#2251

AIVC 2223

Peter L. Lagus[1] *and John C. King*[2]

Air Leakage and Fan Pressurization Measurements in Selected Naval Housing

REFERENCE: Lagus, P. L. and King, J. C., "**Air Leakage and Fan Pressurization Measurements in Selected Naval Housing,**" *Measured Air Leakage of Buildings, ASTM STP 904*, H. R. Trechsel and P. L. Lagus, Eds., American Society for Testing and Materials, Philadelphia, 1986, pp. 5-16.

ABSTRACT: Data from detailed tracer concentration decay and induced pressurization measurements were obtained in tests of duplex and row apartments at Norfolk, Virginia and Pensacola, Florida to accurately determine air leakage characteristics of selected naval housing. Local meteorological information also was collected to facilitate comparison of predicted versus measured air leakage rates. For the Norfolk data, the 4-Pa leakage areas inferred from pressurization/depressurization measurements are uniformly lower than those calculated from the measured tracer dilution air leakage rate via the Sherman air leakage model.

Considerable tracer dilution testing was performed on a single unit of duplex housing at Pensacola. Air leakage testing within rooms of this unit disclosed a uniformly low air leakage rate. The data also illustrated the directional nature of air leakage in a duplex. Of particular additional interest were two measurements taken over a 24-h period utilizing a single tracer injection followed by monitoring of dilution decay. Samples were taken by the container method and analyzed.

KEY WORDS: infiltration, tracer dilution method, fan pressurization, air leakage, sulfur hexafluoride, automated air leakage measurement, leakage area

This paper presents induced pressurization and tracer concentration decay measurements performed in naval housing at Norfolk, Virginia and Pensacola, Florida. In both locations, air leakage or air infiltration data or both were required to fulfill a need by the local naval civil engineering center. In the case of the Norfolk data, measurements were undertaken to understand whether addition of insulation to uninsulated or poorly insulated structures would reduce air leakage [*1-3*]. In the case of the Pensacola data, the mea-

[1]Manager, Applied Science Program, S-CUBED, La Jolla, CA 92038.
[2]Mechanical engineer, Naval Civil Engineering Laboratory, Port Hueneme, CA 93043.

surements were undertaken to accurately characterize air leakage rates within selected structures in order to assist an ongoing research program into the causes of moisture damage within housing in and around Naval Air Station (NAS) Pensacola [4]. During these studies, a quantity of tracer dilution and induced pressurization data were collected, along with attendant meteorological information. These data are presented and discussed in this paper.

Air leakage measurements by the tracer dilution method were performed as per ASTM Method for Determining Air Leakage Rate by Tracer Dilution Test (E 741-83). Tracer dilution data were obtained using an S-CUBED Model 215AUP Envirometer portable tracer gas monitor or the Model 215ACA/ARM automated infiltration monitoring system. Both of these units are owned by the Naval Civil Engineering Laboratory. Indoor temperatures were obtained using the thermometers on individual housing unit thermostats. Outdoor temperatures and wind speeds were obtained from meteorological data routinely taken at NAS Pensacola, or by means of a Meteorology Research, Inc. mechanical weather station at Norfolk. In addition, induced depressurization measurements were performed as per ASTM Method for Determining Air Leakage Rate by Fan Pressurization Test (E 779-81) using Gadzco blower door assemblies.

Norfolk Data

Air leakage measurements in 24 separate three-bedroom apartment units of enlisted personnel housing in the Willoughby Bay area of the Norfolk Naval Base were performed during winter and summer of 1978. These 24 units were segregated into four sixplexes, differentiated only by degree of insulation and orientation.

Sulfur hexafluoride (SF_6) was introduced into the structure through the heating, ventilating, and air-conditioning (HVAC) ducting from outside the structure. The HVAC system was allowed to run for 45 min prior to the onset of measurement. This mixing time provided reasonably homogeneous SF_6 concentrations within the structures. The HVAC blower operated continuously during the testing. Concentration decay was monitored by drawing a sample from the duct and analyzing it with the portable gas chromatograph. Samples were drawn from the ventilation duct using disposable 12-cm^3 polypropylene syringes.

A plot plan of the sixplexes is shown on Fig. 1. Living units are identified by street addresses on O'Connor Crescent. Note that wind directions around 360 and 180° tend to impinge all apartments equally, while winds from 90 to 270° directly impinge only one apartment in each sixplex.

