Limited field study of electrically heated houses

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CANADA

DIVISION OF BUILDING RESEARCH

LIMITED FIELD STUDY OF ELECTRICALLY HEATED HOUSES

by

D. R. Robson

Internal Report No. 317

of the

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OTTAWA

June 1965

PREFACE

There is a growing interest in Canada in electrical house heating, which is giving rise in turn to much discussion on the prediction, in advance of actual experience, of the amount and therefore the annual cost of the electrical energy which will be required in any given case. In view of the many factors involved and the variations and uncertainties in many of them from one house to the next, there are definite limitations in the accuracy of predictions based on calculations. It is of interest, therefore, at this stage in the development of electric heating to obtain field records of actual energy consumption and as suitable opportunities are presented. This has been done in the case of five houses in the Atlantic region and the results are now reported.

The author, a mechanical engineer, is a research officer with the Atlantic Regional Station of the Division.

Ottawa
June 1965

N. B. Hutcheon
Assistant Director

LIMITED FIELD STUDY OF ELECTRICALLY HEATED HOUSES

by

D.R. Robson

This field study developed when a local builder decided to install electric heating in one of the houses in his subdivision. Two other houses of similar size were being built at the same time but would be oil heated. This seemed to be an interesting area for study as all three houses were on the same street and had the same orientation. To supplement further the data collected, an electrically heated house in Sydney having the same orientation but slightly smaller in floor area was included as was a house in Sussex, N.B., that was also slightly smaller. The house in Sussex was built on a basement while the house in Sydney and the house in Dartmouth were both built on concrete slabs. The two oil heated houses in Dartmouth were built on crawl spaces.

DARTMOUTH

The houses in Dartmouth at the Commodore Company subdivision included in this study were on Lots 120, 121, and 124 (Figure 1). The house on Lot 120 is built on a crawl space to the floor plan shown in Figure 3 and insulated with 3 5/8 in. of insulation in the wall and 6 in. in the ceiling. It is heated with an oil-fired warm-air furnace and a crawl space plenum system similar to ones described in previous reports (1).

The house on Lot 121 is built on a concrete floor slab to the floor plan shown in Figure 4. The insulation used was 3 5/8 in. in the wall, 6 in. on the ceiling, and 2 in. rigid insulation between the slab edge and the foundation wall. This 2 in. of insulation followed the foundation wall down about 18 in. and was not continued under the slab. The top edge of the insulation was chamfered at 30° and the floor slab placed to within 1/4 in. of the foundation wall with 1/4 in. insulation left between the top edge of the chamfer on the slab and the foundation wall (Figure 4(a)). The heating system consists of electric baseboard units in each room with individual thermostat control.

The house on Lot 124 is built on a crawl space to the floor plan shown in Figure 3. The insulation here was 3 in. in the wall and 3 in. in the ceiling. The heating system is the same as in the house on Lot 120; an oil-fired forced warm-air furnace and a crawl space plenum system. The crawl space walls in both Lots 120 and 124 are insulated with 2 in. of insulation from the sill to the ground on the inside face of the foundation wall.

SUSSEX

The house in Sussex (Figure 2) is built on a basement to the floor plan shown in Figure 5. The insulation used was 2 in. under the floor, 3 in. in the wall, and 6 in. in the ceiling. The living area was heated with electric baseboard units and individual thermostatic control in each room. The basement was not heated.

SYDNEY

The house in Sydney (Figure 2) was built on a floating concrete slab to the floor plan shown in Figure 6. This house was insulated with 3 5/8 in. of insulation in the wall, 6 in. on the ceiling, and 2 in. rigid insulation around the perimeter on the outside from the sill to 6 in. below grade. Heating here is by electric baseboard units with individual thermostatic control in each room.

INSTRUMENTATION

Each of the houses had a hygrothermograph installed (Figure 7) to record temperature and humidity in the living space on a continuous basis. Due to certain difficulties the temperature-humidity record for the Sydney house is not as complete as for the other four houses.

Extra watt-hour meters were installed in each house. In the house heated electrically there were separate meters on the electric range, electric water heater, and heating system with the one on the heating system having a demand reading that was reset weekly. In the two oil heated houses there were separate meters on the electric range, electric water heater, and on the furnace unit. All of the meters on each house were read and the readings recorded on a weekly basis.

A means of measuring the gallons of domestic hot water used in each house was accomplished by installing a water meter on the cold water feed line to each water heater. These water meters were read on a weekly basis at the same time as the electric meters were read and the readings recorded.

Weather data for Dartmouth were obtained from published weather records of the Meteorological Branch of the Department of Transport, Halifax Station. The data for Sussex were obtained by the New Brunswick Electric Power Commission through the Fredericton Weather Office for the substation at Sussex. The data for Sydney were from published records of the Meteorological Branch of the Department of Transport in Sydney.

With the exception of Sussex all data were processed at the Atlantic Regional Station including weekly summaries of the outdoor weather report. All data collected for Sussex were processed by the Consumer Service Department of the New Brunswick Electric Power Commission.

PRESENTATION OF DATA

The weekly average inside air temperature, relative humidity, humidity ratio, and inside-outside air temperature difference are shown graphically for each house (Figures 8 to 12, incl.). The records for the Sydney house are not complete so it is not possible to present a complete graph (Figure 12). It is evident, however, that the inside air temperature is in the same range as in the other houses.

For ease of comparison the average monthly indoor temperature and the average monthly indoor humidity are also shown graphically (Figure 13).

The average weekly burner and fan on time, fuel consumption, and total weekly degree days are shown graphically in Figures 15 and 17 for Lots 120 and 124. For Lot 121, Sussex, and Sydney the total weekly degree days, and the kwhr consumption for heating (weekly) are shown graphically in Figures 16, 18, and 19. Again with respect to the Sydney house the records are not complete although the monthly records are reliable; and it has been necessary to estimate most of the weekly readings from monthly records for the graphs shown in Figure 19.

INDOOR CLIMATE

The monthly values (Figures 13 and 14) do not include figures for Sydney because the temperature and humidity records were incomplete. From Figure 13 it is evident that the average indoor temperature for the three Dartmouth houses would be

72°F (22.2°C). When the weekly average figures are referred to (Figures 8, 9, and 10), this is substantiated in that there are no major differences evident. It would seem, however, from Figures 11 and 13 that the average temperature maintained in the Sussex house was 1 F degree lower or 71°F (21.7°C).

The relative humidity maintained in the three Dartmouth houses follows the same general pattern except that the record for the electrically heated house (Lot 121) would indicate a slightly lower average relative humidity. Referring to the graphs for the Sussex house (Figures 11 and 14) it would appear that the relative humidity was slightly higher than for the three Dartmouth houses. This is substantiated by the partial record for the Sydney house (Figure 12). Referring to Table V it is evident that the occupancy for the Dartmouth house (Lot 121) is different than for the other four houses. In this house (Lot 121) one man lived alone and did very little cooking. He did not occupy the house full time but rather five or six days per week. This house was used primarily as a demonstration home while the other four houses were lived in by families carrying on normal activities.

From the data collected it appears that the three houses in Dartmouth (Lots 120, 121, and 124) maintained nearly the same temperature and relative humidity, and from previous reports, this is the usual range of temperature and humidity of houses in this area (2). Although it was expected that the electrically heated home would have a slightly higher humidity, this was in fact not the case. The Sussex and partial Sydney records would indicate that a higher relative humidity could be expected in an electrically heated home. The seeming discrepancy in the Dartmouth electrically heated home is explained in part by the difference in occupancy. No measurements were made of air change in the houses. Differences in air change might be expected between the electrically heated home and the two oil heated homes, but these studies provide no basis for establishing what these differences, if any, might be.

HEAT REQUIREMENTS

A summary of data in Table I details the heat requirements for all five houses.

As mentioned in the section on indoor climate, the infiltration or air change rate was not measured although living habits could be similar for Lots 120 and 124. It cannot be stated with certainty that they are, as no detailed attempt to observe this was included in the study.

If one assumes that the house on Lot 124 is representative of the average house of this size in this subdivision and this appears to be so from previous records (1), then the comparison may be made between Lot 124 and Lot 121. On this basis the total cost (heating plus domestic electricity) is 26 per cent higher for Lot 121 than for Lot 124. This is complicated by the occupancy difference between Lots 121 and 124 as explained previously. No allowance has been made for this difference.

This sample of three houses is not representative. It demonstrates, however, the danger of drawing conclusions from such a small number of cases.

The electrically heated houses instrumented in Sydney and Sussex were in areas having more degree days than Dartmouth. In Table I, item 14, a comparison is made of the three electrically heated houses on the basis of kwhr of heating used per degree day per square foot of floor area. For the Dartmouth house this is 3.28×10^{-3}, for Sussex 1.81×10^{-3}, and for Sydney 1.82×10^{-3}. While the Sydney and Sussex houses are in close agreement, the Dartmouth house is much higher. A monthly summary for each of the three houses is given in Tables II, III and IV.

In comparing these three houses, occupancy differences must be considered. The Dartmouth house had only part-time occupancy (one person), whereas houses in Sussex and Sydney were occupied by a typical family. Other variables such as orientation, solar heat gain, etc., must be considered when comparing houses in three different areas. With Sussex and Sydney in such close agreement it would appear that something other than occupancy is needed to explain the high cost of heating the Dartmouth house. The total electricity used in Dartmouth exclusive of heating is less than Sussex by 4, 533 kwhr and less than Sydney by 5, 445 kwhr (Table I). Undoubtedly there would be heat gain from the use of electrical energy in appliances, lighting, and part of the water heating. The electrical consumption in Sussex or Sydney for all uses excluding heating represents 20 to 25 per cent of the total electrical consumption whereas in Dartmouth the electrical energy use, excluding heating, is about 10 per cent of the total electrical energy use.

Following completion and after several months of occupancy an examination of the electrically heated house in Dartmouth was carried out because of the apparent high cost of heating. This examination disclosed the following:

(1) The insulation detail at the edge of the floor slab is poor; the intended thermal break between the edge of the floor slab and the foundation wall was bridged in some places by a skin of concrete.

(2) The insulation on the ceiling was not continuous over the entire ceiling area. A strip 12 to 18 in. wide running the full length of the house front and back was left uninsulated next to the outside wall on the ceiling. This was later corrected but not until the collection of data was almost completed.

(3) A panel was removed from the outside of the house, and in one of the three stud spaces uncovered, the insulation was up about 1 in. above the shoe. This may have been the only stud space insulated in this way, but it is difficult to say without removing all of the exterior siding.

(4) The electric baseboard units are fastened directly to the wall, and as a result, substantial conduction of heat from the baseboard heating unit to the wall takes place. In some instances this has been severe enough to require redecorating of the wall above the unit after only one year of use.

(5) The window drapes are scorched in one room where they pass over the heating unit. The heating equipment manufacturer recommends that drapes be cut 1 1/2 in. off the floor and be 1 1/4 in. in front of the unit. This was not done and as a result the drapes are scorched.

In conjunction with this examination of the electrically heated house in Dartmouth a closer look at the other two houses in Dartmouth was made and one observation recorded.

The insulation detail in the crawl space is poor. The insulation batt is fastened at the top of the wall and hangs free so that an air space of 1 to 2 in. is created behind the insulation which leads directly into the crawl space. This has the effect of cutting down the insulated area of the crawl space by 1/2 to 2/3.

All of the insulation material used in these houses is of good quality but the advantage in adding insulation is lost if care is not taken with its proper installation. The above items contributed to a large degree to the rather poor results obtained from these three houses with regard to heating costs.

