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NATIONAL RESEARCH COUNCIL  
CANADA  
DIVISION OF BUILDING RESEARCH

CONDENSATION PROBLEM IN  
BUILDING ATTACHED TO PUBLIC GARDENS  
GREENHOUSES, HALIFAX, N.S.

by

D.C. Tibbetts

Report No. 118  
of the Division of Building Research

Ottawa

April, 1957

## PREFACE

This report gives an interesting case history of a troublesome condensation condition which was successfully corrected by simple measures. Condensation problems are common in Canadian buildings because of low winter temperatures and occur whenever indoor relative humidities exceed the limits set by the temperatures of the inside surfaces of the building enclosure. Indoor relative humidities are frequently maintained at levels which cause condensation by unsuspected moisture sources such as were provided in this case by the greenhouses attached to the building.

The service rendered in this case is typical of that which the Division is able to provide through field trips and visits whenever there is the possibility of obtaining information and experience which can be used to advantage elsewhere in improving Canadian building.

Ottawa,  
April, 1957.

N.B. Hutcheon,  
Assistant Director.

CONDENSATION PROBLEM IN BUILDING ATTACHED TO PUBLIC  
GARDENS GREENHOUSES, HALIFAX, N.S.

by

D.C. Tibbetts

On March 26, 1956 the Atlantic Regional Station was requested by Mr. C. Dodge, City Engineer, Halifax, to visit the Office-and-Works Building attached to the Public Gardens Greenhouses on Sackville Street. Condensation problems had existed in this building throughout the winter. A visit was made with Mr. Dodge to examine the extent of the condensation and to attempt to determine some of the contributing factors. Mr. George Powers, Superintendent, Halifax Public Gardens was present during the examination.

Description of Building

The building is a one-storey (12 ft.) concrete block structure (Fig. 1). The outside surface of the block has been coated with "Thoroseal" which serves as the exterior finish. The roof is flat, flashed at the edges, and has no overhang. The roof framing is standard wood joist decked with wood sheathing and covered with conventional built-up roofing. Two metal stack vents (8 in. in diameter), have been provided through the roof, one near each end of the building. The concrete foundation encloses a shallow cellar or crawl space. Access to this is by means of a trap door and ladder. The cellar has no floor and a considerable quantity of earth is stored there for potting plants during the winter. One small vent (6" x 6") was open but was partially blocked by snow. More vents were originally provided but are now closed-off by wood blocks.

Part of the building space has been divided into offices. The office ceilings, finished in birch plywood are suspended from the main roof system. The office walls are also finished in birch, and on exterior walls this plywood has been cemented directly to the concrete block without benefit of furring or insulation.

Heating is by hot water, and the radiators are located under or near windows in outside walls. One pane in each of the office windows has been fitted with a circular (6 in. in diameter) wind-activated ventilator.

### Location of Greenhouses Relative to Building

Three greenhouses are attached to the office building, each having a direct access door to this building (Fig. 1). Two of these doors are located on the south side of the building and the third is at the west end. In the past they have been left open for the convenience of the workmen. The greenhouse framing is attached directly to the block wall on the south side of the building; access to the greenhouse at the west end of the building, however, is through a short block tunnel-like appendage to the main building.

### The Condensation Problem

Generally, condensation is limited to the east half of the building. Areas affected in this part are the north and east exterior walls, the underside of the roof sheathing, metal vents, ceilings of offices and bathroom, and bathroom plumbing. Condensation is severe and persists throughout the winter months. Sweating on exterior walls is almost always present in winter, and dripping from the underside of roof deck becomes a problem on relatively warm sunny days following a period of dull, cold weather. Air circulation under the roof framing is partially blocked in the affected east half of the building by the framing arranged for the office ceilings.

### Possible Sources of Humid Air

A warm damp feeling is immediately apparent when one enters the building. The entrance is located in the east wall of the building. Possible sources of moisture are:

- (1) the greenhouses;
- (2) the cellar or crawl space area.

From the condition apparent in the above two areas, it would appear that the greenhouses provide most of the moisture in the building. As was previously mentioned, there is no floor in the cellar, and a quantity of damp earth is stored there.

