RESEARCH REPORT

Indoor Air Quality Survey of Northwest Territories Housing

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INDOOR AIR QUALITY SURVEY OF NORTH WEST TERRITORIES HOUSING

Final Report

Submitted to

CMHC
Project Implementation Division

By

Appin Associates
In association with Dr. A. Yassi

March 1991

Canada Mortgage and Housing Corporation, the Federal Government's housing agency is responsible for administering the National Housing Act

This legislation is designed to aid in the improvement of housing and living in Canada. As a result, the Corporation has interests in all aspects of housing and urban growth and development.

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This publication is one of many items of information published by CMHC with the assistance of federal funds.

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ACKNOWLEDGEMENTS

Appin Associates wishes to acknowledge the assistance of CMHC staff, in particular Mr. R. Sinha, in conducting this research project. Other people that were important to the completion of this project include the staff of the NWT Housing Corporation and the Housing Associations in the various communities. Without the help of the Housing Association staff who acted as interpreters, guides and resource people, the project would not have been completed. The section of the report titled "List of Contacts" contains the names of most of the specific people that helped on the project.

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EXECUTIVE SUMMARY

Appin Associates, on behalf of CMHC and the North West Territories Housing Corporation, conducted a survey to evaluate residential Indoor Air Quality (IAQ) in homes in selected communities in the NWT. New designs and improved construction techniques are being used by the NWT Housing Corporation to increase the energy efficiency and the longevity of the housing. The intent of the study is to provide an indication of the potential for indoor air quality problems that may result from these changes in the design and construction of new housing and the application of similar techniques in the retrofitting of older housing units.

This report details the methods used to gather data and complete the IAQ testing of 60 designated housing units in 7 communities in the NWT. The testing was carried out during the months of November and March/ April of the following year. The temperatures during the testing periods ranged from -35°C to -21°C with high winds and blizzards common during the testing periods. The report also contains an analysis of the data collected.

In summary the data showed the following:

- formaldehyde readings ranged from 0.088 ppm to below detectable limits in many houses, with only 4 houses showing levels above the TARGET LEVEL of 0.05 ppm, and non of the sample readings were above the ACTION LEVEL of 0.10ppm, as set out in the Exposure Guidelines published by Health and Welfare Canada (HWC).

- the highest measured level of particulates was 167 $\mu g/m^3$, with 23 out of 30 results falling above the HWC Acceptable Long-term Exposure Range (ALTER) exposure range of 40 $\mu g/m^3$.

- of the 14 houses tested the highest level of Radon detected was 0.001 Working Level (WL) units (8 Bq/m^3), which is well below the HWC Guideline level of 0.1 WL units (800 Bq/m^3).

- the Relative Humidity (RH) measured over a seven day period varied from 9% to 46%, with the average being 25%.

- the highest level of Carbon Dioxide measured was 2,000 ppm, with 25 out of the 54 houses tested having at least one location in the house with levels above the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) 62-89 guideline of 1000 ppm. None of the houses tested had CO_2 levels that exceeded the 3500 ppm HWC ALTER for residential indoor air.

- air change rates varied from 0.042 air changes per hour (ac/hr) to 2.2 ac/hr, with 35 of the houses having air change rates below 0.30 ac/hr. In one community all houses tested were below the 0.30 ac/hr rate. The 0.30 ac/hr rate is the required ventilation rate of the 1990 National Building Code.

- The Bioquest Biological Assay tests indicated that some houses had microbial contamination levels that affected the nematode bioassay organisms, which are about 1000 times more sensitive than humans. The detection of toxic effects in the nematode bioassay should be considered a flag of poor indoor air quality, rather than an indication of an indication of an immediate health risk.

The results showed that some new houses, as well as some of the older houses that have been retrofitted, have low air change rates. This is occurring in houses that have operable exhaust fans or passive vents. The air flows from a sample of bathroom exhaust fans were measured at between 5.5 L/s and 14 L/s. These low fan flows, plus intermittent usage of the fans; when combined with the tight building envelope that is necessary to protect the building structure, results in low air change rates in some houses. The low fan flows and lower combined air change rates could be responsible for the decrease in indoor air quality in some homes included in the study. Alternative ventilation solutions may be desirable to increase the air change rate to a minimum level in all houses.

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Résumé

La maison Appin Associates a mené, pour le compte de la SCHL et de la Société d'habitation des Territoires du Nord-Ouest, une enquête sur la qualité de l'air à l'intérieur des habitations de certaines collectivités des Territoires. La Société d'habitation a présentement recours à des nouvelles méthodes et à des techniques de construction améliorées afin d'accroître l'efficacité énergétique et la longévité des logements. L'enquête vise à donner une indication des problèmes possibles de qualité de l'air intérieur pouvant découler des modifications des méthodes de conception et de construction des logements neufs et de l'application de techniques semblables dans les mesures de rattrapage des vieux logements.

Le présent exposé livre en détail les méthodes utilisées pour recueillir des données et compléter les essais de 60 logements désignés dans 7 collectivités des Territoires du Nord-Ouest. Les essais se sont déroulés au cours des mois de novembre et de mars/avril de l'année suivante. Pendant la période d'essai, la température oscillait entre -35°C et -21°C et les Territoires étaient balayés par de forts vents et des blizzards. L'exposé comporte également une analyse des données recueillies.

En résumé, les données indiquent ce qui suit :

- dans de nombreuses maisons, les relevés de formaldéhyde variaient entre 0,088 ppm et un niveau en deçà des limites détectables, alors que seulement 4 maisons enregistraient des niveaux supérieurs au NIVEAU CIBLE de 0,05 ppm, et aucun des relevés d'échantillons ne se situait au-dessus du SEUIL D'INTERVENTION de 0,10 ppm, énoncé dans les Directives d'exposition publiées par Santé et Bien-être social Canada.

- le niveau de particules le plus élevé se situait à 167 ug/m^3, 23 des 30 résultats s'inscrivant au-dessus de la plage d'exposition acceptable à long terme (ALTER), soit 40 ug/m^3.

- parmi les 14 maisons testées, le niveau le plus élevé de radon était de 0,001 WL (8 Bq/m^3), soit bien en-deçà du niveau de 0,1 WL (800 Bq/m^3) que prévoit la directive de Santé et Bien-être social.

- le degré d'humidité relative (HR) mesuré sur une période de sept jours variait de 9 à 46 p. 100, la moyenne s'établissant à 25 p. 100.

- le plus haut niveau de dioxyde de carbone relevé s'établissait à 2 000 ppm, 25 des 54 maisons testées présentant au moins un endroit de la maison où la concentration était supérieure à celle de 1 000 ppm qu'établit l'American Society of Heating Regriferation and Air-Conditioning Engineers (ASHRAE) dans sa directive 62-89. Aucune des maisons testées n'affichait des concentrations de CO_x supérieures au seuil (ALTER) de 3 500 ppm fixé par Santé et Bien-être social concernant la qualité de l'air intérieur.

- Le taux de renouvellement d'air variait entre 0,042 et 2,2 renouvellements par heure, 35 des maisons enregistrant un taux inférieur à 0,30 renouvellement d'air par heure. Dans une collectivité, toutes les maisons testées affichaient un taux inférieur à 0,30 renouvellement d'air par heure. Il s'agit du taux de ventilation requis par l'édition 1990 du Code national du bâtiment.

- Les essais biologiques de Bioquest indiquent que certaines maisons enregistraient des niveaux de contamination microbienne qui affectaient les nématodes, organismes environ 1 000 fois plus sensibles que les humains. La détection d'effets toxiques lors des dosages biologiques effectués au moyen de nématodes doit être considérée comme un signe de la piètre qualité de l'air, plutôt qu'une indication d'un risque préjudiciable à la santé.

Les résultats démontrent que certaines maisons neuves, tout comme certaines maisons anciennes ayant subi des mesures de rattrapage, sont aux prises avec de faibles taux de renouvellement d'air. Cela se produit dans les maisons équipées de ventilateurs d'extraction ou d'aérateurs passifs. Les débits d'air provenant d'un échantillon de ventilateurs d'extraction de salles de bain variaient entre 5,5 L/s et 14 L/s. Ces faibles débits, en plus de l'usage intermittent des ventilateurs, et de l'étanchéité à l'air de l'enveloppe requise pour préserver la charpente du bâtiment, donne lieu dans certaines maisons à de faibles taux de renouvellement d'air. Le faible débit des ventilateurs combiné au taux peu élevé de renouvellement d'air pourrait expliquer la diminution de la qualité de l'air de certaines maisons touchées par l'enquête. D'autres solutions pourront s'avérer souhaitables pour assurer le renouvellement d'air minimal dans toutes les maisons.

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1. INTRODUCTION

The Terms of Reference for the study stated that "Over the past several years, CMHC social housing delivery agents in the north, namely the Northwest Territories Housing Corporation (NWTHC) and the Yukon Housing Corporation (YHC) have implemented a multi-year program to improve the quality of their existing and new housing stock. Besides a major repair and renovation program, these delivery agents have adopted many aspects of the R-2000 program in terms of wall insulation values and envelope airtightness specifications for their housing designs. Although the program is important and will achieve significant reductions in energy consumption for space heating, housing officials are becoming increasingly concerned about the impact of the airtight envelope design philosophy as it affects the quality of the indoor air".

In order to study the impact on Indoor Air Quality (IAQ), CMHC, through its Project Implementation Division (PID) engaged Appin Associates of Winnipeg to conduct a survey to evaluate residential IAQ in homes in selected communities in the NWT.

The Terms of Reference stated that a total of 15 houses were to be tested in a first series of tests during the fall /early winter in Rankin Inlet and Arviat (Eskimo Point). Forty houses were to be tested in a second series of tests during the late winter in up to 8 other communities, and 5 of the houses in the first series of tests in Rankin Inlet were to be re-tested.

The test methods used are outlined in this report. Besides sampling for various pollutants, Appin collected building envelope, heating/ventilation system and pollution source data on the houses. Appin also administered an occupant questionnaire regarding the operation of the house and a short health survey of the occupants.

Appin tested 15 houses in the Series 1 tests in November, 1989. Five of these houses were located in Arviat (Eskimo Point) and the remaining ten were in Rankin Inlet. These communities were selected because there is easy access from Winnipeg and because they are larger communities. Rankin is the administrative centre for the Keewatin District and Arviat is the administration headquarters for the NWT Housing Corporation in the Keewatin District. This allowed Appin to obtain the co-operation from housing officials needed during the early stages of this project and allow for a more comprehensive review of the study plan.

For the Series 1 testing, Appin travelled to Arviat and meet with the appropriate housing officials, deploy the samplers, complete the necessary forms and arrange for pick up return of the samplers after the sampling period was completed. Appin then travelled to Rankin to do the same. The samplers in both communities were picked up by the NWTHC officials.

The Series 2 tests were conducted in March and early April of 1990. This series included 40 houses in the communities of Coppermine, Cambridge Bay, Gjoa Haven, Baker Lake and Chesterfield Inlet. In addition to these 40 houses, Appin retested five houses in the community of Rankin Inlet. The purpose of the re-testing was to determine the variance, if any, between the fall and winter test results. Rankin Inlet was chosen because the air travel route required Appin to travel frequently through this community.

Chapter 2 of this report describes the work undertaken to complete the study, including the literature and codes/standards review, the planning process, forms used, contacts and the methods used for data collection in the Series 1 and 2 tests.

Chapter 3 provides an analysis of the data collected. The analysis includes a summary of the major findings of the report. As well, a case study sheet has been produced for 10 houses. These case studies depict the conditions found in each of the ten types of houses included in the study group.

Finally, Chapter 4 gives the conclusions and recommendations from the project.

2. DESCRIPTION OF THE WORK

2.1 CMHC/Contractor Start-up Meeting

Appin held a meeting in Winnipeg in September, 1989 to begin the project. This meeting was key to providing the opportunity for Appin and the CMHC project officer and other technical staff to agree to the goals, objectives, and reference information for the project.

2.2 Review of Existing information, Codes and Standards

The Health and Welfare Canada (HWC) document Exposure Guidelines for Residential Indoor Air Quality - A Report of the Federal - Provincial Advisory Committee on Environmental and Occupational Health was used as the reference document for standards and procedures. A summary table copied from the HWC document is attached. The Canadian guidelines for radon are now available in Radon: You and Your Family - A Personal Perspective and these were used in this project. It should be noted that this guideline of 800 Bq/m^3 (0.1 WL or 21.62 picoCuries per litre (pCi/l)) is above the recommended United States Environmental Protection Agency (USEPA) level of 160 Bq/m^3 (0.02 WL or 4 pCi/l).

Carbon Dioxide ($CO_{2)}$ levels were used as an indicator gas for ventilation performance in this report. As there is no NWT guideline for CO_2 levels, the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) 62-89 guideline of 1000 ppm was used as an indication that there was overcrowding, a malfunctioning or inadequate ventilation system, no ventilation system, a very tight house or a combination of any of these factors. Houses that had CO_2 levels above the 1,000 ppm level are noted in the report.

2.3 Pollutants measured

Two basic measuring techniques were used to sample potential pollutants in the houses. Time averaged systems were placed in the houses and left in place for 7 days. Spot samples for some pollutants were taken during the house visits and thus were taken during the same testing period as the time averaged tests. The following pollutants were measured using the indicated methods:

- **Carbon Dioxide ($CO_{2)}$ using Gastec tubes.** Spot sampling was carried out using Gastec 2LL Extra Low Range (300-5000 ppm) CO_2 tubes. The spot tests were taken in the living areas and bedrooms of the houses.

  Appin also held discussions with ORTECH regarding the use of Gastec tubes left in place for 7 days as a longer term sampler. Initial discussions suggested that this method may give an average reading that approximates the actual range of CO_2 found in the locations sampled. However the calibration and analysis procedure has only been carried out in laboratory situations and Appin believed that it was not a mature enough testing procedure to be used during this field testing survey.

  Typical sources of this pollutant in the surveyed housing would be: the respiration of the occupants of the house, the spillage or leakage of combustion gases from the oil fired space heating and domestic hot water heating appliances and the use of auxiliary combustion space heating appliances. The occupants of the houses surveyed reported that no auxiliary heating equipment was used in the houses except during times of emergency power failures. This situation did not occur during any of the sampling periods in any of the communities.

