specifications

Calculations - None

Certifications - If construction cost is in excess of \$15,000 (excluding mechanical), drawings & specs must be sealed by a licensed architect/engineer (excluding mechanical drawings).

Inspections - Periodic checks at discretion of inspector and underwriters

Fees - \$5 for each \$1,000 of construction cost

Building Code: Counties and municipalities must adopt a code based on one of the following model codes:

Reference Code: Standard Building Code (SBCC), South Florida Building Code, National Building Code (American Insurance Assoc.), EPCOT Code, 1&2 Family Dwelling Code (NCSBCS)

State Enforcement Agency: Bureau of Codes and Standards
Department of Community Affairs
2571 Executive Center Circle, E
Tallahassee, FL 32301

Energy Code: Florida Model Energy Efficiency Code

Reference Code: NCSBCS Code for Energy Conservation in New Construction

State Administrative Agency: State Energy Office
Bryant Building, Room 301
Tallahassee, FL 32304

Enforcement Level: County and municipal level

Comments: All counties must, by state law, enforce energy codes based on one of the following:

Florida Model Energy Efficiency Code
ASHRAE 90-75
HUD Minimum Property Standards
Appendix "J" of the Standard Building Code

Heating Degree Days

Apalachicola	1303
Daytona Beach	879
Fort Myers	442
Jacksonville	1239
Key West	103
Lakeland	661
Miami	214
Miami Beach	141
Orlando	765
Pensacola	1463
Tallahassee	1485
Tampa	683
West Palm Beach	253

**Local
Enforcement
Official:**

Thomas M. Black
Dade County Building Department
909 Southeast 1st Avenue
Miami, FL 33131
(305) 579-2505

Building Code:

South Florida Building Code

Reference Code:

Standard Building Code (SBCC)

Energy Code:

Chapter 52, South Florida Building Code

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments:

Chapter 52 was developed from the Florida Model Energy Efficiency Code, with modifications for local climate. At present, the state is developing a 100 point program which is essentially a "cookbook" approach to satisfying code requirements.

**Statement About
Passive Solar:**

Dade County is very aggressive in achieving energy conservation in buildings. An Energy Regulations Board has been established to facilitate evaluation of any alternate method of meeting energy codes. While solar energy may be aimed mostly at heating, any alternate energy source for cooling would be well received.

Related Programs:

Florida Power and Light has a 100-point energy program which is aimed at reducing energy usage but does not take into consideration the contribution of solar systems. While at present there are no rate benefits for participating, the utility is considering such a program.

**Requirements
to File:**

Plan Review - 2 complete sets of drawings

Calculations - Energy Code: Insulation, EER, and lumen calculation

Certifications - Plans drawn by registered architect or engineer

Inspections - As required by code: structure, insulation, mechanical, electrical, illumination

Fees - Based on square footage; mechanical and electrical fees

Other - None

**Local
Enforcement
Official:**

William Bennet
Chief Building Inspector,
Chief Structural Engineer
100 North Andrews Avenue
Fort Lauderdale, FL 33302
(305) 761-2121

Building Code:

South Florida Building Code

Reference Code:

Standard Building Code (SBCC)

Energy Code:

Chapter 52, South Florida Building Code

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments:

None

**Statement About
Passive Solar:**

Most of the construction in this jurisdiction is concrete block, but alternate methods and materials for residential construction have been viewed positively.

All of the members of the Building Department Permit and Inspection staff have taken a state training program on recommended interpretations of Chapter 52.

Related Programs: None

**Requirements
to File:**

Plan Review - 2 sets of sealed drawings

Calculations - Point system calculations are acceptable. Calculations required on alternative energy systems and materials.

Certifications - If construction costs exceed \$5,000, preparation or certification must be by a licensed architect or engineer.

Inspections - As required in the South Florida Building Code

Fees - (Incomplete Information)

Other - Precalculated R and U values for block construction.

**Local
Enforcement
Official:**

Marvin Boutwell
Chief Building and Zoning Inspection Official
City of Jacksonville
220 East Bay Street
Jacksonville, FL 32202
(904) 633-5450

Building Code:

Reference Code: National Building Code (American Insurance
Association)

Energy Code:

Reference Code: ASHRAE 90-75

No Amendments.

For materials and designs which are unusual,
independent testing may be required to
establish compliance with mandated R and U
values.

**Statement About
Passive Solar:**

Receptive if R or U values can be substantiated and calculations sufficiently completed.

Related Programs: None

**Requirements
to File:**

Plan Review - 2 sets, plot plan

Calculations - Energy calculations using the Building Department's form

Certifications - State law does not require that a licensed professional review drawings.

Inspections - Yes

Fees - Flat filing fee

Other - All construction must conform. Independent testing facility results for unusual materials or systems are accepted. The Building Department has written its own simple form for calculating R values and/or U values.

**Local
Enforcement
Official:**

Richard McDole
Lee County Building Department
County Courthouse
P. O. Box 398
Fort Myers, FL 33902
(813) 335-2393

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: Appendix "J"

Reference Code: Standard Building Code (SBCC)

Comments:

Presently, Appendix "J" is enforced. However, compliance with any one of the following will soon be acceptable:

- 1) Any code based on ASHRAE 90-75
- 2) The Florida State Energy Office 4-point program
- 3) The Florida Power & Light Watt-Wise Program

**Statement About
Passive Solar:**

In the process of adopting a solar ordinance which would take into consideration passive solar techniques.

Related Programs: None

**Requirements
to File:**

Plan Review - Plans and specs; 1 & 2 family residences do not require stamp.

Calculations - For energy compliance

Certifications - None

Inspections - Foundations, framing, insulation, mechanical, final

Fees - According to Appendix K of SBCC

Other - None

**Local
Enforcement
Official:**

Ralph W. Jones, Jr.
Building Official
Orange County Building Department
P. O. Box 2687
Orlando, FL 32802
(305) 420-3253

Building Code:

Reference Code: Standard Building Code (SBCC)
(1976 edition; soon to adopt 1979)

Energy Code: Florida Model Energy Efficiency Code

Reference Code: NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments: Code applies to all housing.

**Statement About
Passive Solar:**

Does not anticipate any problems, but feels that solar systems are too oriented toward heating while the climate in this jurisdiction requires more systems aimed at cooling.

Related Programs: None

**Requirements
to File:**

Plan Review - 2 sets of plans. Architect/
engineer not required.

Calculations - Energy data

Certifications - None

Inspections - Footing, framing, mechanical,
final

Fees - Building permit based on square foot-
age; mechanical inspection fees

Other - None

**Local
Enforcement
Official:**

Robert Brockway
Chief Building Official
Planning, Zoning and Building Department
P. O. Box 1548
West Palm Beach, FL 33402
(305) 837-3330

Building Code:

Palm Beach County Uniform Addendum

Reference Code:

Standard Building Code (SBCC)

Energy Code:

Florida Model Energy Efficiency Code

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments:

Addendum includes wind load and other variations typical of southern Florida which are not included in the SBCC.

Florida State Energy Code Amendments due in July, 1979, incorporating the 100-point system of the Florida Power and Light Company.

Trade-off possibilities have been identified for arriving at prescribed U value levels:

- a) Insulation
- b) AC efficiency ratings
- c) Glass areas

**Statement About
Passive Solar:**

Despite numerous submissions, adjustment (M-factors) for mass in walls has not yet been accepted. Classes and seminars have been held to acquaint designers/builders/developers with code requirements. No other problems are apparent, and officials are receptive to inquiries.

Related Programs: None

**Requirements
to File:**

Plan Review - 2 sets required

Calculations - Only for unusual cases or innovative designs

Certifications - By law, anyone can prepare and submit plans/drawings, but they must certify compliance with codes.