Individual apartment units were nominally identical, two-story, slab-on-grade, three-bedroom apartments, having roughly 102 m^2 of living space. They were clad with continuous aluminum siding. A typical floor plan is shown on Fig. 2. Gas-fired forced air provided heating, and electric air-condi-

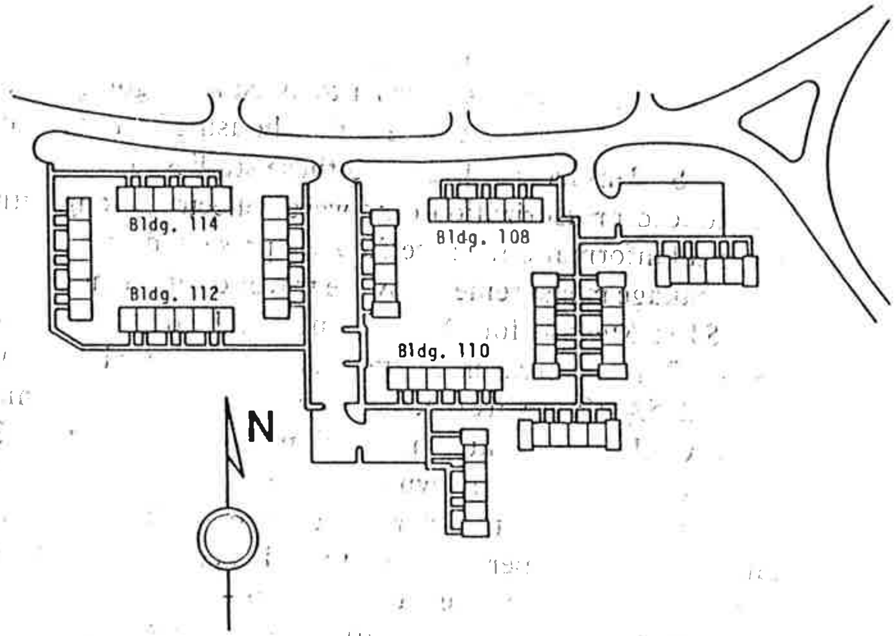

FIG. 1—*Willoughby Bay housing units.*

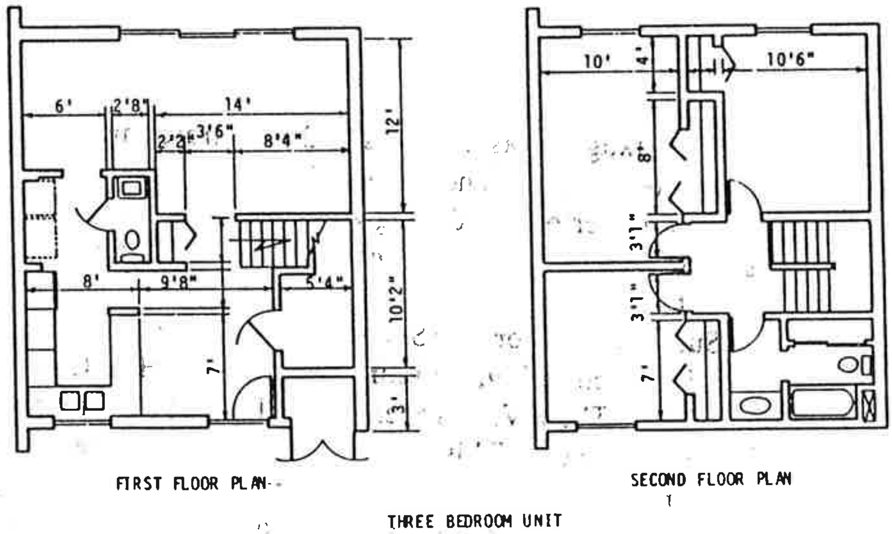

FIG. 2—*Floor plan of typical three-bedroom apartments measured during this study.*

tioning provided cooling. Heating and cooling were accomplished through a common ducting system. The gas-fired heater, as well as the HVAC blower, were accessible from an external utility room.