Summary of Exposure Guidelines

Contaminant	Acceptable Exposure Ranges ASTER	ALTER	Page
Aldehydes (total)	$\Sigma c_i/C_i \leq 1$[a]	–	8
Carbon Dioxide	–	≤ 6300 mg/m³ (≤ 3500 ppm)	8
Carbon Monoxide	≤ 11 ppm – 8 h[b] ≤ 25 ppm – 1 h[b]	–	9
Formaldehyde	[c]	[d]	11
Nitrogen Dioxide	≤ 480 µg/m³ (≤ 0.25 ppm) – 1 h	≤ 100 µg/m³ (≤ 0.05 ppm)	9
Ozone	≤ 240 µg/m³ (≤ 0.12 ppm) – 1 h	–	10
Particulate Matter[e]	≤ 100 µg/m³ – 1 h	≤ 40 µg/m³	10
Sulphur Dioxide	≤ 1000 µg/m³ (≤ 0.38 ppm) – 5 min	≤ 50 µg/m³ (≤ 0.019 ppm)	11
Water Vapour	30-80% R.H. ≥ summer 30-55% R.H. ≥ winter[f]	–	11
Radon	-	[g]	12

a C_i = 120 µg/m³ (formaldehyde); 50 µg/m³ (acrolein); 9000 µg/m³ (acetaldehyde), and c_i are respective concentrations measured over a five-minute period.

b Units given only in parts per million so that guidelines are independent of ambient pressure.

c See Aldehydes (total).

d See page 11.

e ≤ 2.5 µm mass median aerodynamic diameter (MMAD).

f Unless constrained by window condensation.

g See page 12.

Source: Health and Welfare Canada.

- **Carbon Monoxide (CO) using Gastec tubes.** Spot sampling was done through the standard use of Gastec sampling pump and Gastec 1LL Extra Low Range (5-50 ppm) CO tubes. Spot samples were taken in the furnace or boiler room areas as well as in the living spaces of the house. In some instances, spot samples were taken at a warm air register to check for the presence of CO in the forced air heating system. This was undertaken to determine if there was a leak in the oil furnace heat exchanger.

  Again, discussions were held with ORTECH regarding the use of Gastec tubes left in place for 7 days suggest that there is no confidence in this method of testing.

  Typical sources of this pollutant in the surveyed housing would be: tobacco smoke and the spillage or leakage of combustion gases from the oil fired space heating and domestic hot water heating appliances and the use of auxiliary combustion space heating appliances. The occupants of the houses surveyed reported that no auxiliary heating equipment was used in the houses except during times of emergency power failures. This situation did not occur during any of the sampling periods in any of the communities.

- **Nitrogen Dioxide (NO_2) using Gastec tubes.** This test was to be done if the oil or wood house heating system showed signs of combustion spillage. Most houses were tested even though there were no signs of spillage. The tests were usually done in the furnace or boiler room area, at or just after start-up of the heating system. There were no houses heated with wood in the study. The spot sampling was carried out with Gastec 9L Low Range (0.5-30 ppm) NO_2 tubes.

  Typical sources of this pollutant in the surveyed housing would be: the spillage or leakage of combustion gases from the oil fired space heating and domestic hot water heating appliances and the use of auxiliary combustion space heating appliances. The occupants of the houses surveyed reported that no auxiliary heating equipment was used in the houses except during times of emergency power failures. This situation did not occur during any of the sampling periods in any of the communities.

- **Sulphur Dioxide (SO_2) using Gastec tubes.** This test was to be done if the oil or wood house heating system showed signs of combustion spillage. Most houses were tested even though there were no signs of spillage. The tests were usually done in the furnace or boiler room area at or just after start-up of the heating system. There were no houses heated with wood in the study. The spot sampling was carried out with Gastec 5LB Low Range (0.2-5.0 ppm) SO_2 tubes.

  Typical sources of this pollutant in the surveyed housing would be: the spillage or leakage of combustion gases from the oil fired space heating and domestic hot water heating appliances and the use of auxiliary combustion space heating appliances. The occupants of the houses surveyed reported that no auxiliary heating equipment was used in the houses except during times of emergency power failures. This situation did not occur during any of the sampling periods in any of the communities.

- **Formaldehyde (HCHO) using the Air Quality Research, Inc. (AQR) 7 day samplers.** This is a standard system used by Appin and others to monitor formaldehyde levels. Each house was sampled using two samplers. One was generally placed in the living/eating/kitchen areas in the house, while the other sampler was placed either in one of the bedrooms or in the bedroom hallway.

  Typical sources of this pollutant in the surveyed housing would be: construction materials, cabinets and furniture that contains particle board or plywood that use formaldehyde based glues, newer upholstery and draperies that have been treated for stain resistance and tobacco smoke.

- **Indoor Relative Humidity (RH) using the 7 day time averaging Buchan Lawton Parent (BLP) sampling system.** The BLP sampler was generally placed in the living room near the bedroom hallway in the bungalow houses and on the lower floor in the living room near the stairway in the two storey houses. A spot RH and temperature measurement using a Psychrodyne psychrometer was taken. Outdoor RH and temperature data was collected from readings recorded at the nearest weather station.

  Typical sources of moisture in a house would be: Respiration or breathing of the occupants, cooking, bathing, washing clothes, drying clothes inside or using unvented dryers, humidifiers and moisture that enters from the crawl space or basement foundation. Because the houses in the study are built up off the ground, there were few humidifiers in use, the dryers were almost all vented to the outside, the main sources of moisture in the study houses would be from respiration, cooking and bathing as well as the moisture that is carried into the houses in the form of snow attached to clothing.

- **Radon using the 7 day RAD system.** Radon was to be measured if the house had a crawl space, basement or enclosed skirting system. The samplers were placed in the living areas of the house.

  The major source of radon gas is the soil or rocks under the foundation of the house, although radon is also found in well water, building materials and natural gas supplies. The major source for houses in the north would be via the transport of soil gases into the houses. Because the Series 1 tests showed extremely low levels of Radon and the houses are not normally in contact with the ground, in the Series 2 tests fewer radon tests were done, but the RAD Radon pumps were used to collect particulate samples.

- **Particulates** were measured over a seven day period using a technique that calls for pre-weighed filters supplied by ORTECH to replace the air filters in the normal RAD radon detector air pump. As this data is normally collected when a radon test is carried out, this measurement was only to be made when the radon measurement was taken. However, a total of 32 particulate samples were gathered instead of some radon samples.

  Cigarette smoke, house dust, pollens and mould spores are major sources of particulates in houses. There was seal and caribou skin clothing in some houses. This clothing, other than the skin boots, was normally stored in the outer porch of the house.

- **Microbiological contaminants** were sampled using the RCS system to take spot samples. This system collects bacterial and viral samples on an agar strip from a measured volume of air passing over it. Samples were generally taken in the kitchen area, the bathroom and a bedroom in a random sample of houses. Once the samples were taken they were packed in a cooler in an attempt to keep them cool to prevent the cultures from growing. These samples were then shipped to the Agriculture Canada lab in Ottawa to be cultured and identified.

  Typical sources in homes would be microorganisms from humans, pets or insects within the home, or growths on surfaces or in stagnant water.

- The **Bioquest** biological screening technique was to be used to provide an general "fitness" of the house environment. Two samplers were exposed in each house for a seven day period. Samplers were placed in the living room or kitchen area and in the bedroom area of the house. It was to be used especially when occupants presented IAQ symptoms and Appin could not determine the source of the problem. This general screen plus completion of the forms will provide guidance

with respect to requirements for followup measurements using more detailed or specific methods.

- Seven day time averaged air change measurements were made with the PFT/CATS system developed by NAHB and supplied by ORTECH. This allowed determination of the air change rate over the 7 day test period. This information could be related to the dilution/ concentration of pollutants and the performance of the ventilation system. Appin could not arrange for blower door tests to be carried out.

2.4 Forms Used to Collect Information and Record Test Results

Appin developed a series of forms that were used to record information on each house, the occupants, spot test results and other information related to the time averaged testing. Consistency in data collection was improved through the development of a series of data collection forms. The following forms were used:

- Appin had the homeowners complete a Release Form allowing the work to be done. The form was translated into Inuktituk by the Kitikmeot Region staff of the NWTHC for use in this region.

- The work in each house was done according to an IAQ Test Control form. This form gathered basic information on the house and occupant, served as a check list for the completion of the other forms that are listed below, provided a location to record the results from the spot tests and provided a place to record information related to the placement and collection of the time averaged samplers. In most cases key building, equipment and operating information was noted on these forms.

- The House Assessment Prescriptive Procedure (HAPP) Occupant Interview and House Inspection Forms were completed on the 15 Series 1 houses to determine the necessary, relevant information that should be collected. The HAPP forms allow collection of relevant information about the house according to six major performance areas in the house including moisture control, chimney performance, ventilation and air quality, building upkeep and safety, comfort and thermal efficiency and heating and cooling systems. The Occupant Interview Form collects historical information according to the six performance areas as recollected by the occupant. Appin found that there was more similarity in the construction of the NWT houses than what one would find in the South. There were 4 or 5 different types of houses with small differences in the construction methods used to build the different age group and style of house. Therefore the complete House Inspection Form was not used after the initial inspections. The different types of housing and their relevant construction information form part of the data. Deviations, special conditions and variations from the standard were noted on the IAQ Test Control Forms.

- Appin used its Pollution Source Check List to collect pollution source information for each house. The information gathered included items such as: unusual odours upon entering the house, observable dust levels, pollutant sources from occupant activities such as animal fur/skin preparation, equipment servicing, craft activities, evidence of sources of formaldehyde and petroleum vapours, types of cleaning compounds used in the house, evidence of moisture and mould sources, potential for backdrafting and spillage problems, etc.

- The standard CMHC Combustion Spillage Pre-test was to be completed in each case, with the CMHC Venting Systems Test to be done if the house failed the pre-test. During the visits to the first 15 houses there was no evidence of spillage from any of the oil furnaces or oil fired boilers. Oil-fired forced-air furnaces, boilers and domestic

hot water tanks were the only combustion appliances found in the houses that included in the study. Smoke pencil testing at the barometric dampers of the oil fired systems showed few had any spillage at start up. The spillage if it did occur was generally only an initial puff at startup that lasted for less than 5 to 10 seconds. Typically the only exhaust equipment that was installed in the houses was the dryer that was vented to the outside and a small low flow exhaust fan in the bathroom. Some houses had kitchen exhaust hoods with fans or higher wall mounted exhaust fans that had low flow capacity. Some typical bathroom exhaust fan flows are listed later in the report. None of these exhaust devices appeared to have the potential for causing pressure induced spillage of the combustion appliances.

- Dr. Annalea Yassi and Appin designed a **Health Questionnaire** that during the Occupant interview process asked questions about health problems and concerns of the house occupants. These questions were related to those concerns that could relate to IAQ problems. A short and a long form were developed. Only the short form was used after piloting in the Series 1 tests.

- Appin took a front elevation **photograph** of each house plus detailed photographs of relevant house features and problems if they were present.

A complete set of forms is attached as Appendix 1. Slide copies of the photographs are attached as Appendix 2 under separate cover.

2.5 List of Contacts

Appin discussed the project with medical and housing officials in the Federal Government and the Government of the NWT. The contacts made are listed in the **LIST OF CONTACTS** section at the end of this report.

2.6 Literature Survey

Appin was required to conduct a literature search of other IAQ studies of Northern housing. Appin found that there was no information other than the R-2000 survey that was conducted by John Butler of the EMR Conservation and Renewable Energy Office (CREO) in Yellowknife, NWT. Appin interviewed Mr. Butler and his major concern was the need to maintain quality control in the collection of the IAQ samples. The R-2000 Program in the Yukon also conducted IAQ testing of R-2000 and standard housing as part of the R-2000 Program. The data for this testing is contained in the EMR Canada, R-2000 database.

Most the houses in the NWT R-2000 survey and all the houses in the Yukon survey were located below the tree line. These houses generally have basements or other foundations that directly connect them with the ground. The houses above the tree line generally have foundations that isolate them from ground source moisture and Radon gas. The houses located above the tree line do not have wood stoves or other auxiliary heaters, while those below the tree line typically all have wood stoves. No literature was found on IAQ testing in housing located where the wind and weather conditions were similar to and severe as that found in the study communities that are located above the tree line in the high Arctic.

Dr. Annalea Yassi did a computerised literature search of medical literature on the subject. Dr. Yassi and Appin searched the CISILO and NIOSHTIC data bases using such keywords as Native, Northern, Indoor Air Quality, Alaska, Innuit and Eskimo and found no studies that were directly relevant to this project.

2.7 Series 1 testing

Appin tested 15 houses using the IAQ monitoring package described in Chapters 2.3 and 2.4. Samples of the forms used are attached as Appendix 1. Five of these houses were located in Arviat and the remaining ten houses were located in Rankin Inlet.

These communities were selected because there is easy access from Winnipeg and because they are larger communities. This allowed Appin to obtain the co-operation from housing officials needed during the early stages of this project and allowed for discussion of the study with the Keewatin District NWTHC officials located in Arviat.

Mr. John Hockman, of Appin Associates, travelled to Arviat, met with the NWTHC officials for the Keewatin District and the Arviat Housing Association staff and completed the testing program. House visits and translation were arranged by the Housing Association staff located in each community. The house visits and testing included collecting the required information, conducting the occupant interviews, doing the spot testing, deploying the seven day time averaging samplers and completing the necessary forms for the five houses that were selected in Arviat. Instruction was provided to those responsible for collecting the time averaged samplers. Mr. Hockman then travelled to Rankin Inlet and completed the same work for the ten houses selected in Rankin Inlet. The samplers in both communities were picked up by the NWTHC staff after the minimum seven days and then shipped to Appin in Winnipeg. When the samplers were received from the two communities, they were checked, organized and sent to the various laboratories for analysis. The results were tabulated in a spreadsheet and a preliminary report on the Series 1 tests was submitted to CMHC.

The temperature during the testing period of the Series 1 test averaged -21.3°C to -23°C, with the average wind speed at 26 km/hr.

2.8 Series 2 testing

The Series 2 tests involved testing 40 houses in five additional communities plus the re-testing of 5 of the Series 1 houses tested in Rankin Inlet. Samples of the data collection forms used are attached as Appendix 1. The particular communities were selected from the original list of communities provided by the NWTHC. After discussions with the NWTHC staff, an itinerary was developed to reach the key communities in both regions. Eight houses each were to be tested in communities of Chesterfield Inlet and Baker Lake in the Keewatin District. Five houses from the original test group were to be retested in Rankin Inlet, also in the Keewatin District. Eight houses each were to be tested in communities of Coppermine, Cambridge Bay and Gjoa Haven in the Kitikmeot District.

The temperature during the testing period of the Series 2 test also averaged in the -21°C to -23°C range, with the average wind speed between 15 and 30 km/hr.