The greenhouse nearest the affected area of the building contains a large number of big plants (some 8 feet high and heavily foliaged). These plants are potted and practically live on water during the winter months. The plants are watered about 8:00 a.m. on days when water is required.

### Action

It was thought desirable to determine the temperature and humidity conditions in the building and the nearest greenhouse, so at 10:00 a.m. on March 27, the following instruments were installed:

- (1) a Pandux surface temperature thermometer was placed on the north exterior wall near the northeast corner of the main office, 5 feet above the floor;
- (2) two hygro-thermographs were located, one in
  - (a) the southeast corner of the main office,
  - (b) the northeast corner of the east greenhouse.

This equipment was taken back to the Atlantic Regional Station on March 29 and returned to the building on April 3 where it was left until 4:00 p.m. on April 7, 1956.

The charts and wall surface temperature were examined and from that data the following general observations can be made.

### SUMMARY OF CONDITIONS

First Period -- March 27, 28, 29, 1956.

	<u>Office</u>			<u>Greenhouse</u>	
	<u>R.H.%</u>	<u>Temp. °F.</u>	<u>Wall Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>
Minimum	61	55	48	45	50
Maximum	80	64	54	91	77
Average	69	59	51	61	67

Second Period -- April 3, 4, 5, 6, 7, 1956.

	<u>Office</u>			<u>Greenhouse</u>	
	<u>R.H.%</u>	<u>Temp. °F.</u>	<u>Wall Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>
Minimum	57	54	48	34	50
Maximum	83	67	62	93	84
Average	73	61	57	67	64

Average for Both Periods -- March and April

<u>Office</u>			<u>Greenhouse</u>	
<u>R.H.%</u>	<u>Temp. °F.</u>	<u>Wall Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>
71	60	54	64	65

A more detailed tabulation of relative humidities and temperatures is given in Appendix I of this report. In addition, a number of graphs are provided for reference purposes (Fig. 2).

How to Correct Existing Conditions

There are a number of suggested methods for improving conditions caused by condensation in this building. Before positive recommendations could be made that might require costly changes to the building, it was suggested to Mr. Powers that the doors between greenhouses and building be weatherstripped and provided with automatic closing hardware. This was done.

Other suggested corrective measures are:

- (1) furring and insulating exterior walls between plywood finish and blockwork; insulating and vapour proofing entire ceiling of the building and venting above this; or insulating and vapour proofing ceiling of affected area and sealing this portion off from the remainder and venting to outdoors;
- (2) providing mechanical de-humidifying equipment;
- (3) increasing wall surface temperatures by heating;
- (4) isolating greenhouses from the building;
- (5) providing adequate ventilation at the expense of more heat loss from the building.

SECOND PHASE OF THE STUDY - Concluded February, 1957

As mentioned previously, access doors to greenhouses were weatherstripped and equipped with automatic door closers in an attempt to isolate suspected moisture source in the greenhouses.

There has been no evidence of moisture damage to the building or its contents since the closers were provided in the spring of 1956.

At Mr. Powers' request the building was visited on August 16, 1956. He pointed out the dry condition of the roof deck and the absence of moisture on the plywood walls in his office. During previous summers, condensation had occurred periodically on office walls and the underside of the roof deck. Also, mould had formed on books, papers and the backs of pictures. These problems had not arisen that year, and he was pleased that the suggested corrective method was apparently so effective.

Mr. Powers again contacted this office on November 20, 1956, about 10:00 a.m. to report no condensation problems to date. The early morning low for this date was 27°F.

A visit was made to the building about 10:00 a.m. on December 5, 1956. The early morning low was 20°F. There was no evidence of condensation on ceilings or walls. Some condensation was forming on windows but these were not equipped with storms.

Mr. Powers telephoned on the morning of January 3, 1957 to say that there was a small trace of dampness in the northeast corner of the office and some moisture on the metal roof ventilator. The early morning low was 7°F.