DOMESTIC WATER HEATING

In the test data collected, the kwhr used to heat the domestic water was recorded as a separate item. The summary is detailed in the following table.

House	High	Low	Average
Dartmouth, Lot 120	2.73 gal/kwhr	1.56 gal/kwhr	1.96 gal/kwhr
Dartmouth, Lot 121	3.08 gal/kwhr	1.74 gal/kwhr	2.72 gal/kwhr
Dartmouth, Lot 124	3.81 gal/kwhr	2.71 gal/kwhr	3.21 gal/kwhr
Sydney	3.56 gal/kwhr	2.14 gal/kwhr	2.92 gal/kwhr

There is a variation due to the change in the inlet water temperature from season to season which may account in part for the high and low average values of gallons of water heated per kwhr. Although the amount of water flowing through the water heater was measured, the amount of water heated to the temperature setting was not. The house on Lot 120 had an automatic washer-dryer combination unit.

In very general terms, however, it can be said that from 2 to 3 gallons of water will be heated per kwhr in the average domestic establishment.

OBSERVATIONS

With the results available from only five houses it is difficult to draw any firm conclusions. Some general observations, however, are possible:

(1) From the data collected it would seem that the electrical industry's estimate of 25 to 30 per cent increase in over-all cost at present rates when heating with electricity (and insulated properly for it) is a realistic one.

(2) If one is to establish reliable average figures for electric heating, a large number of cases must be studied. It follows also that any prediction of anticipated costs made on the basis of such figures for any one house may differ substantially from the actual cost.

(3) There is a need for more accurate evaluation of the infiltration or air change in houses. Careful tests will be required to establish if there is in fact a difference in infiltration between electrically heated and oil heated houses.

REFERENCES

(1) Robson, D.R. Heat Requirements for Houses Halifax 1960-1961. National Research Council, Division of Building Research, Internal Report No. 271, October 1963.

(2) Robson, D.R. Temperature and Humidity in Houses Halifax 1960-1961. National Research Council, Division of Building Research, Internal Report No. 261, March 1963.

TABLE I

SUMMARY OF DATA - FIVE HOUSES

No.	Item	House: Lot 120, Dartmouth	Lot 121, Dartmouth	Lot 124, Dartmouth	Sussex	Sydney
1	Calculated Heat Loss, Btu/hr	32,340	23,277	35,655	25,700	21,000
2	Floor Area - Sq Ft	950	950	950	840	890
3	Degree Days	7,288	7,288	7,288	9,145	8,641
4	Total Electricity Used, kwhr	12,590	25,360	7,054	21,263	22,205
5	Total Fuel Oil Used - Imp. Gal.	895	-	919	-	-
6	Electricity - Space Heating - kwhr	1,265	22,660	827	13,970	14,000
7	Electricity - Cooking kwhr	767	180	1,296	1,240	1,172
8	Electricity - Water Heating - kwhr	6,677	1,436	3,357	4,409	3,487
9	Electricity - Misc. kwhr	3,881	1,084	1,574	1,644	3,546
10	Electricity - Total Exclusive of Heat, kwhr	11,325	2,760	6,227	7,293	8,205
11	Total Burner Operation hr	1,778	-	1,796	-	-
12	Total Fan Operation hr	3,994	-	2,267	-	-
13	kwhr (Heating)/Gal. Fuel Oil	1.42	-	0.91	-	-
14	kwhr/Degree Day (Heating Only)	-	3.10	-	1.52	1.62
15	kwhr/°D/Sq Ft Floor Area	-	3.28×10^{-3}	-	1.81×10^{-3}	1.82×10^{-3}
16	Gal/°D/Sq Ft Floor Area	13.0×10^{-5}		13.3×10^{-5}		
17	Electricity - Heating kwhr (Corrected to 7600°D)	-	23,700	-	11,600	12,400
18	Electricity Total kwhr (Corrected to 7600°D)	-	26,400	-	17,700	19,600

TABLE II

DARTMOUTH, LOT 121 - MONTHLY SUMMARY

Period	Electrical Energy (kwhr) Used					Degree Days	Heating kw/° D.
	Heating	Range	Water Heater	Misc.	Total		
1962 1963 Dec. 4 - Jan. 4	3,640	14	138	118	3,910	1,166	3.12
1963 Jan. 5 - Feb. 5	3,720	15	130	115	3,980	1,254	2.97
Feb. 6 - Mar. 5	3,140	17	124	109	3,390	1,161	2.70
Mar. 6 - Apr. 3	2,810	18	150	92	3,070	905	3.11
Apr. 4 - May 1	2,420	13	127	70	2,630	766	3.16
May 2 - May 29	1,600	12	118	-	1,730	470	3.41
May 30 - June 26	780	13	112	85	990	220	3.54
June 27 - July 31	320	13	101	106	540	80	4.00
Aug. 1 - Sept. 4	360	21	113	106	600	90	4.00
Sept. 5 - Sept. 25	660	15	106	79	860	191	3.45
Sept. 26 - Oct. 30	1,390	19	123	108	1,640	401	3.46
Oct. 31 - Nov. 27	1,820	10	94	96	2,020	584	3.12
TOTALS	22,660	180	1,436	1,084	25,360	7,288	3.11 Average

TABLE III

SUSSEX - MONTHLY SUMMARY

Period	Electrical Energy (kwhr) Used: Heating	Range	Water Heater	Misc.	Total	Degree Days	Heating kw/°D.
1963							
Jan. 4 - Jan. 31	2,050	80	416	164	2,710	1,259	1.73
Feb. 1 - Mar. 4	2,500	101	453	178	3,232	1,717	1.47
Mar. 5 - Apr. 3	1,980	131	510	18	2,639	1,133	1.75
Apr. 4 - May 3	1,370	111	334	263	2,078	823	1.66
May 4 - June 7	630	136	442	127	1,335	422	1.49
June 8 - July	-	-	-	-			
July - August	-	-	-	-			
August - Sept.	-	-	-	-			
Sept. - Oct. 1	520	340	1,131	341	2,332	728	0.72
Oct. 2 - Nov. 4	640	103	313	122	1,178	576	1.11
Nov. 5 - Dec. 3	1,460	113	373	178	2,124	793	1.84
Dec. 4 - Jan. 5, 1964	2,820	125	437	253	3,635	1,694	1.66
TOTALS	13,970	1,240	4,409	1,644	21,263	9,145	1.52 Average

TABLE IV

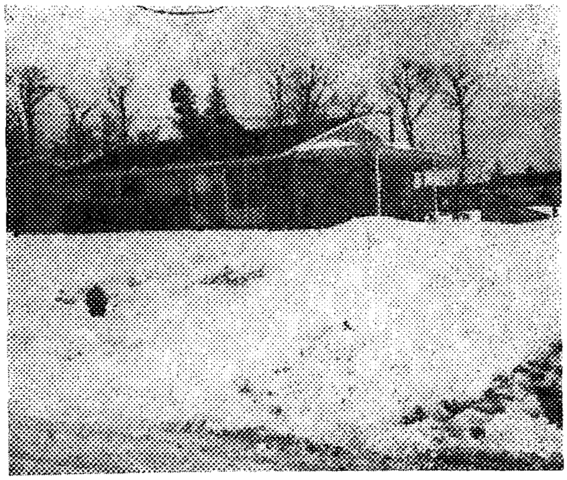
SYDNEY - MONTHLY SUMMARY

Period	Electrical Energy (kwhr) Used						Degree Days	Heating kw/°D.
	Heating	Range	Water Heater	Misc.	Clothes Dryer	Total		
1963								
Jan. 7 - Feb. 4	2,100	111	392	387	82	3,072	1,101	1.90
Feb. 5 - Mar. 4	2,200	127	412	375	92	3,206	1,312	1.68
Mar. 5 - Mar. 31	1,640	98	288	192	90	2,308	1,044	1.57
Apr. 1 - Apr. 30	1,580	46	251	198	62	2,137	944	1.59
May 1 - May 28	880	43	213	141	59	1,336	506	1.84
May 29 - June 26	420	69	300	129	32	950	347	1.21
June 27 - July 25	80	102	174	257	7	620	126	0.63
July 26 - Aug. 26	120	100	243	159	8	630	65	1.85
Aug. 27 - Sept. 25	320	90	220	170	14	814	286	1.12
Sept. 26 - Oct. 21	540	97	223	239	52	1,151	394	1.37
Oct. 22 - Nov. 28	1,400	113	320	335	68	2,236	794	1.76
Nov. 29 - Dec. 27	1,940	125	331	203	89	2,688	1,133	1.71
Dec. 28 - Jan. 9, 1964	780	51	120	82	24	1,057	589	
TOTALS	14,000	1,172	3,487	2,867	679	22,205	8,641	1.62 Average

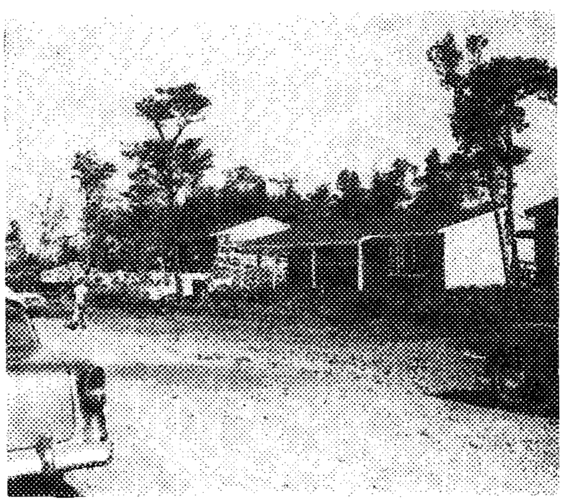
TABLE V

DETAILS

House	Lot 120	Lot 121	Lot 124	Sussex	Sydney
Adults	2	1	2	2	2
Children	2	0	1	2	1
Heating System	Warm Air	Electric Baseboard	Warm Air	Electric Baseboard	Electric Baseboard
Furnace Output	92,000 Btu/hr	-	92,000	-	-
Fireplace	No	No	No	Yes	No
Exhaust Fan	Bathroom	Bathroom	Bathroom	Kitchen	None
Cooking Range	Electric	Electric	Electric	Electric	Electric
Water Heater	Electric	Electric	Electric	Electric	Electric
Washer	Combination Unit	No	Wringer Type	Wringer Type	Automatic
Dryer		No		No	Yes (Vented)