The data collection and testing protocol for the Series 2 houses was slightly modified from the Series 1 tests. The key differences involved changes to the Radon testing, Venting Systems Tests, the addition of 50 biological/fungal tests and the measurement of air flow from 15 bathroom fans. The following is a brief description of the information collected and the testing that was carried out during the Series 2 tests. The Release Form was signed for almost all houses. In some communities the Housing Association arranged to have the forms signed by house occupants before Appin's arrival in the community. However, in some cases the houses that were tested were not those where the occupants had signed the Release Form had been signed. Attempts were made to get the releases signed, but sometimes the interpreter was not available or had left the house before the Release Form was signed. This made it almost impossible to get the Release Form signed in a few cases.

The relevant sections of the Occupant Interview data collection sheets were completed to gather information on the operation of the house with respect to moisture, ventilation, comfort, heating problems, building upkeep and safety and chimney performance.

The IAQ Test Control Form was completed to record age, year of construction, retrofit history, floor area and volume of the house, sampler number and time of placement of the various samplers deployed in the house. The form was used to record the levels of NO_2, SO_2, CO_2 and CO when spot samples were taken using the Gastec pump. The form was used to record any other relevant information that was particular to that house, including information that is normally recorded on the HAPP House Inspection Form. As explained above, there were few differences in construction methods and materials used or in the heating and ventilation system types. Only key characteristics and deviations from the standard construction and equipment were recorded.

The Indoor Air Pollution Source Check List was completed for each house. A check at the two local stores in each community was made to determine if household cleaning products other than those mentioned during the interviews were available in the community.

The Short Form Health Survey was completed for key occupants in each house. Radon tests were to have been carried out only if the house had a crawlspace, basement or enclosed skirting system that coupled the living space of the house to the with the ground. Few of the houses had these conditions. However, radon tests were completed in those houses where snow drifting or crawlspace skirting seemed to have left little opening under the house and where there was the least chance of the RAD sampling pump being unplugged by the occupant or their children. It should be noted that these pumps generate a humming noise that was objectionable to some people who are not used to any background noise in the house, especially during the night. In some cases the occupants did not agree to have the pumps installed for this reason.

During the Series 1 testing an attempt was made to complete some full Venting Systems Tests. During the seasons when the house visits were made there were very strong winds blowing in all the communities. To carry out a complete Combustion Venting Test requires the deployment of a complete pressure equalization tubing system around the outside the house. Even with the pressure equalization system, with winds gusting and blowing as strong as they were in these communities, the pressure fluctuations could not be dampened out for the low pressure readings that are required in this test. This is consistent with Appin's experience in previous research work where measuring small pressure differences at very low ranges was found to be extremely difficult on days when the wind is above 15 km/hour. These weather factors, combined with time constraints due to disrupted travel schedules, meant that complete Combustion Venting Safety Tests were not carried out.

There were only one or two houses that had any signs of combustion spillage at the furnace, boiler or oil fired hot water tank. In many houses, especially the multi-unit duplexes or quadraplexes, there was a separate boiler room. Sometimes the boiler room was not accessible directly from the units, but had a separate door open to the outside the building. Often these boiler room doors were locked or drifted in with snow and this prevented access to the boilers.

In the one or two houses that had any evidence of spillage there was some staining at the inspection port, at the barometric damper and at leaks in the flue connection pipe. These houses, plus some that did not have any evidence of spillage, were checked with a smoke pencil at startup. There was little if any spillage. The spillage, if it did occur, was generally only an initial puff at startup that lasted for less than 5 to 10 seconds.

Additional testing was undertaken during the Series 2 house visits. This work included the taking of 50 biological/fungal samples using agar strips and the RCS tester that was on loan from CMHC and DPW. Generally 3 strips were used in each house, with the kitchen, bathroom and one bedroom being tested. Samples were taken in the houses and then the strips were packed in a small cooler with ice and shipped to Agriculture Canada in Ottawa for analysis.

As well, during the Series 2 house visits, an ACIN model 153 Flow Finder was used to measure the air flow rates of several exhaust fans. Due to the constraints, this testing was done on bathroom exhaust fans where the fans and grilles were easily accessible. Many kitchen fans in the houses were of the charcoal/grease filter recirculation type that are not vented to the outside. Those kitchen fans that were ducted to the outside would have required extensive and time consuming modifications to the fan hood to allow the Flow Finder to be connected correctly. Thus, only bathroom exhaust fans were tested.

While the testing that was carried out in each community, Appin held discussions with the nurse or nurses in each community visited to acquaint them with the study and to gather any observations on general health related to indoor air quality. Specifically, discussions were held to talk about the possibility of the nursing staff reviewing the medical charts for occupants of houses where the testing suggests that there may be problems with the indoor air quality. There was general agreement that this could potentially be done, but that the required authorization would be difficult to obtain from the medical boards and the individuals concerned.

2.9 Organization and Travel Conditions during testing

The weather and travel conditions in the north had an impact on the two series of tests that were completed. The following is a brief discussion of some of the factors that had to be accounted for when planning the travel, and some of the factors that could not be accounted for in the planning stages.

Through discussions with the NWTHC staff in the regional offices, the communities were selected based on the access to the communities during the time of year that the testing was taking place. Often visitors to some communities on the list remain "weathered in" for extended periods of time. This is the case especially in the March/April period along the Hudson's Bay Coast. During this time, blizzards combined with fog conditions often prevent air travel. The organization of the travel was also complicated by the fact that many communities have scheduled flights only twice per week, or at a frequency that would not permit short visits to the community to test five houses without a substantial amount of waiting time until the next flight.

Much time was spent to develop the itinerary for the Series 2 testing that would allow travel into a community, contacting the housing authority personnel, completing the testing of the required houses, teaching of the housing authority staff on the procedures to be followed when collecting the samplers, preparation of the collection kits for each house and then enable the connection with the scheduled flight to the next community. After all the preparation work, the travel itinerary could not be followed after the first four hours of the trip when Appin staff arrived at Churchill, Manitoba. The first stop on the trip was to have been Chesterfield Inlet. It was then impossible to fly into that community. Many people had been waiting in Churchill for some time trying to get into that and other communities in the Keewatin District. The itinerary was abandoned and the first community to be visited was changed to Baker Lake.

In the ensuing 27 days of the trip there were frequent storms, fog and other factors that caused delays in getting into or out of almost all the communities that were visited. Delays were often up to two days in length. Adjustments were made to the travel schedule, and changes in bookings had to be made on the spot to accommodate the change in destinations and schedules. However, with the adjustments and juggling of the itinerary, and through the co-operation of the people in the communities, it was possible with some minor complications to complete the required testing of eight houses in each community and the re-testing of five houses in Rankin Inlet.

3. PRESENTATION AND ANALYSIS OF THE DATA COLLECTED

3.1 Presentation of Information and Data Collected

The information and data that was collected in both Series of tests is presented in various forms:

- Section 3.2 contains a list of the types of houses included in the study has been prepared. House Profile case study sheets have been generated for a typical house within each of the ten house types included in the study. They are attached as Appendix 5.

- Section 3.3 contains an analysis of the various non-building envelope or shell influences on the ventilation and air change rates in the study houses. The influences include passive and mechanical ventilation systems plus the heating and domestic hot water heating systems that in some cases are directly affecting the air change rate of the house.

- Section 3.4 presents a series of tables and graphs that were generated to compare related data to determine if any trends could be established. A spreadsheet of the tabulated data has been generated and is attached as Appendix 3. This spreadsheet lists key house and occupant information, as well as the results of the spot and time averaged testing. The tables and graphs were generated from this spreadsheet. Comments on the various tables and graphs are discussed in this section of the report.

- Copies of the results of the Microbiological samples taken using the RCS system are attached to the report as Appendix 4.

This approach to presentation of the data has been taken because there was a large amount of data collected on a small sample of houses. The number of houses sampled and the type of information collected does not allow for statistical analysis. The IAQ data is intended to provide CMHC and its housing delivery agents an indication of the potential for indoor air quality problems in their housing units. This information is especially important because of the changes to design and construction techniques that have potentially made the houses more air tight and energy efficient.

Finally Appin was requested to analyse the heating and ventilating systems in the house sample and to comment on the appropriateness of the designs. The data base contains listing of type of exhaust fans installed and their reported usage factor, fan flows if measured, the occurrence of passive vents, the occurrence of combustion air ducts and their size, the type of heating system and if there was an outside air duct to the return air plenums of the forced air furnaces. These items were used in the generation of graphs and tables relating to pollutant levels and air change rates.

3.2 Description of House Types

The houses that have been included in the study have been separated into 10 house type classifications. The houses have been separated into groups considering factors such as the house type (bungalow, two storey, one and a half storey, etc.), year of construction, heating system type and whether the house has been retrofitted or not. The following are the house type classifications:

1. Weber panelised construction - Not retrofitted
2. Weber panelised construction - Roof or roof and window retrofit only
3. Weber panelised construction - Full house retrofit
4. 1985 3-4 bedroom 2 storey
5. 1983 3-4 bedroom 1½ storey metal panelised houses - #10 GRP
6. 1985 2 bedroom duplex with separate boiler

rooms in each unit
7. 1986 2 bedroom duplex with common boiler room
8. 1 bedroom quadruplex - newer bungalow style
9. 1 bedroom quadruplex - 1½ storey metal panelised houses
10. 2 bedroom Woolfenden duplex unit

Included in Appendix 5 is a series of House Profile case study sheets. There are ten House Profiles provided. These profiles have been completed for a typical house within each of the ten different house types represented in the study. The profile sheets present the relevant information and data for the particular house. The case study sheets also include relevant photographs of the house.

3.3 Factors Influencing the Ventilation Rates

Indoor air pollutant levels are determined by two major factors: the rate of release or generation of the pollutant in the indoor environment, and the rate of air exchange between the polluted indoor air and the unpolluted outdoor air. In this study it is to be assumed that the outdoor air is somewhat free of those pollutants normally found in the air of southern urban communities. There are however three factors in the outdoor air that can have an influence on indoor air quality if outdoor air is brought into the houses.

One common outdoor air pollution complaint is the dust that is generated in the summer by vehicles driving on the gravel covered roads of the communities. The summer dust was a common complaint in all the communities in the study. The study was done in the winter and there would be little if any dust in the outdoor air brought into the houses from the outside.

During the winter many snow machines and other vehicles are commonly left running outside the houses for extended periods of time. If the outdoor air inlets or open windows are in the path of the exhaust gases, these pollutants could enter the house air. These incidents do not appear to be that frequent, and were reported only occasionally by some occupants.

Perhaps the biggest influence on indoor air quality when outdoor air is brought into the house during the winter is due to the moisture content of the outdoor air. The Arctic is a desert climate and during the winter when outdoor air is brought into the house and warmed to indoor temperatures it has extremely low RH. Thus, bringing in outdoor air can significantly lower the RH in the house. During the study period this would be the major impact on indoor air quality through the introduction of outdoor air.

The rate of introduction of outdoor air into a house is determined by the capacity of the mechanical ventilation system and its usage patterns, as well as by the air leakage characteristics of the building shell/envelope and the resulting natural air leakage rate. The winds in the communities studied were very constant with periods of very high wind conditions when blizzards passed through the area regularly.

The following mechanical system components influenced the mechanical ventilation and whole house air change rate in the houses studied.

- All the houses studied were heated either with an oil fired forced air furnace, or an oil fired boiler. The forced air furnaces were located in a porch area that allowed them to be isolated from the main living areas of the house by closing a door. It appeared that in most of the houses these doors were not closed, especially during the daytime. The boilers were either located in an isolated boiler room within the individual unit or in a separate isolated boiler room shared with other units and accessible from the outside or from a common hallway or directly from the outside.

- Some older Weber houses with forced air furnaces have outside air intakes to the return air plenums of the furnaces. These are most prevalent in those units that had been through a major retrofit,

although some non-retrofitted units also had this air intake. Some houses with forced air furnaces did not have the outside air duct installed. Where there was an outside air duct, they all were hard connected to the return air plenum.

- All houses in the study had bathroom fans that were ducted to the outside. Often the fan air flow capabilities were very low, the fans were broken or they had been disconnected. The fans were often reported to have been disconnected due to the loud noise level generated by the fan. Most of the kitchen range hoods installed in the houses were of the recirculation type. However, some newer housing units also had wall mounted kitchen fans that were ducted down through the floor to the outside.

- Some of the newer houses and many fully retrofitted older units had passive vents installed as an attempt to increase the air change and ventilation rate without having to rely on motor driven fans. These passive vents were typically 1½ or 2 inch ABS plumbing pipe that ran through up the floor in an interior wall and exited through a grille near the ceiling on the first and/or second floor of the house.

- Two houses in the group, the storey and a half metal panelised houses, #10 GRP type, have destratification fans that draw air from the upper floor and the warm attic storage space and recirculate it to the main level. These systems have outside air intakes connected to the suction side of the fan to bring in outside air and mix it with the warm destratified air. In the two houses with these systems installed, both were not working or had been turned off.

- All the newer houses and those houses that have undergone major retrofits have had combustion air ducts installed. Some houses have 6 by 10 inch or 10 inch diameter holes through the outside wall, complete with grilles and screening, opening into the boiler rooms. Another approach that has been taken in some houses is to have 6 inch diameter ducts entering the boiler room through the floor and having a combustion air damper that opens before the oil burner on the boiler fires. Most of the boiler rooms that were located within a dwelling had two combustion air inlets, often a combination of a passive hole with a damper on the inlet. The units that had a shared separate boiler room often had only one combustion air inlet. In most cases the combustion air ducts were fully or partially blocked. The occupants often reported that there was concern that the water lines in the boiler room would freeze unless the very cold air was restricted from entering the room.

- In some of the retrofit houses with furnaces there is a 10 inch diameter insulated pipe coming up through the floor into the porch where the furnace is located. This duct was installed so that the top of the duct ends 6 to 7 feet off the floor. Almost all these large ducts were blocked off by fitting a garbage bag over the top of the open end of the duct and weighting it down so that it would not lift off when air flowed into the room.