Separate measurements in four apartments similar to those under study showed that two units exhibited no change in the measured infiltration rate due to duct leakage, and two units exhibited a 25% increase in measured infiltration rate due to duct leakage. These data were obtained by performing two tracer dilution measurements in succession, one with the HVAC blower system on and one with it off.

On successive days, one apartment unit from each of the buildings was selected for measurement. The apartments occupied the same relative position in each building with respect to ambient wind conditions and were sequentially measured on successive days. For each apartment, two air leakage measurements were performed—one in midmorning and one in midafternoon. These measurements were performed during winter and summer time periods. The winter period provided higher wind speeds and temperature differences than did the summer data. These data, then, provide four nominally independent measurements of infiltration. Raw data are summarized in Tables 1 through 4, which provide wind speed (W_2), wind direction (Θ), temperature differences (ΔT), and measured air leakage rates (I).

Some of the infiltration rates measured are considerably higher than might first be expected. Note, however, that the winter measurements were obtained during a period of near-record winds in the Norfolk area.

It should be emphasized that in the 24 apartment units tested no attempt was made to block or modify obvious sources of leakage such as bathroom vents, kitchen blowers, etc. All of the apartments were occupied during testing. The residents were asked to minimize ingress and egress. All data were taken, otherwise, on an "as available" basis.

In the summer of 1980, pressurization measurements were performed in all of these apartments as per ASTM Standard E 779-81. Pressurization and evacuation measurements were performed using either two or three blowers simultaneously, with flow measurements obtained in the apartment of interest. Adjacent blowers served to equalize pressures within adjacent apartments, eliminating or at least minimizing cross-apartment leakage. Blowers

TABLE 1—*Data from Building 108.*

	Winter Data				Summer Data			
Unit/Time	ΔT, °C	W_s, m/s	Θ, °	I, ACH	ΔT, °C	W_s, m/s	Θ, °	I, ACH
8118/a.m.	24	2.5	345	1.03	3	2.2	255	0.52
8118/p.m.	22	2.1	290	0.85	7	1.7	360	0.76
8119/a.m.	24	1.5	. . .[a]	1.09	1	3.0	030	0.92
8119/p.m.	23	3.0	290	0.84	3	2.5	050	0.81
8120/a.m.	27	4.1	320	1.02	2	3.5	010	1.49
8120/p.m.	24	4.8	285	0.96	0	3.6	025	1.29
8121/a.m.	19	9.1	255	1.96	2	2.3	010	0.62
8121/p.m.	15	8.7	260	1.35	0	2.5	025	0.58
8122/a.m.	9	10.5	240	2.41	2	2.3	060	0.64
8122/p.m.	10	10.4	240	2.50	5	2.5	040	0.78
8123/a.m.	9	4.3	140	0.94	6	1.7	260	0.60
8123/p.m.	4	6.4	180	1.65	10	1.9	260	0.52

[a] Wind shift of 65° during test—from 75° during first half to 10° during second half.

TABLE 2—*Data from Building 114.*

Unit/Time	Winter Data				Summer Data			
	ΔT,°C	W_s, m/s	Θ, °	I, ACH	ΔT, °C	W_s, m/s	Θ, °	I, ACH
8160/a.m.	24	2.5	345	1.23	7	2.2	255	0.60
8160/p.m.	22	2.1	290	1.11	10	1.7	360	0.79
8161/a.m.	21	1.5	...[a]	1.06	6	3.0	030	0.83
8161/p.m.	20	3.0	290	0.96	8	2.5	050	0.63
8162/a.m.	26	4.1	320	1.63	3	3.5	010	1.10
8162/p.m.	23	4.8	285	1.28	0	3.6	025	1.36
8163/a.m.	22	9.1	255	1.62	1	2.3	010	0.99
8163/p.m.	18	8.7	260	1.51	2	2.5	025	0.88
8164/a.m.	15	10.5	240	2.53	1	2.3	060	0.61
8164/p.m.	16	10.4	240	2.73	4	2.5	040	0.67
8165/a.m.	8	4.8	140	0.78	5	1.7	260	0.68
8165/p.m.	3	6.4	180	1.40	9	1.9	260	0.52

[a] Wind shift of 65° during test—from 75° during first half to 10° during second half.