(a) Lot 120 - Dartmouth

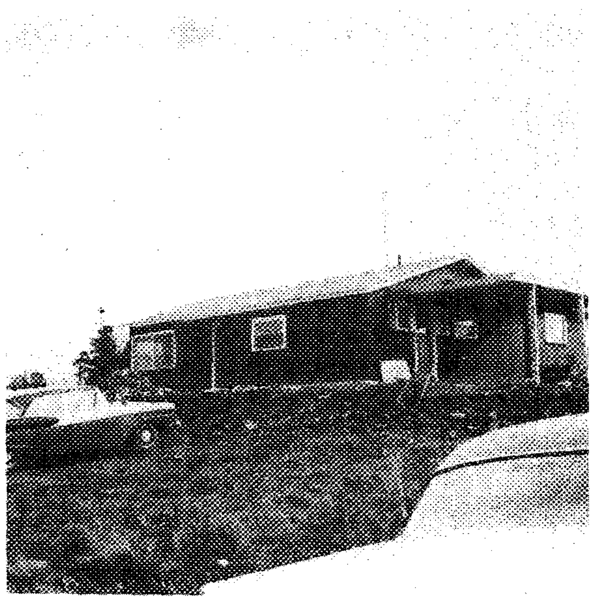


(b) Lot 121 - Dartmouth

(c) Lot 124 - Dartmouth

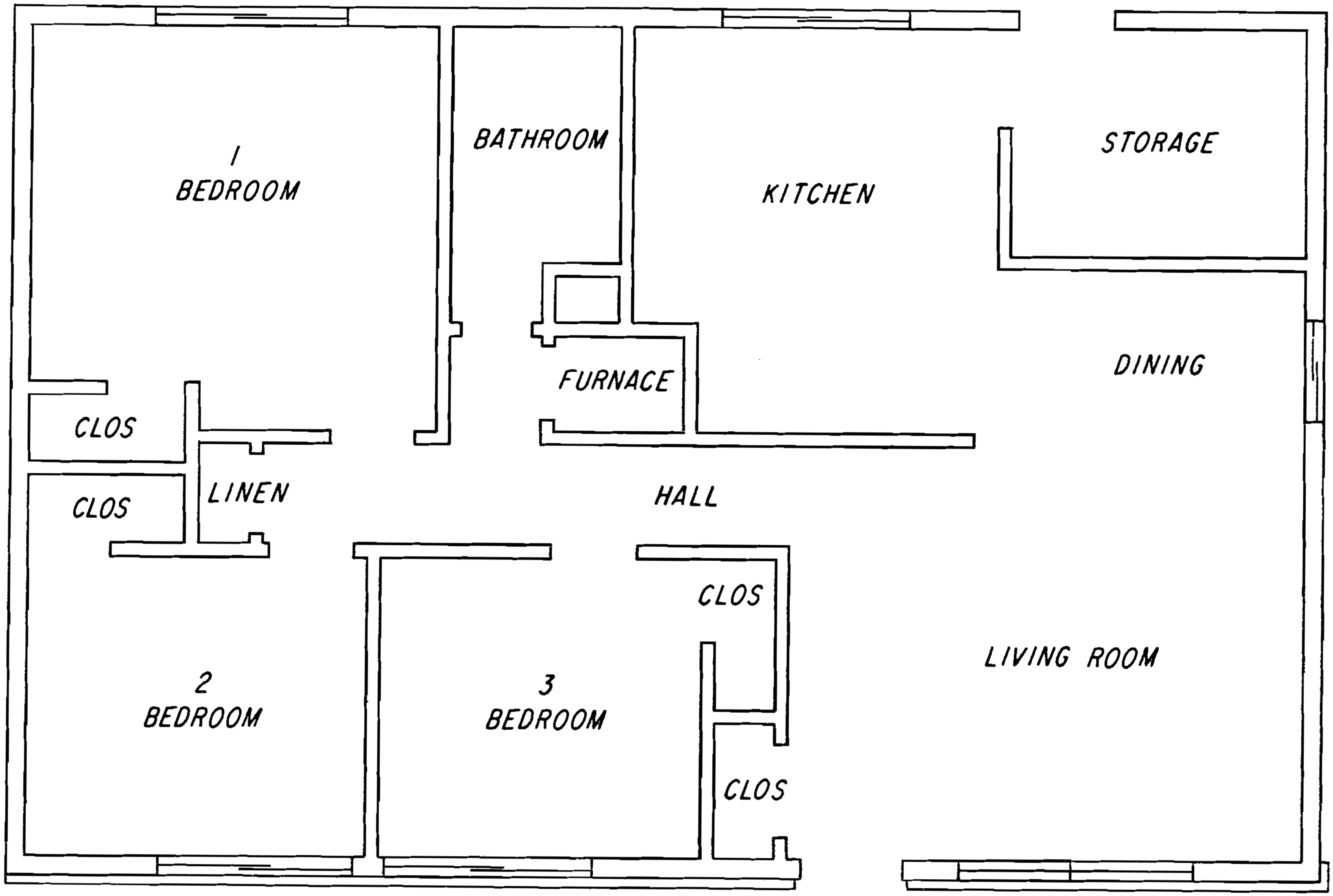
Figure 1

(a) Sussex House



(b) Sydney House

Figure 2



FLOOR PLAN

FIGURE 3 DARTMOUTH, N.S., LOTS 120 AND 124

BR 3003-2

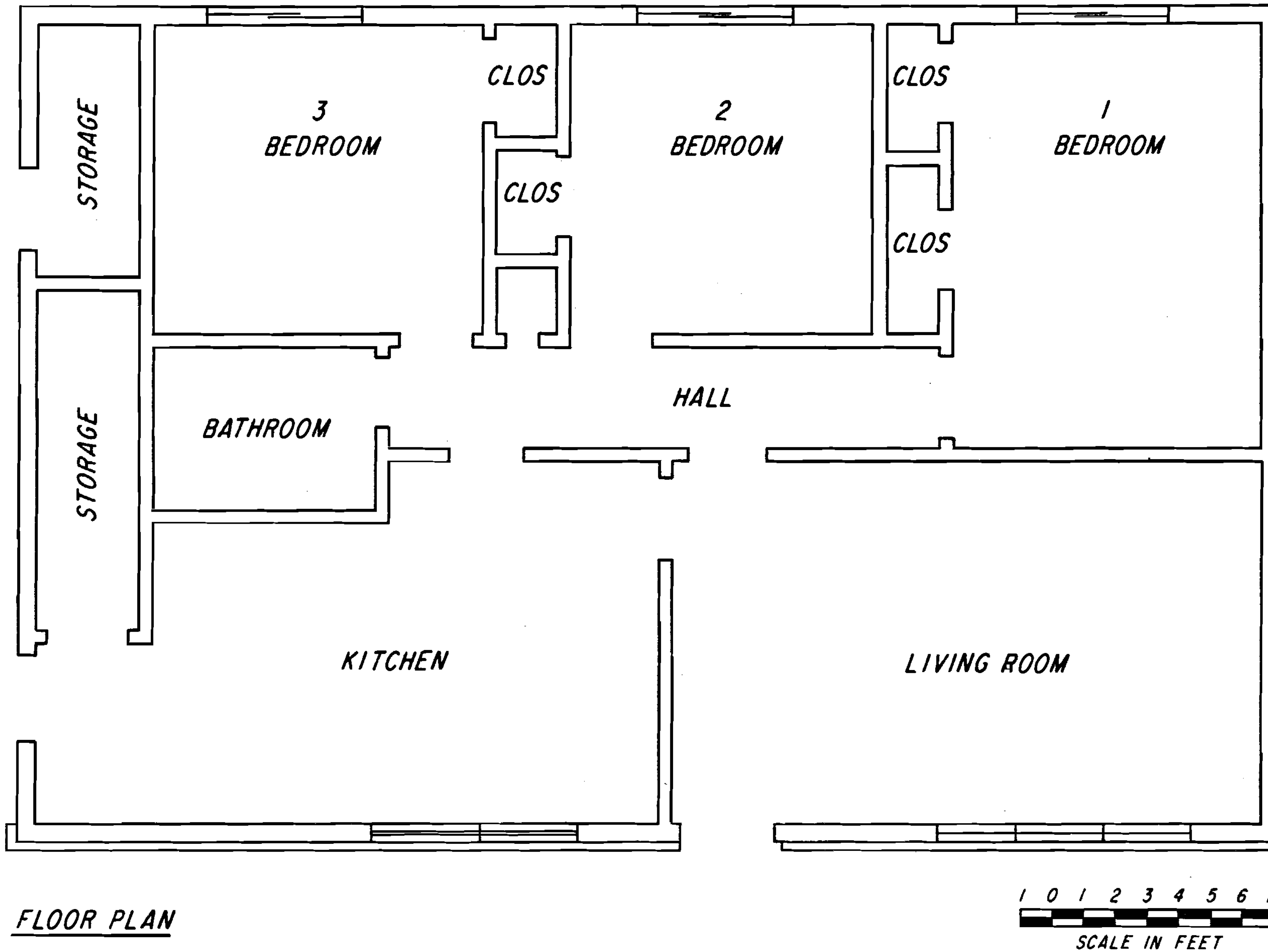
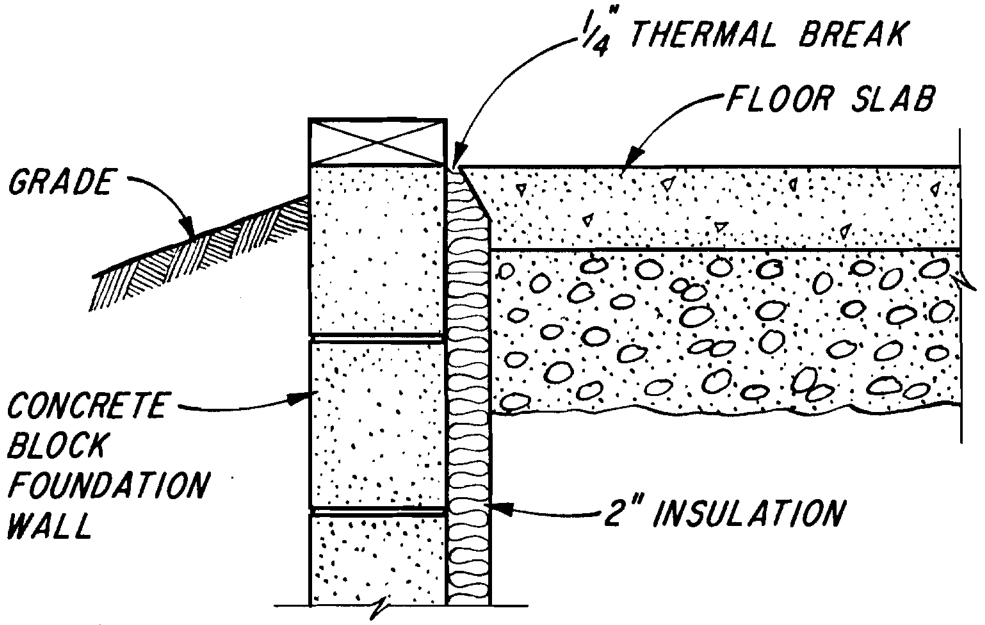