Inspections - Building construction, insulation, electrical, plumbing, HVAC

Fees - (Incomplete Information)

Other - Certified testing facility results are acceptable if innovative design or materials are employed. This includes buildings using non-depletable energy sources.

**Local
Enforcement
Official:**

Douglas Moore
Chief, Department of Licensing and
Inspection
P. O. Box 2842
St. Petersburg, FL 33731
(813) 893-7381

Building Code:

Reference Code: Standard Building Code, (1978 ed.) (SBCC)

Energy Code: Florida Model Energy Efficiency Code

Reference Code: NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments:

1. Significant changes to reference building code:
 - Storage tanks. When the tanks are above the first floor, an engineer must prepare structural drawings of structural analysis.
 - Details of unusual materials and construction are required.
2. Significant changes for reference energy code:
 - Code applies to all residential construction of all square footages.
 - Definition of renovation was redefined.
 - AC efficiency ratings were altered. More than two local suppliers must be handling the particular unit specified.
 - AC EER = 6.8

**Statement About
Passive Solar:**

Very receptive to alternative designs and materials.

Related Programs:

The local power authority prepares calculations for permit submissions and will do monitoring studies for a minimum fee.

**Requirements
to File:**

Plan Review - 2 sets required, including energy calculations

Calculations - Primarily interested in cooling cycle. Trade-offs for alternative designs and materials are possible. Mass concept is acceptable.

Certifications - Anyone can file.

Inspections - (Incomplete information)

Fees - None now, but soon to be adopted.

Other - Office uses ASHRAE Index as basis for R and U values. Awaiting Florida State Code Amendments utilizing a "cookbook method" of points for all systems materials, designs and construction.

**Local
Enforcement
Official:**

Phil Koch
Chief Administrator of Building & Zoning
City of Sarasota/Building Department
P. O. Box 1058
Sarasota, FL 33578
(813) 365-2200

Building Code:

Reference Code: Standard Building Code (1973 ed.) (SBCC)

Energy Code: No complete code adopted.

Reference Code:

Comments: There are local amendments to the requirements for heating and plumbing.

They enforce only Chapter 553, Part 7, of the Florida Model Energy Efficiency Code. All heating and cooling calculations must be done by designer.

All single family homes must conform with:

1. Ceiling of R-19 insulation
2. Walls of R-11 insulation

**Statement About
Passive Solar:**

Adheres to written guidelines. He is receptive to traditional construction types.

Related Programs:

None

**Requirements
to File:**

Plan Review - Plans for all construction
Calculations - Energy form for thermal energy performance of housing over 1500 square feet
Certifications - Insulation certificate by installer specifying that a minimum of 6 inches was installed
Inspections - As specified in SBCC model
Fees - Based on cost of construction
Other - Over 14 units (including housing developments) must be submitted to the Department of Environmental Regulations, State of Florida.

**Local
Enforcement
Official:**

Ted Nicoletto or Enrique Marcet
Chief Building Inspector
City of Tampa Building Bureau
306 East Jackson Street
Tampa, FL 33607
(813) 223-8307

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: City of Tampa Energy Code

Reference Code:

Comments:

Codes from several areas provided the basis for Tampa code:

1. South Florida
2. Houston, Texas
3. Jacksonville

The testing facilities at Cape Canaveral are used to evaluate all unusual designs and materials. Final evaluations are also done at these facilities.

**Statement About
Passive Solar:**

Evaluations of new or unusual designs are done by the State Testing Facilities or the staff engineer. All information and calculations should be prepared in order to facilitate their evaluation.

Related Programs:

None

**Requirements
to File:**

Plan Review - Yes

Calculations - Energy calculations

Certifications - Drawings by registered
architect/engineer

Inspections - As called for by SBCC model

Fees - For testing or evaluation, if necessary

Other -

Building Code: Georgia State Building Code (non-mandatory)

Reference Code: Standard Building Code (SBCC)

**State
Enforcement
Agency:** State Building Administrative Board
166 Pryor Street, SW
Atlanta, GA 30303
(404) 656-5530

Energy Code: Georgia State Energy Code for Buildings

Reference Code: NCSBCS Model Code for Energy Conservation
in New Building Construction

**State
Administrative
Agency:** State Building Administrative Board
166 Pryor Street, SW
Atlanta, GA 30303
(404) 656-5530

**Enforcement
Level:** Local

Comments: While the building code is not mandatory, the energy code is. All enforcement is done at the local level.

Heating Degree Days

Athens	2929
Atlanta	2961
Augusta	2397
Columbus	2383
Macon	2136
Rome	3326
Savannah	1819
Thomasville	1529

**Local
Enforcement
Official:**

Ronny Schooner
Energy Expert
800 City Hall
Atlanta, GA 30303
(404) 658-6336

Building Code:

City of Atlanta Building Code

Reference Code:

Standard Building Code (SBCC)
National Building Code (American Insurance
Association)

Energy Code:

Georgia State Energy Code for Building

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments:

Chapter 6, Atlanta Fire Safety Code has been
adopted statewide as the Fire Protection Code.

State code includes two calculation methods:

1. "Steady state" based on charted R and/or
U values:
 - a. Carpet on the floor instead of floor
insulation
 - b. Exterior wall insulation R-11 with a
vapor barrier
 - c. Ceiling insulation R-20+
2. Consumption values based on BTU/square foot
figures.

**Statement About
Passive Solar:**

The building department has trained a staff member in the evaluation of active and passive systems. Although submissions to date have not included any energy-conscious designs, calculation methodologies based on BTU/SF consumption are included in the energy conservation codes and would be used to evaluate passive and active systems.

Related Programs:

Georgia Power Company has no mandatory restrictions, and there are no programs which are aimed at passive solar. However, the company has been doing research into active solar systems and is beginning a large scale initiative facilitating conversion of electric hot water heaters to solar hot water heating. In addition, there is a program called "Good Cents Home" in which a builder meeting energy conservation requirements would receive a certificate, and the "Centsible Homes Improvement" program which provides an energy audit and retrofit recommendations to homeowners.

**Requirements
to File:**

Plan Review - 2 sets of plans

Calculations - As required by the Energy Code

Certifications - None

Inspections - Foundation, framing, mechanical (HVAC), electrical, plumbing, and a final inspection

Fees - Based on the cost of construction

Other - None

Building Code: Kentucky Basic Building Code

Reference Code: BOCA Basic Building Code

**State
Enforcement
Agency:** State Department of Housing,
Building and Construction
Capital Tower Building
Frankfort, KY 40601
(502) 564-3626

Energy Code: Kentucky Energy Conservation Code

Reference Code: BOCA Basic Energy Conservation Code

**State
Administrative
Agency:** State Department of Housing,
Building and Construction
Capital Tower Building
Frankfort, KY 40601
(502) 564-3626

**Enforcement
Level:** State and local

Comments: The Department of Housing, Building and Construction is in the process of adopting the entire BOCA code, including energy conservation. Significant dates in the process are:

August 2, 1979 - Public hearing
September 5, 1979 - Hearing by the legislative research committee, regulations review subcommittee
February 15, 1980 - Code becomes effective

Enforcement of the codes for buildings under 3 stories or 20,000 square feet would be at the local level. Single family dwellings would be exempt unless the local government passed regulations stating otherwise.

Heating Degree Days

Covington	5265
Lexington	4683
Louisville	4660

**Local
Enforcement
Official:**

Bob Myers
Department of Building & Housing
617 West Jefferson Street
Louisville, KY 40204
(502) 587-3321

Building Code:

Reference Code: The BOCA Basic Building Code (1975 ed.)