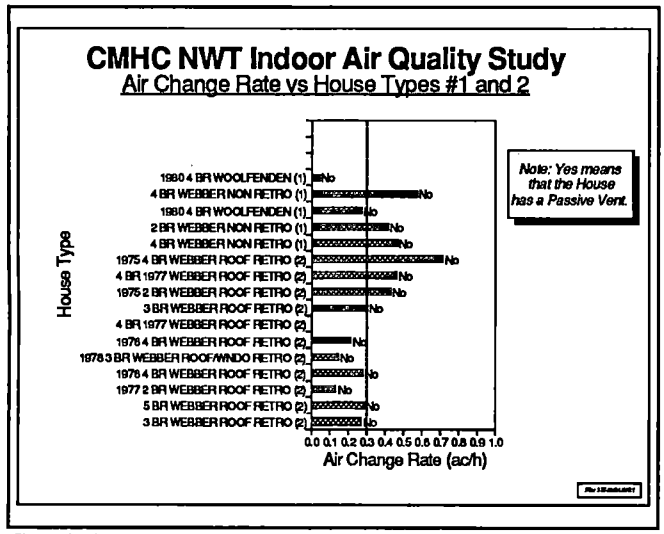
The impacts of these various mechanical system components on the air change characteristics and the indoor IAQ are discussed in detail in Section 4.3.

3.4 Analysis of the Data

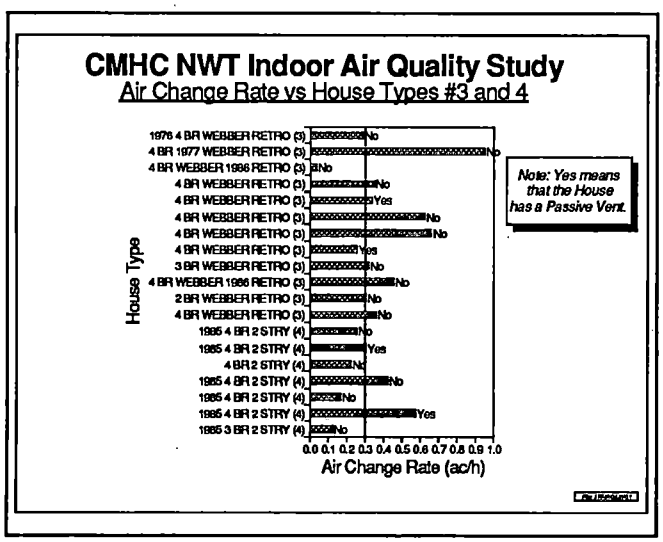
Appin has prepared a series of graphs to see if trends could be established. The full size copies of the graphs are attached in Appendix 6. A description of each graph is followed by an analysis of the results, including possible explanations for the results. *The graphs and descriptions are labelled with the X axis (independent variable) followed by the Y axis (dependant variable).*

Air Change Rates vs. House Types. Graphs 1,2,3,4 and 5 show the air change rates of the houses arranged by house type.

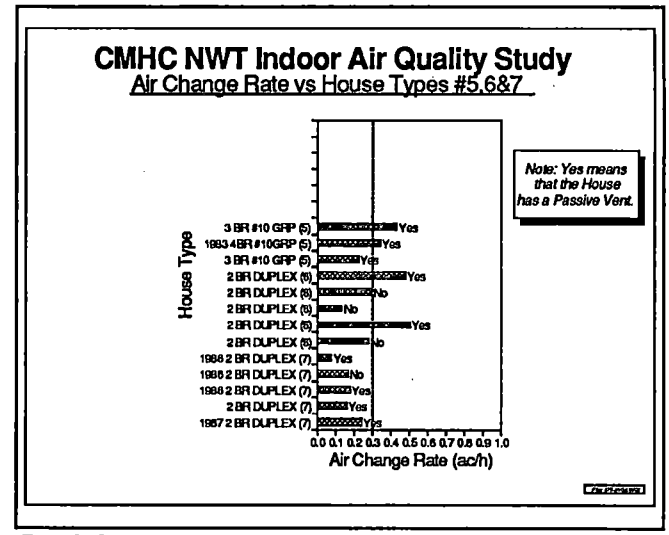
The air change rates are based on the Time Averaged Air Change measurements provided by the PFT/CATS system that was typically run over a



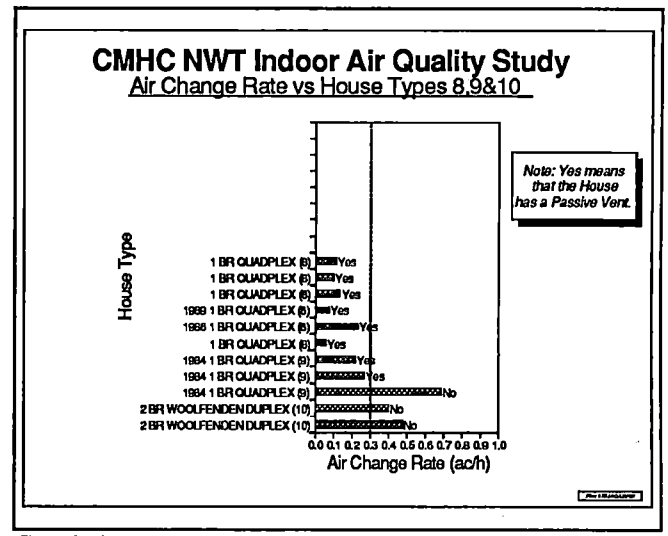
Graph 1



Graph 2



Graph 3



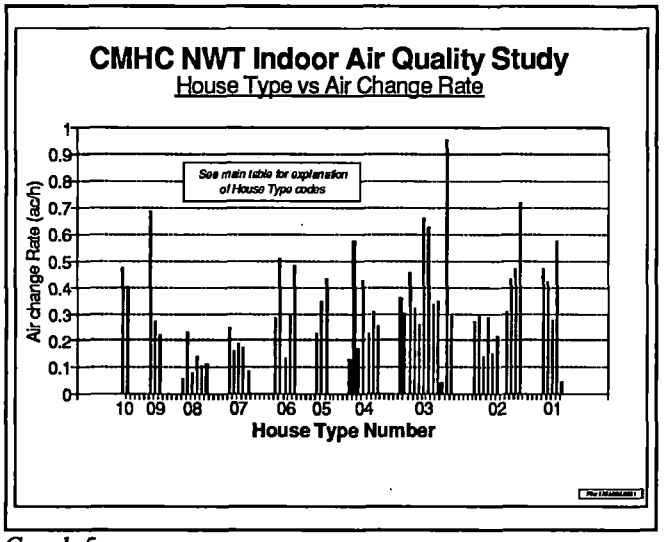
Graph 4

seven day period. Houses that had a passive vent installed are noted with a YES at the end of the bar, while those houses that did not have passive vents installed are noted with a NO at the end of the bar.

The air change rates tend to vary within each house type, but an analysis of the air change rates by house types shows that some newer single family 2 storey houses (type 4) and especially the newer duplex and quadruplex units (types 7 and 8) have average air change rates lower than other types of houses including the Weber houses that have had a complete retrofit. House types 4, 7 and 8 have average air change rates that fall below 0.30 air changes per hour. The line on the graphs at the 0.30 air changes

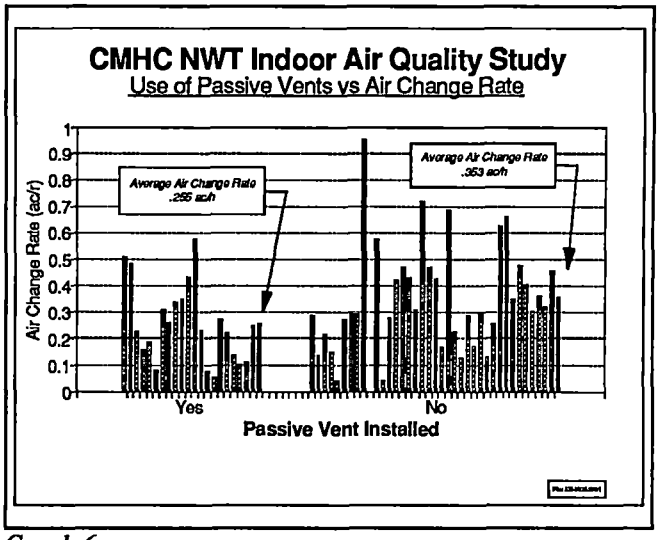
per hour range denotes the new National Building Code (NBC) requirement to have a residential mechanical ventilation system that can ventilate a house to this minimum air change rate. As has been noted, some houses in the study group fall below the 0.30 ac/hr rate, however, most of the houses that did fall below this rate have exhaust fans.

Although the air flows from these fans may be restricted, it is probable that the houses could be ventilated at the 0.30 ac/hr rate through a combination of natural air leakage and the use of the exhaust fans. The houses in the study were built to meet the code requirements at the time of construction, and should not necessarily be expected to meet the requirements of the new codes and standards that have recently been adopted.



Graph 5

Use of Passive Vents vs. Air Change Rates. Graph 6 shows the air change rates of houses with and without passive vents installed as a ventilation measure. Those houses with the passive vents installed tended to be from the newer housing stock or in newly retrofitted older houses. The average air change rate of the houses with the passive ventilation systems was lower than the average air change rate for those houses that did not have the passive system.

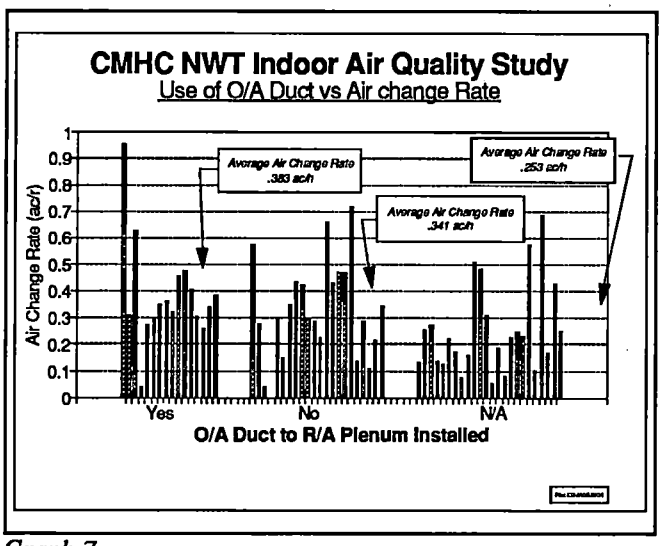


Graph 6

The newer houses tend to have boiler rooms that are separated from the main living areas of the house. Some of the boiler rooms in the newer housing stock are completely isolated from the units and must be entered from outside the units, some must be entered from a common hallway or vestibule between the units, while others are within the unit, but are separated by one or two doors that were most often kept closed. The older housing stock without passive vents and with forced air furnaces tend to have furnaces in back porches. Although these porches have doors to separate the furnace area from the living area, the doors are usually kept open. This means that the older houses without passive vent also have chimney flues that can more easily contribute to the whole house air change rate. The passive vents do not appear to compensate for the fact that the newer houses tend to be more tightly constructed and have little or no access to the chimney flue as a

means of air change.

Use of Outside Air Ducts vs. Air Change Rates. Graph 7 shows the air change rates of houses with outside air ducts to the return air plenums compared to houses that did not have this type of ventilation installation.

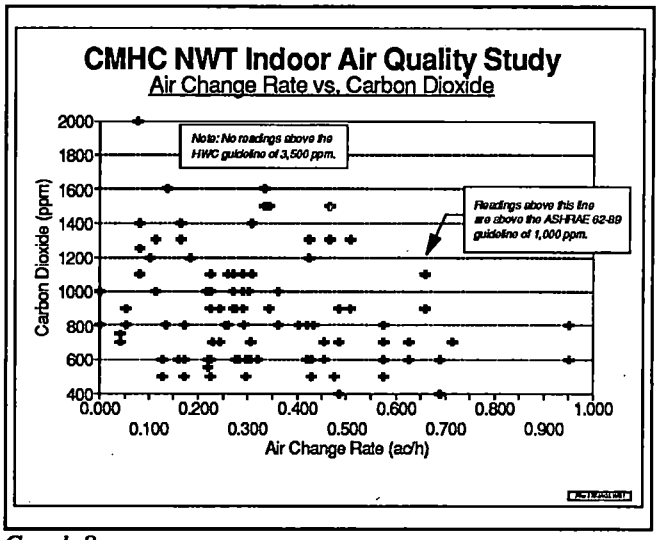


Graph 7

The houses that have the outside air duct to the return air plenum of the forced air furnace have a slightly higher average air change rate than those without this installation. The houses that are in the N/A category are those houses with boilers and radiant baseboard heating systems, rather than forced air heating systems. This type of heating system has been installed in the newer houses and as mentioned above, the units tend to have separate boiler rooms that are not directly connected to the house conditioned space. Again, the lower air change rate could be explained by the fact that the houses are newer and therefore constructed tighter and because the units do not have chimneys that are acting as a means of air change from the conditioned space.

Number of Occupants vs. Carbon Dioxide levels. A graph of this data was produced, but it was not included as the two sets of information are not really related to each other. The data on the spread sheet is related to the number of occupants in the house at nighttime, and not when the spot Carbon Dioxide testing was carried out. The CO_2 testing was carried out by taking spot readings over less than a ten minute period at various times between 8:00 am and 10:00 pm in the day. Thus, the two sets of data cannot be related to each other in any way that is meaningful.

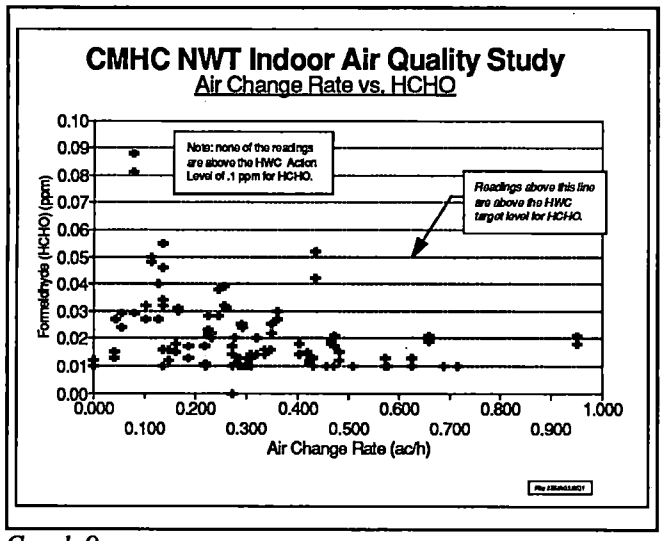
Air Change Rates vs. Carbon Dioxide spot measurements. Graph 8 shows air change rates of the houses related to CO_2 spot readings. This graph shows an inverse relationship. That is, the level of CO_2 decreases as the air change rate increases.



Graph 8

The data on the spot testing for Carbon Dioxide levels shows that none of the houses tested had CO_2 levels above the HWC residential guideline of 3500 ppm. There were some houses that had CO_2 levels over the ASHRAE 62-89 guideline of 1,000 ppm.