A visit was made to the building on the morning of January 4, 1957. The outside temperature at 9:00 a.m. was 20°F. There was no evidence of condensation on walls and ceiling although a slight drip had formed on the metal ventilator. The following readings were taken at that time:

	<u>Office</u>	<u>East End of Hallway</u>	<u>East Greenhouse</u>	<u>West End Work Area</u>
Dry Bulb	69.5°F.	(1) 65.0°F.	(1) 73.0°F.	67.5°F.
Wet Bulb	55.0°F.	54.0°F.	64.0°F.	54.0°F.
R.H.	40%	49.5%	62%	42%
Dry Bulb		(2) 64.5°F.	(2) 74.0°F.	
Wet Bulb		53.0°F.	65.0°F.	
R.H.		47%	62%	
Dry Bulb			(3) 74.5°F.	
Wet Bulb			67.0°F.	
R.H.			68%	

There was no condensation at any time during periods of unusually low temperature experienced in January. The minimum temperature for the month was -8°F.



Another visit was made to the building on the afternoon of February 4, 1957, and a hygro-thermograph was left in the office at the same location as a year before (Fig. 1). The hygro-thermograph was removed at noon on February 8, and the following summary of recorded conditions was made.

For the Period -- February 4, 5, 6, 7, 8, 1957.

Office Only

	<u>R.H.%</u>	<u>Temperature °F.</u>	<u>Wall Temperature °F.</u>
Minimum	45	56	Not recorded.
Maximum	72	69	
Average	61	62.8	

The maximum relative humidity occurred at midnight on February 4. The minimum temperature of 56°F. was also recorded for this time. The minimum relative humidity occurred at 8:00 a.m. on February 6, when the maximum temperature of 69°F. was also recorded.

A detailed tabulation of relative humidities and temperatures is given in Appendix I as an addendum to the 1956 readings. An additional graph to those provided for 1956 has also been added (Fig. 3).

Conclusion

It is the opinion of the Superintendent, Mr. Powers, that the situation has been corrected by isolating the moisture source. The source of moisture, as was suggested earlier, was from the attached greenhouses. Isolation was provided by simply stripping the edges of the doors leading to the greenhouses and equipping these doors with automatic closing hardware. As unusually low temperatures were recorded in the Halifax area during the month of January, 1957, and no condensation problems occurred in the building then, it seems reasonable to agree with Mr. Powers that the suggested corrective measures were successful. It is gratifying to know that this simple solution has resulted in a considerable saving to the City of Halifax over the cost of correcting the situation by other means.

# APPENDIX I

## Greenhouses

## Offices

<u>Date</u>	<u>Time</u>	<u>Greenhouses</u>		<u>Offices</u>		<u>Wall Surface Temp.</u>
		<u>R.H.%</u>	<u>Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>	
27-3-56	11:00 a.m.	55 .....	70 .....	70 ....	61 .....	50
	Noon	52 .....	70 .....	75 ....	61 .....	
	1:00 p.m.	58 .....	68 .....	73 ....	61 .....	50
	3:00 p.m.	53 .....	73 .....	80 ....	62 .....	54
	5:00 p.m.	63 .....	72 .....	70 ....	62 .....	54
	7:00 p.m.	82 .....	57 .....	75 ....	62 .....	53
	8:00 p.m.	90 .....	54 .....	65 ....	58 .....	51
	10:00 p.m.	91 .....	50 .....	70 ....	55 .....	
	Midnight	72 .....	58 .....	70 ....	55 .....	48
28-3-56	2:00 a.m.	67 .....	62 .....	63 ....	58 .....	
	4:00 a.m.	72 .....	56 .....	63 ....	56 .....	
	6:00 a.m.	62 .....	65 .....	61 ....	57 .....	
	8:00 a.m.	62 .....	66 .....	60 ....	60 .....	50
	10:00 a.m.	55 .....	70 .....	67 ....	60 .....	48
	11:00 a.m.	57 .....	70 .....	70 ....	60 .....	48
	Noon	50 .....	74 .....	74 ....	60 .....	
	1:00 p.m.	52 .....	72 .....	70 ....	61 .....	50
	3:00 p.m.	45 .....	74 .....	73 ....	62 .....	52
	5:00 p.m.	57 .....	68 .....	73 ....	62 .....	53
	7:00 p.m.	63 .....	64 .....	67 ....	63 .....	54
	10:00 p.m.	73 .....	58 .....	66 ....	62 .....	
	Midnight	62 .....	64 .....	66 ....	60 .....	

