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#9

Retrospectors inc

AIR TIGHTNESS TESTING AND SEALING
OF HOMES IN OTTAWA, ONTARIO
(PURCHASE ORDER # PHO 11501)

PREPARED FOR
THE ONTARIO MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING,
TECHNICAL SERVICES DIVISION,
RESEARCH AND DEVELOPMENT SECTION

BY
RETROSPECTORS INC.

PROJECT UNDERTAKEN BY
THE ONTARIO MINISTRY OF MUNICIPAL AFFAIRS AND HOUSING.

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INTRODUCTION

The following report describes the results obtained and the problems encountered in the sealing and testing of fifteen homes in Ottawa, Ontario for the MMAH.

The reductions in Equivalent Leakage Areas (ELA) have been protrayed in tables 1 and 2.

Table 3 is a data summary for the 15 homes, outlining house characteristics, reductions in air leakage, materials and time needed.

The forms filled out for each house (A to J) and an air leakage profile graph of tests 1 to 5 are also attached.

AIR LEAKAGE REDUCTIONS

The average reduction obtained for each house was 38.7%, ranging from a high of 69% to a low of 11%. The average reduction between the sum of the before and after ELA's is 45%. The average of 38.7% is a more useful piece of data.

The tests from 1 to 5 were all conducted with the furnace and other vents blocked, as per the terms of reference, thereby providing consistent data.

LABOUR REQUIREMENTS

The average time needed per house to perform the sealing and testing was 31 hours. This ranged from a low of 13.5 to a high of 64.5. The average time required to seal the pre-1920 homes was 40 hours, as opposed to 23.25 hours for the post-1920 homes. Approximately half the homes could have been completed by a three person crew in one day. House # 6 required a disproportionate amount of time as the crawlspace walls had to be wrapped in polyethelene.

WINDOWS

The reduction of air leakage through the windows of the fifteen homes proved to be a time-consuming, yet only relatively successful activity.

The majority of the windows involved were vertical single and double hung types. These were weatherstripped using 3m vinyl in the tracks and across the center sash, and closed cell foam under the lower sash. All weatherstripping was stapled securely in place. The weatherstripping seemed to work quite well, except for the two following areas: through the pulley holes (when present) which lead directly into the wall cavity, and the center sash/sliding sash joint. Many of these windows had deteriorated sashes and guides, missing latches and so on. Many of Retrospectors' private clients have expressed a desire for window upgrading, i.e. a more comprehensive maintenance service. This would include planing and oiling of sashes, refitting of latches, reconnection of sash weights and so on.

The second most common window encountered was the Pearson glass sliding type. Many of these windows were simply not latched properly. After installing 3m vinyl in the tracks and vertically between the glass panels; and after having latched the windows secruely, the leaks were very effectively sealed.

The remaining windows were largely double-hung aluminum types. These proved impossible to weatherstrip properly. Retrospectors is currently advising owners of such windows to either caulk them shut each winter using a clear removable caulking, or to install a layer of 1/8" acrylic on the inside to create triple-glazed, airtight windows.

Basement windows were almost always extremely leaky and/or unlatched. Most were taped shut with the homeowners permission using high quality duct tape.

Windows in the upstairs living areas were also sealed shut as often as possible. A discussion with the resident always took place weighing the relative pro's and con's of comfort, energy savings, security, fire hazard, summer ventilation and so on.

It is Retrospectors' opinion that the weatherstripping of most windows has a relatively long payback period, yet a very positive effect on the comfort levels in the living space.

DOORS

Very few generalisations can be made regarding weatherstripping doors.

Most of the doors involved in the project fit reasonably well, and were adequately sealed using various types of weatherstripping (3m, climaloc, schlegel). Others, however, were practically falling off their hinges. Many were extremely warped and mis-hung. Barring major reworking of the doors and jambs, these doors can only be slightly tightened.

Many of the doors on newer homes had high quality weatherstipping installed, which only needed re-adjustment. Most door thresholds, however, needed replacement bulbs. Obviously door weatherstripping has to be maintained regularly to remain effective.