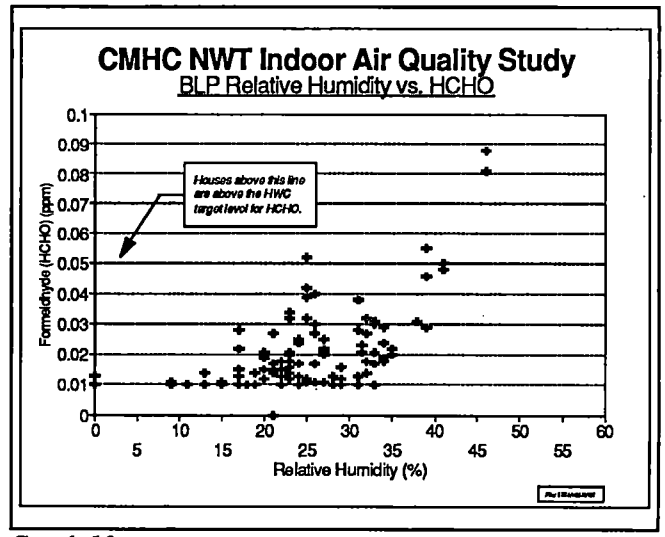
Air Change Rates vs. Formaldehyde (HCHO) levels. Graph 9 shows air change rates of the houses related to the seven day HCHO levels. The graph for HCHO shows an inverse relationship. That is, the level of HCHO decreases as the air change rate increases. The HCHO readings are in pairs as two sample stations were placed in each house.



Graph 9

There are no HCHO readings that are above the HWC action level of 0.10 ppm, but a few were above the 0.05 ppm target level. Three of the four units that have readings over the 0.05 ppm level are newly constructed one bedroom quadruplex units. The fourth unit that has a reading above the 0.05 ppm level is a one and a half storey insulated metal panel unit identified as a #10 GRP type. The levels of HCHO are somewhat low given that the air change/ventilation rate is low in the houses studied. This is most probably because there are fewer Formaldehyde sources found in the Northern houses, compared to those built in the South. The information in the Pollution Source Check List for the houses shows that the houses in the study did not contain much new upholstered furnishings, carpeting, draperies or cabinets that would emit HCHO gas into the indoor environment. Few of the building materials that contain formaldehyde based glues that are used in Southern construction are used in the North. Even the kitchen cupboards, which are normally made in the most part from particle board, are constructed from painted steel and only have laminate covered particle board doors.

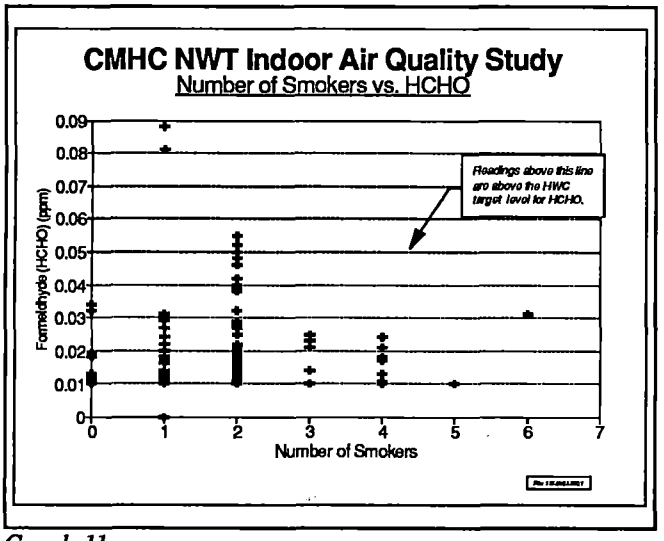
Seven Day Time Averaged BLP Relative Humidity (RH) vs HCHO levels. Graph 10 shows the BLP seven day average RH levels vs. HCHO levels. The graph shows that the houses with the highest RHs also have the highest HCHO values.



Graph 10

This is the classical relationship that has been reported in other studies. As temperature and humidity increase, the outgassing of HCHO also tends to increase from most of the HCHO sources found in residences. If the HCHO source strength is somewhat constant between the group of houses being studied, one would expect to see this relationship between RH and HCHO in this study. Again, note that three of the four houses with the higher readings are newer houses. This means that they still have the potential to have-off-gassing of the HCHO from newer furnishings and from the building materials. These houses are also tighter houses as can be seen in Graph 9.

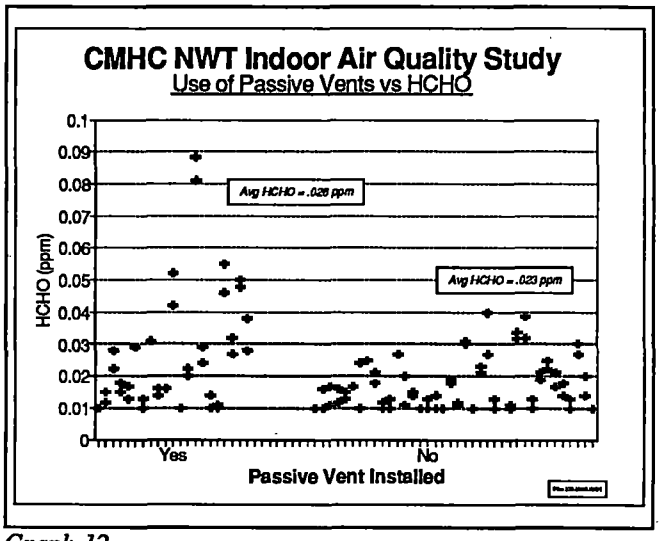
Number of Smokers vs. HCHO levels. Graph 11 shows that there is little relationship between the number of smokers and HCHO levels in the group of houses tested. This suggests that the previous two factors, the rate of air change and the level of RH, are much stronger determinants of the HCHO levels.



Graph 11

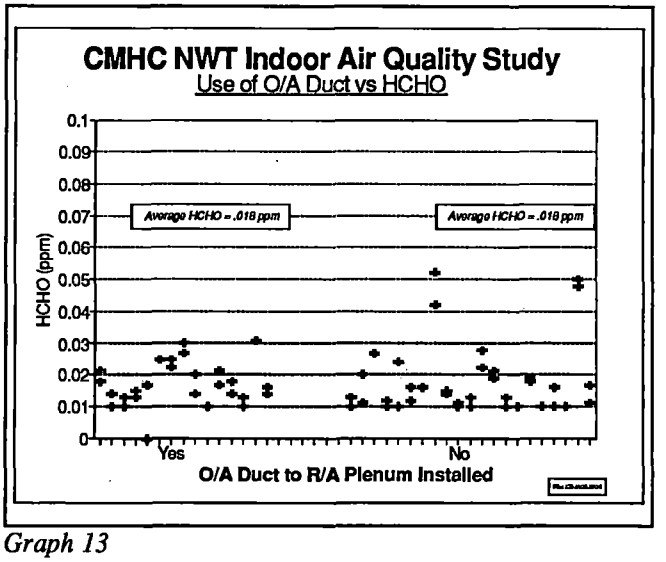
Use of Passive Vents vs. HCHO levels. Graph 12 shows that the houses with passive vents tended to have only slightly higher levels of HCHO than those houses without passive vents. This is most probably because the houses with passive vents still have lower overall air change rates than do houses without the passive vents. As mentioned in the discussion of Graph 6 above, the passive vents did not appear to compensate for the fact that the newer houses are being built tighter with less air change potential. Given this situation, one would expect this graph to show that those houses with passive vents would have higher average HCHO levels than those houses without passive vents.

Use of Outside Air Ducts vs. HCHO levels. Graph 13 shows that the houses with outside air ducts to the return air plenum have the same average levels of HCHO as those houses without the outside air duct. If the high and low HCHO readings are dropped from the averaging calculation on both the with and without situation, the houses with the outside air duct



Graph 12

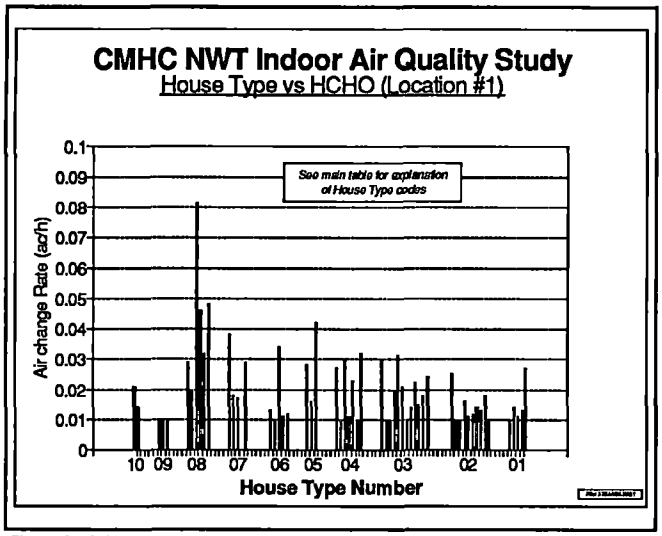
do tend to have lower levels of HCHO. Again, this is to be expected as the air change rates of these houses tend to be slightly higher than those houses with forced air furnaces but without the outside air duct to the return air plenum.



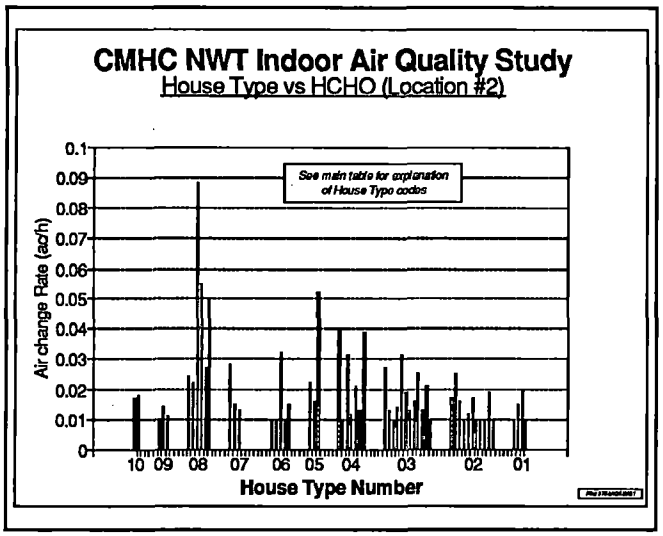
Graph 13

House Type vs. HCHO levels. There are two graphs provided, one for each of the two HCHO sampling locations in the houses. Graphs 14 and 15 show that the newer houses and the completely retrofitted houses of House Types 4, 7, and 8 tend to have higher levels of HCHO than the older houses. House

type 8 is a group of newer smaller one bedroom quadraplexes. As mentioned before, these units tend to be tighter, and one of the units is very new. This is to be expected as the air change rates of these houses tend to be slightly lower than the older houses. The trends for HCHO levels compared to house type appear to be the inverse of the air change rate and house type comparison.

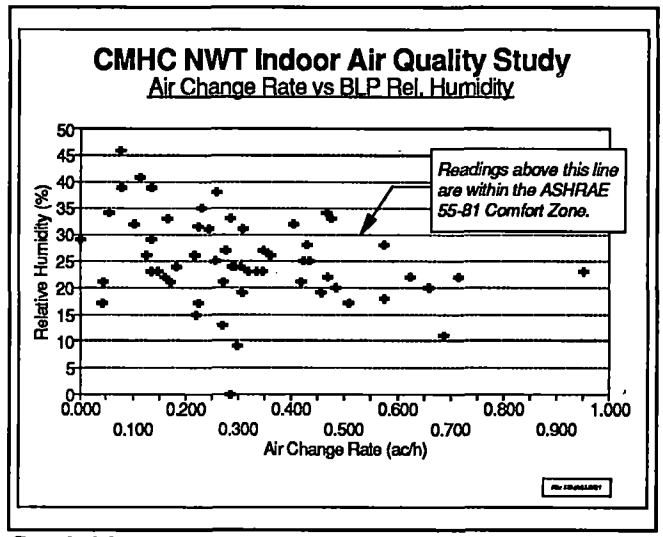


Graph 14



Graph 15

Air Change Rates vs. Seven Day Time Averaged BLP RH. Graph 16 shows air change rates of the houses related to the time average BLP RH measurements. The BLP RH levels show a much weaker relationship to air change rate than do the CO_2 and HCHO levels. There is however a trend for the RH levels to be higher as the air change rate decreases.



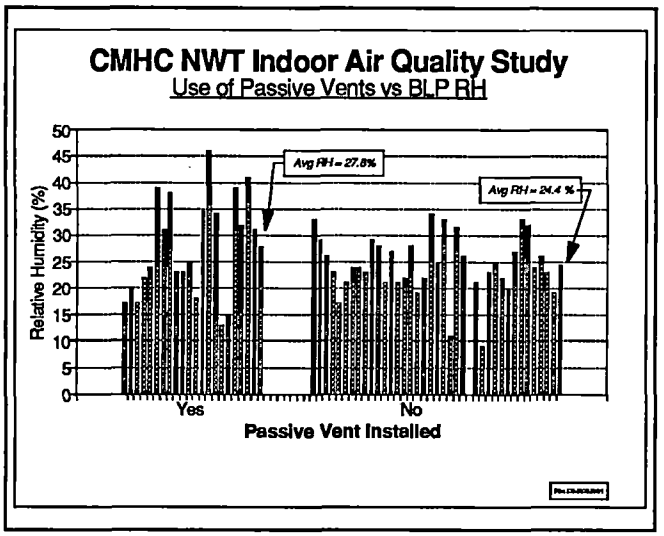
Graph 16

Most houses had RH levels that were below the ASHRAE 55-81 Comfort Zone level of 30% RH. This is not surprising in that the winter climate in the Arctic is especially dry. Even a low level of air change will remove and dilute the moisture that is produced in the houses. If the houses in the study were ventilated at the 0.30 ac/hr rate, few of the houses would have RH levels that would fall within the ASHRAE 55-81 Comfort Zone.

One common moisture source in Canadian houses is the moisture that enters the house through the foundation that is in contact with the ground. This is not a factor in these houses because they are built up off the ground. A few of the houses tested had skirting enclosing the open crawl space under the houses, however, the floor of the house still comprised the main air/vapour barrier and the skirting was not air tight.

