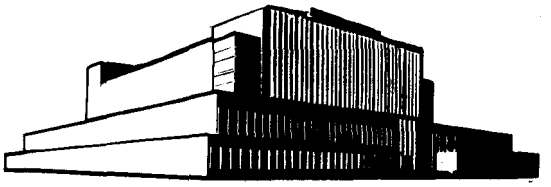


U.S. Forest Service Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE • FOREST SERVICE • FOREST PRODUCTS LABORATORY • MADISON WIS

In Cooperation with the University of Wisconsin

STUDY OF TEMPERATURE IN WOOD PARTS OF HOUSES THROUGHOUT THE UNITED STATES

FPL-012

August 1963

STUDY OF TEMPERATURE IN WOOD PARTS OF HOUSES THROUGHOUT THE UNITED STATES[1]

By

OTTO C. HEYER, Research Engineer

Forest Products Laboratory,[2] Forest Service
U.S. Department of Agriculture

Summary

Based on data from six houses and one office building, temperatures in walls and roofs can rise appreciably above the air temperature. Maximum values in walls may occasionally exceed 130° F., but the cumulative duration of temperatures of 120° F. or higher was not observed to exceed 32 hours in any one year. Maximum values in roofs can reach 170° F., but cumulative durations of temperatures of 160° F. or higher were not observed to exceed 21 hours, or of 150° F. or higher to exceed 64 hours in any one year. Roof temperatures in a house at Madison, Wis., fell as low as the air temperatures, which were below -10° F. for short periods in winter. Temperatures reached are affected by the orientation and the surface characteristics of the wall or roof as well as by the exterior climate. The study points out the value of ventilation and insulation of roof areas and the value of roof overhang in controlling wall temperatures.

Introduction

Temperatures of wood structural parts of houses have been a topic of much discussion for many years. Now the steadily expanding use of glued wood products in residential

---

[1] This study was undertaken by the U.S. Forest Products Laboratory at the request of the Products and Research Committee and the Technical Advisory Committee of the National Lumber Manufacturers Association.

[2] Maintained at Madison, Wis,, in cooperation with the University of Wisconsin.

construction has focused attention on glues, gluing techniques, and problems relating to the use of these products. Some of the principal points of concern involve the reaction of various glues and glued members to thermal conditions encountered in frame walls, ceilings, and roofs. The study was undertaken to determine the maximum temperatures of various elements in a house, in order to understand better the relationship of maximum temperatures to glued construction.

The objectives of the study were to obtain data pertaining to temperature and temperature changes in frame houses in the Southeast, South, Southwest, Northwest, and North Central areas of the United States, This information may help to determine the type of adhesives that are adequate for glued-up members for walls and roof constructions.

This report presents temperature data collected in houses located in Tucson, Ariz., Athens, Ga., Portland, Oreg., Diboll, Tex., and Madison, Wis., and one office building located in Madison, Wis.

The houses were selected and instrumented preferably during the construction period. Thermocouples or other temperature-sensing devices were installed so that continuous temperature measurement could be made during the summer, at each of several stations, during occupancy of the houses.

Factors that Affect Temperatures

Many factors affect temperature, but not all can reasonably be expected to apply in any one house. Some significant factors that cause high temperatures in various parts of a house are:

(1) Orientation of the house. South and southwest exposures for walls and roof are most severe.

(2) Color of materials used. Dark colors are most severe.

(3) Slope of roof. High temperatures are reached when the rays of the sun at its greatest height will strike the roof at an angle perpendicular to its surface.

(4) House in the sun or unshaded areas.

(5) Insulation
   (a) When walls are exposed to direct sunlight in warm weather, insulation will increase temperature in some sections of the house, such as in sidewalls, since heat is less readily dissipated than in an uninsulated wall of roof space.

(b) Ventilation. A well-ventilated attic will carry the heat away more rapidly than a poorly ventilated attic.

(6) Other factors
(a) Wind velocity
(b) Clarity of atmosphere
(c) Height above ground
(d) Character of ground surface
(e) Proximity of trees or other buildings

Choice of Houses

It is nearly impossible to meet all these requirements for maximum temperatures when selecting houses for temperature readings. A house in a new development would be ideal, since new developments seldom have trees and shade from trees is a factor. A desirable house for the study would be finished in a dark color, with a roof sloping towards the south, insulation placed between the rafters as in a 1-1/2-story house, and little or no effective attic ventilation. Another suitable house would be one with a roof of rather low slope over an unused attic with insulation in the attic floor and poor ventilation. The houses selected for this study, as most houses, could not meet all the suggested requirements.

Description of Houses

At Tucson, Ariz.

In cooperation with the Rocky Mountain Forest and Range Experiment Station and the Applied Research Laboratory of the College of Engineering at the University of Arizona, a study was made of the temperatures in a house representative of the southwestern United States.

The house chosen at Tucson, Ariz., was one-story with masonry walls of burned adobe. One wall of the living area was finished in conventional wood construction and the 2- by 4-inch frame wall areas were sheathed with 1/2-inch plywood. The outside of the wall, covered with striated plywood siding (back batten effect), was painted white. The main roof exposure faced east and west with a slope of 1 in 12. The roof and ceiling were unitized with no attic space and the roof had an overhang of approximately 2 feet on the ends and side. Roof-framing members were sheathed with 1/2-inch plywood and covered with a built-up roofing with a pea-gravel and sand added finish. The roof had approximately 2 inches of insulation. Evaporative cooling provided air-conditioning for the interior of the dwelling.

At Athens, Ga.

The Southeastern Forest Experiment Station selected a one-story brick veneer house for the portion of the study in this city. Its 2- by 4-inch wood framing members, used in the walls, were of southern yellow pine spaced 16 inches on center, and the exterior walls were sheathed with an insulated type fiberboard. The hip-type roof, with a slope of 4-1/2 in 12, was covered with dark gray asbestos shingles and the roof overhang was approximately 18 inches. The main roof exposure faced north and south.

Thermocouples were located at the rear of the house (the south exposure), where there was no shade. Ventilators were installed in the roof.

At Portland, Oreg.

The Pacific Northwest Forest and Range Experiment Station, located in Portland, Oreg., selected two houses in this area for temperature measurements.

House A.--This one-story wood-frame house, with a daylight basement was located on the south slope of Mt. Scott, fully exposed to the sun. Its walls were conventionally constructed, using 2 by 4 studs spaced 16 inches on centers with 3/8-inch plywood sheathing. The redcedar bevel siding had the sawn side exposed and was finished with linseed oil without pigment. The walls were fully insulated and finished with gypsum board on the inside. Constructed with 2- by 6-inch rafters sheathed with 1/2-inch plywood, the roof was covered with brown asphalt shingles. The gable roof, which faced north and south, had a slope of 5 in 12 and an overhang of approximately 20 inches on the sides and ends. Attic space was ventilated at both ends by louvers.

House B.--Fully exposed to the sun, this one-story home was of conventional frame construction with a daylight basement. The walls were sheathed with 1/2-inch plywood covered with redcedar bevel siding--sawn surface exposed--and finished with a gray-green pigmented stain. The interior walls were finished with gypsum board. Sheathed with spaced boards, the rafters were covered with redcedar shingles. The roof, facing to the east and west, had a slope of 5 in 12 with a 2-foot overhang on the sides and ends. Louvers at the gable ends of the house provided ventilation for the attic space.

At Diboll, Tex.

The data presented for a house in the Southwest area were obtained by the Texas Forest Service in cooperation with the Southern Pine Lumber Company.[3]

---

[3] Childs, Montgomery R. Progress report on "Temperature Tests on Wood in Frame Buildings." Texas Forest Service Research Note No. 24, Lufkin, Tex. (April 1960).

The house chosen for this study was located about 10 miles southwest of Lufkin, Tex. It was a one–story floor plan, five–room, wood–frame house erected on masonry piers. Its hip–type roof had a 5 in 12 slope and was reported to have gray–white asphalt shingles and the main roof expanse faced east and west. The walls were of conventional construction using laminated 2 by 4's (fabricated from1 by 4's glued with a urea resin glue). The exterior walls were sheathed with an insulating board and finished with southern yellow pine drop siding (the finish of the siding was not reported). The interior was finished with gypsum board and the ceiling was sheathed with insulating board prior to applying the gypsum board. Floor joists were sheathed with inverted 1–inch drop siding overlaid with insulation board and finished with 2–1/2–inch oak flooring. Attic ventilation was provided by two screened soffit openings, 6 inches wide and 50 feet long.

At Madison, Wis.

The study house chosen in the North Central area was a one–story frame structure with approximately 1,900 square feet of enclosed area. Its hip roof had a 3 in 12 slope with an overhang of 3 feet and ventilationfor the attic space was provided in the soffit. The main expanse of the roof faced approximately east and west, and the hip–type roof construction combined 1/2–inch plywood roof sheathing fastened to the rafters, followed by building paper and composition shingles, off–white in color. The walls were of stand–ard construction featuring 1/2–inch plywood sheathing and redwood bevel siding painted a light pink. Walls were fully insulated, the ceiling had 4 inches of insulation, and the interior walls and ceiling were plastered.

Forest Products Research Society Building

In addition to the residence chosen in the Madison area, temperature readings were taken in the Forest Products Research Society building located on North Walnut Street in Madison on the edge of the University of Wisconsin campus and close to the Forest Products Laboratory.

This contemporary designed structure utilized wood and wood products expressed in their true functional form. The main structural framing was composed of glued–laminated columns and beams, and the roof had a slope of 1/2 in 12, which is virtually flat. The main expanse of the roof faced approximately east and west. Its laminated beams were covered with a 3–1/2–inchwood decking, over which 2–1/2 inches of rigid insulation were placed, followed by a built–up roofing with a sand and gravel finish. The roof projected 4 feet on the sides and 3 feet on the ends. End walls were constructed of 2– by 6–inch framing members sheathed with 5/16–inch plywood. Wood strips were nailed horizontally to the plywood and framing members to accommodate the vertical redwood siding. The

vertical redwood siding was finished with the Forest Products Laboratory natural finish light redwood color, The curtain wall construction used on the sides had similar construction to the end walls above and below the window areas. Insulation was used in all walls.

Methods of Obtaining Data

The nature of the data to be obtained made the use of a temperature–recorder imperative. Furthermore, since the space in which the temperature–sensing element was placed was in most cases very limited, thermocouples were the most practical sensing elements. Thus, the temperature–recorder was a recording potentiometer with automatic cold junction compensation.