TABLE 3—*Data from Building 110.*

Unit/Time	Winter Data				Summer Data			
	ΔT,°C	W_s, m/s	Θ, °	I, ACH	ΔT, °C	W_s, m/s	Θ, °	I, ACH
8130/a.m.	9	4.8	140	0.68	4	1.7	260	0.51
8130/p.m.	4	6.4	180	1.16	8	1.9	260	0.62
8131/a.m.	14	10.5	240	2.35	1	2.3	060	0.56
8131/p.m.	15	10.4	240	2.34	4	2.5	040	0.75
8132/a.m.	23	9.1	255	1.91	2	3.5	010	0.99
8132/p.m.	19	8.7	260	1.58	0	3.6	025	1.04
8133/a.m.	26	4.1	320	0.85	2	3.5	010	0.85
8133/p.m.	23	4.8	285	0.82	0	3.6	025	1.25
8134/a.m.	24	1.5	...[a]	1.05	6	3.0	030	0.76
8134/p.m.	23	3.0	290	0.94	8	2.5	050	0.87
8135/a.m.	29	2.5	345	0.81	2	2.2	255	0.51
8135/p.m.	22	2.1	290	0.77	6	1.7	360	0.58

[a] Wind shift of 65° during test—from 75° during first half to 10° during second half.

were standard blower-door units obtained from Gadzco, Inc. of Princeton, New Jersey. Pressurization and evacuation tests were performed in each of the 24 apartments at positive and negative pressures of 25, 50, and 75 Pa. For these 24 apartments, the cross-apartment leakage at 50 Pa averaged 14% of the single blower flow rate and varied from a low of 7% to a high of 24%.

The Sherman air leakage model [5-7] allows calculation of infiltration rates in a structure under specified wind and temperature conditions. The model requires a measure of the 4-Pa leakage area. This is normally obtained from the least squares fit to induced pressurization data. Sherman and co-

TABLE 4—*Data from Building 112.*

Unit/Time	Winter Data				Summer Data			
	ΔT,°C	W_s, m/s	θ, °	*I*, ACH	ΔT, °C	W_s, m/s	θ, °	*I*, ACH
8148/a.m.	10	4.8	140	0.85	6	1.7	260	0.60
8148/p.m.	6	6.4	180	1.70	10	1.9	260	0.47
8149/a.m.	14	10.5	240	2.77	1	2.3	060	0.51
8149/p.m.	16	10.4	240	2.44	2	2.5	040	0.66
8150/a.m.	21	9.1	255	3.73	6	3.5	010	0.87
8150/p.m.	17	8.7	260	2.00	3	3.6	025	1.26
8151/a.m.	24	4.1	320	0.97	2	3.5	010	1.02
8151/p.m.	22	4.8	285	0.84	0	3.6	025	1.05
8152/a.m.	23	1.5	. . . [a]	1.01	5	3.6	030	0.67
8152/p.m.	23	3.0	290	0.86	7	2.5	050	0.70
8153/a.m.	29	2.5	345	0.98	7	2.2	255	0.30
8153/p.m.	26	2.1	290	1.06	10	1.7	360	0.55

[a] Wind shift of 65° during test—from 75° during first half to 10° during second half.

workers [7] also point out that it is possible to use tracer dilution data to force a fit with the Sherman air leakage model and thereby calculate an equivalent leakage area as sensed by a tracer dilution measurement. The 4-Pa leakage area, as determined by the average leakage area under both pressurization and evacuation, is presented in Table 5. Also included is a calculation of the leakage area by forcing a fit to the tracer dilution infiltration rate. Infiltration values used in obtaining the equivalent leakage area were obtained by averaging the four infiltration measurements provided in Tables 1 through 4. This value, along with an estimate of building volume (249 m^3), allows calculation of the tracer infiltration "sensed" leakage area.

Note that, for these particular data, the tracer dilution measurement is consistent with a leakage area two to three times larger than that predicted from the pressurization data. A major source of uncertainty in calculating leakage areas from the tracer dilution data for these units is in the assumption of averaging overall wind directions implicit in the Sherman air leakage model. At least some of this difference may be attributable to directional effects. While wind direction data are provided, no attempt at incorporating these data into the analyses was made. Agreements of factors of two or three, however, are extremely useful in an engineering sense and illustrate that it is possible to utilize tracer measurements to obtain leakage areas for the purposes of comparison or for further model calculation.