Greenhouses

Offices

<u>Date</u>	<u>Time</u>	<u>R.H.%</u>	<u>Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>	<u>Wall Surface Temp.</u>
29-3-56	2:00 a.m.	62	..... 68	..... 64	..... 63	.....
	4:00 a.m.	65	..... 62	..... 65	..... 60	.....
	6:00 a.m.	57	..... 68	..... 63	..... 62	.....
	8:00 a.m.	57	..... 73	..... 63	..... 64	..... 52
	10:00 a.m.	53	..... 77	..... 67	..... 62	..... 50
	11:00 a.m.	50	..... 74	..... 67	..... 61	..... 50
	Noon	50	..... 76	..... 72	..... 60	.....
	1:00 p.m.	56	..... 74	..... 76	..... 61	..... 50
	2:00 p.m.	50	..... 76	..... 75	..... 62	.....
	4:00 p.m.	50	..... 76	..... 72	..... 62	..... 53
3-4-56	Noon	50	..... 80	..... 73	..... 64	.....
	4:00 p.m.	50	..... 75	..... 66	..... 66	.....
	5:00 p.m.	62	..... 82	..... 71	..... 66	.....
	6:00 p.m.	71	..... 74	..... 73	..... 66	.....
	8:00 p.m.	84	..... 62	..... 74	..... 64	.....
	10:00 p.m.	90	..... 58	..... 76	..... 62	.....
	Midnight	91	..... 55	..... 78	..... 59	.....

<u>Greenhouses</u>				<u>Offices</u>		Wall Surface Temp.
<u>Date</u>	<u>Time</u>	<u>R.H.%</u>	<u>Temp. °F.</u>	<u>R.H.%</u>	<u>Temp. °F.</u>	
4-4-56	2:00 a.m.	93	53	79	56	
	4:00 a.m.	85	55	80	56	
	6:00 a.m.	73	62	75	59	
	8:00 a.m.	80	58	76	58	
	10:00 a.m.	67	68	77	62	
	Noon	57	72	67	66	
	1:00 p.m.	56	70	66	67	56
	2:00 p.m.	53	72	60	66	
	4:00 p.m.	60	66	63	66	
	5:00 p.m.	68	64	68	66	62
	8:00 p.m.	83	58	73	61	
	9:00 p.m.	85	54	74	59	58
	Midnight	93	52	77	55	
5-4-56	2:00 a.m.	87	52	77	54	
	4:00 a.m.	82	60	74	57	
	6:00 a.m.	91	54	75	56	
	8:00 a.m.	95	53	80	55	51
	10:00 a.m.	67	66	77	63	
	Noon	55	80	70	64	
	1:00 p.m.	57	78	82	68	62
	3:00 p.m.	45	78	78	66	
	5:00 p.m.	60	73	68	66	61
	7:00 p.m.	75	65	76	66	
	9:00 p.m.	85	58	78	63	
	Midnight	90	53	78	58	