Description of the instruments, location of the thermocouples, and other data regarding the houses selected for this study are given in more detail in the description of the individual houses.

At Tucson, Ariz.

Thermocouples were installed in 16 different locations (fig. 1). Two of the thermocouples (7 and 9) were omitted from the results because they were installed only as spares. The leads were brought out to a multichannel recorder. Temperature readings for each thermocouple location were electrically plotted on a graph sheet. The readings of the outdoor thermocouples were compared routinely with a mercury in glass thermometer in order to check the overall accuracy of the temperature–recorder. Hourly data on the recorder charts were readand the information punched on cards. A computer was programmed to produce print–out sheets giving: (1) the average temperature for each thermocouple per 24–hour period; (2) the maximum and minimum temperatures reached by each thermocouple per 24–hour period; and (3) the time each thermocouple recorded a temperature above 100° F.

Readings were taken from July 1 to September 30, 1959, except when neccessary to change charts or to make mechanical repairs.

At Athens, Ga.

Figure 2 shows the location of seven of the eight thermocouples installed. Leads were connected to the automatic recording potentiometer and the temperature readings were electrically plotted on a graph sheet.

Readings were taken from August 7 to 31, 1958, June 9 to October 3, 1959, and from July 15 to October 3, 1960. A total of 1,392 temperature hours were recorded in 1958, 2,485 in 1959, and 1,861 in 1960.

House A at Portland, Oreg.

The locations of seven thermocouples are shown in figure 3. Temperature readings were taken with a portable-type potentiometer which was equipped with a reference junction in an ice water bath in a vacuum bottle.

Readings were taken at thermocouple stations located in the walls and roof areas during the day at various times from June 17 to September 1958. On July 6, 1960, readings were taken at approximately half-hour intervals starting at 11:50 a.m. and ending at 4:05 p.m.

House B at Portland, Oreg.

Figure 4 shows the location of the seven thermocouples in the wall and roof. A portable-type potentiometer, equipped with a reference junction in an ice water bath in a vacuum bottle, was used to record the temperatures.

On July 15, 1958, one reading was taken at 3:30 p.m. at the thermocouple stations located in the wall and roof areas, and two readings on August 6, 1958, one at 2:55 p.m. and the other at 3:15 p.m. On September 17, 1960, readings were taken approximately at half-hour intervals starting at 12:45 p.m. and ending at 3:38 p.m.

At Diboll, Tex.

Temperature measurements were obtained through the use of eight copper-constantan thermocouples (fig. 5) placed in the structure during the construction. Hourly temperature readings were taken by a potentiometer with automatic cold junction compensation. Temperature data were recorded during 20 days in the month of August 1958 and 40 days during the summer of 1959. Readings were taken only on days when relatively high temperatures were anticipated. Figure 5 shows the location of the eight thermocouples.

At Madison, Wis.

Seven thermocouples were installed in the west wall and roof area of the house at Madison, Wis. (fig. 6). The leads were brought out to the automatic recording potentiometer and the temperature readings were electrically plotted on a graph sheet.

Readings were taken from May 8 to December 31, 1959, and from January 1 to October 23, 1960. The total number of hours recorded in 1959 was 5,426 and 5,993 in 1960.

Forest Products Research Society Building

Eight thermocouples were installed in the wall and roof area (fig. 7). The leads, installed in the wall and roof area during the initial construction of the building, were brought out to the automatic recording potentiometer. Temperature readings were electrically plotted on graph sheets.

Presentation of Data

Temperature readings together with related information are given in tables 1 to .8. Figure 8 shows the maximum temperature isotherm, the highest temperatures ever observed in the United States.

Table 1 shows the temperature data from the house at Tucson, Ariz., by thermo–couple location. It lists the maximum temperature number of days the temperature reached 100° F. or over for each of the thermocouples, and the maximum duration in hours the temperature recorded over 100° F. for each of the thermocouples. During the months of June, July, August, and September, 1959, a total of 2,541 hours were recorded.

The data presented in table 2 show the temperature range by 10" levels from 50" to 150" F. and the number of hours each thermocouple remained at the various tempera–ture ranges during the hours recorded. The data in table 2 for the house located in Athens, Ga., were taken from the temperature charts furnished to the Laboratory.

Tables 3 and4 showtheday, month, year, time, air temperature, and the temperature in degrees Fahrenheit recorded for each of the thermocouples located in the two residences in Portland, Oreg.

Data shown in table 5 were taken in a residence in Diboll, Tex., and were furnished to the Laboratory by the Forest Products Department of the Texas Forest Service.

The data in table 6 give the number of hours for the different temperature levels at the various thermocouple stations in the house at Madison, Wis. Also included is the number of hours the air temperature remained at or above the different temperature levels.

Table 7 lists the number of hours for the different temperature levels at the various thermocouple stations and the number of hours the air temperature remained at or above the different temperature levels in the Forest Products Research Society building, also in Madison, Wis.

Discussion

For some of the houses, the data received are not complete with regard to precise temperature maxima, wind velocities, type of ground cover, coefficient of absorptivity and emissivity of the exposed surface, and atmospheric conditions. Absence of such data reduces the usefulness of many of the data.

However, a great quantity of data were obtained from the five houses and the one office building used in this study in various parts of the United States. Despite some inadequacies, these dataprovide a substantial basis for broad consideration in reaching some conclusions regarding the practicability of glued members for use in wall and roof construction systems.

The summary data in table 8 indicate that in a maximum temperature range of 130" to 139" F., the duration of time of the wall surface was only 1 hour in any one year. At a lower temperature range of 120° to 129° F., the time duration was 31 hours. The roof surface readings show that in a temperature range of 150° to 159° F., the maximum duration was 43 hours. At a temperature range of 160° to 169° F., the duration of time was 20 hours, and 1 hour in the temperature range of 170° to 179° F.

The minimum temperature recorded in the Madison house for the 8-month period in 1959 (May to December} occurred in November at the -9' to 0" F. temperature level, at which time the air temperature remained at this level for 9 hours and the roof surface recorded 23 hours at this temperature level.

The maximum temperature level recorded in the summer of 1959 occurred in August, at which time the roof surface recorded 1 hour at the temperature range of 140" to 149' F.

In 1960, the minimum temperature recorded in the 10-month period (January to October) was in February at the -19° to -10° F. level, at which time the roof surface recorded 3 hours at this temperature level.

The roof surface recorded an 8-hour period for a maximum temperature level of 130° to 139° F. in July 1960.

The data collected in the Madison house indicate that certain parts of a structure in that area will pass through a broad temperature range in a 12-month period. In the winter period, the minimum temperatures can drop to a -20° F. and in the summer season the temperature can rise to 139° F. The extreme temperature levels are generally only for short durations of time. The long duration seems to occur in the temperature range of 50° to 89° F. for most of the stations in the wall and roof areas. These temperature ranges generally occur during the spring, summer, and fall. During the winter time the long temperature durations occur in the temperature range of 10° to 39° F.

In general, the data differences between the roof area and wall area temperatures suggest several things. First, the angle of incidence of the sun has a marked effect on the magnitude of the temperature attained. During the summer the sun is high overhead at midday and the roof area receives strong radiation during the late forenoon or early afternoon (no protection during the morning or hot afternoon). The wall area, on the other hand, is not affected by direct exposure to the sun until 3 or 4 p.m. This, of course, can be further prolonged by wide roof overhang. When the sun is low on the horizon, the sun's rays are filtered and diluted considerably by atmospheric haze, and the radiation is less severe.

Thermal build–up in the wall area is retarded by the sheathing material. This also suggests that there is merit in sheathing the roof deck, in addition to the ceiling area, with some form of insulation to reduce temperatures in the rafters as well as the upper house enclosure.

Conclusions

The temperature data collected tend to support several basic conclusions of a general nature:

(1) The area between the ceiling joist and the rafter should be provided with some means of ventilation (forced) to reduce temperature build–up on hot days.

(2) Insulation of roof and ceiling areas would be more than justified in most resi–dences.

(3) Wide overhang and landscape shade are substantial contributors to control equable interior house temperatures.

For service in the United States, it appears to be safe to assume that the maximum ambient temperature that might be attained would be 125° F. (fig. 8, a map of maximum temperature isotherms for the United States, highest temperatures ever observed).[4] General temperatures above this will be extremely transitory and thus of little con–sequence except where temperature–sensitive elements are involved. In the hottest desert regions, the temperature may rise to 110" F. or higher during about 75 percent of the summer days and may exceed 120" F. on about 6 days during the hottest month. Furthermore, the peak will generally be attained about 3 hours after solar noon and will last about 2 hours on the average. For a 6–hour period, the temperature may remain within 4" F. of the peak.

---

[4] "Climate and Man. Yearbook of Agriculture 1941." U.S. Department of Agriculture. p. 708.

The maximum temperature recorded will logically be the maximum of the monthly maximum temperature on record. It is possibly useful in determining the maximum temperature that a building or equipment is likely to undergo. It may be desirable to add a safety factor to provide for any future "record-breaking temperature."

Table 1.--Summary of temperatures by thermocouple locations, residence at Tucson, Ariz., (1959) [1], [2]

Month [3] (1959)	Maximum air temperature [4]	Walls: Storage area (west): Face of siding (1)	Walls: Storage area (west): Between felt and siding (2)	Walls: Storage area (west): Exterior face of stud (16)	Walls: Storage area (west): Center of stud (3)	Walls: Living room area (south): Face of siding (5)	Walls: Living room area (south): Between felt and siding (4)	Walls: Living room area (south): Exterior face of stud (8)	Walls: Living room area (south): Center of stud (6)	Roof: House area: Between felt and roof sheathing (10)	Roof: House area: Between insulation and sheathing (11)	Roof: House area: Outside surface of roof (12)	Roof: Storage area: Between felt and roof sheathing (13)	Roof: Storage area: Between ceiling and roof sheathing (14)	Roof: Storage area: Outside surface of roof (15)
	°F.														
MAXIMUM TEMPERATURE REACHED, °F. [5]															
June	109	129	124	122	113	103	101	103	98	154	145	160	158	151	162
July	106	130	125	124	114	106	102	102	96	157	148	161	160	151	165
August	101	128	123	120	108	124	113	130	133	159	157	163	158	152	162
September	104	130	125	123	110	126	133	115	102	150	143	158	155	152	158
NUMBER OF DAYS TEMPERATURE REACHED 100° F. OR HIGHER [5]															
June	21 [2]	25	25	25	25	12	2	4	.....	25	25	25	25	25	25
July	22	26	26	26	26	12	4	2	.....	27	27	27	27	27	27
August	3	25	25	25	13	28	20	18	3	29	29	29	29	30	29
September	9	26	25	25	16	27	25	25	7	27	27	27	27	27	27
MAXIMUM DURATION OVER 100° F., HOURS [5]															
June	.....	8	8	8	7	5	2	3	.....	12	12	12	12	12	12
July	.....	7	7	7	7	8	4	5	.....	10	10	11	11	11	12
August	.....	5	5	6	4	8	8	7	2	10	9	10	10	10	10
September	.....	6	6	6	6	8	7	7	3	10	9	10	10	10	10

[1] Numbers in parentheses refer to location of thermocouples as shown in figure 1.