Most older homes had bronze spring weatherstripping in place. This type is simply not effective. The material does not have enough "give" to conform to the minor irregularities in the door edges. Retrospectors is currently recommending that this type of w/strip be removed and replaced with a more flexible spring vinyl version.

CAULKING

An average of 28 tubes of caulking was used on the pre 1945 homes, and 10.5 tubes for the post 45 homes. Two main types were used: acrylic latex and Geocel.

The acrylic latex was used primarily in the basement joist space area and around door and window frames. The Geocel (a high quality clear elastomeric) was used wherever an invisible caulk was needed - primarily baseboards and trim.

Acrylic latex worked well enough in the basement joist spaces which had cracks under ¼" wide. After that point, it became difficult to seal the holes effectively. Polyethelene, fiberglass and acoustical sealant was used occasionaly, yet took quite a long period of time. Single component urethane foam (1S-550) was used in some of the extremely uneven stone wall cracks. It proved very difficult to apply. An option which was subsequently attempted was the use of 1" thick beadboard panels sealed with acrylic latex. This system is very effective, yet time consuming, and leaves a flammable material exposed in the living area.

It is clear that an inexpensive and effective method is needed to seal uneven joist space areas and attic partition wall plates. A paint spraying system which could handle a viscous caulking material, powered by rechargeable compressed air tanks, would be ideal. The system could be developed as a portable back-pack with an air tank, a caulking tank, a few feet of hose and a spray gun.

EQUIPMENT

The fan depressurization equipment used by Retrospectors was the Door Fan system, developped by Retrospectors. Problems were encountered in obtaining highly consistent results for the test data. In general, the air flow readings at 10 pa. and 15 pa. were not used, as they frequently distorted the slope of the air leakage profile. Occasionaly, a point at a higher pressure also had to be discarded. Retrospectors has subsequently changed the design of the unit to provide more consistent results, and have also accurately recalibrated the unit.

Aside from the occasional problems mentioned above, the system worked well. It has, however, become very obvious that quite high air flows are needed to test the average pre- 1920's home. To maintain a pressure of 50 pa. in the average of the 7 pre-1920 homes an air flow of 2.06 m^3/s was required. The minimum pressure required to accurately test a home is approximately 30 pa. To maintain this pressure, an air flow of 1.5 m^3/s would have been required. As older buildings can benefit the most from air leakage retrofit, it is clear that a professional weatherizing firm should have a fan capable of blowing over 2 m^3/s.

Houses # 10 and 15 were tested using a Saskatoon bell mouth nozzle as the air flows were very low.

The caulking was applied using simple manual caulking guns. It is our opinion that a pneumatic caulking system would not give a large net increase in caulking speed, as the time spent preparing the job (moving furniture, cleaning surfaces, replacing furniture, reloading guns) represents at least half the time requirements. Cracks in older homes also have quite irregular edges, and a bead must be applied slowly to look decent.

VENTILATION REQUIREMENTS

None of the homes were tightened to an air leakage rate approaching 4 ac/hr at 50 pa. It appears that this guideline is still too general for use as an indication of ventilation requirements. Each house is very different in terms of the number of occupants, their moisture producing habits, the total volume of the building, the thermal resistance of window surfaces and so on. The following cases illustrate this point.

House # 14 is a post 1970 electrically heated home. The air leakage was reduced by 46%, now having an air change rate of 6 per hour at 50 pa. There are no bathroom vents, and the kitchen vent has been sealed. There are many potted plants in the home, yet no humidifier. The owner says that the humidity levels are under control as condensation on the windows is never extreme. It would appear that this is a result of there only being 2 occupants, and because the house volume is quite high (634 m^3).

House # 15 is a small (86 m^3), electrically heated bungalow with both a kitchen and bathroom vent. The current air change rate is a high 12 per hour at 50 pa. The owner was having condensation problems on his windows prior to our working on the house, yet hasn't worsened significantly, even though the ELA was reduced by 38%. It would appear that the problem is due to a high occupancy level of 4 people, and a low volume of 86 m^3.