Greenhouses

Offices

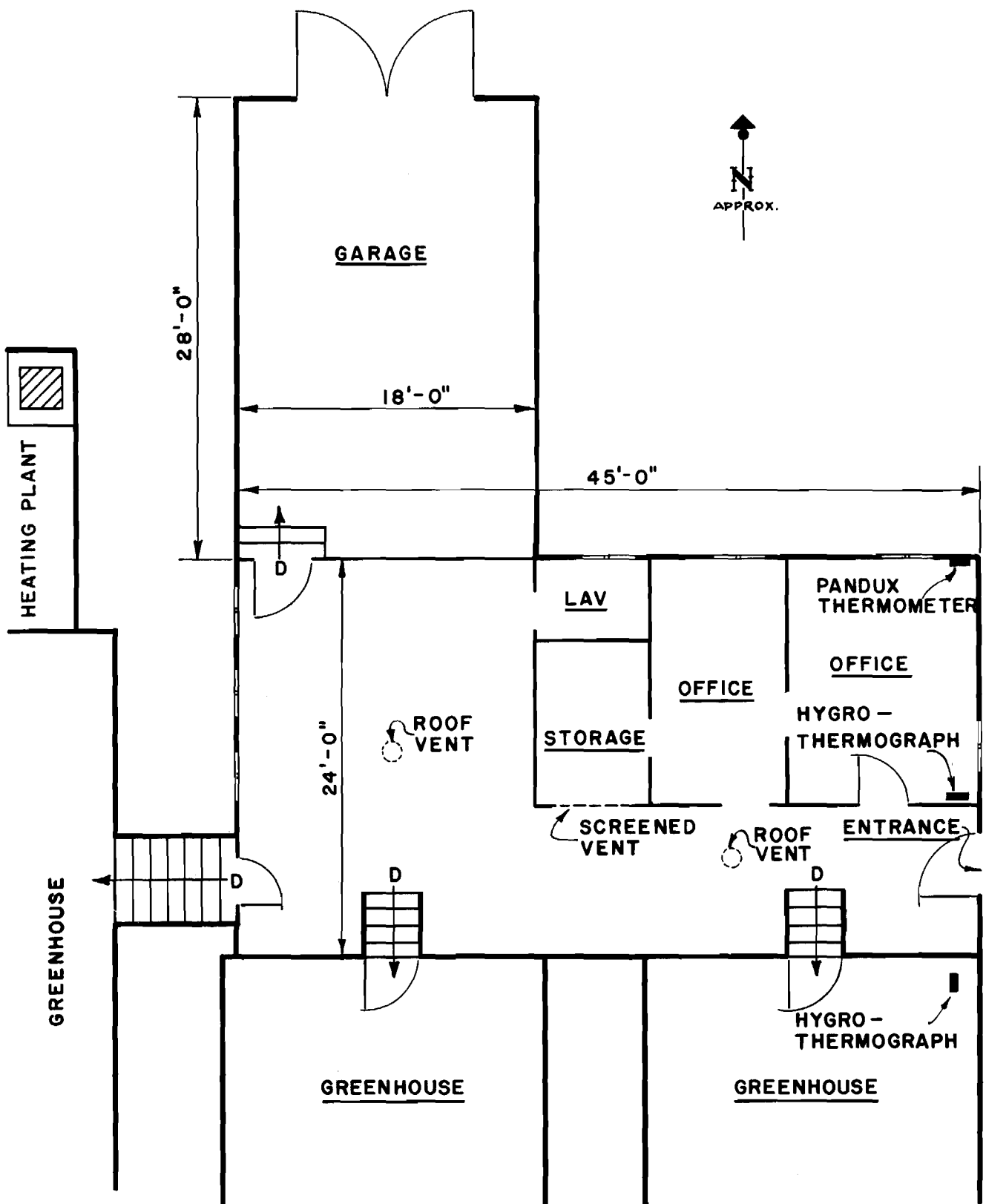
Date	Time	Greenhouses		Offices		Wall
		R.H.%	Temp. °F.	R.H.%	Temp. °F.	Surface Temp.
6-4-56	2:00 a.m.	79	56	76	59	
	4:00 a.m.	75	60	75	60	
	6:00 a.m.	82	55	75	58	
	8:00 a.m.	63	76	75	62	48
	10:00 a.m.	44	84	77	62	
	Noon	37	76	83	64	
	1:00 p.m.	40	78	78	64	59
	3:00 p.m.	35	82	57	64	
	5:00 p.m.	55	76	71	66	60
	8:00 p.m.	86	59	78	64	
	10:00 p.m.	91	54	77	61	
	Midnight	94	50	76	58	
7-4-56	2:00 a.m.	82	55	74	57	
	4:00 a.m.	71	64	69	60	
	6:00 a.m.	78	56	67	58	
	8:00 a.m.	68	65	72	55	52
	10:00 a.m.	50	80	61	55	
	Noon	47	78	81	57	
	1:00 p.m.	45	78		56	58
	2:00 p.m.	47	75			
	4:00 p.m.	34	78			