FIGURE 4 DARTMOUTH, N.S., LOT 121

BR 3003-1



NOTE:
NOT TO SCALE

FIGURE 4(a) EDGE INSULATION DETAIL

BR3409-1

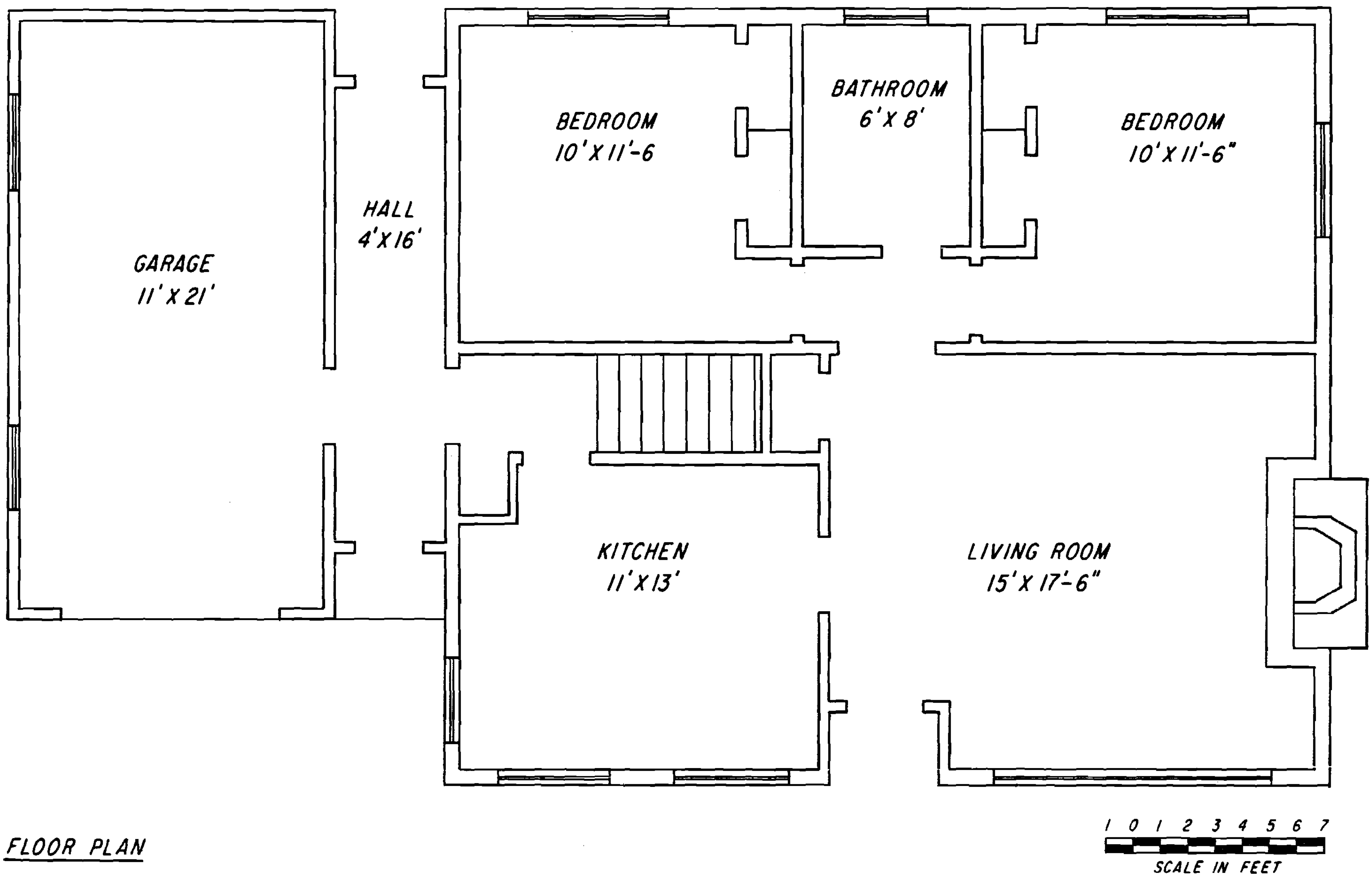


FIGURE 5 HOUSE IN SUSSEX, N.B.

BR 3003-4

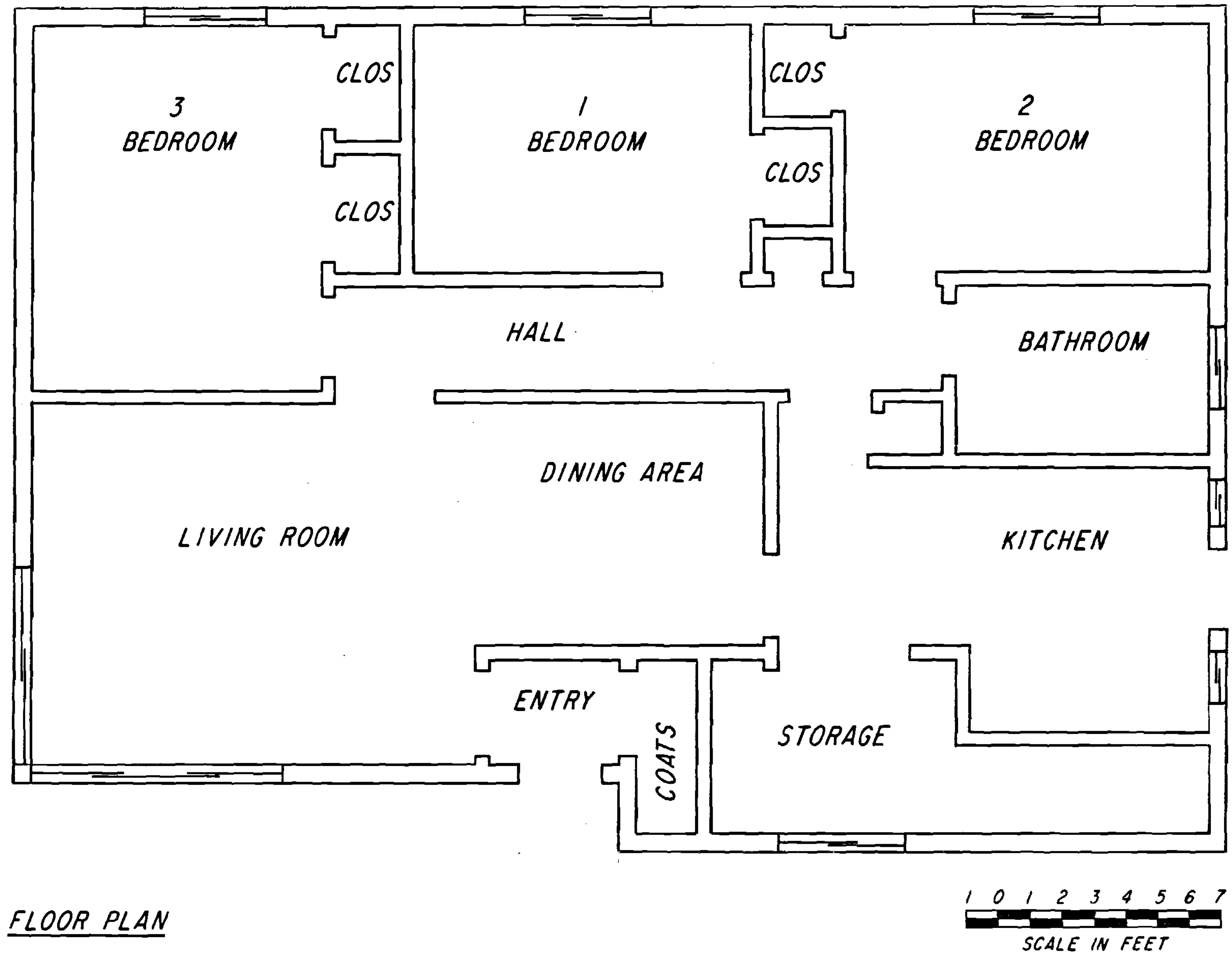


FIGURE 6 HOUSE IN SYDNEY, N.S.

BR 3003-3

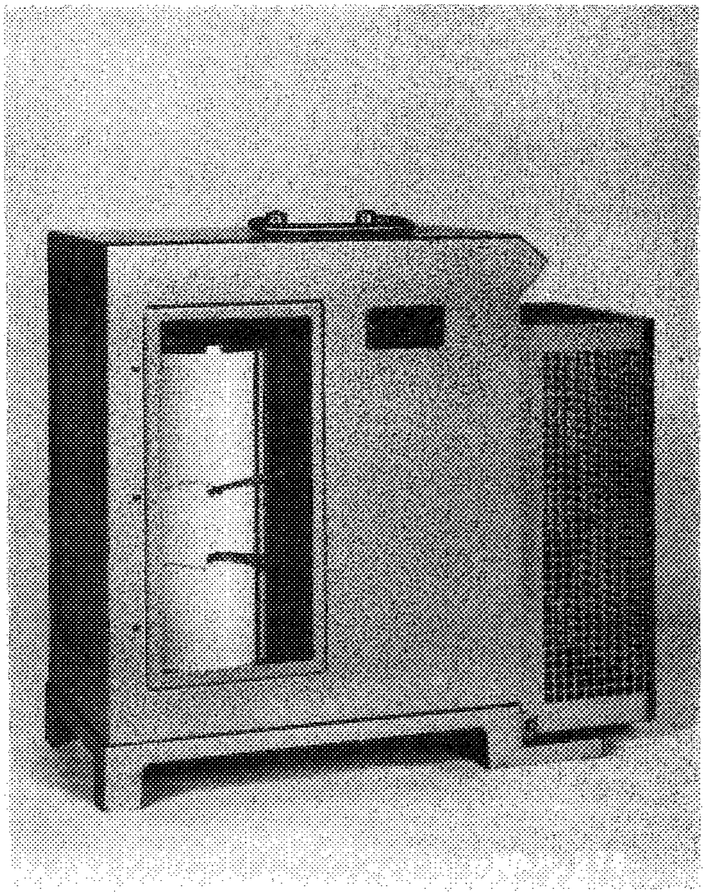
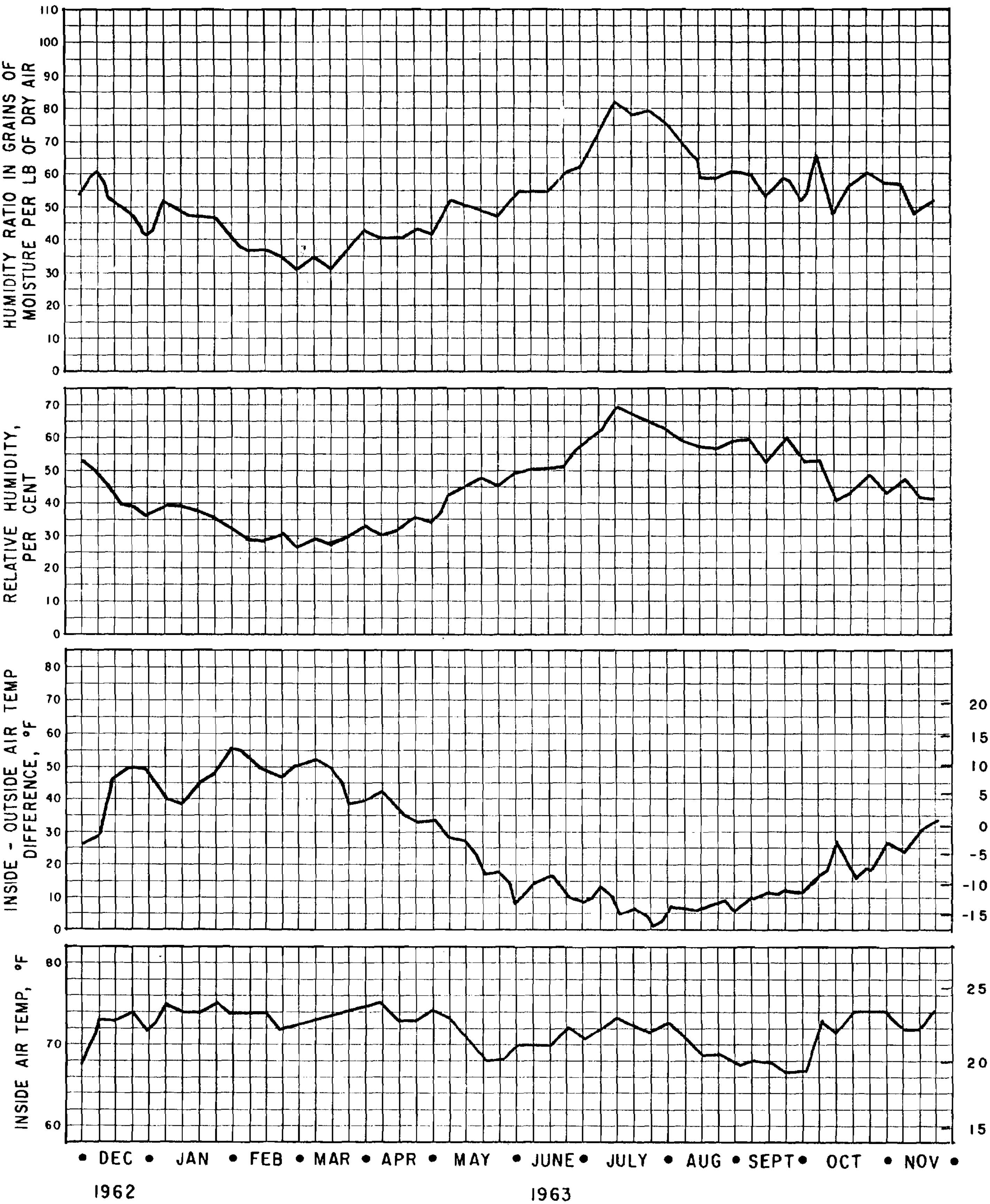