[2] Thermocouples 7 and 9 were omitted from the results because they were installed only as spares.

[3] Total number of days and hours read for each month:

Month	Days	Hours	Total number hours in the month
June	28	593	720
July	28	632	744
August	30	633	744
September	30	683	720

[4] Maximum air temperature and days above 100° F. were taken from the U.S. Department of Commerce, Weather Bureau Station at the University of Arizona.

[5] Data on temperature, days, and hours at each thermocouple station were taken from IBM cards furnished by the University of Arizona.

Table 2.--Summary of duration of temperatures at various locations in wall and roof, residence at Athens, Ga. (1958 to 1960)[1]

Temperature	Duration of temperature in hours								
		Wall				Roof		
	Air temperature	Exterior face of brick	Face of sheathing	Between wall sheathing and stud	Center of stud	Exterior surface of roof	Between shingles and roof sheathing	Between roof sheathing and rafter
		(5)	(6)	(7)	(8)	(2)	(3)	(4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
AUGUST 7 TO 31, 1958 (600 HOURS)								
50 - 59	4					29	9	2
60 - 69	131	39	11	10	9	174	118	66
70 - 79	251	241	242	236	238	112	147	196
80 - 89	149	167	195	208	238	31	63	79
90 - 99	22	78	107	102	71	33	37	57
100 - 109		27				33	39	70
110 - 119		1				41	47	72
120 - 129						48	59	14
130 - 139						43	37	14
140 - 149						1		
SEPTEMBER 1 TO 30, 1958 (720 HOURS)								
50 - 59		24	2					
60 - 69	79	184	128	114	94			
70 - 79	244	242	289	308	339			
80 - 89	199	157	177	183	227			
90 - 99	141	66	108	113	58			
100 - 109	15	39	13					
110 - 119		6						
120 - 129								
130 - 139								
140 - 149								
OCTOBER 1 TO 3, 1958 (72 HOURS)								
50 - 59	24	40	35	33	9	19	16	35
60 - 69	20	22	19	17	34	18	24	18
70 - 79		1	9	13	20	3	19	5
JUNE 9 TO 30, 1959 (483 HOURS)								
50 - 59						36	10	
60 - 69		75	14	11	9	162	124	74
70 - 79	2	203	232	230	232	76	100	143
80 - 89	428	158	204	214	232	30	54	74
90 - 99	77	65	57	52	34	29	40	57
100 - 109		6				29	32	56
110 - 119						38	42	66
120 - 129						41	49	33
130 - 139						38	42	4
140 - 149						26	14	

Table 2.--Summary of duration of temperatures at various locations in wall and roof, residence at Athens, Ga. (1958 50 1960) [1] (Cont.)

Temperature	Duration of temperature in hours								
		Wall				Roof		
	Air temperature	Exterior face of brick	Face of sheathing	Between wall sheathing and stud	Center of stud	Exterior surface of roof	Between shingles and roof sheathing	Between roof sheathing and rafter
		(5)	(6)	(7)	(8)	(2)	(3)	(4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
JULY 1 TO 20, 1959 (500 HOURS)								
50 - 59						4		
60 - 69		25				159	81	26
70 - 79	19	239	217	210	215	114	164	201
80 - 89	263	162	222	232	243	35	54	80
90 - 99	218	69	60	57	42	39	48	65
100 - 109		5	1	1		29	40	53
110 - 119						32	34	53
120 - 129		21					40	43
130 - 139						25	27	1
140 - 149						19		
AUGUST 1 TO 31, 1959 (734 HOURS)								
50 - 59						3		
60 - 69		20				196	96	20
70 - 79		310	259	248	241	189	236	281
80 - 89	164	222	294	320	365	58	87	117
90 - 99	570	142	160	149	128	41	56	89
100 - 109		35	21	17		39	53	81
110 - 119		5				49	61	91
120 - 129						51	62	52
130 - 139						53	60	3
140 - 149						47	21	
SEPTEMBER 1 TO 30, 1959 (716 HOURS)								
50 - 59		13				99	51	19
60 - 69		207	150	139	131	269	257	219
70 - 79		287	317	328	350	108	150	226
80 - 89	583	123	153	166	195	43	64	83
90 - 99	133	58	84	79	40	39	40	67
100 - 109		25	12	4		39	46	67
110 - 119		3				36	50	33
120 - 129						39	43	2
130 - 139						27	15	
140 - 149						11		
OCTOBER 1 TO 3, 1959 (62 HOURS)								
50 - 59						16	2	
60 - 69		22	11	8	1	17	27	27
70 - 79		18	27	31	37	4	7	10
80 - 89	59	11	11	10	16	3	5	5
90 - 99	3	4	8	9	8	3	1	5
100 - 109		4	5	4		1	6	8
110 - 119		3				5	4	7
120 - 129						6	6	
130 - 139						7	4	
140 - 149								

Table 2.--Summary of duration of temperatures at various locations in wall and roof, residence at Athtens, Ga. (1958 to 1960) [1] (Cont.)

Temperature	Air temperature	Wall: Exterior face of brick (5)	Wall: Face of sheathing (6)	Wall: Between sheathing and stud (7)	Wall: Center of stud (8)	Roof: Exterior surface of roof (2)	Roof: Between shingles and roof sheathing (3)	Roof: Between roof sheathing and rafter (4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
JULY 15 TO 31, 1960 (347 HOURS)								
50 - 59						66	30	4
60 - 69		142	101	96	91	112	123	130
70 - 79	131	108	147	157	175	28	44	61
80 - 89	216	80	95	92	81	28	27	40
90 - 99		17	4	2		11	25	32
100 - 109						19	17	37
110 - 119						27	26	42
120 - 129						19	38	1
130 - 139						34	17	
140 - 149						3		
150 - 159								
AUGUST 1 TO 31, 1960 (713 HOURS)								
50 - 59						32	2	
60 - 69		35	9	7	4	152	95	41
70 - 79	2	299	251	252	241	209	240	262
80 - 89	251	234	311	316	368	53	96	121
90 - 99	454	104	121	124	97	45	43	81
100 - 109	6	35	21	14	3	32	56	79
110 - 119		5				53	51	75
120 - 129		1				49	64	39
130 - 139						44	33	14
140 - 149						23	20	1
150 - 159						14	11	
160 - 169						7	2	
SEPTEMBER 1 TO 30, 1960 (713 HOURS)								
50 - 59		123	66	53	33	198	152	134
60 - 69		208	186	194	200	157	200	193
70 - 79	1	164	205	218	239	49	74	133
80 - 89	423	98	123	121	149	45	54	60
90 - 99	289	62	82	90	82	23	32	47
100 - 109		27	47	37	10	22	30	44
110 - 119		20	4			26	32	45
120 - 129		8				25	34	41
130 - 139						40	29	12
140 - 149						22	30	
150 - 159						23	19	
160 - 169						13	1	1
170 - 179						1		
OCTOBER 1 TO 4, 1960 (88 HOURS)								
50 - 59		15	4	2		29	29	23
60 - 69		28	34	33	32	7	14	22
70 - 79		17	23	26	30	6	4	12
80 - 89	82	12	13	14	19	2	6	4
90 - 99	6	6	10	12	7	2	3	5
100 - 109		7	4	1		5	3	9
110 - 119		2				2	6	9
120 - 129		1				6	6	4
130 - 139						6	6	
140 - 149						5	4	
150 - 159						3	1	
160 - 169								

[1] Numbers in parentheses refer Lo location of thermocouples as shown in figure 2.

Table 3.--Temperatures recorded in House A at Portland, Oreg., (1958 to 1960)[1]

Month, day, year	Time	Air temperature	Wall				Roof		
			Exterior face of siding (5)	Exterior face of sheathing (6)	Face of stud (7)	Center of stud (8)	Exterior roof surface (2)	Face of felt over sheathing (3)	Between roof sheathing and rafter (4)
		°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
June 17, 1958	3:25 p.m.	92	93	97	95	95	.....	150	142
July 15, 1958	12 noon	91	102	98	92	88	.....	146	128
	1:00 p.m.	91	97	96	93	89	.....	141	129
	2:00 p.m.	92	97	99	95	93	.....	146	132
August 6, 1958	1:15 p.m.	88	122	100	99	90	158	149	129
	1:50 p.m.	88	125	104	104	99	158	148	132
September 5, 1958	11:20 a.m.	82	120	99	92	79	145	130	109
	12:15 p.m.	84	129	104	97	84	150	139	119
	1:45 p.m.	88	124	106	102	91	144	135	123
	2:50 p.m.	88	121	104	102	93	131	131	123
	3:45 p.m.	86	111	98	99	94	118	122	119
July 6, 1960	11:50 a.m.	.....	118	101	90	85	156	154	134
	12:30 p.m.	.....	124	102	90	87	166	158	140
	1:05 p.m.	.....	130	105	94	89	159	158	142
	1:40 p.m.	.....	120	102	94	91	154	156	143
	2:05 p.m.	.....	110	104	96	93	162	158	145
	2:35 p.m.	96	105	102	98	93	159	156	145
	3:25 p.m.	96	103	101	98	95	152	149	144
	4:05 p.m.	95	102	99	100	97	138	141	140

[1] Plumbers in parentheses refer to location of thermocouples as shown in figure 3.