ADDENDUM TO APPENDIX I

Offices

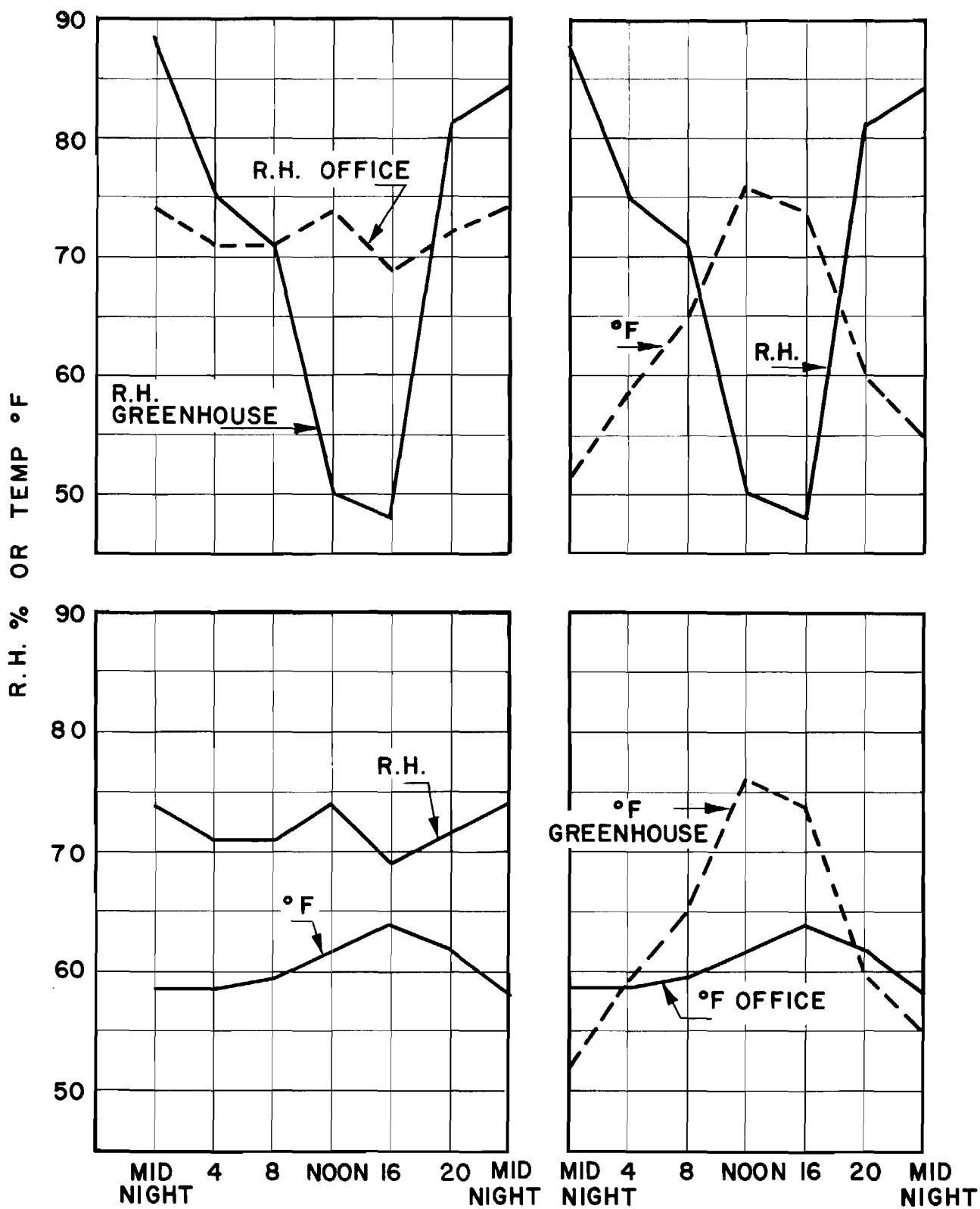
<u>Date</u>	<u>Time</u>	<u>R.H.%</u>	<u>Temp. °F.</u>
4-2-57	4:00 p.m. ....	70 .....	62
	6:00 p.m. ....	63 .....	62
	8:00 p.m. ....	66 .....	60
	10:00 p.m. ....	71 .....	57
	Midnight .....	72 .....	58
5-2-57	2:00 a.m. ....	63 .....	63
	4:00 a.m. ....	65 .....	60
	6:00 a.m. ....	58 .....	64
	8:00 a.m. ....	57 .....	62
	10:00 a.m. ....	56 .....	66
	Noon .....	60 .....	62
	2:00 p.m. ....	65 .....	60
	4:00 p.m. ....	68 .....	59
	6:00 p.m. ....	63 .....	58
	8:00 p.m. ....	60 .....	61
	10:00 p.m. ....	52 .....	67
	Midnight .....	48 .....	68
6-2-57	2:00 a.m. ....	47 .....	69
	4:00 a.m. ....	46 .....	69
	6:00 a.m. ....	46 .....	69
	8:00 a.m. ....	45 .....	69
	10:00 a.m. ....	49 .....	68
	Noon .....	55 .....	64