Figure 7

Hygrothermograph

LOCATION DARTMOUTH, N.S. BUILDING LOT 120

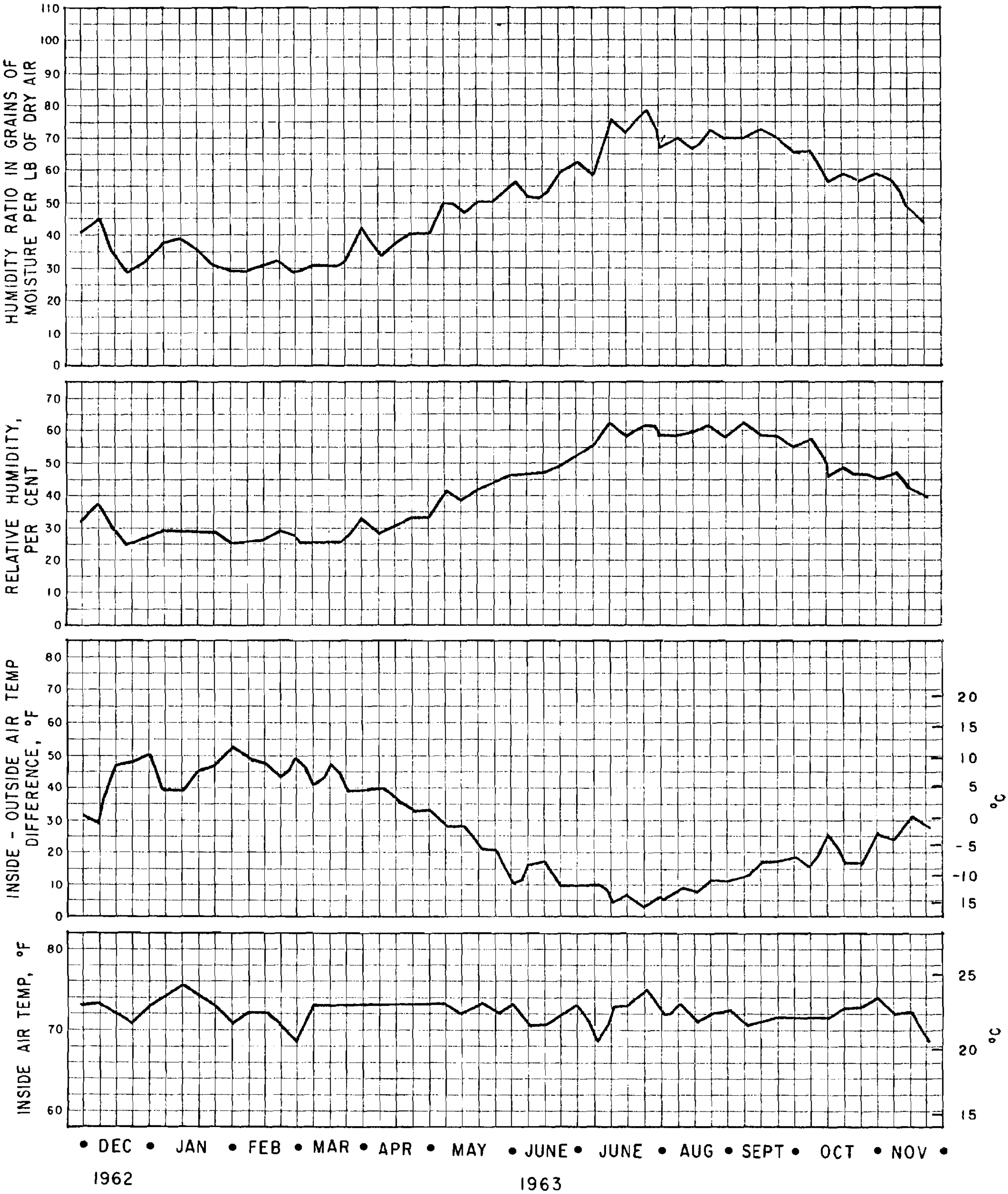


BR. 3409-2

FIGURE 8

D.B.R. **INDOOR CLIMATE OF BUILDINGS** N.R.C.

LOCATION DARTMOUTH, N.S. BUILDING LOT 121

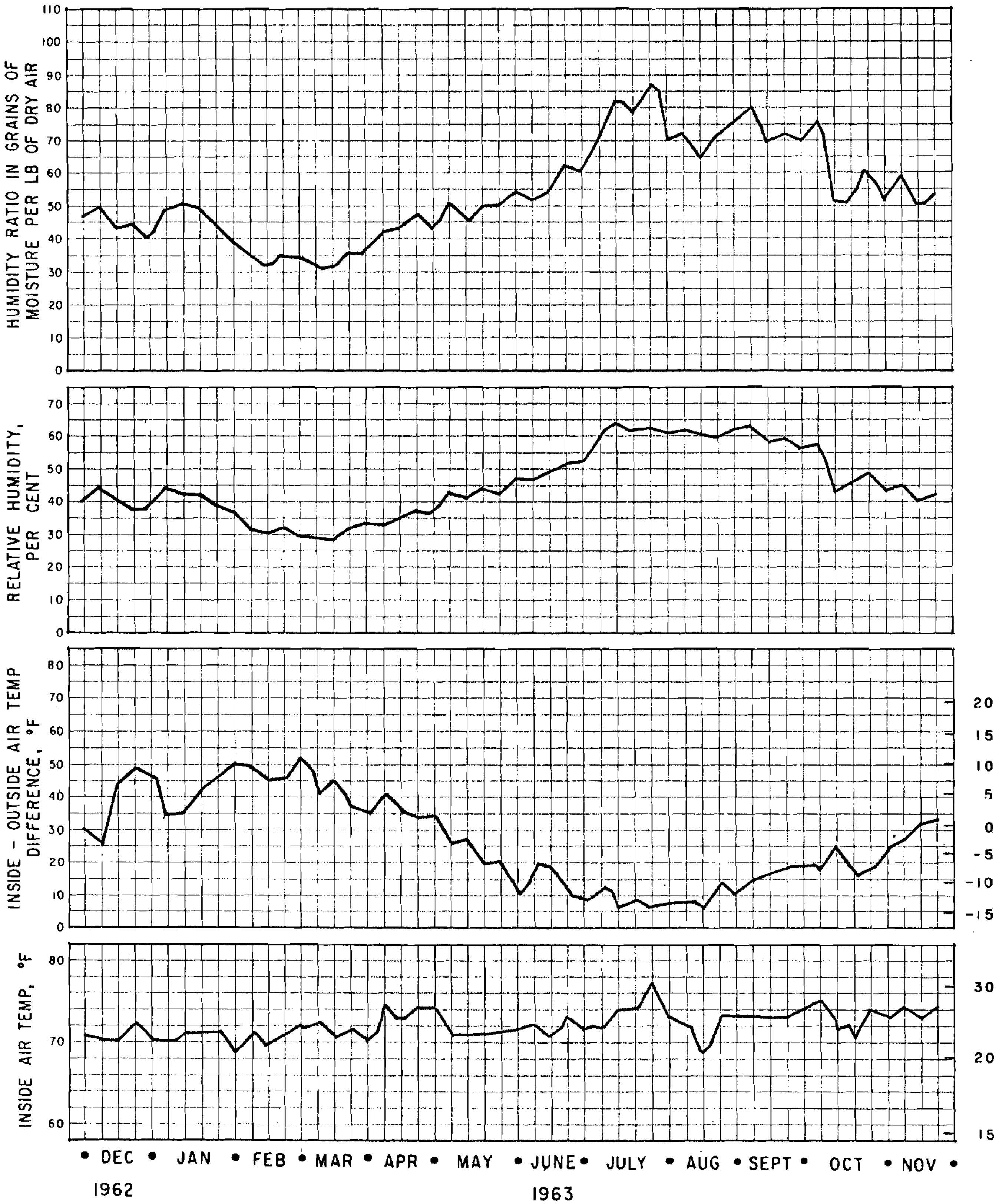


BR. 3409-3

FIGURE 9

D.B.R. **INDOOR CLIMATE OF BUILDINGS** N.R.C.