Energy Code: None until February, 1980, when the 1978
BOCA code goes into effect.

Reference Code:

Comments:

In February, 1980, the 1978 BOCA code will be statewide. After this time, amendments for particular local jurisdictions may be submitted to the State Building Department for review and evaluation. No local building authority will be permitted to amend independently the building code for an individual jurisdiction.

**Statement About
Passive Solar:**

The building department will not deal with energy or energy-related concerns until February, 1980, when the Energy Chapter of the 1978 BOCA code goes into effect. At present, for new designs or materials not covered by the BOCA code submission to BOCA for approval is requested.

Related Programs:

Louisville Gas and Electric is in the process of developing an energy audit program, but its scope and methods are still undecided.

**Requirements
to File:**

Plan Review - A complete set of plans; mechanical, structural, and electrical drawings

Calculations - All calculations as required by BOCA

Certifications - No certification is required for residential construction of 20,000 square feet or less.

Inspections - Foundation; rough-in for mechanical, plumbing, and electrical; final

Fees - \$18 for first 5,000 square feet; \$1.50 for each additional 1,000 square feet up to 50,000 square feet

Other -

LOUISIANA

Building Code: None

Reference Code:

**State
Enforcement
Agency:**

State Fire Marshal has various offices throughout the state. Reviews plans of buildings other than single family residences for compliance with NFPA and ANSI codes.

Energy Code: None

Reference Code:

**State
Administrative
Agency:**

Department of Natural Resources
P. O. Box 44156
Capital Station
Baton Rouge, LA 70804
(504) 342-5540

**Enforcement
Level:**

Comments:

The state legislature is presently considering an energy code based on the NCSBCS model that would apply to all but single family dwellings. As of this writing the issue has not been resolved.

Heating Degree Days

Alexandria	1921
Baton Rouge	1560
Lake Charles	1459
New Orleans	1385
Shreveport	2184

Baton Rouge

**Local
Enforcement
Official:**

Robert Groht
Inspection Division
Department of Public Works
P. O. Box 1471
Baton Rouge, LA 70821
(504) 389-3205

Building Code:

Reference Code:

National Building Code (1967 ed.)
(American Insurance Association)

Energy Code:

None

Reference Code:

Comments:

None

**Statement About
Passive Solar:**

Has not seen any passive designs, but does not foresee any problems in meeting the code.

Related Programs: None

**Requirements
to File:**

Plan Review - Plans, specifications, site plans

Calculations - None

Certifications - None

Inspections - None

Fees - Fee for permit

Other - None

New Orleans

**Local
Enforcement
Official:**

Harold Gorman
Director
Department of Safety and Permits
City Hall, Room 7E05
New Orleans, LA 70112
(504) 586-4412

Building Code: New Orleans Building Code

Reference Code: Based on the 1949 Uniform Building Code
and adapted to local requirements ever
since.

Energy Code: None

Reference Code:

Comments: None

**Statement About
Passive Solar:**

Has had little experience with passive solar systems, but was very receptive to the idea. Even if there are problems, there is an appeals process which would review any novel or innovative design.

Related Programs:

New Orleans Power and Light is presently undertaking a research project on solar water heaters, but this is not for consumers. There is, however, a mail-in computer energy audit program and an Energy Efficient Home Award for new construction. If a home satisfies specified criteria the builder is awarded a certificate. There are no provisions for solar contribution. Lastly, there is a local management system through which the utility can remotely switch off residential hot water, heating or air-conditioning during peak hours. The consumer, in addition to reduced usage, gets a small monetary incentive.

**Requirements
to File:**

Plan Review - Plans & specifications. Over 2,500 sq. ft. must be signed by registered architect/engineer.

Calculations - If review process indicates that they would be required.

Certifications - None

Inspections - Four: Initial, framing, rough-in, final

Fees - Depends on size, starting at \$10.00.

Other - Fill out application.

Building Code: None

Reference Code:

**State
Enforcement
Agency:**

Department of Economic & Community Development
1748 Forest Drive
Annapolis, MD 21401 (301) 269-2701
(Assists local communities in administering
their codes.)

Energy Code: Maryland Energy Guidelines

Reference Code: BOCA, NCSBCS, and others

**State
Administrative
Agency:**

Energy Policy Office
State of Maryland
301 West Preston Street
Baltimore, MD 21201

**Enforcement
Level:** County level

Comments: The state guidelines require the use of some energy code by counties. The predominant code used is the one contained in the BOCA Basic Building Code. However, any code can be submitted to the Energy Policy Office for approval.

Heating Degree Days

Baltimore	4654
Frederick	5087

**Local
Enforcement
Official:**

Samuel Mortimer
Chief, Building Inspection
City of Baltimore
222 East Saratoga Street, Room 100
Baltimore, MD 21202
(301) 396-3487

Building Code: "Building Regulations" - Baltimore City Code,
Vol. I, Art. 32

Reference Code:

Energy Code: None

Reference Code:

Comments:

The building code is unique to the city of Baltimore. Requirements for natural light and ventilation are as follows:

Windows must be 10 percent of floor area.
Half of the window area must be operable.

There are variations from the state code. State energy guidelines have just been passed. The question of a city energy code has not yet been addressed.

**Statement About
Passive Solar:**

Has seen some active systems and some hybrid passive/conventional designs, and there were no problems. He did not anticipate any difficulty with the codes.

Related Programs:

None. Baltimore Gas and Electric Company has a voluntary program called the National Energy Watch Program which, based on a point system, awards a certificate for achieving a certain level of energy conservation. While having provisions for active solar, it does not acknowledge the contribution of passive solar techniques.

**Requirements
to File:**

Plan Review - 3 sets of complete plans;
9 plot plans

Calculations - None

Certifications - None

Inspections - None

Fees - Based on size and type

Other - Forms for soil erosion and
sedimentation control

Building Code: None

Reference Code:

**State
Enforcement
Agency:**

State Building Commission
P. O. Box 2108
Jackson, MS 39205 (601) 354-6326
(In charge of state construction and provides
technical assistance to local governments
concerning their codes.)

Energy Code:

Mississippi State Code for Energy Conserva-
tion in New Construction

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

**State
Administrative
Agency:**

Mississippi Fuel & Energy Management
Commission
P. O. Box 139
Woolfolk Street Office Bldg./Room 1307
Jackson, MS 39202 (601) 354-5792

**Enforcement
Level:**

Local

Comments:

The state energy code applies only to public
buildings.

Heating Degree Days

Jackson	2239
Meridian	2289
Vicksburg	2041

**Local
Enforcement
Official:**

W. S. Nicholas
Assistant City Engineer/City of Jackson
Director of Building Permit Department
P. O. Box 17
Jackson, MS 39205
(601) 969-7500

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: None

Reference Code:

Comments: None

**Statement About
Passive Solar:**

Follows the codes.

Related Programs:

None

**Requirements
to File:**

Plan Review - 2 sets of plans, 2 sets of specs

Calculations - None

Certifications - As per code

Inspections - By code. Minimum: mechanical,
plumbing, gas, electrical

Fees - Fee schedule based on value plus basic
fee.

Other -

NORTH CAROLINA

Building Code:

Uniform Residential Building Code (1&2 family)
North Carolina State Building Code (other construction)

Reference Code:

Standard Building Code (SBCC)

**State
Enforcement
Agency:**

Department of Insurance
Engineering Division
P. O. Box 26387
Raleigh, NC 27611
(919) 733-3901

Energy Code:

Chapter 32, Efficient Energy Utilization in
New Buildings

Reference Code:

ASHRAE 90-75 and a preliminary draft of
NCSBCS Model Code.