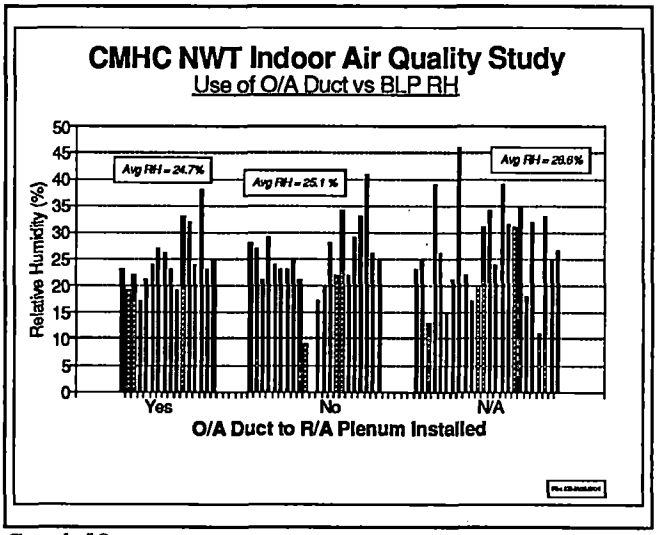
It is important to note that increased RH levels in this climate in houses that do not have a perfect or near perfect air/vapour barrier could lead to very severe damage to the building envelope.

Use of Passive Vents vs. Seven Day Time Averaged BLP RH. Graph 17 shows that the houses with the passive vents tend to have slightly higher average levels of RH than houses with no passive vent installed. Again, this is to be expected because the houses with the passive vents installed tend to have lower air change rates than those houses without the passive vents. The air change rate is the strongest determinant of RH levels in the houses studied.



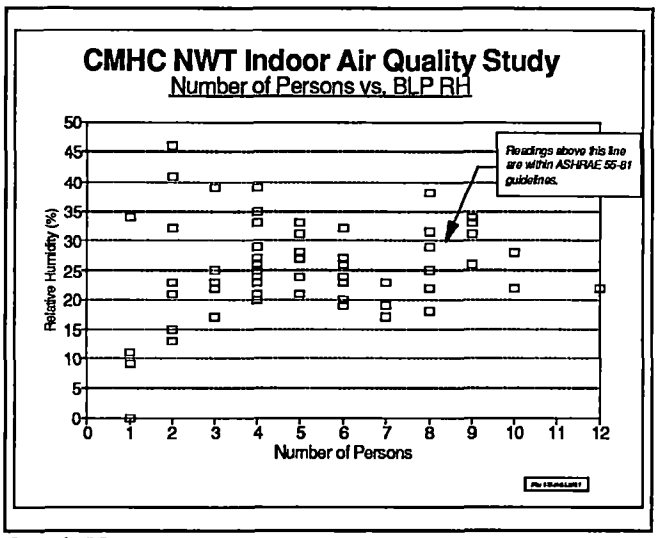
Graph 17

Use of Outside Air Ducts vs. Seven Day Time Averaged BLP RH. Graph 18 shows that the houses with outside air ducts to the return air plenum tended to have slightly lower average levels of RH, although the differences are insignificant and within the realm of experimental error. The houses with outside air ducts to the return air plenum do tend to have slightly higher air change rates and this would suggest that given equal rates of moisture production these houses would have lower levels of RH.



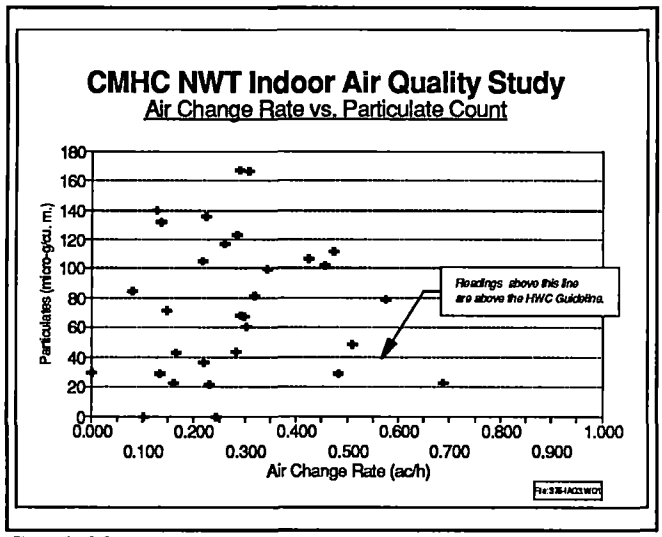
Graph 18

Number of Persons vs. Seven Day Time Averaged BLP RH. Graph 19 suggests that there is no relationship between the RH levels averaged over the seven day period and the number of occupants in the house at night. This suggests that the average RH levels in the houses is much more dependant on the air change rate than on the strength of the moisture source contributed by human respiration and other human activities that produce moisture.



Graph 19

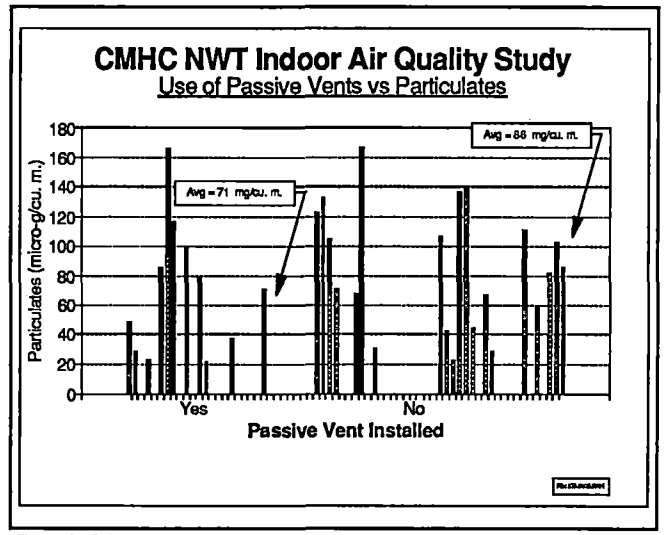
Air Change Rates vs. Particulate Counts. Graph 20 shows air change rates of the houses related to the seven day particulate count. The graph shows an inverse relationship between the air change rate and the particulate count. Increased air change reduces particulate counts in the houses.



Graph 20

Most houses tested had particulate counts that are above the HWC Guideline level for particulates. The occupants complained during the interviews that the houses were dusty, especially during the summer when the vehicular traffic on the unpaved roads in the communities created large amounts of dust outside the houses. However, the testing was completed in the most part during the winter when outside dust was not the problem. One explanation for the high particulate levels may be because almost all houses had occupants that smoked. Another explanation for the high particulate count could be the use of clothing and boots that are made from animal fur, mostly seal and caribou. The skins may be shedding hair and other dust particles. Only two of the houses where particulate levels were above the HWC Guideline levels had occupants who were actively carving soapstone, antlers or tusks in the house. Few occupants of the houses surveyed reported that they did any carving, when asked the question during the pollution source survey.

Use of Passive Vents vs. Particulate Counts. Graph 21 shows the levels of particulates compared to the houses with and without passive vents installed. The houses with passive vents did on average tend to have slightly lower air change rates than those houses that did not have passive vents. This plus the information in Graph 19 would suggest that the houses with the passive vents should have higher particulate counts. This is not what the Graph 20 results show.

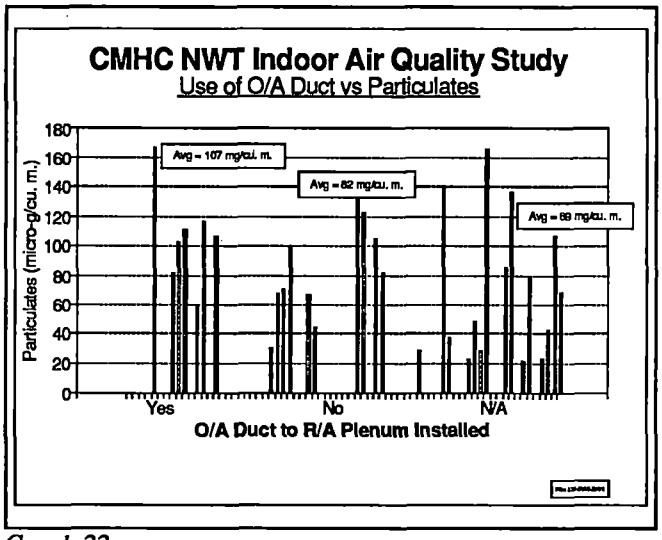


Graph 21

The fact that the houses with no passive vents have a higher average particulate count could possibly be because more of the people living in the older styles of houses that do not have the passive vents are people who still live a more traditional lifestyle. This lifestyle still includes the use of more traditional clothing and the bringing into the house of more fur bearing game that is thawed in the house for used as food.

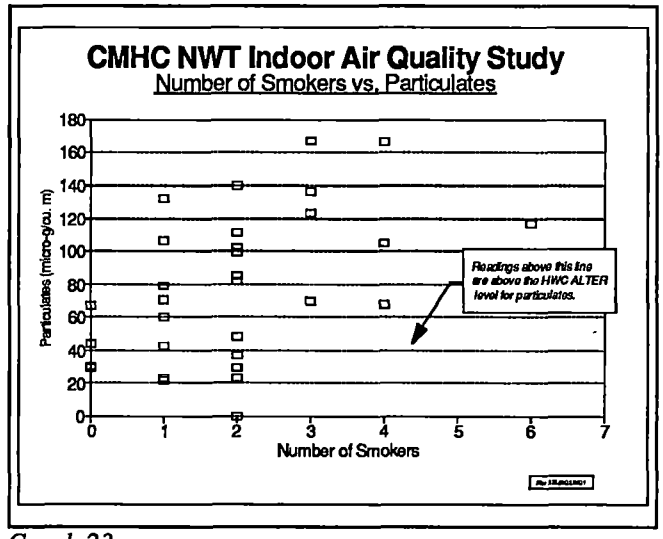
Use of Outside Air Duct vs. Particulate Count. Graph 22 shows that the houses with outside air ducts to the return air plenum have higher particulate counts. This type of outcome would be expected if the testing had been carried out in the summer, when the outside air brought into the house might contain a high level of dust and particulates. However, in the winter this should not be a factor. The fact that

the YES and NO averages are above the N/A averages is probably also because the N/A houses are units that have boilers and baseboard heating. This type of heating system has been found to have less potential for picking up and distributing particulates and dust in the air.



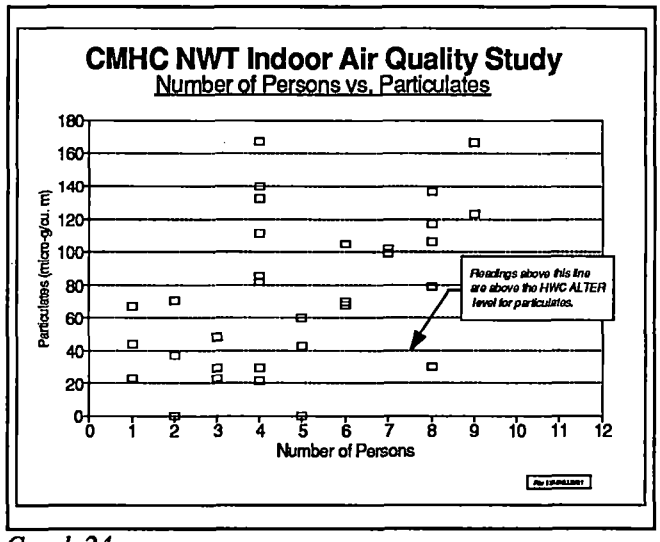
Graph 22

Number of Smoking Occupants vs. Particulate Counts. Graph 23 shows that although there is wide scatter and there are few particulate samples for some groupings, there does appear to be a weak relationship between an increased number of smokers and an increase in the particulate count.



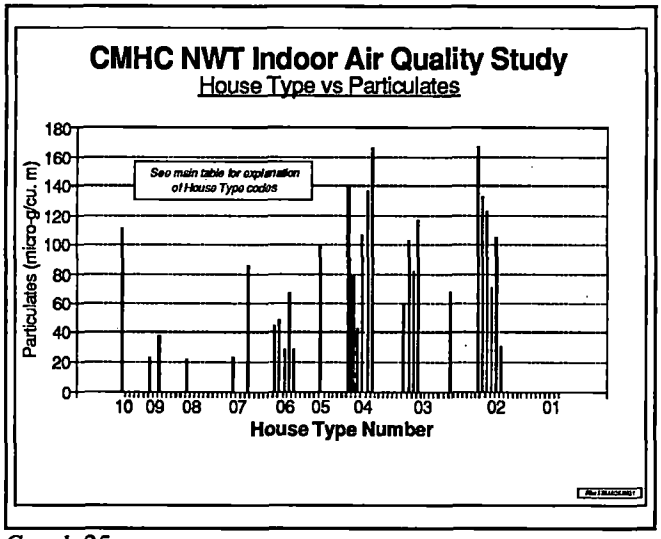
Graph 23

Number of Occupants vs. Particulate Counts. Graph 24 also shows that although there is wide scatter and there are few particulate samples for some groupings, there does appear to be a weak relationship between the number of occupants and the increase in the particulate count. This is to be expected as there is a high rate of smoking among Northern residents and thus the trend for particulate counts versus both the number of smokers and the number of occupants would tend to be the same.



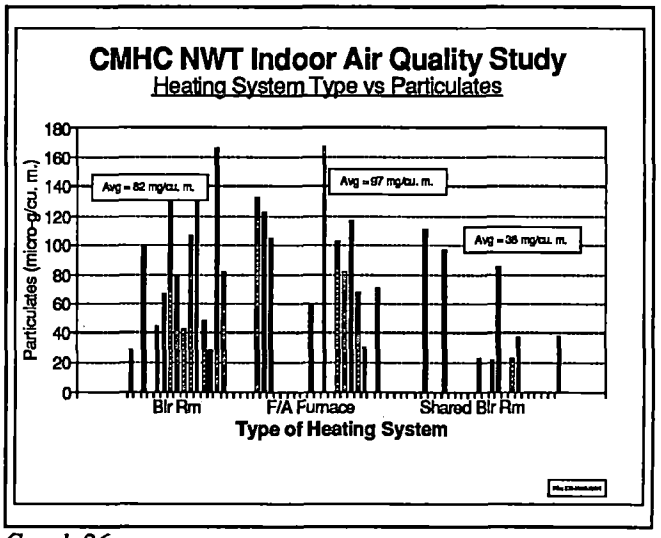
Graph 24

House Type vs. Particulate Counts. Graph 25 shows comparisons the various house types versus the seven day particulate counts. House types 1,2,3 and 10 are houses that have forced air furnace heating systems, while the other houses have boilers and baseboard radiation heating. It is difficult to draw any hard conclusions from the data as there are too few data points in some groupings.