Measurements at Pensacola, Florida

Measurements in selected naval housing at Pensacola, Florida were performed during the summer, winter, fall, and spring of 1982/1983. Data were required to characterize air leakage rates in selected structures in order to

TABLE 5—*Leakage area[a] calculated from pressurization/evacuation and tracer dilution data.*

Apartment Number	A_O, Pressurization/ Evacuation	A_O, Tracer[b]
8165	0.038	0.065
8164	0.048	0.074
8163	0.042	0.089
8162	0.038	0.088
8161	0.049	0.073
8160	0.039	0.080
8135	0.036	0.063
8134	0.033	0.074
8133	0.047	0.065
8132	0.046	0.069
8131	0.048	0.071
8130	0.036	0.058
8153	0.036	0.058
8152	0.062	0.067
8151	0.039	0.067
8150	0.039	0.087
8149	0.055	0.072
8148	0.038	0.066
8123	0.040	0.066
8122	0.036	0.075
8121	0.026	0.063
8120	0.053	0.083
8119	0.030	0.081
8118	0.044	0.073

[a]Area units are in m².
[b]Calculated from the Sherman air leakage model, assuming: (1) Sherman Class II terrain parameters; (2) Sherman Class III shielding coefficients; (3) Sherman model parameters of $R = 0.3$, $x = 0$, and $h = 3$; and (4) meterological data taken at a height of 2.6 m.

assist ongoing research into the causes of moisture damage within naval housing in and around Pensacola, Florida [*4,8,9*].

Many of the measurements were performed in an unoccupied unit of a duplex within the Corey Field housing complex. These units are slab-on-grade, single-story construction with concrete block walls and have very tightly weather-stripped doors and windows. A drawing of a typical floor plan is included on Fig. 3. The HVAC system is contained inside the structure in a separate utility room. The air-conditioning exchange condenser is located on a concrete slab immediately in front of the duplex unit. The floor area of the 2363A unit is approximately 102 m².

With the HVAC system running in the Corey unit, it was determined that approximately 30 min were required to obtain a roughly homogeneous SF_6

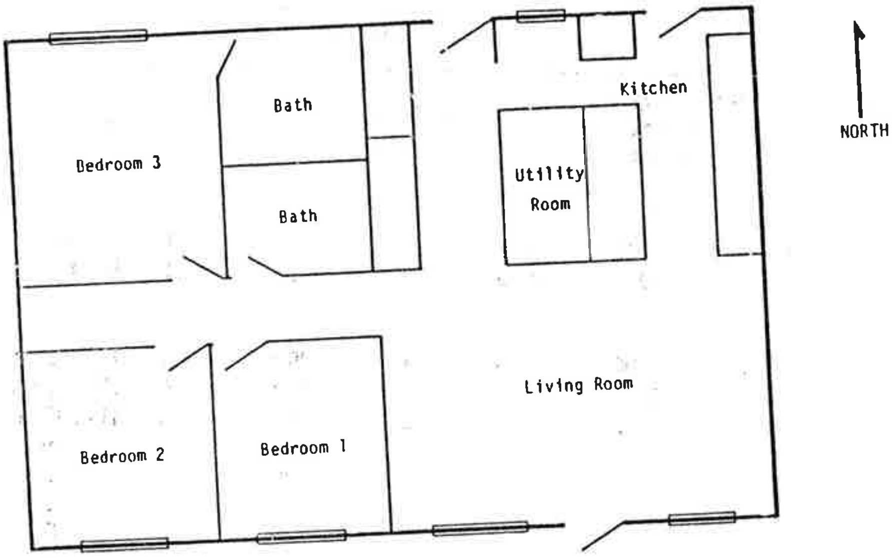

FIG. 3—*Schematic floor plan for 2363A Corey.*

and air mixture. Tracer decay measurements were initiated, therefore, 30 min after SF_6 introduction.

Selected tracer data are presented in Table 6 and discussed in following paragraphs. On 12 Aug. 1982, initial tests were performed with the HVAC system on and off. No change in the leakage rate was noted between the two HVAC states under essentially constant meteorological conditions. Accordingly, for this unit, the contribution to the measured air change with the HVAC system operating appears to be negligible. Air leakage rates with the unit having zero, one, and two doors open under similar meteorological conditions are presented.