Table 4.--Temperatures recorded in House B at Portland, Oreg. (1958 to 1960)[1]

Month, day, year	Time	Air temperature	Wall				Roof		
			Exterior face of siding (5)	Exterior face of sheathing (6)	Face of stud (7)	Center of stud (8)	Exterior roof surface (2)	Between spaced roof boards and shingles (3)	Between spaced roof boards and rafter (4)
		°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
July 15, 1958	3:30 p.m.	92	92	97	95	93	121	108	95
August 6, 1958	2:55 p.m.	88	96	97	95	95	127	112	97
	3:15 p.m.	89	93	95	93	93	121	112	97
September 7, 1960	12:45 p.m.	82	88	99	98	89	130	115	104
	1:28 p.m.	84	88	95	94	88	135	122	110
	1:55 p.m.	84	90	93	91	89	127	124	113
	2:35 p.m.	84	90	93	90	90	126	124	116
	3:11 p.m.	84	88	88	88	88	126	125	117
	3:38 p.m.	85	89	91	88	88	123	121	114

[1] Numbers in parentheses refer to location of thermocouples as shown in figure 4.

Table 5.--Summary of duration of temperatures at various locations in wall and roof,[1] residence at Diboll, Texas (1959)[2]

Temperature	Air temperature	Wall: Between siding and sheathing (1)	Wall: Between sheathing and stud (2)	Wall: Center of stud (3)	Wall: Between stud and gypsum board (4)	Roof: Top of ceiling joists (5)	Roof: Center of roof rafter (6)	Roof: Between rafter and sheathing (7)	Roof: Between sheathing and building paper (8)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
JUNE 1959 (61 HOURS)									
50 - 59									
60 - 69									
70 - 79			1	1					
80 - 89	22	17	30	41	43	7	6	4	3
90 - 99	39	34	30	19	18	18	16	4	4
100 - 109		10				35	36	19	8
110 - 119						1	3	32	6
120 - 129								2	17
130 - 139									23
JULY 1959 (101 HOURS)									
50 - 59									
60 - 69									
70 - 79	7	12	15	17	16	10	11	9	7
80 - 89	36	27	44	60	62	10	10	6	7
90 - 99	58	56	42	24	23	35	26	13	13
100 - 109		6				46	52	29	14
110 - 119						2	40	15	
120 - 129							4	21	
130 - 139									28
AUGUST 1959 (86 HOURS)									
50 - 59									
60 - 69									
70 - 79	5	8	9	10	10	7	7	6	6
80 - 89	30	30	44	59	59	9	11	8	10
90 - 99	51	43	33	17	17	38	27	12	9
100 - 109		5				32	41	15	17
110 - 119								28	14
120 - 129								1	20
130 - 139									12
SEPTEMBER 1959 (48 HOURS)									
50 - 59									
60 - 69	1	3	3	3	1	2	3	2	4
70 - 79	8	11	13	14	16	9	7	6	4
80 - 89	21	22	24	29	30	7	8	7	7
90 - 99	18	12	8	2	1	26	24	13	7
100 - 109						4	6	17	11
110 - 119							3	7	
120 - 129									8
130 - 139									

[1] Data taken from temperature data sheets, Forest Products Department, Texas Forest Service.
[2] Numbers in parentheses refer to location of thermocouples as shown in figure 5.

Table 6.--Summary of duration of temperatures at various locations in wall and roof, residence at Madison, Wis. (1959 to 1960)[1]

Temperature	Air temperature	Wall: Exterior surface of siding (5)	Wall: Between siding and sheathing (6)	Wall: Between sheathing and stud (7)	Roof: Center of rafter (8)	Roof: Exterior roof surface (2)	Roof: Between shingles and roof sheathing (3)	Roof: Between sheathing and rafter (4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
MAY 8 TO 31, 1959 (560 HOURS)								
30 - 39	2					25	15	4
40 - 49	74	55	35	15	5	73	71	63
50 - 59	144	132	114	121	298	138	126	130
60 - 69	224	181	219	215	113	127	144	160
70 - 79	103	99	99	122	77	66	71	84
80 - 89	13	55	59	56	48	57	53	67
90 - 99		26	22	23	19	42	45	38
100 - 109		8	9	7		24	24	14
110 - 119		3	3	1		7	11	
120 - 129		1				1		
JUNE 1 TO 30, 1959 (707 HOURS)								
30 - 39						3		
40 - 49	5	1				34	32	22
50 - 59	112	73	53	28	70	143	131	110
60 - 69	234	234	249	246	203	177	172	179
70 - 79	262	196	212	231	191	118	118	146
80 - 89	94	106	101	109	121	80	66	81
90 - 99		41	40	51	110	79	61	74
100 - 109		36	45	41	11	59	67	82
110 - 119		20	7	1	1	9	51	12
120 - 129						4	8	1
130 - 139						1	1	
JULY 1 TO 31, 1959 (560 HOURS)								
40 - 49						21	15	3
50 - 59	74	56	51	26	45	155	143	107
60 - 69	228	231	224	222	201	174	170	178
70 - 79	277	193	210	235	183	97	93	134
80 - 89	133	102	94	107	115	65	62	79
90 - 99		41	45	52	103	84	54	69
100 - 109		57	58	58	64	54	74	81
110 - 119		28	27	10		46	62	56
120 - 129		4				24	37	3
130 - 139						2	3	
AUGUST 1 TO 31, 1959 (678 HOURS)								
50 - 59	4	3	2		1	38	23	10
60 - 69	190	144	137	107	117	232	217	182
70 - 79	338	298	303	326	315	170	197	246
80 - 89	132	111	116	133	120	61	66	83
90 - 99	14	55	56	59	94	45	56	63
100 - 109		34	30	30	26	57	58	68
110 - 119		23	28	19	5	48	40	21
120 - 129		9	6	4		18	17	5
130 - 139		1				8	4	
140 - 149						1		

Table 6.--Sununary of duration of temperatures at various locations in wall and roof, residence at Madison, Wis. (1959 to 1960)[1](Cont.)

Temperature	Air temperature	Wall: Exterior surface of siding	Wall: Between siding and sheathing	Wall: Between sheathing and stud	Wall: Center of rafter	Roof: Exterior roof surface	Roof: Between shingles and roof sheathing	Roof: Between sheathing and rafter
	(5)	(6)	(7)	(8)	(2)	(3)	(4)	
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
SEPTEMBER 1 TO 30, 1959 (720 HOURS)								
20 - 29					3			
30 - 39	3				42	33	11	
40 - 49	85	58	48	14	65	100	85	91
50 - 59	180	160	158	138	160	155	171	160
60 - 69	228	205	208	251	204	169	175	180
70 - 79	161	149	156	164	164	81	91	121
80 - 89	61	63	67	77	82	50	51	76
90 - 99	2	32	37	39	41	52	57	44
100 - 109		30	26	26	4	42	33	31
110 - 119		14	19	11		21	19	6
120 - 129		9	1			5	5	
OCTOBER 1 TO 31, 1959 (743 HOURS)								
10 - 19					1			
20 - 29	3				24	12	6	
30 - 39	202	61	14		129	227	223	201
40 - 49	222	291	295	179	256	165	180	199
50 - 59	266	227	242	287	259	200	200	219
60 - 69	50	120	145	222	95	76	78	92
70 - 79		18	21	31	4	40	44	24
80 - 89		17	20	21		8	6	2
90 - 99		8	6	3		2		
100 - 109		1						
NOVEMBER 1 TO 30, 1959 (720 HOURS)								
-9 - 0	9				23	11	9	
0 - 9	39	13	2		17	38	35	27
10 - 19	98	71	41	3	76	111	105	91
20 - 29	247	139	122	65	226	231	235	232
30 - 39	236	256	225	204	280	232	250	263
40 - 49	70	155	234	307	90	40	39	60
50 - 59	17	51	60	96	26	31	30	28
60 - 69	4	20	20	29	5	9	12	8
70 - 79		10	13	14		5	3	2
80 - 89		4	2	2				
90 - 99		1	1	0				
DECEMBER 1 TO 31, 1959 (738 HOURS)								
0 - 9					20	10	6	
10 - 19	25	4			17	90	82	50
20 - 29	305	112	49	4	219	258	258	265
30 - 39	338	377	351	186	365	268	281	312
40 - 49	65	187	265	425	131	79	84	89
50 - 59	5	31	47	91	6	19	20	15
60 - 69		14	17	23		4	3	1
70 - 79		11	9	9				
80 - 89		2						

Table 6.--Summary of duration of temperatures at various Locations in wall and roof, residence at Madison, Wis. (1959 to 1960)[1] (Cont.)

Temperature	Air temperature	Wall: Exterior surface of siding (5)	Wall: Between siding and sheathing (6)	Wall: Between sheathing and stud (7)	Wall: Center of rafter (8)	Roof: Exterior roof surface (2)	Roof: Between shingles and roof sheathing (3)	Roof: Between sheathing and rafter (4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
JANUARY 1 TO 15 AND 19 TO 31, 1960 (630 HOURS)								
-10 - 0	7					33	22	9
0 - 9	67	21	2		30	90	68	54
10 - 19	155	94	56	3	130	121	133	138
20 - 29	239	140	138	75	207	196	206	223
30 - 39	152	223	234	212	217	149	160	174
40 - 49	10	112	149	252	46	39	39	32
50 - 59		23	35	68		2	2	
60 - 69		11	12	15				
70 - 79		4	3	4				
80 - 89		2	1	1				
FEBRUARY 1 TO 29, 1960 (670 HOURS)								
-19 - -10						3		
-9 - -1	1					44	23	5
0 - 9	63	8			18	55	65	62
10 - 19	165	73	59		81	162	143	122
20 - 29	315	212	153	70	313	198	225	251
30 - 39	120	223	255	258	234	141	144	173
40 - 49	6	89	129	236	24	43	46	52
50 - 59		30	40	58		24	24	5
60 - 69		16	18	31				
70 - 79		12	14	14				
80 - 89		5	2	3				
90 - 99		2						
MARCH 1 TO 31, 1960 (707 HOURS)								
-19 - -10						18	1	
-9 - -1	15					53	43	18
0 - 9	101	42	14		27	103	100	80
10 - 19	184	100	78	15	149	126	139	160
20 - 29	196	169	163	104	224	114	119	148
30 - 39	160	138	156	196	170	138	135	143
40 - 49	39	126	144	188	94	67	81	96
50 - 59	11	60	77	113	31	56	52	41
60 - 69	1	30	30	43	9	19	24	12
70 - 79		20	24	30	3	6	8	8
80 - 89		17	17	14		6	4	1
90 - 99		5	4	4		1	1	
APRIL 1 TO 21, 1960 (493 HOURS)								
0 - 9						5	1	
10 - 19					1	23	20	13
20 - 29	34	22	12		28	45	44	41
30 - 39	165	88	67	29	121	129	119	116
40 - 49	133	164	174	151	142	101	109	116
50 - 59	97	106	121	173	100	77	86	94
60 - 69	60	72	74	87	82	49	49	62
70 - 79	4	32	32	44	14	37	43	40
80 - 89		8	12	8	5	18	16	8
90 - 99			1	1		5	3	3
100 - 109		1				3	3	
110 - 119						1		

Table 6.--Summary of duration of temperatures at various locations in wall and roof, residence at Madison, Wis. (1959 to 1960)[1] (Cont.)