<u>Date</u>	<u>Time</u>	<u>R.H.%</u>	<u>Temp. °F.</u>
6-2-57	2:00 p.m.	..... 63 .....	62
	4:00 p.m.	..... 66 .....	59
	6:00 p.m.	..... 70 .....	59
	8:00 p.m.	..... 69 .....	57
	10:00 p.m.	..... 62 .....	63
	Midnight	..... 60 .....	63
7-2-57	2:00 a.m.	..... 60 .....	62
	4:00 a.m.	..... 59 .....	63
	6:00 a.m.	..... 60 .....	61
	8:00 a.m.	..... 57 .....	64
	10:00 a.m.	..... 63 .....	59
	Noon	..... 69 .....	56
	2:00 p.m.	..... 69 .....	59
	4:00 p.m.	..... 70 .....	60
	6:00 p.m.	..... 63 .....	62
	8:00 p.m.	..... 66 .....	62
	10:00 p.m.	..... 62 .....	67
	Midnight	..... 65 .....	63
8-2-57	2:00 a.m.	..... 63 .....	67
	4:00 a.m.	..... 65 .....	63
	6:00 a.m.	..... 65 .....	65
	8:00 a.m.	..... 61 .....	68
	10:00 a.m.	..... 58 .....	66
	Noon	..... 58 .....	64



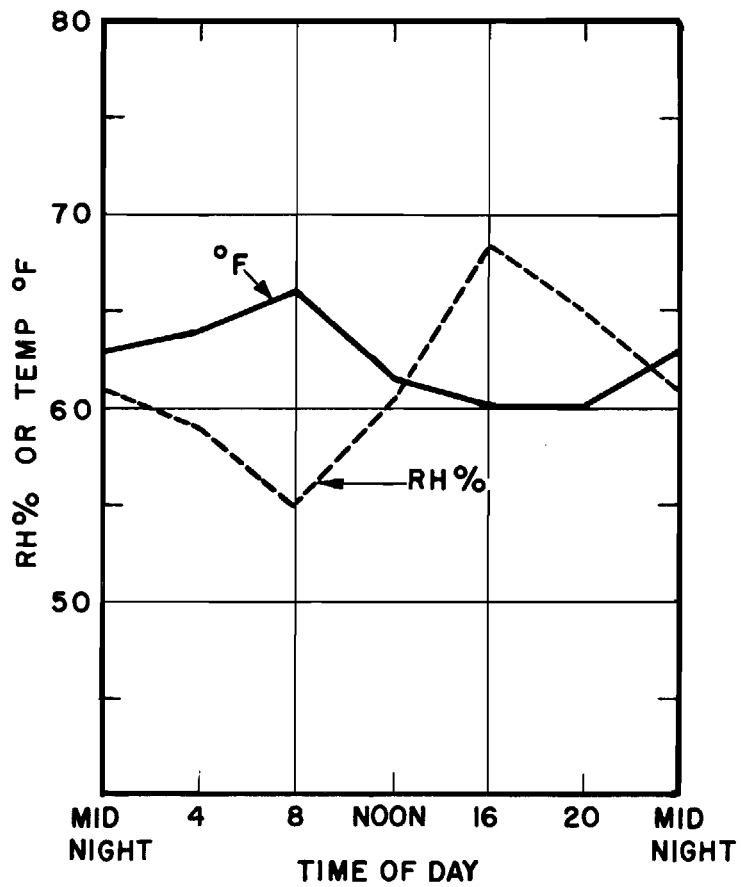
**FIGURE I**  
**SKETCH OF BUILDING**





NOTE: GRAPHS SHOW COMBINED AVERAGES DURING MARCH AND APRIL FOR PERIODS RECORDED

FIGURE 2



**FIGURE 3**  
**READINGS TAKEN IN OFFICE**  
**(AVERAGE FOR PERIOD RECORDED**  
**FEBRUARY 1957)**