LOCATION DARTMOUTH, N.S. BUILDING LOT 124



BR. 3409-4

FIGURE 10

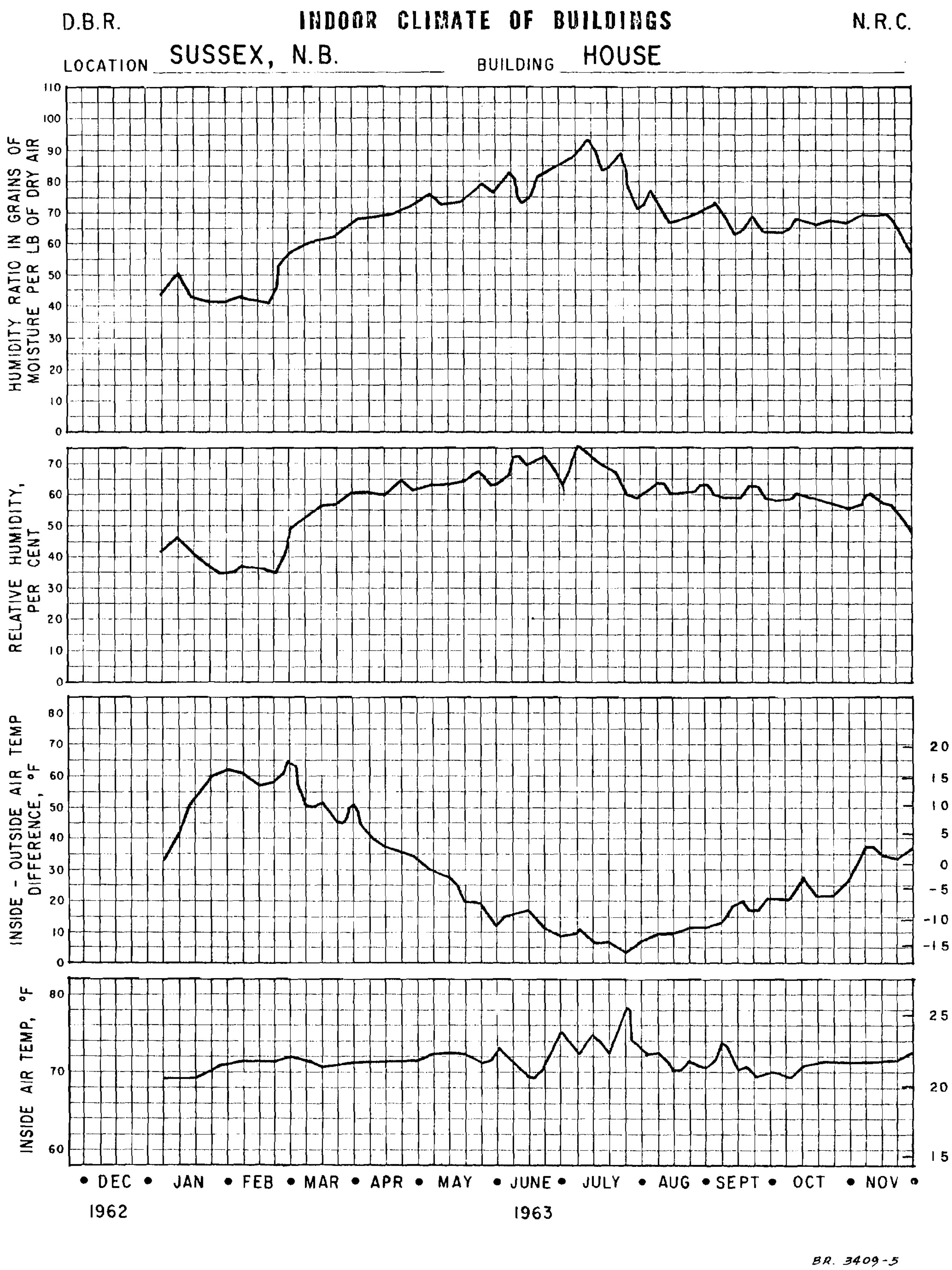

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION SUSSEX, N.B.
BUILDING HOUSE
HUMIDITY RATIO IN GRAINS OF MOISTURE PER LB OF DRY AIR
0 10 20 30 40 50 60 70 80 90 100 110
RELATIVE HUMIDITY, PER CENT
0 10 20 30 40 50 60 70
INSIDE - OUTSIDE AIR TEMP DIFFERENCE, °F
0 10 20 30 40 50 60 70 80
-15 -10 -5 0 5 10 15 20 °C
INSIDE AIR TEMP, °F
60 70 80
15 20 25 °C
DEC JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV
1962
1963
BR. 3409-5

FIGURE 11

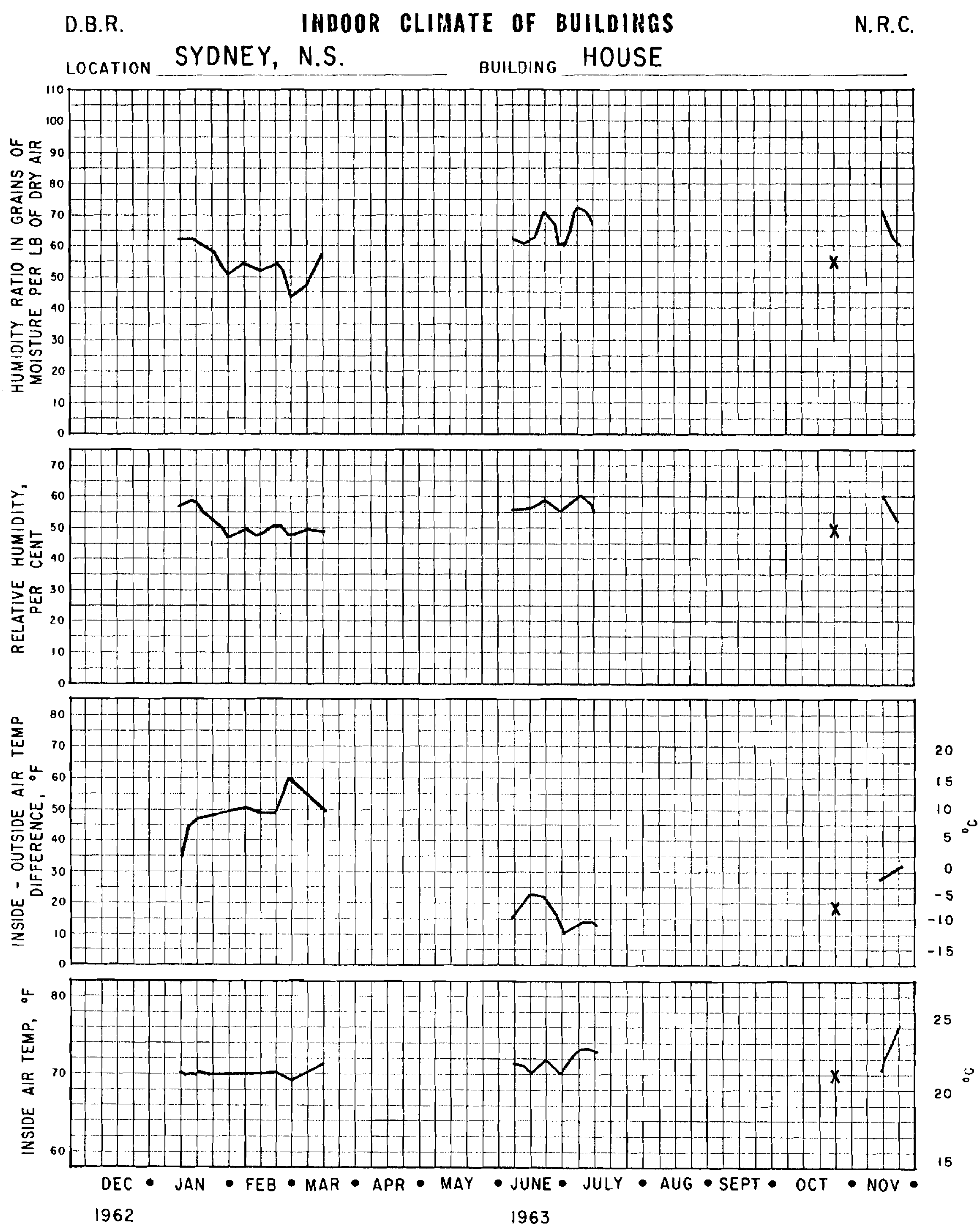

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION SYDNEY, N.S.
BUILDING HOUSE
HUMIDITY RATIO IN GRAINS OF MOISTURE PER LB OF DRY AIR
RELATIVE HUMIDITY, PER CENT
INSIDE - OUTSIDE AIR TEMP DIFFERENCE, °F
INSIDE AIR TEMP, °F
°C
DEC • JAN • FEB • MAR • APR • MAY • JUNE • JULY • AUG • SEPT • OCT • NOV •
1962
1963
BR. 3409-6