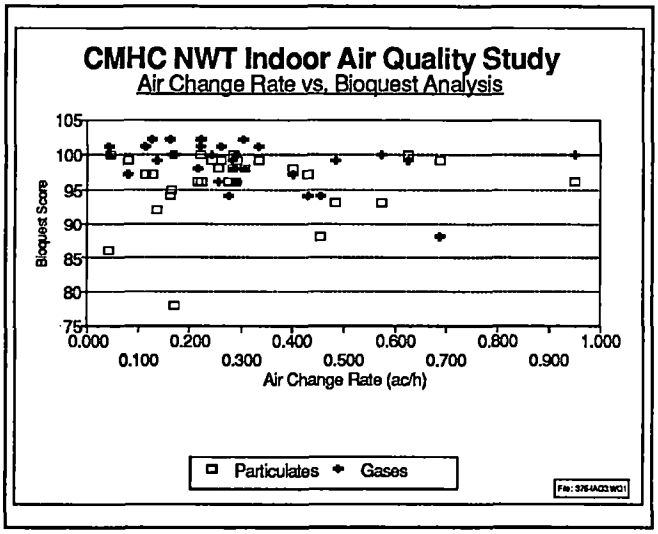
Graph 25

Heating System Type vs. Particulate Count. Graph 26 shows the type of heating system versus the seven day particulate count. The graph shows that the houses with forced air furnace systems tend to have slightly higher particulate counts than the houses with the boiler rooms in the unit or the shared boiler room. The forced air systems have the advantage that they can be used to filter the air. Their disadvantage is that they can pick up and move any dust that is in the air, the house and the ductwork and distribute it into the air in the house. This is particularly true in houses where the filters are not cleaned, changed or even kept in place in the furnaces, which was noted to be the case in many houses included in the study.



Graph 26

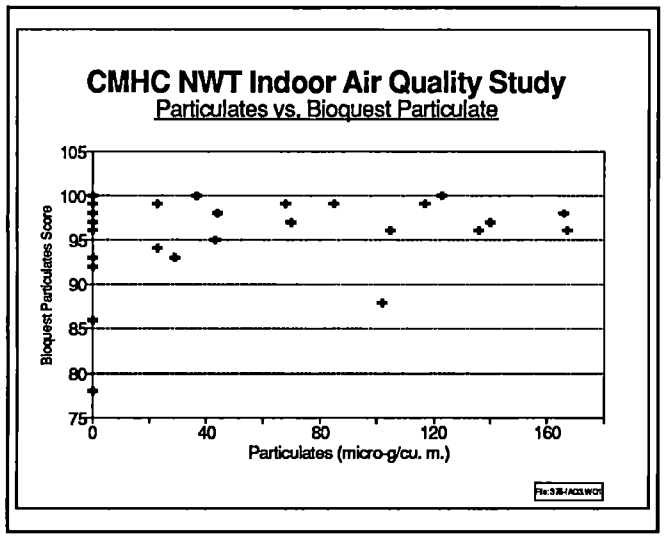
Air Change Rate vs. Bioquest Analysis. Graph 27 shows the results of the Time Averaged Air Change Rate versus the Bioquest Bioassay Analysis. There is some indication that as the house air change rate decreases there is a lessening of the fitness values for the particulate samples. There does not appear to be any strong relationship between the house air change rate and the gas samples.



Graph 27

Bioquest Overall Gas Index vs. measured pollution sources. There was not enough data to prepare this graph.

Seven Day Particulate Count vs. Bioquest Overall Particles Index. Graph 28 shows the seven day particulate count versus the Bioquest Bioassay particulate Index. From the little data that is available there does not appear to be a relationship between the two tests involving particulate. On the graph, the Bioquest fitness values located on the 0 μ/m^3 Particulate line show those houses where there was a Bioquest sampler installed but where there was no seven day particulate samples taken.



Graph 28

Comparison of the Bioquest data to the RCS data. Appin met with Bioquest to review the results. There was not enough data to make any meaningful comparison.

4. PROJECT CONCLUSIONS AND RECOMMENDATIONS

4.1 Pollutants and Sources

The levels of formaldehyde found in the houses were significantly below those expected, given the low levels of air change in the test houses. From the information collected in the Pollution Source Check Lists, the major contributing factor to the low levels of Formeldhyde (HCHO) is because there are few sources of HCHO in the houses. Few houses have extensive areas of new carpeting or draperies. The houses in the study tended to have less furniture than would be found in southern homes. There tended to be little furniture that was made from particle board. Kitchen cabinets installed in the houses have much less particle board content than normally found in kitchen cabinets. This is because kitchen cabinets that have been installed have steel frames and a small area of particle board in the door faces. The one source of formaldehyde that was present in almost all houses in the study was cigarette smoke. Almost all the test houses had occupants that smoked, but from the test results it appears that the cigarette smoke had little impact on the HCHO levels in the test houses.

The levels of particulates found in the houses exceeded the Health and Welfare Canada (HWC) Acceptable Long-term Exposure Range ALTER exposure range of 40 $\mu g/m^3$ in 23 out of the 30 houses tested for particulates. One house tested had levels of particulates that were four times the HWC ALTER guideline level. The potential sources for the particulates in these communities include hair and particles from animal furs that are used as clothing, from carving in one or two instances, from residual summer dust from the road systems in the communities and from cigarette smoke.

Those houses where people prepared skins reported that no chemicals are used in this process. The preparation is mostly carried out by careful scraping of the skin, which is mostly done outside. However, frozen seal, fish and caribou with skins on are often brought inside to thaw out so that it can be cut up for food. This can allow any pests or biological matter to enter the house. Most of the occupants of the study houses used or had on hand items of clothing, most notably the multi-layered kamik footwear, that were made from caribou or seal skins. This footwear is often not removed, or only an outer layer of the multi-layered foot wear is removed upon entering the house. Usually this also means that the skins were prepared and the clothing was sewn in the house. There is the probability that particulates, dust and microorganisms could be brought into the house on the furs and skins that are used for the clothing. Few if any houses had animals that entered the house unless the animal was sick.

One common air quality complaint in all communities was the dust that occurs in the summer time with the all terrain vehicles and the few cars and trucks driving around on the gravel roads in the towns. This was a most persistent complaint in Rankin Inlet, but may have been exacerbated in this community by the extension of the airport runway that had been taking place the previous summer. There is a possibility that some particulates in the houses were residual particles that had entered the houses during the summer and were still resident in the house. Few if any of the households have vacuum cleaners to pick up small dust and dirt particles. The houses were swept and the floors washed often more than twice a week because in many of the more traditional houses there was little furniture and much of the living was done on the floor. This method of cleaning may not pick up some of the fine road dust and particulates.

The analysis of the test results show a link between the particulate counts and the number of smokers reported in the house. It is possible that one of the major contributing sources to the high particulate counts is the particles given off in cigarette smoke. Cigarette smoke contains

particulates has been reported in the literature. Given that almost all study houses had occupants who smoked, this may be major contributing factor to the high particulate counts.

There were no unusual chemical pollutant sources. Household cleaning compounds were those available from the local Bay or Co-op, and included Mr. Clean™, Spic and Span™, laundry detergent, bleach, etc. Powerful cleaners such as oven cleaners were used very much. Most occupants reported that the floors were washed usually once or twice a week. The floors were generally very clean but a few showed some sign of tiles lifting from the water. Many houses where people lived a more traditional lifestyle had little furniture and people sat and lived on the floors, therefore the desire for clean floors.

The radon levels in the houses tested were usually at the lower limits of detection. The vast majority of the houses had no contact with the ground and therefore no potential for soil (radon) gas entry. A few houses did have skirting surrounding the crawl space and a few of the houses were connected to Utilidor systems that were in contact with the ground. In the Series 1 tests half the houses were tested for radon even though only one house had a skirting system around the foundation. These tests indicated that because the houses are all built up off the ground, there was very little potential for radon to enter the houses, even if the radon is present in the ground.

In some houses, especially those older bungalows with forced-air furnaces in a back porch, there was evidence of some fuel oil leakage from the fuel pump or the filter. This was collected in a small can or by the drip pan under the furnace. Because there is a return air grille on the central return plenum in the furnace area in many houses, there is a good probability that the fuel oil vapours are spread throughout the house. Where there was a furnace in a cold porch off the kitchen, the door to this area was most often not closed, especially during the day.

In some houses the fuel oil smell was noticeable upon entering the house. No testing was done for the fuel oil vapours because the special test equipment was not available.

Most occupants reported that repairs to snow machines and three wheelers were not carried out indoors. On one occasion when a return visit was made to a house to collect some additional information, the occupants were outside in near blizzard conditions removing a plugged fuel pump from the snow machine. The fuel pump was then brought inside and cleared of the blockage at the only table in the house - the one in the kitchen eating area. This work was completed on top of rags and paper, but there were obviously residual gasoline compounds in the air. In many houses, spare parts for machines were kept in the back porches, again with the door separating this area from the house not closed and with a return air grille approximately 12 feet away. This probably results in residual oil and gasoline vapours entering the house. There was generally no storage of gasoline or oil in the house or porch as people most often had outside storage sheds.

The biological testing completed using the RCS sampling system showed the presence of microorganisms. Dr. J. D. Miller, Senior Research Scientist with Agriculture Canada, reported that the levels of microorganisms in the RCS samples were within normal limits except for one or two instances where levels of Penicillium species were high. In that particular instance the source of the Penicillium was most probably food wastes that had not been removed and placed in the garbage. The RCS biological samples that were taken in Unit 400 in Rankin Inlet show levels of *Penicillium decumbens* that are within normal limits but elevated in the furnace room/porch of the unit. At the time of the sample collection there was the front half a caribou thawing in this area. The Bioquest samples from this house also showed a low fitness value of 94 - for the test related to gases and 88i for the test related to particulates in the air. Fitness values of between 80 and 88 is an indication of toxic or noxious materials to cause complaints in more than 30% of exposed

individuals. This house had the lowest fitness values of all the NWT Department of Public Works (DPW) houses. However, there are reports of some lower fitness values in some NWT DPW housing units and office spaces that were tested using the same system.

4.2 Conclusions from the Health Questionnaire and related information

The general results of the Series 1 tests and health questionnaires were reviewed with Dr. A. Yassi. She suggested that besides the number of colds and other illnesses reported, the information on the severity of the illness should also be collected. This information may be as necessary as collecting the number of illnesses. Dr. T. Kue Young, Director of the Northern Health Research Unit, Department of Community Health Sciences of the University of Manitoba, has done research that shows that the perceived level of illnesses amongst native populations is lower than the professional interpretation of actual illness. Dr. Yassi suggested that at this stage and later when all the testing was completed, that it may be difficult if not impossible to separate out the effects of Indoor Air Quality (IAQ) on the health of the occupants.

The results of the health questionnaire did not show major problems or symptoms that could be directly attributable to indoor air quality problems. A few cases of chronic headaches were reported, although stress and non-IAQ issues could also be linked and considered as causes of the headaches. Most people reported 1 to 2 "colds" (upper respiratory tract infections) per year, generally at the change of seasons. Most of these "colds" that were reported did not linger longer than expected and were not reported to be more severe in nature than common colds. The length of time that these lasted and their severity were added to the Health Questionnaire in the Series 2 testing.

The reported level of smoking was less than anticipated. However, medical personnel in Rankin Inlet reported that experience shows that people often report the level of smoking that they wished to have, rather than the actual level. It is felt that the actual level of smoking may be twice that being reported.

There may be influences other than IAQ that have a much larger impact on occupant health, especially respiratory system infection. Smoking is one of those influences. It is interesting that the formeldhyde test, which could be expected to be influenced by smoking, generally showed low levels in the test results. The particulate tests do show levels that are higher than expected and these levels may be related to the number of smokers in the houses. One influence that may affect the health and spread of illnesses is that in many of the more traditional homes, people sleep together in common beds. The parents will often sleep with the youngest children, while the older children sleep many to a bed. This may be a result of traditional lifestyle or a lack of furniture, but the possibility for the spread of illnesses is increased because of this factor. Another influence may be that many people spend time on the land in tents in the summer, spring and fall. In these tents, there may be open fires or oil lamps and heaters that subject the people to many higher levels of pollutants than are experienced in the houses. Some traditional hunters spend a good deal of time in these conditions during the winter as well.

A final influence on the susceptibility to breathing related illness is the possibility that the breathing passage linings are not as able to resist infection because the cells lining the passageway are dehydrated. Most houses had indoor RH levels that were below the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) 55-81 Comfort Zone level of 30% RH. Dryness of the air in the winter was a common complaint, but was accepted as a normal condition in these locations. The non-Inuit people seemed to complain more than the local Inuit population. Dr. Yassi pointed out that breathing passage dehydration can be caused not only by dry air, but by dietary factors, medication use and consumption of alcohol.

4.3 Impact of House Characteristics on IAQ problems

The test results show that many houses, especially the newer and the retrofitted houses, have low air change rates. Some newer quadruplexes have air change rates of 0.136, 0.076, 0.113, and 0.054 air changes per hour (ac/hr). Many newer two storey houses and the newer duplex units have air change rates that fall below 0.30 ac/hr. The results of the air change rate testing suggests that even though the newer houses have exhaust fans and passive vents to increase the ventilation air change rates, these systems are not providing the expected air change rate. It appears from the results that the fans are not used often enough to provide additional ventilation and an increased air change rate. The passive vents are also not functioning as expected to provide the additional ventilation.

The newer houses rely on the exhaust fans and passive vents to provide the increase in air change rates, as the oil fired equipment with the active flues that often provide some air change in the house are located in separate isolated boiler rooms. The newer houses have oil-fired boilers with hot water baseboard heating around the whole perimeter of the house. The boilers are located in separate rooms that most often have weatherstripped doors between the boiler room and the rest of the house. The boiler rooms all have at least one combustion air inlet consisting of one or two grilled openings through the exterior walls directly to the outside. Some units have combustion air ducts running up through the floor with motorized dampers on these inlets. The openings through the wall often have been partially blocked with rags and clothing to reduce or stop the entry of the very cold air. In those houses with the motorized dampers, the damper opening was often restricted by placing small boxes or other items under the damper to restrict or limit the amount that the damper could open. Some duplex or quadruplex units have a completely separate boiler room that cannot be entered directly from the house, but require the exit from the housing unit and entry to the boiler room from the exterior or from a common hallway.

All these factors eliminate the ventilation effect that can be provided by a chimney flue as the furnace or boiler send air up the chimney.