Temperature	Air temperature	Wall: Exterior surface of siding	Wall: Between siding and sheathing	Wall: Between sheathing and stud	Wall: Center of rafter	Roof: Exterior roof surface	Roof: Between shingles and roof sheathing	Roof: Between sheathing and rafter
	(5)	(6)	(7)	(8)	(2)	(3)	(4)	
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
MAY 22 TO 31, 1960 (222 HOURS)								
30 - 39					3			
40 - 49	10	5	3		8	21	17	12
50 - 59	82	56	50	27	63	82	77	61
60 - 69	95	84	88	105	66	40	44	65
70 - 79	35	41	48	58	41	19	28	38
80 - 89		23	20	20	24	24	23	21
90 - 99		5	5	5	14	13	15	13
100 - 109		5	6	6	6	8	8	9
110 - 119		3	2	1		7	7	3
120 - 129						4	3	
130 - 139						1		
JUNE 1 TO 30, 1960 (708 HOURS)								
30 - 39						14	6	
40 - 49	20	12	5		38	64	57	38
50 - 59	165	135	115	79	151	181	168	156
60 - 69	310	261	285	303	194	153	174	205
70 - 79	196	147	155	188	109	80	90	104
80 - 89	17	74	68	67	76	70	69	81
90 - 99		38	43	43	65	54	59	72
100 - 109		25	24	25	32	51	50	37
110 - 119		15	13	3	12	21	21	13
120 - 129		1				18	14	2
130 - 139						2		
JULY 1 TO 31, 1960 (705 HOURS)								
40 - 49						52	34	9
50 - 59	88	84	54	39	9	130	123	109
60 - 69	261	225	232	223	62	171	174	181
70 - 79	243	174	205	227	94	71	91	121
80 - 89	111	101	97	103	47	57	61	72
90 - 99	2	36	37	46	60	60	62	85
100 - 109		39	47	49	37	64	73	86
110 - 119		36	27	18	3	62	60	36
120 - 129		10	6			30	24	6
130 - 139						8	3	

Table 6.--Summary of duration of temperatures at various locations in wall and roof, residence at Madison, Wis. (1959 to 1960)[1] (Cont.)

Temperature	Air temperature	Wall: Exterior surface of siding (5)	Wall: Between siding and sheathing (6)	Wall: Between sheathing and stud (7)	Roof: Center of rafter (8)	Roof: Exterior roof surface (2)	Roof: Between shingles and roof sheathing (3)	Roof: Between sheathing and rafter (4)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
AUGUST 1 TO 31, 1960 (724 HOURS)								
30 - 39						3		
40 - 49		1	1			32	21	10
50 - 59	51	32	30	23	34	93	83	54
60 - 69	249	208	209	189	194	220	216	202
70 - 79	297	240	250	265	223	109	137	184
80 - 89	125	117	107	129	126	60	60	77
90 - 99	2	54	55	53	119	56	60	97
100 - 109		35	45	53	28	74	75	78
110 - 119		29	20	11		49	57	22
120 - 129		7	7	1		26	15	
130 - 139		1				2		
SEPTEMBER 1 TO 30, 1960 (720 HOURS)								
30 - 39						24	12	2
40 - 49	29	22	10		20	95	89	62
50 - 59	225	162	148	117	177	175	176	172
60 - 69	214	221	244	269	201	156	148	172
70 - 79	172	155	151	166	164	95	112	139
80 - 89	60	58	64	75	89	43	55	63
90 - 99	20	42	46	43	40	47	53	57
100 - 109		23	29	33	27	39	37	34
110 - 119		24	25	17	2	31	29	17
120 - 129		13	3			11	8	2
130 - 139						4	1	
OCTOBER 1 TO 23, 1960 (534 HOURS)								
10 - 19						11	7	1
20 - 29	10	6			7	21	10	12
30 - 39	52	25	19	7	23	117	100	79
40 - 49	125	137	124	79	146	105	123	129
50 - 59	160	138	148	165	136	103	109	114
60 - 69	135	115	128	160	124	58	63	82
70 - 79	49	47	45	54	71	36	50	55
80 - 89	3	21	30	35	25	40	35	45
90 - 99		20	17	18	2	24	25	15
100 - 109		14	18	15		18	12	2
110 - 119		11	5	1		1		

[1] Numbers in parentheses refer to location of thermocouples as shown in figure 6.

Table 7.--Summary of duration of temperatures at various locations in wall and roof at Forest Products Research Society building, Madison, Wis. (1961) [1]

Temperature	Duration of temperature in hours							
	Wall				Roof			
	Air temperature	Surface of vertical siding south wall	Back of siding at furring strip	In stud 6 feet above sill plate south wall	In center of stud 5 feet above sill plate	East section of roof surface	Top of roof insulation	Top of wood roof decking
	(4)	(5)	(7)	(8)	(1)	(2)	(3)	
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
JUNE 1961 (394 HOURS)								
30 - 39							4	
40 - 49	3	4	1	3			32	
50 - 59	70	78	51	70			72	
60 - 69	130	128	105	129	44	45	66	75
70 - 79	115	128	122	118	219	218	52	117
80 - 89	58	43	86	56	219	131	25	102
90 - 99	18	13	28	18			26	81
100 - 109			1				34	19
110 - 119							26	
120 - 129							30	
130 - 139							22	
140 - 149							5	
JULY 1961 (744 HOURS)								
40 - 49		39				16	15	
50 - 59	36	205	14	36		104	95	
60 - 69	197	325	165	197	21	186	183	43
70 - 79	322	167	273	322	373	112	130	295
80 - 89	186	8	196	186	333	93	63	216
90 - 99	3		87	3	17	58	61	155
100 - 109			9			50	46	35
110 - 119						57	41	
120 - 129						50	60	
130 - 139						17	38	
140 - 149						1	12	
AUGUST 1961 (739 HOURS)								
40 - 49						27	23	
50 - 59	38	3	18	38		87	92	
60 - 69	212	89	144	210	149	191	206	58
70 - 79	337	131	276	339	138	119	126	311
80 - 89	143	76	163	143	3	98	78	224
90 - 99	9	5	96	9		54	49	135
100 - 109			27			44	40	11
110 - 119			8			64	48	
120 - 129			4			40	58	
130 - 139						3	17	
140 - 149							2	

(Sheet 1 of 2)

Table 7.--Summary of duration of temperatures at various locations in wall and roof at Forest Products Research Society building, Madison, Wis. (1961)[1](Cont.)

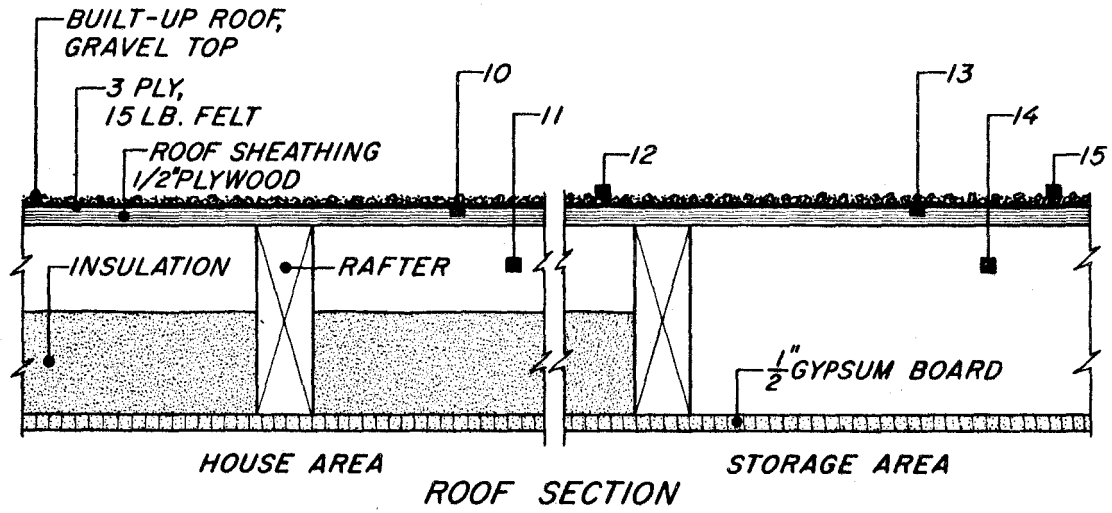
Temperature	Duration of temperature in hours							
	Wall					Roof		
	Air temperature	Surface of vertical siding south wall (4)	Rack of siding at furring strip (5)	In stud 6 feet above sill plate south wall (7)	In center of stud 5 feet above sill plate (8)	East section of roof surface (1)	Top of roof insulation (2)	Top of wood roof decking (3)
°F.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.
SEPTEMBER 1961 (744 HOURS)								
20 - 29						7	4	
30 - 39	12			12		40	42	
40 - 49	51		32	51		83	76	
50 - 59	192		140	192	3	117	133	81
60 - 69	210		176	210	44	180	200	223
70 - 79	165	3	139	165	64	88	87	241
80 - 89	66	2	78	66	7	53	42	115
90 - 99	2		40	2		44	39	38
100 - 109			40			26	40	
110 - 119			29			25	18	
120 - 129			10			5	14	
130 - 139						2	3	
OCTOBER 1961 (744 HOURS)								
20 - 29						30	29	
30 - 39	51		20	51		87	67	
40 - 49	261		152	261		211	221	32
50 - 59	233		223	233		193	192	218
60 - 69	127		151	127		100	105	321
70 - 79	72		61	72		50	49	147
80 - 89			35			32	37	26
90 - 99			28			31	27	
100 - 109			31			10	17	
110 - 119			32					
120 - 129			11					
NOVEMBER 1961 (238 HOURS)								
10 - 19						7	5	
20 - 29	33			33		60	59	
30 - 39	114		72	114		76	74	
40 - 49	52		63	52		27	27	44
50 - 59	24		37	24		45	43	130
60 - 69	11		26	11		22	26	57
70 - 79	4		15	4		1	4	7
80 - 89			7					
90 - 99			11					
100 - 109			4					
110 - 119			3					