FIGURE 12

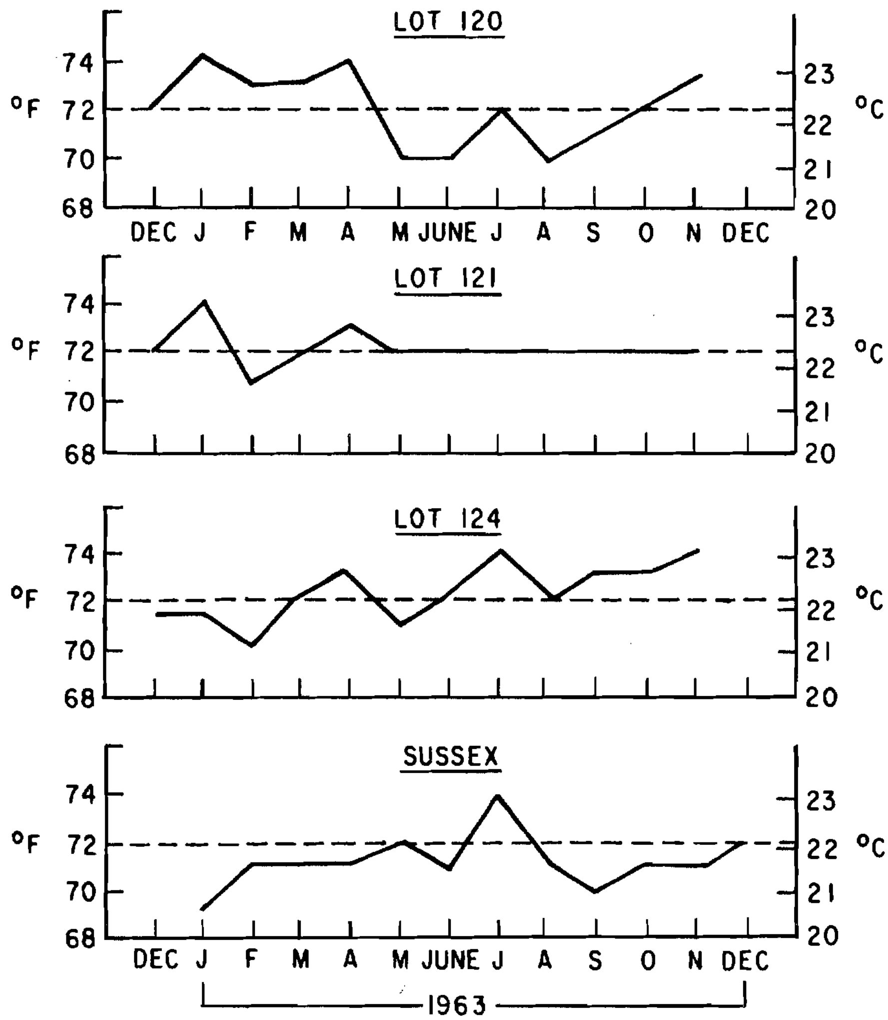


FIGURE 13 MONTHLY AVERAGE INDOOR TEMPERATURE

BR. 3409-7

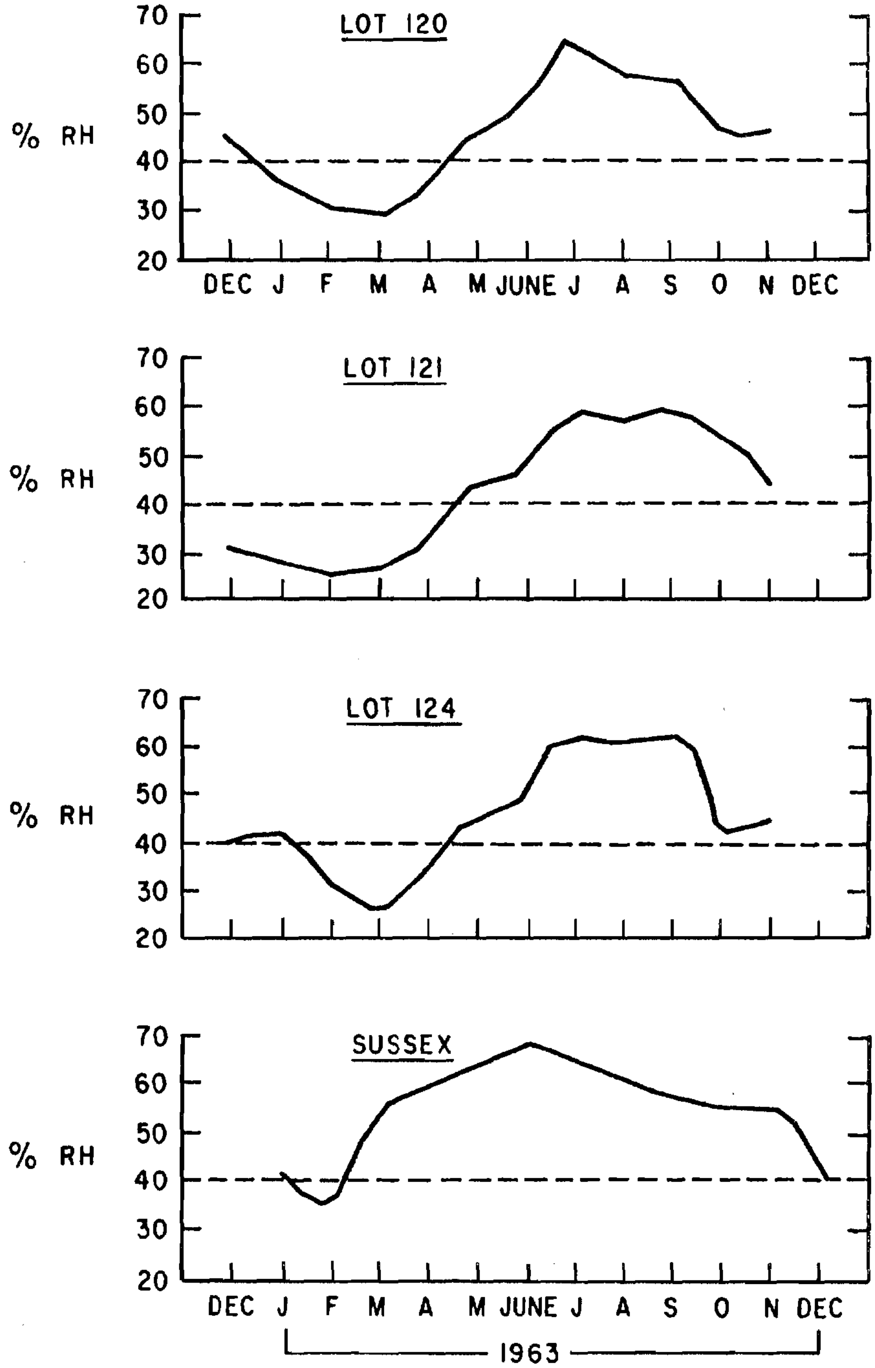


FIGURE 14 MONTHLY AVERAGE INDOOR RELATIVE HUMIDITY

BR. 3409-8

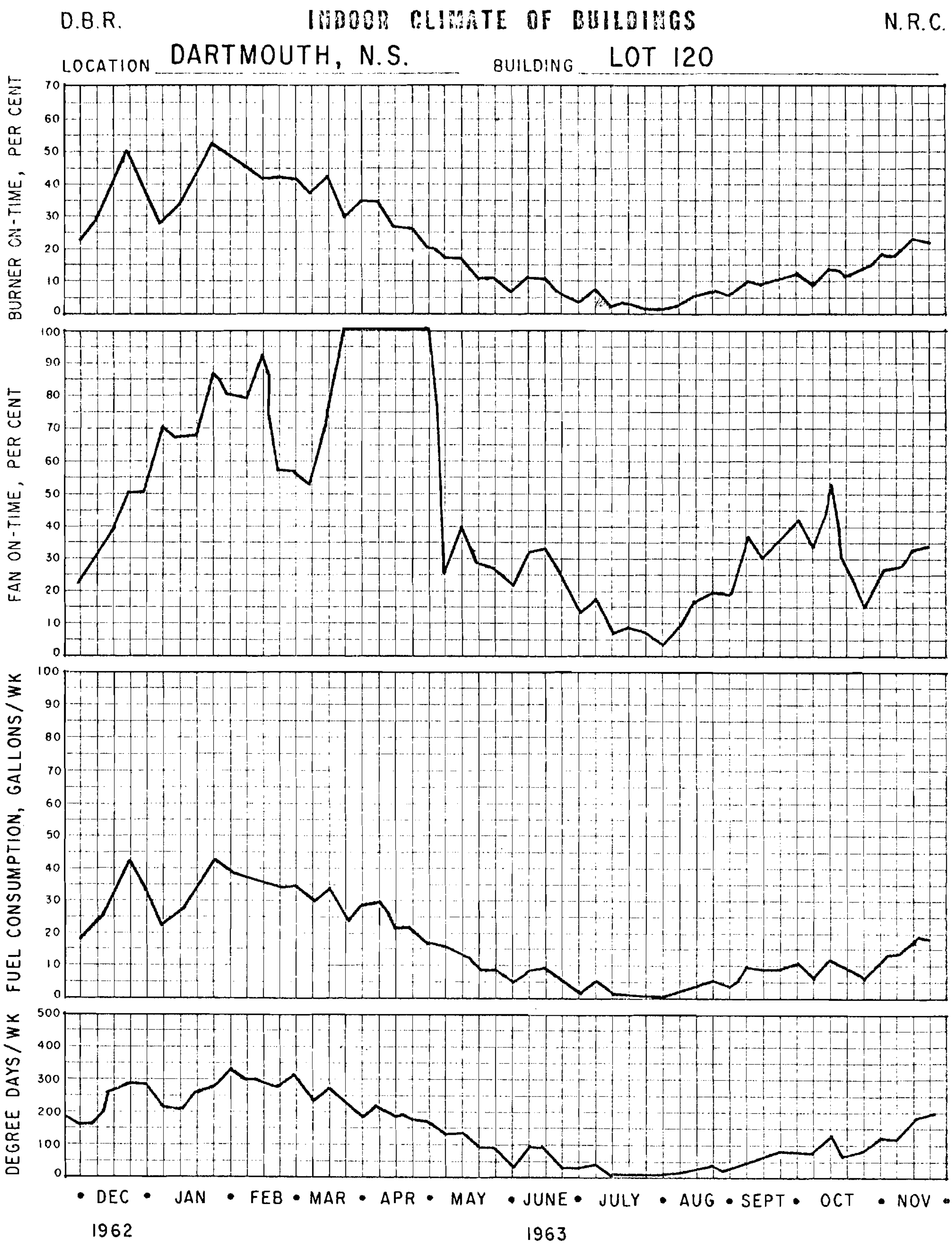
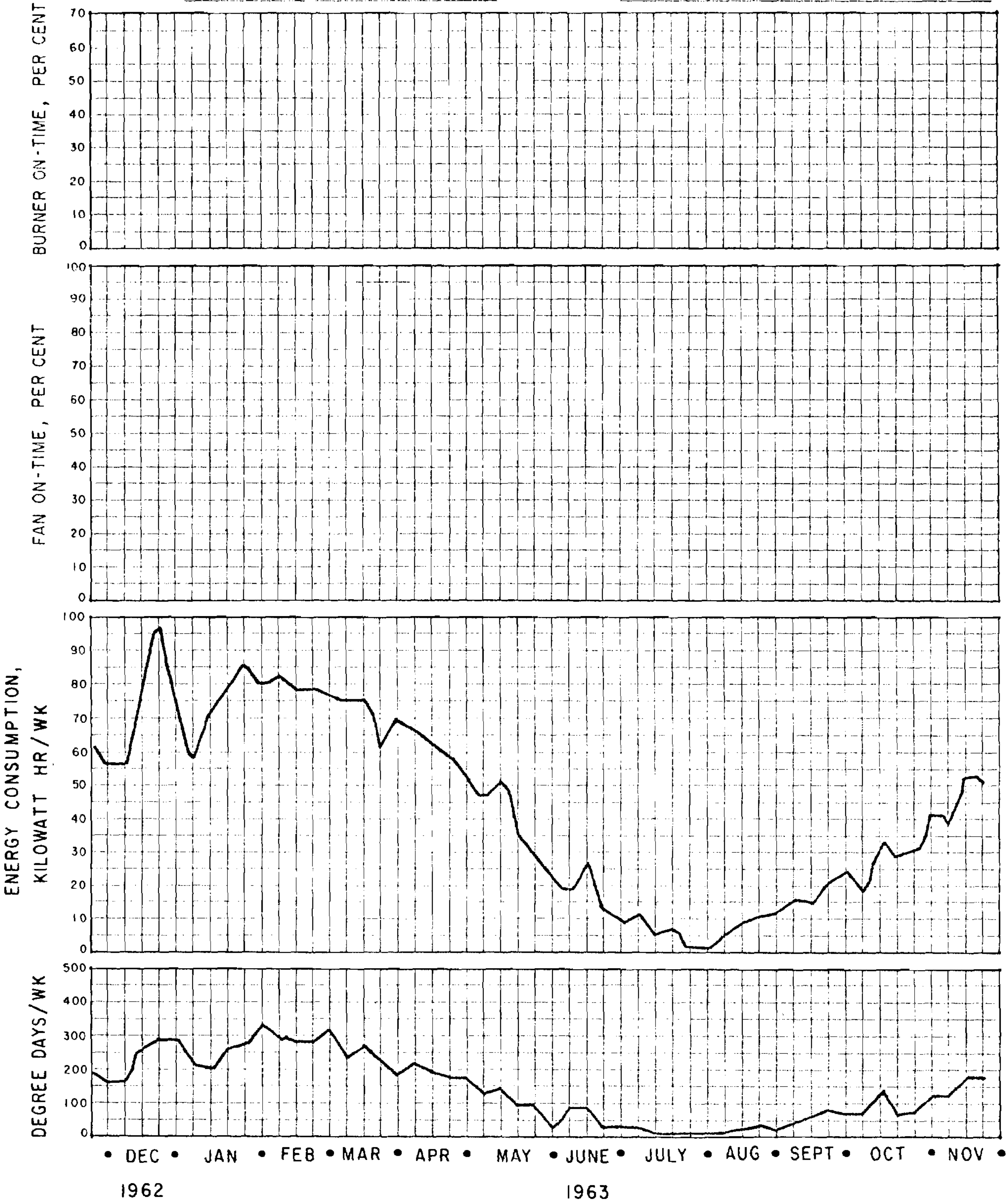

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION DARTMOUTH, N.S.
BUILDING LOT 120
BURNER ON-TIME, PER CENT
FAN ON-TIME, PER CENT
FUEL CONSUMPTION, GALLONS/WK
DEGREE DAYS/WK
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
1962
1963
BR 3409-9

FIGURE 15

D.B.R. INDOOR CLIMATE OF BUILDINGS N.R.C.