Data taken on 13 Aug. 1982 are particularly interesting in that a measurement centered at 1000 h exhibited an infiltration rate of essentially zero. Immediately after that, with meteorological conditions unchanged, the HVAC fan was turned off within the structure, and the kitchen and two bath vent fans were turned on. The air leakage rates within the structure immediately increased to 0.75 air changes per hour (ACH). This 0.75 air change rate is greater than any air change rate measured in the period 12 Aug. 1982 through 28 April 1983. Thus, for this particular structure, the functioning of the kitchen and bathroom vents can assist materially the interchange of inside and outside air.

Data obtained in the 2363A unit on 17 Nov. 1982 and 18 Nov. 1982 under comparable wind speed and temperature differences indicate the magnitude of air leakage within the living room and three bedrooms, respectively. In particular, note that the air leakage in Bedroom No. 1 is noticeably less than the leakage in all other rooms measured. All leakages measured are low when compared to, for instance, air leakage measurements in naval housing at Nor-

TABLE 6—*Selected air leakage data for 2363A Corey.*

Date	Time[a]	I	ΔT, °C	Θ, °	V, m/s	Comments
8/12/82	1730	0.19	3	...	7.2	all doors closed/HVAC on
	1745	3.2	3	...	7.2	front door open/HVAC on
	1750	36	3	...	7.2	front back doors open/HVAC on
8/13/82	1000	0.01	7	...	3.1	HVAC on
	1010	0.75	7	...	3.1	HVAC off/kitchen baths fans on
11/17/82	1400	0.19	3	090	4.1	HVAC on
	1525	0.16	2	090	4.6	HVAC off/in Living room
	1525	0.04	2	090	4.6	HVAC off/Bedroom 1 door open
	1525	0.11	2	090	4.6	HVAC off/Bedroom 2 door open
	1525	0.16	2	090	4.6	HVAC off/Bedroom 3 door open
11/18/82	1045	0.25	3	160	4.6	HVAC off/in Living room
	1045	0.07	3	160	4.6	HVAC off/Bedroom 1 door closed
	1045	0.25	3	160	4.6	HVAC off/Bedroom 2 door closed
	1045	0.22	3	160	4.6	HVAC off/Bedroom 3 door closed

[a]Figures are in military time.

folk, Virginia. These data also demonstrate the direction-dependent nature of air leakage in the duplex. The leakage rate on 18 Nov. 1982 is roughly 75% greater than that measured on 17 Nov. 1982, even though wind speed and temperature differences are roughly identical. However, the wind direction on 17 Nov. 1982 during the measurement period was from the east (90°), while on 18 Nov. 1982 it was from almost due west (160°). Thus, winds on 18 Nov. 1982 impinged on the 2363A duplex directly, while on 17 Nov. 1983 they impinged on its companion unit 2363B, with 2363A being downwind. Note also that the measurements taken with 2363A indicate that Bedroom No. 1 exhibits an extraordinarily low infiltration rate. In fact, the equivalent ventilation rate is less than the 8.5 m^3/h (5 ft^3/m) per person recommended in ASHRAE Standard 62.

A few additional measurements were performed in several unoccupied units at Lexington Terrace. These units are considerably smaller—averaging approximately 65 m^2—and are slab-on-grade construction.

Data were obtained on 18 Nov. 1982 and 19 Nov. 1982 in apartments at 333 and 375 Lexington Terrace. These data are notable in that they represent a 24-h tracer concentration decay measurement due to a single injection of tracer gas. It was not possible to utilize the HVAC in the Lexington Terrace apartments for continual mixing during the entire measurement period as the system could be used only for heating. Accordingly, the heater fan was used during the first hour of measurement to ensure mixing within the structure. After this, the fan was turned off. Subsequent measurements were taken using 60-cm³ polypropylene syringes. Five 10-cm³ samples were taken consecutively in each of five rooms within the structure, yielding a total average 50-cm³ sampler per data point. This sampling procedure is consistent with the container sampling technique contained within ASTM Standard E 741-83. Data are presented graphically in Fig. 4. Average temperature difference and wind speed over 24 h are 6°C and 2.6 m/s, respectively.