**State
Administrative
Agency:**

Energy Office, Conservation Programs
Department of Commerce
P. O. Box 25249
Raleigh, NC 27611
(919) 733-5078

**Enforcement
Level:**

County level

Comments:

Enforcement of both energy and building codes
is done at the county level with the state
involved only in large projects or when technical
assistance is requested by the local
official.

Heating Degree Days

Asheville	4042
Cape Hatteras	2612
Charlotte	3191
Greensboro	3805
Raleigh	3393
Wilmington	2347
Winston-Salem	3595

**Local
Enforcement
Official:**

Lawrence Glenn
City of Charlotte Building Department
600 East Trade Street
Charlotte, NC 28202
(704) 374-2271

Building Code:

Uniform Residential Code (1&2 family)
North Carolina State Building Code (other
construction)

Reference Code:

Standard Building Code (SBCC)

Energy Code:

Chapter 32, Efficient Energy Utilization in
New Buildings

Reference Code:

ASHRAE 90-75 and a preliminary draft of
NCSBCS model code

Comments:

None

**Statement About
Passive Solar:**

Has seen very few, but is interested in maintaining R-11 wall and R-19 ceiling values as minimum requirements.

Related Programs:

Duke Power Company advises going beyond insulation requirements of codes; 50 percent of houses being built include R-30 ceiling insulation.

**Requirements
to File:**

Plan Review - 1 plan; 1 set of specs; energy code has requirements for specs of unusual systems

Calculations - "R" values, as per code

Certifications - Only licensed general contractors can apply for construction permits for \$30,000+

Inspections - As required by code

Fees - Flat fee plus (cost based on construction). Fee for mechanical inspection.

Other - Testing facility results required on any material or design not specifically mentioned in the codes.

**Local
Enforcement
Official:**

John A. Parham
Superintendent of Inspection Services
101 City Hall Plaza
Durham, NC 27701
(919) 683-4144

Building Code: Uniform Residential Building Code (1&2 family)
North Carolina State Building Code (other
construction)

Reference Code: Standard Building Code (SBCC)

Energy Code: Chapter 32, Efficient Energy Utilization in
New Buildings

Reference Code: ASHRAE 90-75 and a preliminary draft of
NCSBCS model code

Comments: None

**Statement About
Passive Solar:**

Has not seen very many, but feels that there is sufficient leeway in codes to allow them. Each design differing from conventional will be evaluated, but there is nothing inherent in the code that would prevent the use of passive solar.

Related Programs:

None

**Requirements
to File:**

Plan Review - Full set, plot plan, site plan.
For 1&2 family do not need
registered architect/engineer.

Calculations - Only for unusual construction

Certifications - Form prepared by licensed
contractor attesting to com-
pliance with insulation re-
quirements

Inspections - Building: foundation, framing,
insulation, final; mechanical
and electrical

Fees - Based on cost of construction; fees for
mechanical and electrical inspections.

Other - None

Guilford County

**Local
Enforcement
Official:**

John Hanner
P. O. Box 3427
Greensboro, NC 27402
(919) 373-3784

Building Code: Uniform Residential Building Code (1&2 family)
North Carolina State Building Code (other
construction)

Reference Code: Standard Building Code (SBCC)

Energy Code: Chapter 32, Efficient Energy Utilization in
New Buildings

Reference Code: ASHRAE 90-75 and a preliminary draft of the
NCSBCS model code

Comments: None

**Statement About
Passive Solar:**

Doesn't see any conflicts or problems.

Related Programs: None

**Requirements
to File:**

Plan Review - None

Calculations - None

Certifications - None

Inspections - At excavation, roughing-in, and
final

Fees - For building permit and for plumbing,
heat, and electrical inspection

Other - Application with permit from health
department and deed to property

**Local
Enforcement
Official:**

Gene Harrelson
City of Raleigh
P. O. Box 590
Raleigh, NC 27602
(919) 755-6285

Building Code: Uniform Residential Building Code (1&2 family)
North Carolina State Building Code (other construction)

Reference Code: Standard Building Code (SBCC)

Energy Code: Chapter 32, Efficient Energy Utilization in
New Building

Reference Code: ASHRAE 90-75 and a preliminary draft of the
NCSBCS model code

Comments: None

**Statement About
Passive Solar:**

Was very receptive, but stated that there had been a problem at one time concerning passive design. Because the area of glass exceeded 20 percent, the code officials insisted that double glazing was required. The builder insisted that this would reduce the solar gain. The issue was not resolved because it was discovered that the house was outside of the department's jurisdiction.

Related Programs:

None

**Requirements
to File:**

Plan Review - 2 sets of plans and plot plan

Calculations - Only if there is something out of the ordinary

Certifications - Only if there is something out of the ordinary

Inspections - Footing, framing, insulation, roughing-in, final

Fees - Building permit, based on cost of construction; mechanical, based on quantity

Other - None

**Local
Enforcement
Official:**

Mr. A. Smith
City of Winston-Salem
Inspections Division
810 NCNB Building
Winston-Salem, NC 27101
(919) 727-2494

Building Code: Uniform Residential Building Code (1&2 family)
North Carolina State Building Code (other
construction)

Reference Code: Standard Building Code (SBCC)

Energy Code: Chapter 32, Efficient Energy Utilization in
New Buildings

Reference Code: ASHRAE 90-75 and a preliminary draft of
NCSBCS model code

Comments: None

**Statement About
Passive Solar:**

The energy portion of the building code is essentially a "cookbook" approach to "U" values. As a result, passive designs may have greater difficulty meeting the "U₀". However, the building official can accept alternate designs if calculations convince him that they are at least equivalent to the energy usage of conventional buildings.

Related Programs: None

**Requirements
to File:**

Plan Review - None under 15,000 square feet

Calculations - None under 15,000 square feet

Certifications - None

Inspections - Footing, framing, insulation,
mechanical, final

Fees - Based on cost of construction and size
and quantity of mechanical

Other - Application form

Building Code:

None

**State
Enforcement
Agency:****Energy Code:**

None

Reference Code:**State
Administrative
Agency:**

Oklahoma Department of Energy
440 N. Lincoln Blvd.
Oklahoma City, OK 73105
(405) 521-3941

**Enforcement
Level:****Comments:**

The Oklahoma legislature has passed enabling legislation which would allow local jurisdictions to adopt any of the following codes:

- BOCA Basic Building Code
- Uniform Building Code
- Standard Building Code
- NCSBCS Model Code for Energy Conservation in New Building Construction

The municipalities can adopt all or part of these codes (including energy aspects), which they must enforce themselves.

Heating Degree Days

Oklahoma City	3725
Tulsa	3860

**Local
Enforcement
Official:**

Dale Wagner
Code Administrator
200 North Wallser Avenue
Oklahoma City, OK 73102
(405) 231-2597

Building Code:

Reference Code: BOCA Basic Building Code (1978 ed.)

Energy Code: None, yet.

Reference Code:

Comments:

On August 17, amendments to the building codes will be evaluated for acceptance.

If Oklahoma City does not adopt an energy code of its own, they anticipate the required enforcement of a state developed energy code.

**Statement About
Passive Solar:**

As long as the new structure conforms with the Basic Building Code requirements it is acceptable to the building department.

Related Programs:

None. Oklahoma Gas & Electric Company provides advice on request and has pamphlets for energy conservation, but no actual programs.

**Requirements
to File:**

Plan Review - 2 sets of plans, applications,
wall section, zone (plot) plan

Calculations - None

Certifications - None

Inspections - Foundation, framing, final

Fees - Based on cost of construction

Other - None

**Local
Enforcement
Official:**

Don Irwin
Building Inspection
City of Tulsa
200 Civic Center
Tulsa, OK
(918) 581-5321

Building Code:

Reference Code: BOCA Basic Building Code (1978 ed.)