LOCATION DARTMOUTH, N.S. BUILDING LOT 121



BR. 3409-10

FIGURE 16

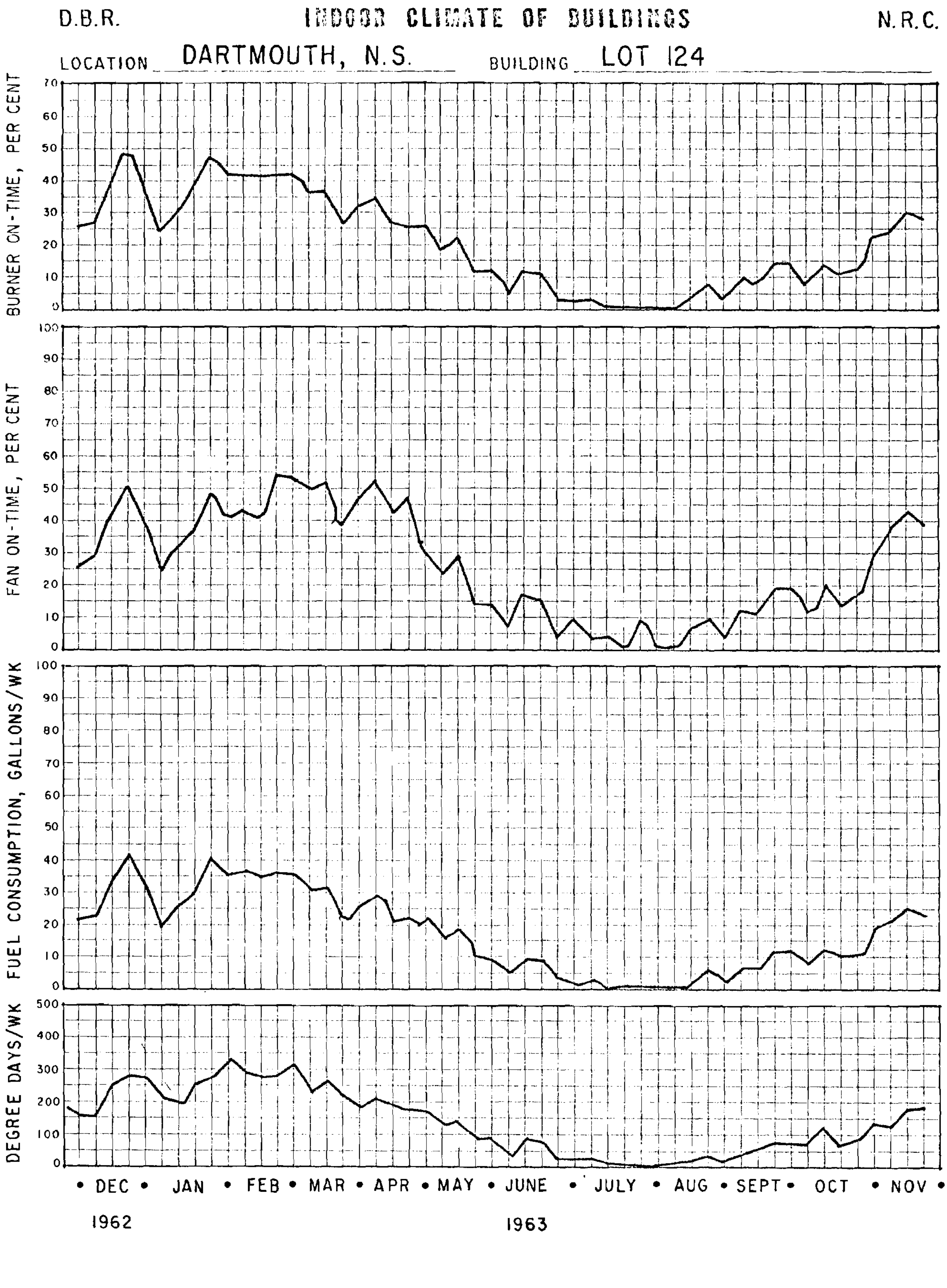

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION DARTMOUTH, N.S.
BUILDING LOT 124
BURNER ON-TIME, PER CENT
FAN ON-TIME, PER CENT
FUEL CONSUMPTION, GALLONS/WK
DEGREE DAYS/WK
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
1962
1963
BR. 3409-11

FIGURE 17

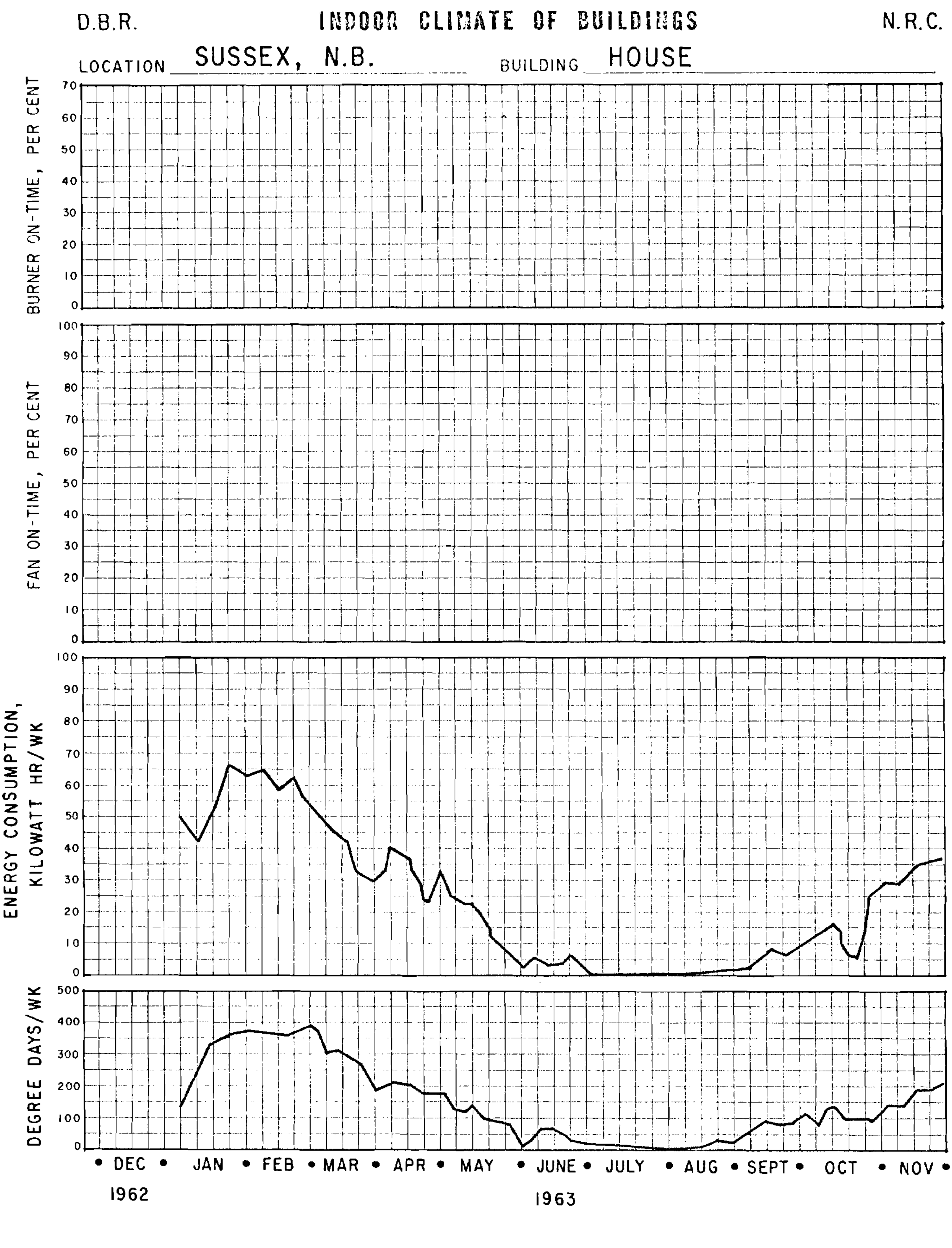

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION SUSSEX, N.B.
BUILDING HOUSE
BURNER ON-TIME, PER CENT
FAN ON-TIME, PER CENT
ENERGY CONSUMPTION, KILOWATT HR/WK
DEGREE DAYS/WK
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
1962
1963
BR 3409-12

FIGURE 18

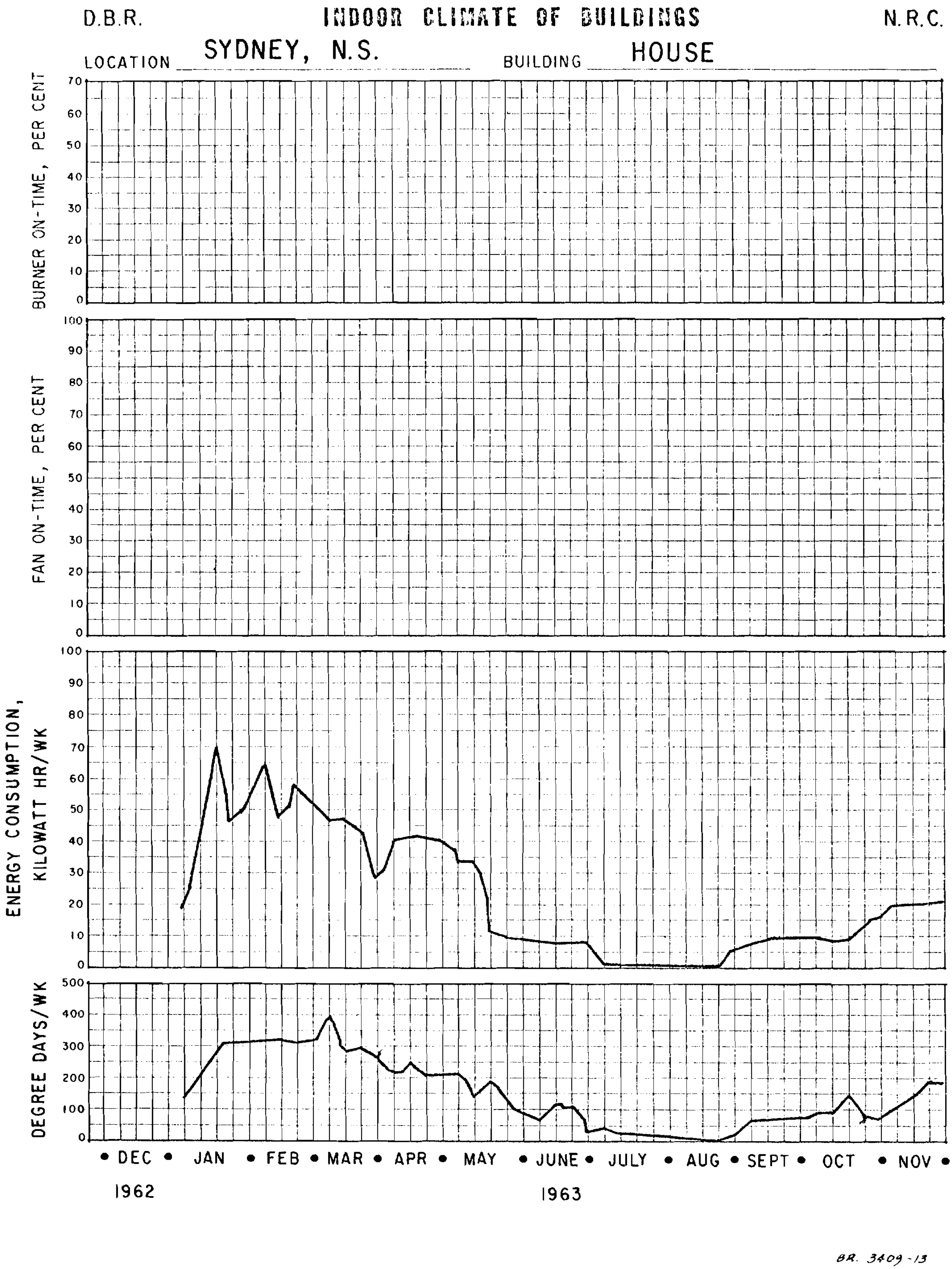

D.B.R.
INDOOR CLIMATE OF BUILDINGS
N.R.C.
LOCATION SYDNEY, N.S.
BUILDING HOUSE
BURNER ON-TIME, PER CENT
FAN ON-TIME, PER CENT
ENERGY CONSUMPTION, KILOWATT HR/WK
DEGREE DAYS/WK
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
1962
1963
BR. 3409-13

FIGURE 19