Pressurization and evacuation data were obtained for the 2363A Corey structure using both single- and double-blower doors. The average 4-Pa leak-

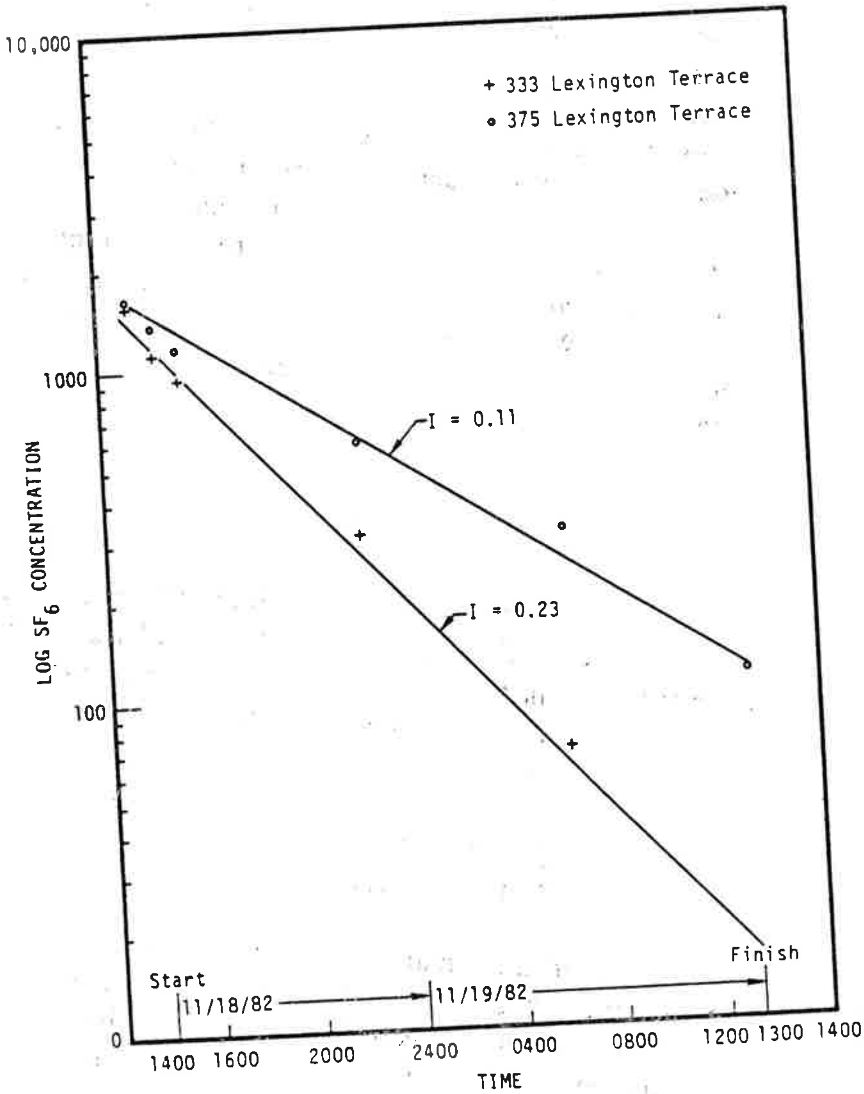

FIG. 4—*Concentration decay over a 24-h period in 333 and 375 Lexington Terrace.*

age area for pressurization and evacuation is 0.050 m^2. Calculation of infiltration rates, using this leakage area, led to values uniformly higher by factors of two to three than those measured by tracer dilution.

Pressurization and evacuation data, as well as tracer dilution measurements, also were obtained on Apartment 881 Umphill, which is the end unit of a sixplex located on the NAS Pensacola grounds. This unit is similar to the units measured at Norfolk in that it is an approximately 102 m^2, two-story, slab-on-grade construction. Simultaneous pressurization of 881 Umphill and the apartment immediately adjacent to it was performed so as to eliminate or minimize cross-apartment leakage. Tracer dilution air leakage measurements were performed over a single 24-h period, with samples taken every 10 min using the S-CUBED Model 215ACA/ARM automated infiltration monitoring system. Resultant data were segregated into 1-h blocks and then fit by least squares to an exponential decay in order to determine 1-h average infiltration rates.