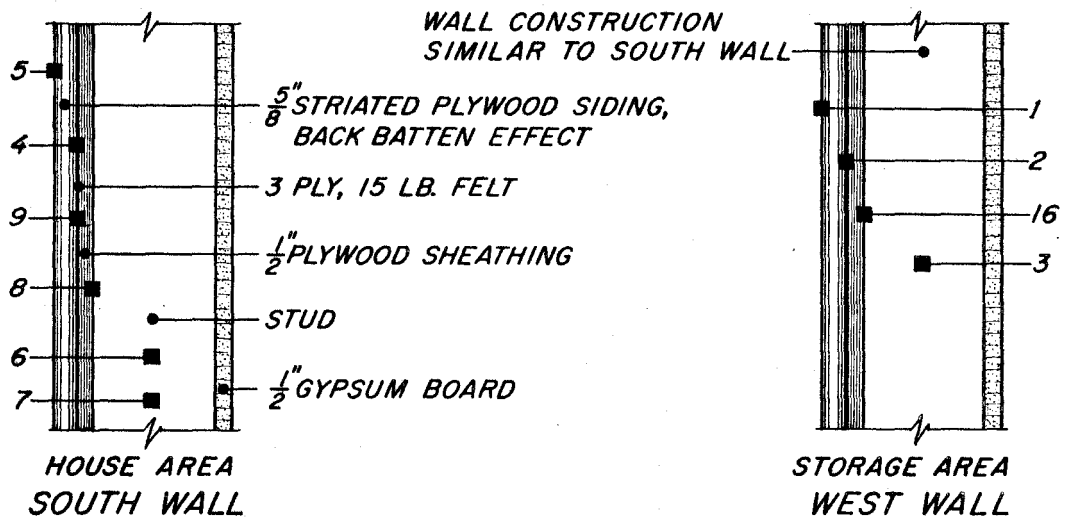
[1]Numbers in parentheses refer to location of thermocouples as shown in figure 7.

Table 8.-- Summary of maximum temperatures

Location of building	Year	Wall				Roof			
		Maximum temperature range observed	Duration of maximum temperature range	Next lower temperature range observed	Duration of next lower temperature range	Maximum temperature range observed	Duration of maximum temperature range	Next lower temperature range observed	Duration of next lower temperature range
		°F.	Hr.	°F.	Hr.	°F.	Hr.	°F.	Hr.
Tucson, Ariz.	1959	130 - 139	.....	120 - 129	.....	160 - 169	.....	150 - 159	.....
Athens, Ga.	1958	110 - 119	7	100 - 109	66	140 - 149	1	130 - 139	90
	1959	120 - 129	21	110 - 119	8	140 - 149	103	130 - 139	150
	1960	120 - 129	10	110 - 119	27	170 - 179	1	160 - 169	20
Diboll, Texas	1959	100 - 109	21	90 - 99	145	130 - 139	63	120 - 129	66
Portland, Oreg. [1](1)	1958	120 - 129	.....	110 - 119	.....	90 - 99	.....	80 - 89	.....
	1960	90 - 99	.....	89 - 90	.....	130 - 139	.....	120 - 129	.....
Portland, Oreg. [1](2)	1958	120 - 129	.....	110 - 119	.....	150 - 159	.....	140 - 149	.....
	1959	130 - 139	.....	120 - 129	.....	160 - 169	.....	150 - 159	.....
Madison, Wis. (house)	1959	130 - 139	1	120 - 129	23	140 - 149	1	130 - 139	11
	1960	130 - 139	1	120 - 129	31	130 - 139	17	120 - 129	89
Madison, Wis. (office building)	1961	120 - 129	25	110 - 119	72	140 - 149	19	130 - 139	80

[1]House B (1); House A (2).

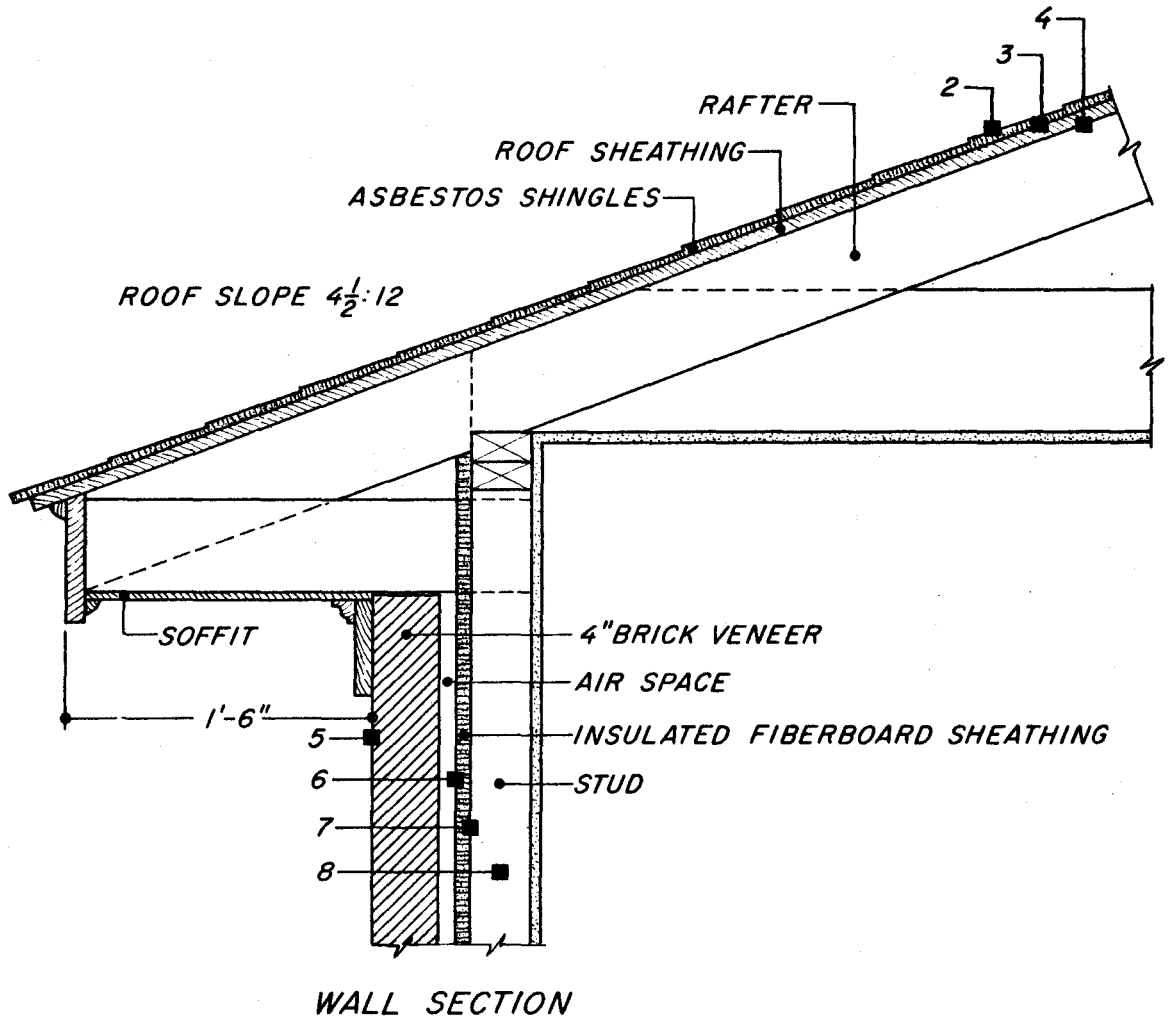




THERMOCOUPLE LOCATIONS ■

1 FACE OF SIDING
2 BETWEEN FELT AND SIDING
3 CENTER OF STUD
4 BETWEEN FELT AND SIDING
5 FACE OF SIDING
6 CENTER OF STUD
7 CENTER OF STUD
8 EXTERIOR FACE OF STUD
9 BETWEEN FELT AND SIDING
10 BETWEEN FELT AND ROOF SHEATHING
11 BETWEEN INSULATION AND ROOF SHEATHING
12 OUTSIDE SURFACE OF ROOF
13 BETWEEN FELT AND ROOF SHEATHING
14 BETWEEN CEILING AND ROOF SHEATHING
15 OUTSIDE SURFACE OF ROOF
16 EXTERIOR FACE OF STUD

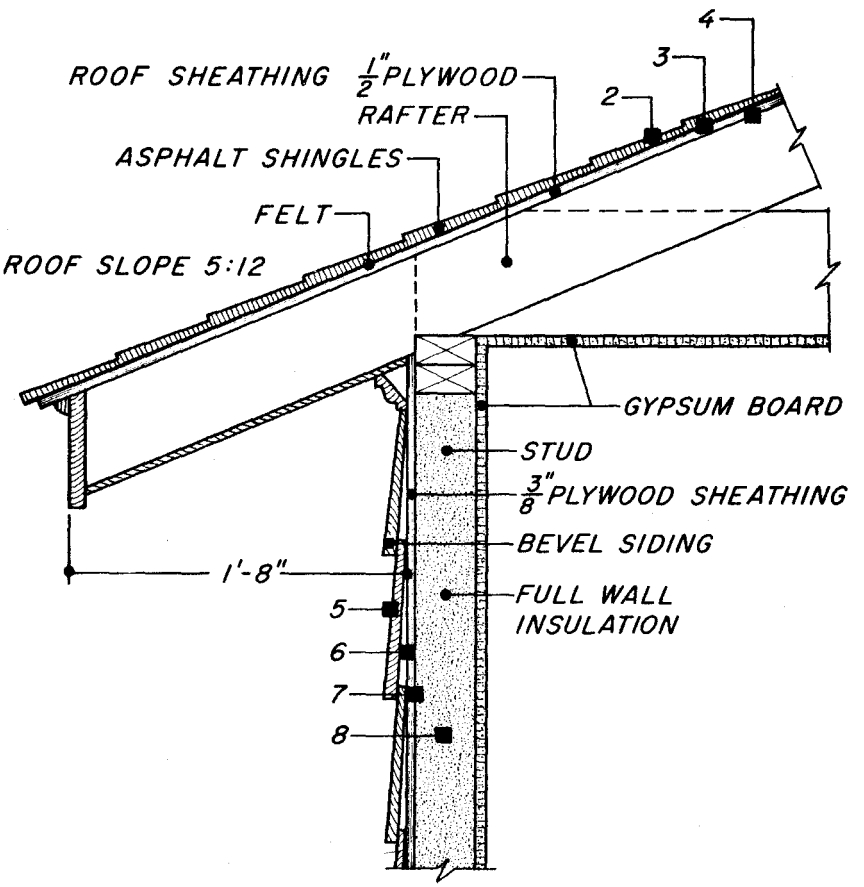
Figure 1.--Location of thermocouples in the house at Tucson, Ariz.