Energy Code: Article 20

Reference Code: BOCA Basic Building Code

Comments: Presently adopting ordinance amendments.

The building department has converted the energy calculations to a set of specifications so that calculations by individuals are not required:

- a) R-19 ceiling
- b) R-11 walls

Compliance for unusual designs can be demonstrated by the normal calculations in the BOCA code or other calculations that can be substantiated.

**Statement About
Passive Solar:**

Very little passive so far in this area.
Will negotiate and trade off possible
alternative solutions.

Related Programs:

None

**Requirements
to File:**

Plan Review - Plot plan, 1 set of drawings

Calculations - Only for unusual cases

Certifications - None

Inspections - Footing, framing, final

Fees - \$5 basic fee, plus a percentage of the
cost of construction

Other - None

PUERTO RICO

Building Code:

Puerto Rico Building Regulations

BOCA Basic Building Code

**State
Enforcement
Agency:**

Regulations and Permits Administration
Minillas Government Center/North Building
P. O. Box 41179/Minillas Station
San Dulce, Puerto Rico 00940
(809) 726-3710 Engineer-William Salva Matos

Energy Code:

Energy Conservation Code for New
Building Construction in Puerto Rico

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

**State
Administrative
Agency:**

Energy Office
Minillas Government Center
P. O. Box 41059/Minillas Station
San Dulce, Puerto Rico 00940
(809) 726-8444

**Enforcement
Level:**

Regulations & Permits Administration
(Address above)

Comments:

The building code is presently based on the BOCA model as modified for the local requirements of Puerto Rico. However, the government has been in touch with ICBO and is considering adopting a version of the Uniform Building Code. The Regulations and Permits Administration enforces all codes on the island.

**Statement About
Passive Solar:**

Has not had much experience with passive solar systems, but foresees no problems or conflicts.

Related Programs:

Puerto Rico Water Resources Authority, the local utility, has several internal programs to increase its own efficiency, but has no special consumer programs for either solar or energy conservation.

**Requirements
to File:**

Plan Review - None

Calculations - None

Certifications - For any construction over \$15,000 in value an architect/engineer must certify that the plans are in accordance with regulations.

Inspections - Only for final use permit

Fees - None

Other - None

SOUTH CAROLINA

Building Code: (Non-Mandatory)

Standard Building Code (SBCC)

**State
Enforcement
Agency:** South Carolina Building Codes Council
P. O. Box 147
Columbia, SC 29217

Energy Code: Appendix "J"

Reference Code: Standard Building Code (SBCC)

**State
Administrative
Agency:** Energy Management Office
Edgar A. Brown Building
1205 Pendleton Street
Columbia, SC 29201

**Enforcement
Level:** Local level

Comments: The adoption of the SBCC building code on the local level is optional; however, adoption of Appendix "J" has recently become mandatory.

Heating Degree Days

Charleston	2033
Columbia	2484
Florence	2387
Greenville/Spartanburg	2980

**Local
Enforcement
Official:**

Vaughn Wicker
Chief Building Inspector
City Hall/Building Zoning Department
P. O. Box 2207
Greenville, SC 29602
(803) 242-1250

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: None, yet

Reference Code:

Comments: None

**Statement About
Passive Solar:**

Has had no experience with passive designs, but doesn't see any reason why there should be any problems.

Related Programs:

Duke Power Company has an Energy Efficient Structure Program which offers lower rates to buildings which are more energy efficient. Makes no recognition of solar contribution.

**Requirements
to File:**

Plan Review - None, unless the design is very unusual

Calculations - Either calculations or certification that house is in compliance when energy code is passed.

Certifications - Either calculations or certifications that house is in compliance when energy code is passed.

Inspections- Footings, framing, mechanical, final

Fees - Building permit based on cost of construction; mechanical based on number of fixtures

Other - Application form

**Local
Enforcement
Official:**

Richard S. Campbell
Building Official/Director of Public Works
City of Spartanburg
P. O. Box 1749
Spartanburg, SC 29304
(803) 585-4361

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: None

Reference Code:

Comments:

The building official has not yet been advised of an energy code requirement. Adoption of the Standard Building Code does not mean adoption of the appendices; they are strictly advisory.

**Statement About
Passive Solar:**

Does not see any special problems.

Related Programs: None

**Requirements
to File:**

Plan Review - Only above 5,000 square feet;
drawn by registered architect/
engineer. All others at the
discretion of the department.

Calculations - Only if review process deter-
mines a need for them.

Certifications - None

Inspections - Footings, roughing-in, final

Fees - Based on cost of construction

Other - None

Building Code:

State Building Code

Standard Building Code (SBCC) and
National Fire Code (NFPA)

**State
Enforcement
Agency:**

Division of Fire Prevention
202 Capital Towers Building
Nashville, TN 37219
(615) 741-2981

Energy Code:

Tennessee Code for Energy Conservation
in New Building Construction

Reference Code:

NCSBCS Model Code for Energy Conservation
in New Building Construction

**State
Administrative
Agency:**

Tennessee Energy Authority
250 Capital Hill Building
7th and Union
Nashville, TN 37219
(615) 741-2994

**Enforcement
Level:****Comments:**

Enforcement of the state energy code is as follows:

- 1) Any county which has in force as of January 1, 1979, the Standard Building Code (SBCC) satisfies the requirements of the law.
- 2) Any county which has no code but wishes to adopt one must use a code based on the NCSBCS model.
- 3) Any county not wishing to adopt a code is not required to do so.

Heating Degree Days

Bristol	4143
Chattanooga	3254
Knoxville	3494
Memphis	3232
Nashville	3578
Oak Ridge	3817

Davidson County

**Local
Enforcement
Official:**

Jim Anglea
Senior Building Inspector
Department of Codes and Administration
802 Second Avenue South
Nashville, TN 37201
(615) 259-6719

Building Code:

Reference Code: Standard Building Code (SBCC)

Energy Code: Tennessee Code for Energy Conservation in
New Building Construction

Reference Code: NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments: None

**Statement About
Passive Solar:**

Building Code Appeals Board has ruled favorably in cases of passive solar design and materials and is enthusiastic about innovation in energy conservation in residential construction.

Related Programs: None

**Requirements
to File:**

Plan Review - Does not include 1&2 family residences; if unusual construction, plans and details must be submitted.

Calculations - As per ASHRAE 90-75

Certifications - None

Inspections - All construction

Fees - \$25 total

Other - Credit for passive solar is difficult to determine but is regarded as a bonus in accepted designs. Acceptance determined by the Building Code Appeals Board.

Building Code: None

Reference Code:

**State
Enforcement
Agency:** Division of Housing
Department of Community Affairs
P. O. Box 13166/Capital Station
Austin, TX 78711
(512) 475- 3383

Energy Code:

Reference Code: None

**State
Administrative
Agency:** Governor's Office of Energy Resources
7703 N. Lamar Blvd./Suite 502
Austin, TX 78752
(512) 425-2323

**Enforcement
Level:**

Comments: Texas has neither a state building code nor state energy code. In the final days of the biennial session, the state legislature allowed to die in committee a bill mandating the NCSBCS model energy code. The Department of Community Affairs provides technical assistance to local jurisdictions on their building codes, and the Governor's Office of Energy Resources has been working to get a state energy code passed.