By examining only the air change rate at 50 pa.,it would appear that house # 14 would require additional ventilation more than # 15. This is obviously not the case. House # 14 has an air flow per hour at 50 pa. to inhabitant ratio of 1902 m^3/hr./inhabitant at 50 pa. while # 15 has only 258 m^3/hr/inhabitant at 50 pa. It is clear that a more accurate procedure to predict ventilation requirements is needed.

The problems encountered in House # 1 merit mention. After the tightening was completed, the owner called to complain about condensation on his bedroom ceiling. (The house still has an air change rate of 16 at 50 pa.) A vent was installed in the adjacent bathroom. It was later determined that the cause of the problem was a too high humidistat setting on his central humidifier, combined with a total absence of insulation in the attic above the ceiling.

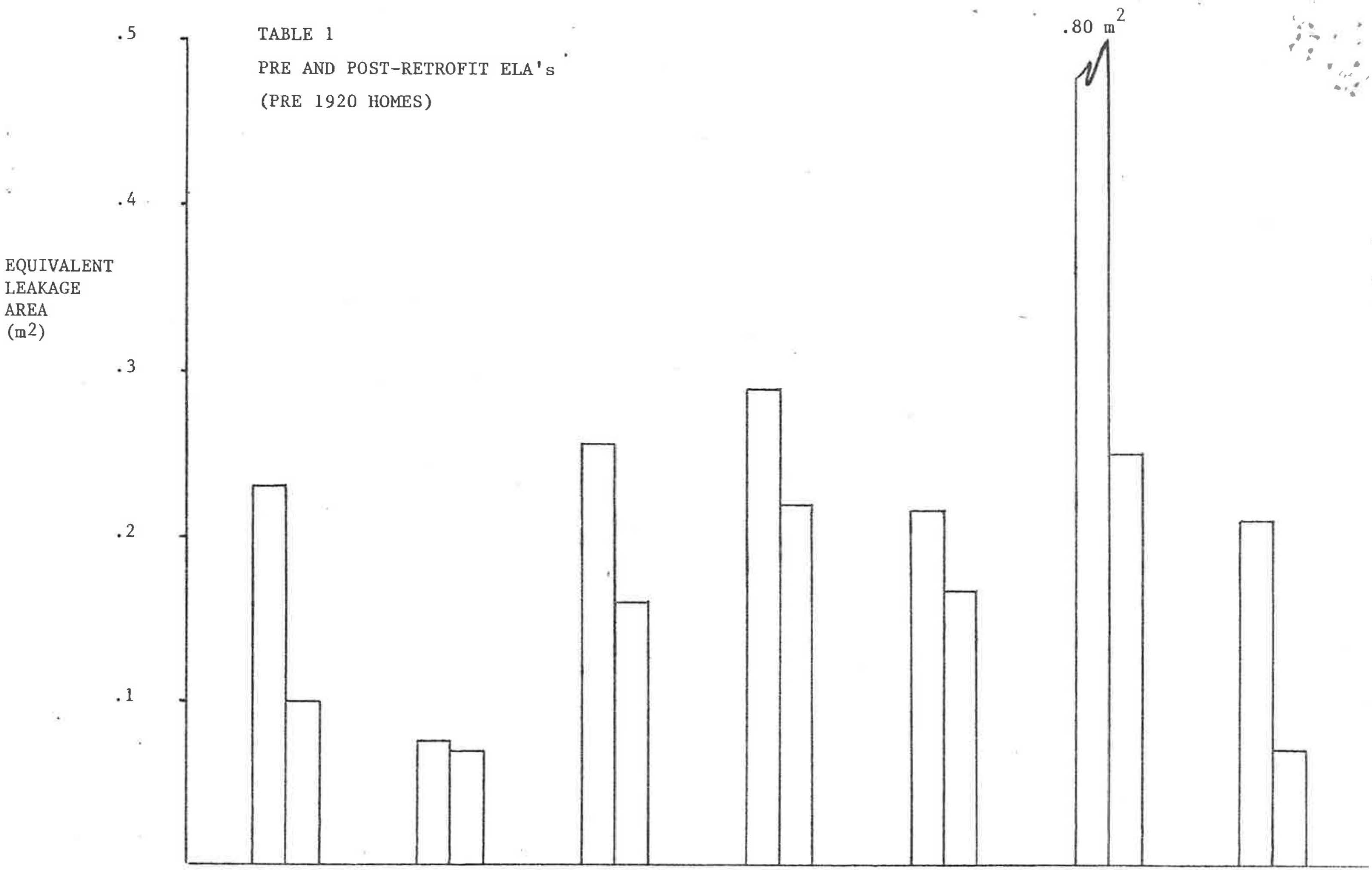
HOUSE SELECTION

A third of the houses which were tightened were in a relatively poor state of repair. Windows and doors especially needed a lot of work. The Brittania area homes were all converted from summer cottages, with very little evidence of air barrier integrity. House # 6 had such large holes in the crawlspace that it was possible to watch the squirrels playing outside (and inside). Half of the homes selected were pre-1920, and only one house was built between 1920 and 1945. It could be maintained that the Ottawa project did not have a very representative sample of Ontario homes.

TABLE 1

PRE AND POST-RETROFIT ELA's

(PRE 1920 HOMES)