THERMOCOUPLE LOCATIONS ■

1 (NOT SHOWN) RECORDED AIR TEMPERATURE
2 EXTERIOR SURFACE OF ROOF
3 BETWEEN SHINGLES AND ROOF SHEATHING
4 BETWEEN ROOF SHEATHING AND RAFTER
5 EXTERIOR FACE OF BRICK
6 FACE OF SHEATHING
7 BETWEEN WALL SHEATHING AND STUD
8 CENTER OF STUD

Figure 2.--Thermocouple locations in the house at Athens, Ga.

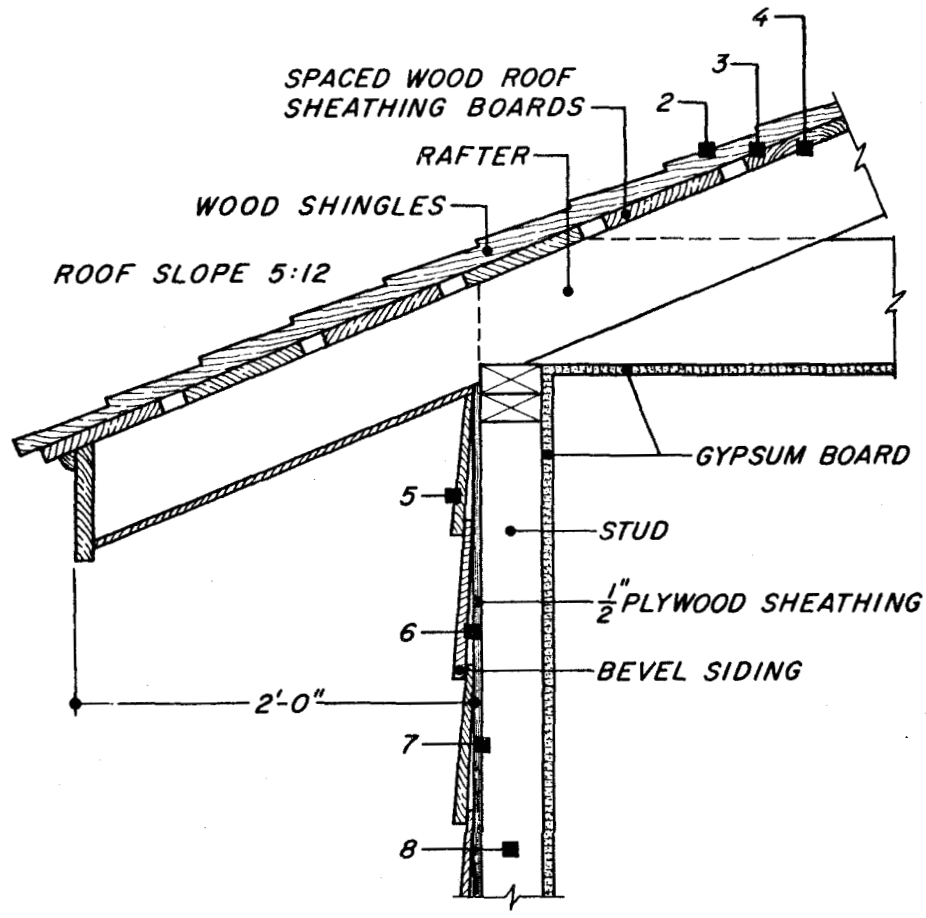


WALL SECTION

THERMOCOUPLE LOCATIONS ■

1 (NOT SHOWN) RECORDED AIR TEMPERATURE
2 EXTERIOR ROOF SURFACE
3 FACE OF FELT OVER ROOF SHEATHING
4 BETWEEN ROOF SHEATHING AND RAFTER
5 EXTERIOR FACE OF SIDING
6 EXTERIOR FACE OF SHEATHING
7 FACE OF STUD
8 CENTER OF STUD

Figure 3.--A cross section of House A at Portland, Oreg., showing the location of seven of the eight thermocouples installed.



WALL SECTION

THERMOCOUPLE LOCATIONS ■

1 (NOT SHOWN) RECORDED AIR TEMPERATURE
2 EXTERIOR ROOF SURFACE
3 BETWEEN SPACED ROOF BOARDS AND SHINGLES
4 BETWEEN SPACED ROOF BOARDS AND RAFTERS
5 EXTERIOR FACE OF SIDING
6 EXTERIOR FACE OF SHEATHING
7 FACE OF STUD
8 CENTER OF STUD

Figure 4.--A cross section of House B at Portland, Oreg., showing the location of seven of the eight thermocouples installed.

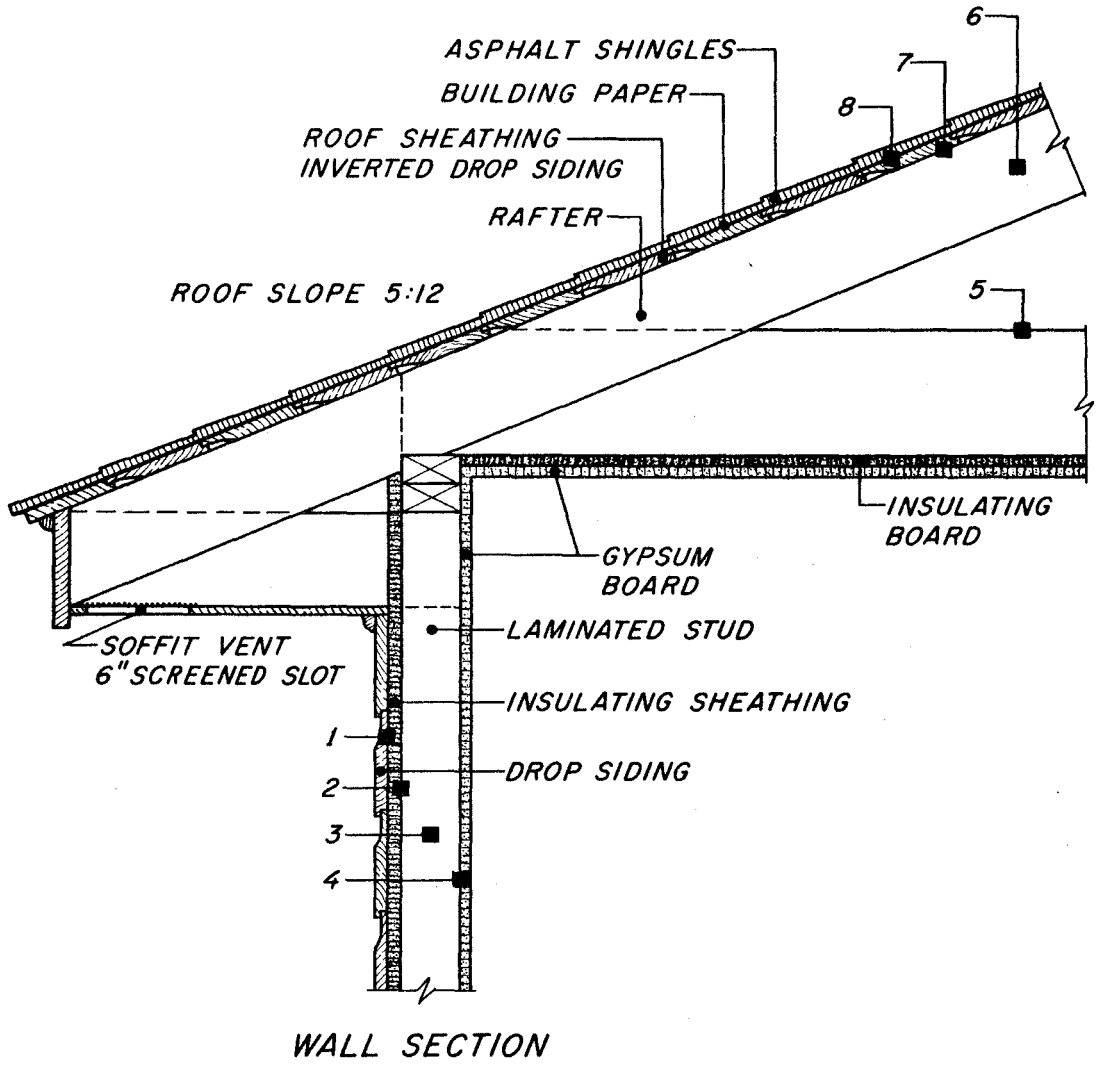
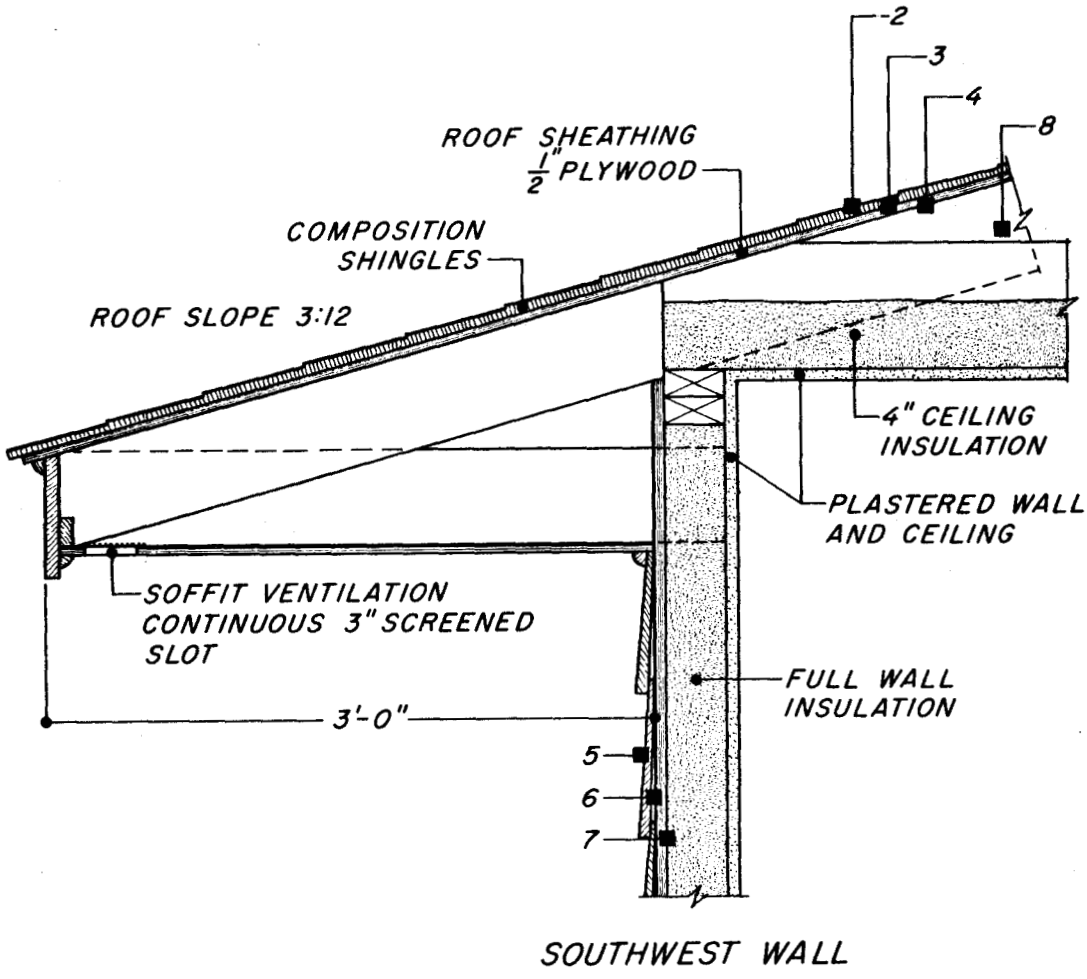