Heating Degree Days

Abilene	2624
Amarillo	3985
Austin	1711
Brownsville	600
Corpus Christi	914
Dallas	2363
El Paso	2700
Fort Worth	2405
Galveston	1274
Houston	1396
Laredo	797
Lubbock	3578
Midland	2591
Port Arthur	1447
San Angelo	2255
San Antonio	1546
Victoria	1173
Waco	2030
Wichita Falls	2832

**Local
Enforcement
Official:**

J. Tom Jones
Building Department
City of Dallas
Division of Building Inspection
1500 West Mockingbird Land
Dallas, TX 75235

Building Code:

Reference Code: Uniform Building Code (1976 ed.) (ICBO)

Energy Code:

Reference Code: None

Comments: None

**Statement About
Passive Solar:**

The city has a solar heated fire station, and there is a section in the building code which deals specifically with solar. Plumbing code questions related to alternative energy systems should be referred to Robert Good.

Related Programs: None

**Requirements
to File:**

Plan Review - Submit plans

Calculations - None

Certifications - None

Inspections - As per code requirements

Fees - As per code requirements

Other - None

**Local
Enforcement
Official:**

James Hunt
Building Official
Public Inspection Division
500 East San Antonio Street/Room 200
El Paso, TX 79999
(915) 543-4554

Building Code:

Reference Code: Standard Building Code (1976) with
'77/'78 amendments

Energy Code:

Reference Code: NCSBCS Model Code for Energy Conservation
in New Building Construction

Comments: None

**Statement About
Passive Solar:**

There have been passive solar examples in the city, including an award winning design. Mr. Hunt sees absolutely no problem with passive systems meeting codes.

Related Programs:

None

**Requirements
to File:**

Plan Review - 3 sets of working drawings

Calculations - Standard calculations for energy code

Certifications - None

Inspections - Footings, structural, final; electrical, plumbing, mechanical

Fees - Building permit based on construction cost. Electrical, plumbing, mechanical based on number of outlets or fixtures.

Other - None

**Local
Enforcement
Official:**

Lester Paige
Building Official
City of Fort Worth
1000 Throckmorton Street
Fort Worth, TX 76102
(817) 870-7820

Building Code:

Reference Code: Uniform Building Code (1973 ed.) (ICBO)

Energy Code: None

Reference Code:

Comments: None

**Statement About
Passive Solar:**

Has not seen any passive applications, but does not foresee problems or conflicts. Mr. Paige hopes to be able to hire some people who are familiar with such designs.

Related Programs:

None

**Requirements
to File:**

Plan Review - 2 sets of plans and site plan; must be stamped by registered architect/engineer only if multi-family over 1 story.

Calculations - Only for unusual construction

Certifications - None

Inspections - Building: stake out, foundation, framing, final; electrical, mechanical, plumbing

Fees - Valuation for building permit; fixture/outlet for electrical, mechanical, plumbing

Other - None

**Local
Enforcement
Official:** Bill Bradberry
Chief Plan Checker
City Hall Annex
900 Bagby Avenue
Houston, TX 77002
(713) 222-4891

Building Code:

Reference Code: Uniform Building Code (1973 ed.) (ICBO)
(There have been numerous changes, but none
which have bearing on the application of
passive solar systems.)

Energy Code: None

Reference Code:

Comments: None

**Statement About
Passive Solar:**

Has had no experience with passive systems,
but does not foresee any problems.

Related Programs:

Houston Lighting & Power Company has no mandatory requirements, but does have voluntary programs for energy conservation. For new construction there is the "Energy Checked Home" certificate awarded to homes that meet specified thermal criteria. However, there is no credit for solar contribution. There has been some study of solar applications, but it is essentially an internal research project.

**Requirements
to File:**

Plan Review - Application, plans & specifications

Calculations - None

Certifications - None

Inspections - Foundation, framing, final;
mechanical

Fees - New construction: Cost/square foot
Remodeling: Based on construction cost
Mechanical based on fixture outlets.

Other - None

**Local
Enforcement
Official:**

Bill Mellon
Department of Building & Zoning
P. O. Box 9066
San Antonio, TX 78285
(512) 225-4051

Building Code:

Reference Code: Uniform Building Code (1970 ed.) with
amendments

Energy Code: Insulation Ordinance 44,600; November 14, 1974

Reference Code:

Comments: The local insulation ordinance requires the
following levels in residences:

R-11 exterior walls
R-19 ceiling

**Statement About
Passive Solar:**

Has not had experience with this sort of design before but feels there would be no conflicts.

Related Programs:

Any construction along the San Antonio River Walk must be approved by the River Walk Commission.

**Requirements
to File:**

Plan Review - 2 sets of plans for review, and a stamp is required for large projects.

Calculations - None

Certifications - Will accept engineers' certifications of calculations and field inspection in lieu of their own.

Inspections - Foundation, framing, insulation, final; mechanicals

Fees - Based on cost for building permit; based on fixtures for mechanical

Other - None

Building Code: Virgin Island Building Code

Reference Code: South Florida Building Code (i.e., Standard Building Code - SBCC)

State Enforcement Agency: Building Permits Division
Public Works
St. Thomas, VI 00801
(809) 774-2070

Energy Code: Virgin Island Energy Code

Reference Code: NCSBCS Model Code for Energy Conservation in New Building Construction

State Administrative Agency: Virgin Island Energy Office
P. O. Box 575
Frederiksted, St. Croix, VI 00840
(809) 772-2616 (Joma Mahoney)

Enforcement Level: By above agencies

Comments: For residential construction that is not air-conditioned, the only aspects of the energy code that apply are those concerning reducing water usage. For air-conditioned residential construction, all aspects of the energy code apply.

**Statement About
Passive Solar:**

Passive solar heating is not required at all. Instead, means of natural ventilation and sun screening are encouraged to reduce the need for air-conditioning.

Related Programs: None

**Requirements
to File:**

Plan Review - 3 sets of plans

Calculations - Heat gain calculations

Certifications - None

Inspections - At various times during construction by various sections of the department

Fees - Based on estimated cost of construction

Other - Building application
Energy form
Earth change/coastal zone forms

VIRGINIA

Building Code: Virginia Uniform Statewide Building Code

Reference Code: BOCA Basic Building Code (1978)
1&2 Family Dwelling Code

State Enforcement Agency: State Fire Marshal
P. O. Box 1157 and Dept. of Housing & Community Development
Richmond, VA 23219 205 N. 4th Street
(804) 786-4751 Richmond, VA 23219
(804) 786-1575

Energy Code: BOCA Basic Building Code (1978); Chapter 20

Reference Code: ASHRAE 90-75

State Administrative Agency: Department of Housing & Community Development
205 North 4th Street
Richmond, VA 23219
(804) 786-1575

Enforcement Level: Local level

Comments: The building code is a statewide one, but is enforced at the local level.

Heating Degree Days

Cape Henry	3279
Lynchburg	4166
Norfolk	3421
Richmond	3865
Roanoke	4150

**Local
Enforcement
Official:**

R. A. Ledbetter
Building Official
City of Norfolk
P. O. Box 1531
Norfolk, VA 23501
(804) 441-2326

Building Code: Virginia Uniform Statewide Building Code

Reference Code: BOCA Basic Building Code

Energy Code: Chapter 20

Reference Code: BOCA Basic Building Code

Comments: None

**Statement About
Passive Solar:**

Active systems have been evaluated for conformance with the plumbing and mechanical codes only. Passive systems would be reviewed only if heat loss and structural calculations were provided. Only domestic hot water systems in solar applications have been submitted to date.

Related Programs: None

**Requirements
to File:**

Plan Review - 2 plans
Calculations - Heat loss calculations must be prepared by a licensed architect or engineer.
Certifications - Not for 1 & 2 family dwellings
Inspections - Foundation, framing, nailing, insulation, fire rating, electrical, rough-in, final
Fees - Based on square footage (\$5/100 sq.ft.)
Other - If window area is greater than 10 percent of the gross wall area, windows must be double glazed or include storms. All EER's for mechanical equipment must be supplied at time of application for permit.