Blower door data were notable in that the 4-Pa pressurization leakage area is identical to the 4-Pa depressurization data and in that the single- and double-blower door pressurization and evacuation data were indistinguishable. The 4-Pa leakage area determined for the 881 Umphill apartment was 0.048 m^2. Calculation of an hourly infiltration rate using this leakage area and the Sherman air leakage model yields values which agree with hourly tracer dilution values to within $\pm 5\%$. However, the data set was limited to only 24 h of data.

Conclusions

A quantity of tracer dilution and induced pressurization data has been obtained for selected naval housing at Norfolk, Virginia and Pensacola, Florida. For the Norfolk test, pressurization data are consistent with leakage areas somewhat smaller than those calculated from tracer dilution measured infiltration rates and the Sherman air leakage model. On the other hand, pressurization data from the Pensacola structures are consistent with leakage areas somewhat larger than those calculated from measured tracer dilution rates and the Sherman air leakage model. Some of the Pensacola data illustrate the directional nature of the air leakage for row apartments and duplexes.

The tracer dilution air leakage rates for the Norfolk units are significantly higher than those measured in the Pensacola structures. The 4-Pa leakage areas for the units measured in the two locations, however, are comparable.

Summer tracer dilution air leakage rates for the Norfolk units range from 0.5 to 1.4 ACH, while air leakage rates for Pensacola range from less than 0.1 to 0.4 ACH. Winter tracer dilution rates for the Norfolk units range from 0.6 to almost 4.0 ACH, while winter rates for Pensacola range from 0.1 to almost 0.7 ACH.

Acknowledgments

Measurements at Norfolk, Virginia were performed under Contracts N68305-77-C-0045 and N68305-79-C-0034. Data obtained at Pensacola were gathered during performance of Contracts N62583/82M and N62583/83MT140.

References

[1] Lagus, P. L., "Air Leakage in Navy Housing," S-CUBED Report SSS-R-77-3179, prepared for Naval Construction Battalion Center S-CUBED, La Jolla, CA, 1977.

[2] Lagus, P. L., Ellefson, L. D., Broce, R. D., and Talkington, H. A., "Air Leakage Measurements and Energy Consumption Economic Analysis in Navy Housing at Norfolk, Virginia," S-CUBED Report SSS-R-80-4233, prepared for Naval Construction Battalion Center, S-CUBED, La Jolla, CA, Feb. 1980.

[3] Lagus, P. L., "Air Leakage Measurements in Navy Family Housing Units at Norfolk, Virginia," S-CUBED Report SSS-R-82-5288-1, prepared for Naval Construction Battalion Center, S-CUBED, La Jolla, CA, May 1982.

[4] Trechsel, H. R. and Achenbach, P. R., "Field Study on Moisture Problems in Exterior Walls of Family Housing Units at Naval Air Station, Pensacola, Florida," final report on Contract N62583/82 MT145, Naval Civil Engineering Laboratory, Port Hueneme, CA, Aug. 1983.

[5] Sherman, M. H. and Grimsrud, D. T., "Infiltration Pressurization Correlation: Simplified Physical Modeling," *ASHRAE Transactions*, Vol. 86, 1980.

[6] Sherman, M. H., "Air Infiltration in Buildings," Ph.D. thesis, University of California, Berkeley, 1981.

[7] Sherman, M. H. and Grimsrud, D. T., "Measurement of Infiltration Using Fan Pressurization and Weather Data," LBL Report No. 10852, Lawrence Berkeley Laboratory, Berkeley, CA, Oct. 1980.

[8] Lagus, P. L., "Building Air Leakage Tests and Measurements," S-CUBED Report SSS-R-83-6300, prepared for Naval Construction Battalion Center, S-CUBED, La Jolla, CA, Aug. 1983.

[9] Lagus, P. L., "Air Leakage Measurements in Naval Housing at Pensacola, Florida," S-CUBED Report SSS-R-84-6344, prepared for Naval Construction Battalion Center, S-CUBED, La Jolla, CA, Sept. 1983.

DISCUSSION

J. Griffith[1] *(written discussion)*—Was the Norfolk homes' test done with decay tracer?

P. L. Lagus and J. C. King (authors' closure)—Yes, the test was done per ASTM Method for Determining Air Leakage Rate by Tracer Dilution Test (E 741-83), which is specifically for tracer concentration decay.

[1]PSE&G Research Corp., Maplewood, NJ 07040.