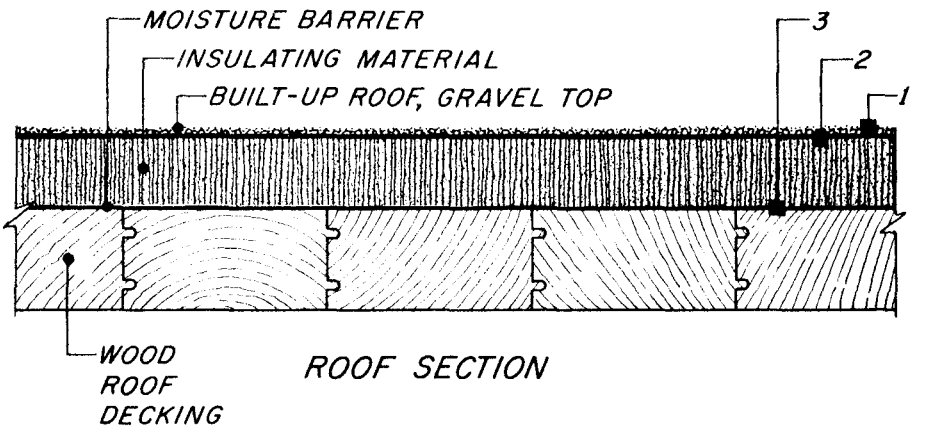
Figure 5.--Location of the thermocouples installed in the house at Diboll, Tex.

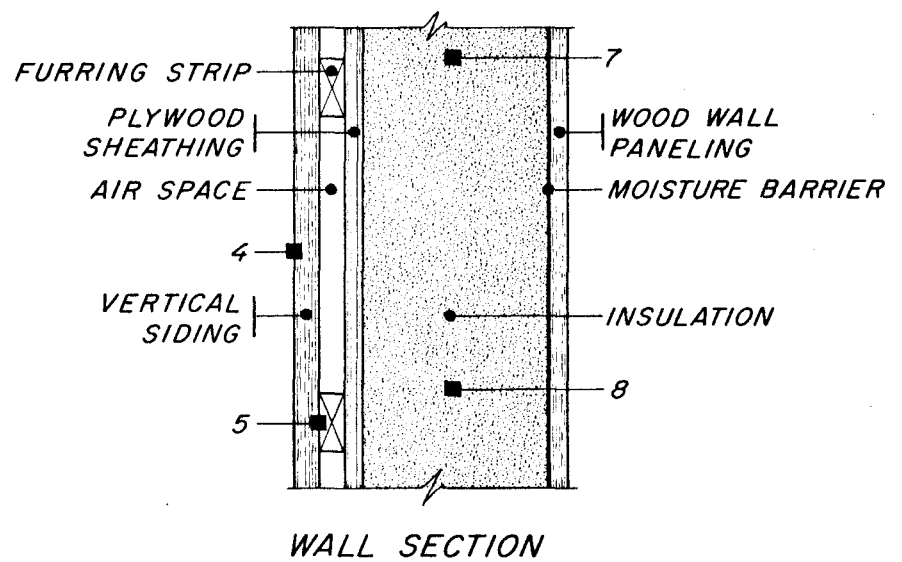


THERMOCOUPLE LOCATIONS ■

1 (NOT SHOWN) LOCATED NEAR FRONT ENTRY IN PROTECTED AREA. RECORDED AIR TEMPERATURE
2 EXTERIOR SURFACE OF ROOF
3 BETWEEN SHINGLES AND ROOF SHEATHING
4 BETWEEN ROOF SHEATHING AND RAFTER
5 EXTERIOR SURFACE OF SIDING
6 BETWEEN SIDING AND SHEATHING
7 BETWEEN SHEATHING AND STUD
8 CENTER OF RAFTER

Figure 6.--A typical section of the house at Madison, Wis., showing the location of seven of the eight thermocouples installed. The roof stations were located at the center of the roof and the wall stations were located between the sill plate and the top plate.

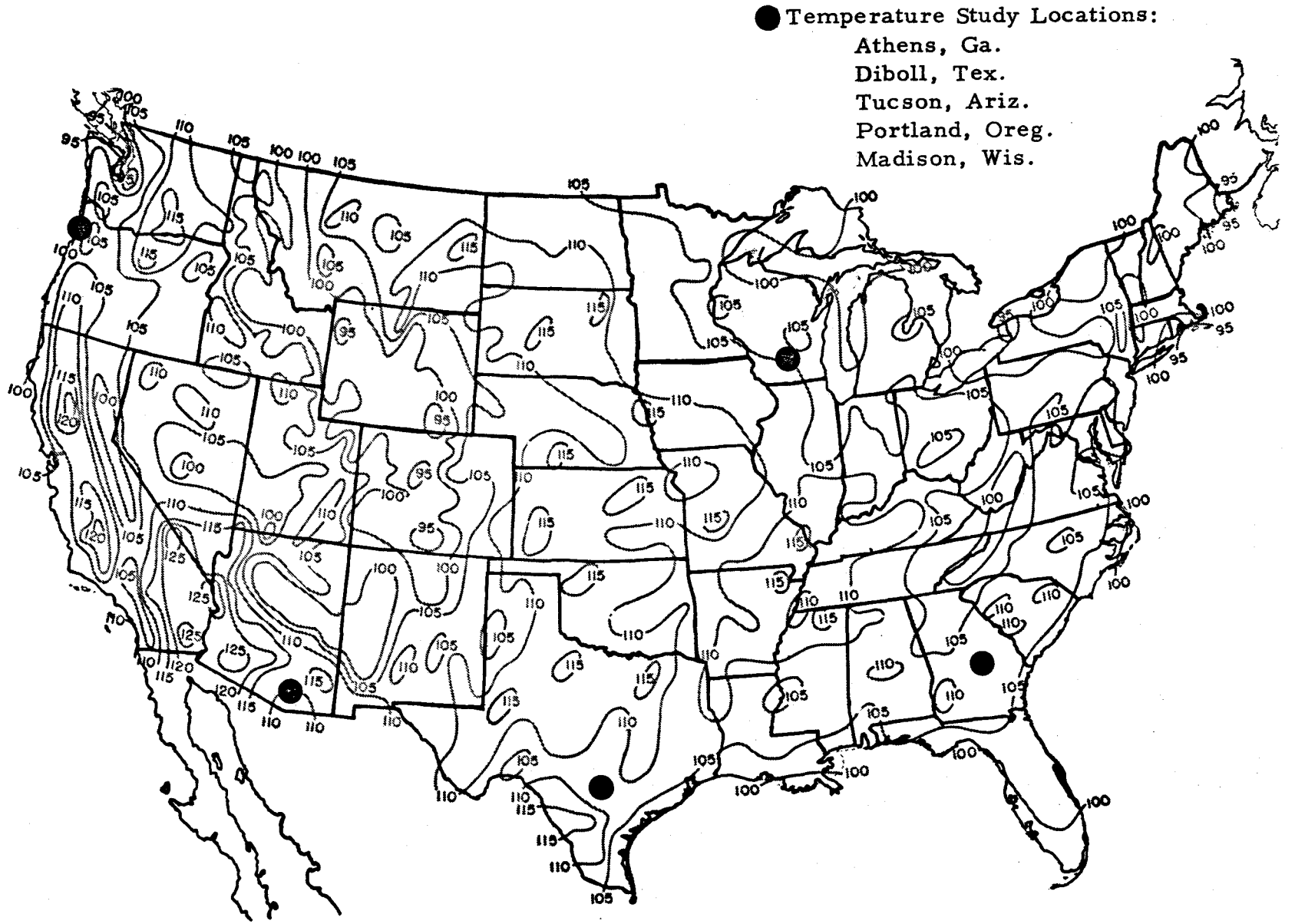




THERMOCOUPLE LOCATIONS ■

1	EAST SECTION OF ROOF SURFACE
2	TOP OF ROOF INSULATION
3	TOP OF WOOD ROOF DECKING
4	SURFACE OF VERTICAL SIDING, SOUTH WALL
5	BACK OF SIDING AT FURRING STRIP
6	(NOT SHOWN) LOCATED ON NORTH WALL. RECORDED AIR TEMPERATURE
7	IN STUD 6 FT. ABOVE SILL PLATE, SOUTH WALL
8	IN CENTER OF STUD 5 FT. ABOVE SILL PLATE

Figure 7.--A typical wall and roof section of the Forest Products Research Society building at Madison, Wis., showing the location of seven of the eight thermocouples installed.



M 121 8

Figure 8.--Maximum temperature isotherms (highest temperatures observed) for the United States and temperature study locations.