**Local
Enforcement
Official:**

B. B. Chamblin
Senior Structural Engineer
City of Richmond
Bureau of Building Inspection
501 North 9th Street/Room 124
Richmond, VA 23219
(804) 780-8751

Building Code: Virginia Uniform Statewide Building Code

Reference Code: BOCA Basic Building Code

Energy Code: Chapter 20

Reference Code: BOCA Basic Building Code

Comments: None

**Statement About
Passive Solar:**

There have been only a few cases of active solar designs in his jurisdiction and no passive designs. However, Mr. Chamblin feels that there should be no problem at all in using such systems.

Related Programs:

None

**Requirements
to File:**

Plan Review - 2 site plans and working drawings

Calculations - None for 1 & 2 family housing

Certifications - None for 1&2 family housing

Inspections - Footing, framing, final;
electrical and plumbing

Fees - Based on cost of construction

Other - None

WEST VIRGINIA

Building Code: None

Reference Code:

**State
Enforcement
Agency:**

State Fire Marshal
State Capital, Unit 1
1800 Washington Street East
Charleston, WV 25305
(304) 348-2191

Energy Code:

Enforces fire safety aspects of National Building Code.
None

Reference Code:

**State
Administrative
Agency:**

Fuel and Energy Office
Office of Federal-State Relations
1262½ Greenbrier Street
Charleston, WV 25311
(304) 348-8860

**Enforcement
Level:**

Comments:

Passage of a state energy code was attempted, and failed, three times. The fire regulations do not apply to 1 and 2 family residences.

Heating Degree Days

Charleston	4476
Elkins	5675
Huntington	4446
Parkersburg	4754

**Local
Enforcement
Official:**

Roy H. Jones, Jr.
Building Commissioner
City of Charleston
P. O. Box 2749
Charleston, WV 25330
(304) 348-6833

Building Code:

Reference Code: BOCA Basic Building Code (1978 ed.)

Energy Code: None

Reference Code:

Comments:

City retained the 1976 mechanical code (BOCA).
Part of the present code requires that during
the winter the house must be able to be heated
to 70°F.

**Statement About
Passive Solar:**

Sees no problem with the use of passive solar, but feels that application in his area is limited. This is due, he said, to the fact that most houses are built in the valleys of the Appalachian Mountains and are in the shade much of the time.

Related Programs:

The Appalachian Power Company has an information program for energy conservation and provides free heat loss and heat gain calculations to builders. In addition, they will provide a certificate of achievement to homeowners who have installed specified levels of insulation. The only program dealing with solar is an in-house information gathering. Their plans are to build ten solar houses throughout their region and monitor them for 2 years. However, all ten installations will use active solar systems.

**Requirements
to File:**

Plan Review - 2 sets of plans & specifications.
Signed by registered architect/
engineer if cost exceeds \$50,000.

Calculations - Required only for unusual construction

Certifications - (Incomplete information)

Inspections - Foundation, rough-in, final
(including mechanical)

Fees - Building permit based on construction cost; mechanical based on quantities of units.

Other - None

GLOSSARY

Active Solar System: An assembly of collectors, thermal storage device(s), and transfer liquid which converts solar energy into thermal energy, and in which another form of energy is used to accomplish the transfer of thermal energy.

Annual Energy Use Index (AEUI): Annual Heating Load (AHL) divided by the building floor area gives energy use per square foot (SF).

Annual Fuel Requirement: Annual heating load divided by the product of the Mechanical Plan Efficiency (MPE) and a conversion factor gives amount of fuel required per square foot per year.

Annual Heating Load (AHL): Amount of energy required of the auxiliary heating system in one year.

Auxiliary Energy Subsystem: Equipment utilizing energy other than solar both to supplement the output provided by the solar energy system, as required by the design conditions, and to provide full energy backup requirements during periods when the solar heating or domestic hot water systems are inoperable.

Auxiliary Heating Fraction (AHF): Auxiliary Heating Fraction (AHF) plus Solar Heating Fraction (SHF) equals one. That part of the total building envelope heat loss supplied by the auxiliary heating system.

Building Envelope: The elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior.

Building Official: The official authorized to act on behalf of the responsible government agency for the enforcement of a code.

Building Loss Coefficient (BLC): The total amount of heat loss by the building in 24 hours (usually the sum of loss by conduction and infiltration).

Building Skin Conductance: Weighted average conductance of all the components of the building skin.

Collector, Integral (Passive): The collector is constructed and operated as part of the building structure and heating system. The thermal performance is considered a part of the building heating load and solar energy provides a significant fraction of the building heat requirements.

Component: An individually distinguishable product that forms part of a more complex product (i.e., subsystem or system).

Contaminants (hazardous): Materials (solids, liquids, or gases) which when added to the potable water supply cause it to be unfit for human or animal consumption. (ASSE 1013)

Control Subsystem: The assembly of devices and their electrical, pneumatic or hydraulic auxiliaries used to regulate the processes of collecting, transporting, storing, and utilizing energy in response to the thermal, safety, and health requirements of the building occupants.

Creep: A time-dependent deformation resulting from sustained loads which can be influenced by local environmental factors such as thermal atmosphere and/or cycling, and solar radiation.

Cross Connection: Any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other either water of unknown or questionable safety, steam, gas, chemicals, or other substances whereby there may be a flow from one system to the other; the direction of flow depends on the pressure differential between the two systems.

Conductance: The ability of a material to permit heat flow. (BTU/HR·SF·F)

Convective Loop: The flow of air in a closed path induced by the fact that hot air rises and cold air falls. Here it is the process by which thermal storage mass relinquishes some of its heat.

Degree Day, Heating: A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F.

Design Life: The period of time during which a heating or domestic hot water system is expected to perform its intended function without requiring major maintenance or replacement.

DHW: Domestic hot water system.

DG: Direct gain passive solar storage system (e.g., floors).

Direct Gain Passive Heating System: A simple system utilizing large south-facing windows and thermal storage mass (e.g., direct gain, Trombe wall, and water wall) in the living space.

Energy: The capacity for doing work. It takes a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical, and chemical; customarily measured in kilowatt-hours (kwh) or British thermal units (BTU).

Energy Efficiency Ratio (EER): The ratio of net cooling capacity in BTU/HR to total rate of electric input in watts under designated operating conditions.

Energy Budget: Annual Energy Use Index (AEUI) divided by the Mechanical Plan Efficiency (MPE) equals energy/square foot/year.

Energy Transport Subsystem: The portion of the heating and domestic hot water systems which contains heat transfer fluids and transports energy throughout the system.

Fuel: A substance which may be burned to give heat or generate electricity; a nuclear substance used to generate electricity.

Gross Floor Area: The sum of the areas of the several floors of the building -- including basements, cellars, mezzanine and intermediate floored tiers, and penthouses of headroom height-- measured from the exterior faces of exterior walls or from the centerline of the walls separating buildings.

Gross Wall Area: The vertical projection of the exterior wall area bounding interior space which is conditioned by an energy-using system; includes opaque wall, window, and door areas.

The gross area of exterior walls consists of all opaque wall areas (including foundation walls, areas between floor spandrels, peripheral edges of floors, window areas including sash, and door areas) where such surfaces are exposed to outdoor air and enclose a heated or mechanically cooled space, including interstitial areas between two such spaces.

Heat: The form of energy that is transferred by virtue of a temperature difference.

Heat Capacity: The amount of heat necessary to raise the temperature of a given mass one degree.

Heat Transfer Medium: A medium -- liquid, air, or solid -- which is used to transport thermal energy.

Heated Space: Space within a building which is provided with a positive heat supply to maintain air temperature of 50°F or higher.