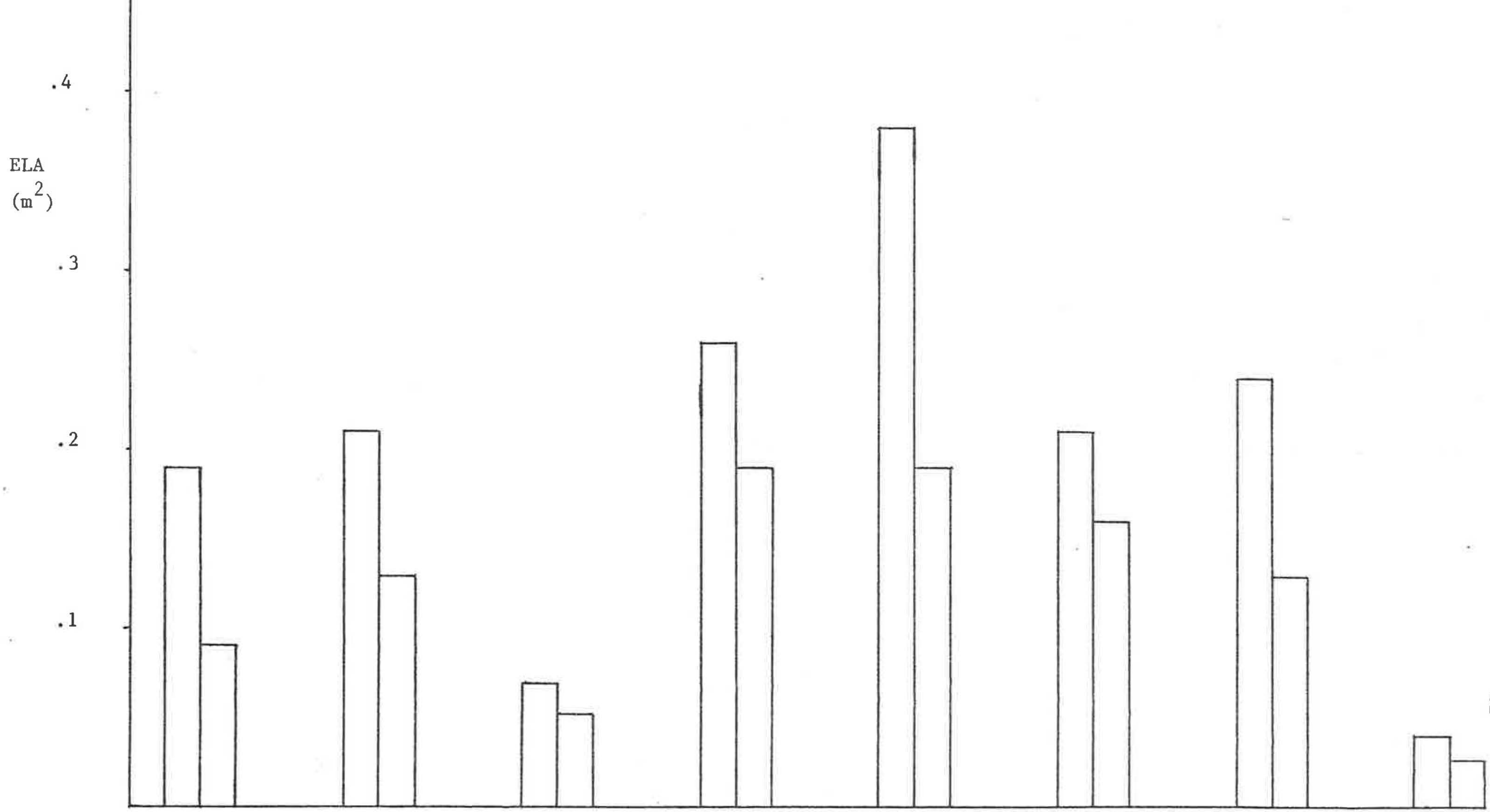


HOUSE #	1	2	3	4	5	6	7
YEAR OF CONSTR.	PRE 1920	PRE 1920	PRE 1920	PRE 1920	PRE 1920	PRE 1920	PRE 1920
PRE-ELA:	.23	,076	.257	.290	.217	.80	.21
POST-ELA:	.10	.068	.160	.220	.168	.25	.07
% RED.	56%	11%	38%	24%	[illegible]	[illegible]	[illegible]

TABLE 2

PRE AND POST-RETROFIT ELA's

(1920 - 1980)



HOUSE #	8	9	10	11	12	13	14	15
YEAR OF CONST.	1920-45	1946-60	1946-60	1946-60	1961-70	1961-70	1970-80	1970-8
PRE-ELA:	.19	.21	.068	.26	.38	.21	.24	.040
POST-ELA:	.09	.13	.056	.19	.19	.16	.13	.025
% RED.	53%	38%	17%	27%	50%	24%	46%	37.5%

SUMMARY DATA SHEET - TABLE 3

HOUSE #	YEAR OF CONS.	# OF STORIES	VOLUME m^3	ENVELOPE AREA m^2	ELA BEFORE m^2	ELA AFTER m^2	ELA % REDUCTION	WDW W/S m	DOOR W/S m	CAULKING # TUBES USED	ELEC. GASKETS	POLY m^2	PERSON HOURS (TOTAL)