HVAC: Heating, ventilating, and air-conditioning.

HVAC System: A system that provides either collectively or individually the processes of comfort heating, ventilating, and/or air-conditioning within or associated with a building.

Infiltration: The uncontrolled inward air leakage through cracks and interstices in any building element and around windows and doors of a building, caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

Load Collector Ratio (LCR): Building Loss Coefficient (BLC) divided by passive solar collector area gives energy use per degree day (DD) per square foot (SF).

NI: Night insulation

Non-Depletable Energy Sources: Sources of energy (excluding minerals) derived from incoming solar radiation, including photo-synthetic processes; from phenomena resulting therefrom, including wind, waves, and tides, lake or pond thermal differences; and energy derived from the internal heat of the earth, including nocturnal thermal exchanges.

Mechanical Plan Efficiency (MPE): The efficiency of the mechanical system, usually obtainable from the manufacturer.

Outside Air: Air taken from the outdoors and, therefore, not previously circulated through the system.

Passive Solar System: An assembly of natural and architectural components, including collectors, thermal storage device(s), and transfer fluid, which converts solar energy into thermal energy in a controlled manner and in which no fans or pumps are used to accomplish the transfer of thermal energy. The prime elements in a passive solar system are usually some form of thermal capacitance and solar energy control.

Power: In connection with machines, power is the time rate of doing work. In connection with the transmission of energy of all types, power refers to the rate at which energy is transmitted; in customary units, it is measured in watts (W) or British thermal units per hour (BTU/HR).

Recovered Energy: Energy utilized which would otherwise be wasted from an energy utilization system.

Reflectance: The ratio of the light reflected by a surface to the light falling upon it.

Reheat: The application of sensible heat to supply air that

has been previously cooled below the temperature of the conditioned space by either mechanical refrigeration or the introduction of outdoor air to provide cooling.

SF: Square foot.

Solar Absorptance: The ratio of the amount of solar radiation absorbed by a surface to the amount of radiation incident on it.

Safety Glazing Materials: Glazing materials so constructed, treated, or combined with other materials as to minimize the likelihood of cutting and piercing injuries resulting from human contact with these glazing materials.

Solar Building: A building which utilizes solar energy by means of an active or passive solar system.

Solar Degradation: The process by which exposure to sunlight deteriorates the properties of materials and components.

Solar Energy: The photon energy originating from the sun's radiation in the wavelength region from 0.3 to 2.7 micrometers.

Solar Heating Fraction (SHF): That part of the total building envelope heat loss supplied by the passive solar system.

Solar Heating System: The complete assembly of subsystems and components necessary to convert solar energy into thermal energy for heating purposes, in combination with auxiliary energy, when required.

Solar Time: The hours of the day as reckoned by the apparent position of the sun. Solar noon is that instant on any day at which time the sun reaches its maximum altitude for that day. Solar time is very rarely the same as local standard time in any locality.

Storage Subsystem: The assembly used for storing thermal energy so that it can be used when required.

Subsystem: A major, separable, functional assembly of a system, such as a complete collector, storage, assembly, etc.

Thermal Energy: Heat possessed by a material resulting from the motion of molecules which can do work.

Thermal Storage Mass: A heavy structure used to collect and store heat energy. In a passive solar system, the mass absorbs the sun's heat during the day and reradiates it at night.

Thermal Storage Roof: A type of thermal mass storage; can be water or masonry, and usually has movable insulation.

Thermal Storage Wall: A type of thermal mass storage; can be a variety of materials and is located on the south wall of the building.

Thermal Transmittance (U): Overall coefficient of heat transmission (air to air) expressed in units of BTU per hour per square foot per degree F. It is the time rate of heat flow. The U value applies to combinations of different materials used in series along the heat flow path, single materials that comprise a building section, cavity air spaces, and surface air films on both sides of a building element.

Thermostat: An instrument which measures changes in temperature and controls device(s) for maintaining a desired temperature.

Thermosiphon Loop: See convective loop.

Transmittance: That fraction of solar radiation (e.g., light) which passes through transparent or translucent materials such as glass.

TW: Trombe wall passive solar storage system (masonry).

WW: Water wall or roof passive solar storage system.

Zone: A space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

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(Garden Way Publishing, Charlotte, VT 05445; 240 pp., \$8.95)

The First Passive Solar Catalog, D. A. Bainbridge
Covers the basics of solar design; includes examples of passive houses and a guide to components, consultants, and information sources. (Passive Solar Institute, P. O. Box 722, Davis, CA 95616; 1978; 71 pp., \$5.00)

First Passive Solar Home Awards¹, National Solar Heating and Cooling Information Center
Presents the state-of-the-art designs that won the competition sponsored by the U. S. Department of Housing and Urban Development (HUD). (266 pp., January, 1979)

Natural Solar Architecture: A Passive Primer, D. Wright
An attractive and entertaining exploration of the principles of passive solar energy. (Van Nostrand Reinhold Co., New York, NY 10001; 1978, 245 pp., \$7.95)

Passive Solar Buildings: A Compilation of Data and Results, prepared by Sandia Laboratories for U. S. Department of Energy.
Reviews examples of solar houses and covers computational techniques. (June, 1978, Report No. SAND 77-1204, 71 pp., \$5.25)

Passive Solar Design: A Short Bibliography for Practitioners,² AIA Research Corporation
Covers a variety of subject areas of passive solar energy design -- including costs, design aids, comfort, greenhouses, glazing, storage, thermosiphon systems, and cooling. (October, 1978, Report No. HCP/CS-4113, 17 pp., \$4.50)

The Passive Solar Energy Book, E. Mazria
Describes the steps involved in choosing and sizing a passive system; includes climatic information, photos, and descriptions of passive buildings. (Rodale Press, Emmaus, PA 18049; 1979, paperback, 400 pp., \$10.95; professional version \$19.95)

Regional Guidelines for Building Passive Energy Conserving Homes³
Divides the United States into 13 climatic areas and explains the heating and cooling building requirements of each area. (Available from the Government Printing Office, stock number 023-000-00481-0, 312 pp., \$5.25)

Solar Dwelling Design Concepts,³ AIA Research Corporation for HUD.

Explores basic considerations for designing a solar home that is in tune with the environment. (Available from the Government Printing Office, stock number 023-000-22334-1, 146 pp., \$2.30)

The Solar Home Book, B. Anderson

Everything you need to know about passive solar energy, from passive principles to the history of this technology. (Cheshire Books, Harrisville, NH; 1977, 297 pp., \$7.50)

A Survey of Passive Solar Buildings,³ prepared by the American Institute of Architects (AIA) Research Corporation for HUD.

Describes solar homes around the country. (Available from the Government Printing Office, stock number 023-000-00473-2, 176 pp., \$3.75)

NOTES

¹The National Solar Heating and Cooling Information Center is operated by the Franklin Research Center for HUD and DoE. Other free information which may be of interest:

Passive Solar Buildings Soak Up the Sun. Discusses passive buildings in different parts of the country. This fact sheet is reprinted from an article published in PEOPLE & ENERGY, an alternative-energy magazine (8 pp.).

Passive Solar Heating. Shows examples of passive solar homes with diagrams of their energy systems. (Published by the U. S. Department of Energy, 10 pp.)

What Is Passive Solar Heating? Presents the different types of passive solar energy systems and explains how they work. (8 pp.)

For more information contact NSHCIC at P. O. Box 1607, Rockville, MD 20850; or call toll free (800) 523-2929, in Pennsylvania (800) 463-4983, in Alaska and Hawaii (800) 523-4700.

²These publications can be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

³These publications can be obtained by writing to:

U. S. Government Printing Office
Washington, DC 20402

or from your local GPO bookstore.