1	PRE 1920	2	311	220	0.23	.10	56	21	5	28	16	4.5	28.5
2	PRE 1920	1½	319	202	0.076	.068	11	31	6	10	17	--	17.25
3	PRE 1920	2½	483	303	0.257	0.16	38	52	16	36	16	--	46
4	PRE 1920	2½	483	304	0.29	0.22	24	18	11	32	34	1	64.5
5	PRE 1920	2	378	257	0.217	0.168	23	7	3	39	30	3	38
6	PRE 1920	1½	290	197	0.80	0.25	69	43	3	37	10	58	53.5
7	PRE 1920	2	232	197	0.21	0.07	67	15	–	26	17	1	30.5
8	1920-45	1½	456	236	0.19	0.09	53	19	–	18	19	--	24
9	1946 - 60	1½	301	176	0.21	.13	38	30	3	16	16	1	21.75
10	1946 - 60	2	447	234	0.068	0.056	17	37	3	6	25	–	17 ½
11	1946 - 60	1	459	254	0.26	0.19	27	22	1	8	29	5	49.75
12	1961 - 70	1	635	284	0.38	0.19	50	37	2	20	23	–	18
13	1961 - 70	1½	380	344	0.21	0.16	24	15	–	6	12	–	13 ½
14	POST 1970	1½	634	375	0.24	0.13	46	10	–	6	37	–	21.5
15	POST 1970	1	86	184	0.04	0.025	38	–	–	12	35	2	20
AVERAGE:			393	251	.245	.134	38.7%	23.8	3.7	20	22.4	1.5	31