The test results show that the older houses have higher air change rates than the newer houses. This probably partially because the older houses are slightly leakier than the new houses, but it is also due to the mechanical systems that are operating in the houses. The older bungalow houses in the most part have oil-fired, forced-air furnaces that are located in the back entrance porches. The forced air furnaces typically have a central return from the bedroom hallway and sometimes from the furnace room itself. The porches have doors that are meant to provide a separation between the porch and the main living areas of the house. In most cases the doors are left open, at least during the day. This means that the chimney flue will function as an air removal device for the whole house. Air to replace that sent up the flue enters the house either through general air leakage, by way of an outside air duct connected to the return air plenum or in the retrofitted units, by way of a combustion air duct if it has not been blocked off. Many newer retrofits of the older Weber housing units include the installation of outside combustion air intakes to the furnace room. The inlet was often plugged because the occupants felt that there was too much cold air entering the house. This means that the furnaces must depend on air leakage into the house to provide the combustion and dilution air that is sent up the chimney when the oil burner is firing. This air will sometimes enter the house via the outside air duct connected to the return air plenum.

None of the houses that were checked had spillage at start-up that lasted longer than 30 seconds, with only a few that spilled longer than 10 seconds. This shows that the furnaces and boilers were able to get the required air even though there no dedicated combustion air ducts or the ducts that were installed were blocked off. This is because the heating systems were all oil fired burners with standard fan forced draft.

Most of the older houses with the higher air change rates have forced air furnaces with outdoor air intakes to the return air plenum. These ducts will bring outdoor air into the house when the furnace fan is running. This is because the duct is connected to the suction side of the main furnace fan, and when the furnace fan comes on the outside air can be drawn into the furnace. The outdoor air is then distributed throughout the house. All the outdoor air intakes are directly connected as opposed to being indirectly connected through a "breather T" connection. Normally this type of direct connection has the potential to positively pressurize the house when the furnace is operating. Because oil fired burners have air supply fans to the burner head that exhaust air out of the house when the oil burner is firing, the direct connection may replace the air sent up the flue. Thus, in these oil heated houses the direct connection may be providing outdoor air to the house and increasing the air change rate without positively pressurizing the house.

Most of the houses have at least one exhaust fan vented to the exterior, most often the bathroom fan. These fans are sometimes very noisy and therefore not used very often by the occupants. The low air change rates in houses that rely on the exhaust fan to provide additional ventilation show that the fans are not used often enough to provide the additional ventilation.

Another factor that affects the additional ventilation that can be provided by the exhaust fans is the exhaust air capability of the fans. In the Series 2 tests, measurements were made of the inlet air flow to the bathroom fans in 15 houses. These measurements were taken at the inlet to the fan and do not consider any leakage of the inlet air back into the house through holes in the fan housing, ducting and duct connections. It was not possible to measure the outlet air flow during this study. In one newer unit in Rankin Inlet, the exhaust airflow of the fan was measured to be approximately 8 L/s (16 CFM). This is from a fan model that is rated at 25 L/s (50 CFM). In all, air flows from 15 bathroom fans were measured and the flows ranged from a low of 4.0 L/s (8 CFM) to a high of 22 L/s (44 CFM). The average air flow from the 15 fans tested was 10.6 L/s (21 CFM). It is probable that these low air flow rates could provide the desired air change rate if they were operated continuously. However, because they create too much noise and because they are not automatically controlled, this is not likely to occur.

Many newer housing units and some retrofitted houses have passive vents installed. The passive vents consist of pipes or ducts that run from an intake located outside under the floor of the house, up an interior wall and then have a 90° elbow on the upper end so that the air can enter the living space in the house through a grille. Some houses have one passive vent in the living room area, others have vents into the bedroom area or each bedroom. The two storey houses often had a passive vent on each level. The size of the passive vent ducts generally ranged from 1½ inch to 2 inch diameter ABS plumbing pipe, although some are larger in diameter.

The newer houses that are being built by the NWTHC are becoming increasingly air tight because of design and construction changes. The passive ventilation systems alone do not appear to compensate for the tighter envelope and the moving of the boilers and chimney flue to a isolated room where it does not remove air from the living space and increase the overall ventilation. The exhaust fans that are being installed may be able to provide an increased ventilation rate when required, although their exhaust capacity is much below a desirable maximum capability. The fact that many of these fans have been disconnected or blocked off is an indication of the noise that they create.

Many occupants, especially those in the newer boiler heated houses, complained of the lack of temperature control. The temperature was very high in some houses. In one house the temperature was around 28 °C on the main floor and had been at that level or higher for many days. The occupant was reporting severe lethargy. They had moved the beds from the upper floor to the main floor of the living room to be able to sleep.

4.4 Recommendations

The exterior building envelopes/shells in new and retrofitted houses in the NWT are being constructed in ways that lead to low air leakage rates. This achievement is desirable in that it reduces the potential for moisture damage to the houses and provides a more comfortable draft free home. Given the severe climate and the high cost of building in the NWT, the protection of the building shell from moisture damage has been a major concern. The designs and construction techniques used has resulted in less air leakage. The only remaining areas where air leakage is still reported to be occurring is at window and door openings. The design of these openings requires further research and design to consider the wind and snow drifting that occurs in this severe environment.

The tighter building envelopes, combined with low passive and active ventilation rates in many newer houses is leading to situations where some indoor pollutant levels are elevated. Formaldehyde, Carbon Monoxide, Nitrogen Dioxide, Sulphur Dioxide and Radon gas levels are low and below the guidelines set by HWC. These low levels are most likely because there are few sources of these pollutants in the houses.

There are elevated levels of particulates in many houses. This may be due to the presence of smokers, animal skins used for clothing, or the result of residual dust from the road systems in the house. The actual sources of the particulates has not been determined. Further research work should be undertaken to determine the sizes and sources of the particulates in the house air. It could then be determined if there is a method that could be used to control the particulates at the source. Work could also be undertaken to determine if ventilation and filtration could be used to control particulate levels at an acceptable cost.

There are elevated levels of Carbon Dioxide in many houses. These levels are not above the HWC guideline levels and are not dangerous levels, but they are above the levels recommended by ASHRAE. Some of the elevated levels were measured in unoccupied, closed bedrooms that have baseboard hot water heating and no method of air exchange to and from the room.

The current ventilation systems, bathroom and some kitchen fans ducted to the outside, with or without passive vents, are not providing the recommended ventilation rates. A possible research project to better understand the extent of the use of these systems should be undertaken. A small timing device could be provide to the local housing maintenance staff. This device could be wired into the wall switch that controls the fans so that the run time are recorded.

Better quality, quieter, low energy usage fans with automatic controls should be considered as potential solution. Some trial work could be done using the existing ducting to the exterior from the bathroom or kitchen fans. A quiet running fan could be retrofitted into the housing and set to run at a continuous low rate. The low speed setting could be bypassed or another fan used to provide high speed or peak ventilation rate requirements. This, coupled with adjustable passive inlets to each room of the house, could provide increased ventilation rates for the removal of indoor pollutants, and better supply and distribution of the outdoor air throughout the house. Because the boiler rooms in the new houses are isolated from the living areas and have combustion air inlets, running the houses in a slight depressurized mode will not cause spillage from the combustion appliances.

There are two major concerns related to increasing the ventilation/air change rates. The first concern is the cost to operate the ventilation system. The electrical energy costs are very high in the northern communities. Therefore the costs to run exhaust fans can be very prohibitively expensive unless care is taken in selecting the fan. There is also the cost to heat the replacement air brought into the house from the outside. The ventilation system should therefore be run at the minimum acceptable rate to control indoor pollutants. The second concern is that bringing in outside air by increasing the air

change rate will result in a lowering of the indoor RH. Even if the house is ventilated at a minimum ventilation rate of 0.20 to 0.30 ac/hr, the house air may need to be humidified to provide minimum acceptable RH levels.

There is some addition IAQ testing that should be considered for future testing. This testing could include:

- This round of Indoor Air Quality testing did not sample for the presence of VOCs (Volatile Organic Compounds). There is increasing information that these compounds are often the cause of indoor air quality problems. Testing for these compounds is recommended.

- The testing completed in this study did not include the testing for the presence of fuel oil vapours in the indoor air. It is recommended that some testing be carried out for these substances to determine the levels present in the houses.

- There is an ongoing problem of sewage gases entering the homes after the sewage holding tanks have been pumped out. When the tanks are pumped out the plumbing traps are sucked dry allowing residual vapours to enter the house. There may be methane present in these gases and this could be a safety as well as a health hazard.

- Because the travel to and from the communities is a major expense when undertaking sampling and testing work of this nature, and because there are now people in the communities that are familiar with the basics of testing, it is recommended that a video presentation on the testing procedures be developed. This would allow local NWT Housing Corporation and Association people to be trained to place and collect the air quality samplers. This approach would reduce the costs of an ongoing IAQ program dramatically.

- The use of the health questionnaire did not point to any direct link between IAQ and illnesses as reported by the house occupants. This may have been due in part to the lack of medical training in those asking the questions and in those persons who acted as interpreters. A valuable followup project would be to identify the houses with the highest level of IAQ concerns. The local Community Health Representatives would then re-administer a health questionnaire and would have the occupants to give their permission to release their health records to qualified medical practioners for proper analysis. Such a project would permit a better evaluation of the potential links between IAQ and occupant illness or health concerns in NWT housing.

LIST OF CONTACTS

Jack MacKinnon
Head, Environmental Health
GNWT
Yellowknife

Mr. MacKinnon provided an introduction to the regional Environmental Health Officers (EHOs) who need to be informed about such studies taking place.

Mike Vadik
Chairman
Keewatin Regional Health Board
Rankin Inlet
GNWT

Mr. Vadik is Chairman of the Health Board and his organisation was helpful is conducting the health survey.

Frank Russell
CEO
Keewatin Regional Health Board
Rankin Inlet
GNWT

Mr. Russell will meet with Mr. Hockman to discuss the IAQ testing to be done and to follow the procedure for house testing and documentation.

Pierce Brewster
Senior EHO
Keewatin Regional Health Board
Rankin Inlet
GNWT

Mr. Brewster will meet with Mr. Hockman to discuss the IAQ testing to be done and to follow the procedure for house testing and documentation.

Marc Acquin
NWT Housing Corp
Project Co-ordinator
Rankin Inlet
GNWT

Mr. Aquin has notified Project Officers in Rankin Inlet and Arviat regarding the selection and testing of houses in these communities. He has arranged for an interpreter to accompany the testing team in each community.

Alan Robinson
NWT Housing Corp
Project Co-ordinator
Arviat
GNWT

Mr. Robinson is a Project Officer in Arviat and will accompany the testing team in this community. He will be responsible for collecting the samplers, the final data and for shipping this material to Appin.

Lou Banel
NWT Housing Corp
Rankin Inlet
GNWT

Mr. Banel is a Project Officer in Rankin Inlet and will accompany the testing team in this community. He will be responsible for collecting the samplers, the final data and for shipping this material to Appin.

Dick Bushell
Director
Design Services
Construction/Development Division

Mr. Bushell arranged for the houses to be surveyed by Appin.

David Miller
Agriculture Canada
Ottawa

Mr. Miller is lending CMHC an RCS microbiological sampler for use in this project and will be analyzing the kits at no charge.

Ted Nathanson
Public Works Canada
Ottawa

Mr. Nathanson will be assisting Appin with the RCS protocol.

Dr. Peter Scarsfield
Northern Medical Unit (NMU)
University of Manitoba
Winnipeg

Dr. Scarsfield is Assistant Director of the NMU which is under contract with Heath and Welfare Medical Services to provide doctors to the NWT and to selected Indian Bands in Northern Manitoba.

Dr. Lisa Lugtik
Rankin Inlet, NWT

Dr. Lugtik is the doctor for Rankin Inlet, Whale Cove, and Chesterfield Inlet.

Dr. Mike Figursky
Churchill Health Center
Churchill, MB

Dr. Figursky is the doctor at the Health Center which services Arviat and Baker Inlet.

Dr. Brian Fennimore
Cambridge Bay Health Center
Cambridge Bay, NWT

Dr. Fennimore is the doctor at the Health Center which services Cambridge Bay, Gjoa Haven, Pelly Bay, Spence Bay, Coppermine and Holman Island.

Linda Peemik
Mayor
Arviat, NWT

Ms. Peemik is also on the local community health committee and is an important contact in the community.

Livinia Brown
Mayor
Rankin Inlet, NWT

Ms. Brown is an important contact in the community.

Mr. John Butler
(formerly Technical Officer)
CREO Office, EMR
Yellowknife, NWT

Mr. Butler was responsible for organising the IAQ testing and monitoring of R-2000 houses in he NWT. The testing and monitoring of these R-2000 houses plus a selection of standard houses for comparison is in the R-2000 data base. Mr. Butler had related some of the problems he had in undertaking the IAQ testing in remote communities.

Mr. Peter Piersol
Mr. Jim Collins
ORTECH
Toronto

These individuals related some of the problems that have been experienced with samples returned that had no location or date or time marked on the testers. He also provided additional information on the use of the PFT/CATS system regarding the placement of the emitters and receivers in the different house types. ORTECH also provides the formeldhyde and particulate testers used in this project.

The following is a list of the main contacts in the district offices of the NWTHC and in the local Housing Association offices. This list does not include all the people, such as the many Housing Association management, office and maintenance staff in the communities that provided assistance. This list includes some of the contacts from the Series I testing in November of 1989.

Keewatin District NWT Housing Corporation Staff

Peter Scott
Manager, Keewatin District
Northwest Territories Housing Corporation
Bag 5000,
Eskimo Point, N.W.T.
X0C 0E0

Alain Barriault P. Eng.
Maintenance Manager
Keewatin District
Bag 5000,
Eskimo Point, N.W.T.
X0C 0E0

Alan Robinson
Project Officer
Keewatin District
Bag 5000,
Eskimo Point, N.W.T.
X0C 0E0

Lewis Bonnell
Project Officer
P.O. 27,
Rankin Inlet, N.W.T.
X0C 0G0

Mark Aquin who has now left the Territorial Housing Corporation.

Baker Lake Housing Association Staff

Ruth Smith
Housing Manager
Baker Lake Housing Association
P.O. Box 02
Baker Lake, N.W.T.
X0C 0A0

Chesterfield Inlet Housing Association Staff

John Wallace
Housing Manager
Chesterfield Inlet Housing Association
Chesterfield Inlet, N.W.T
X0C 0B0

Rankin Inlet Housing Association Staff

Joan Kalaserk
Tenant Relations Officer
Rankin Inlet Housing Association
Rankin Inlet, N.W.T.
X0C 0G0

Arviat Housing Association Staff

Hanna Muckpah
Tenant Relations Officer
Arviat Housing Association
Arviat, N.W.T.
X0C 0E0

Kitikmeot District NWT Housing Corporation Staff

Larry Roche
Regional Project Co-ordinator, Construction
Northwest Territories Housing Association
Box 90,
Cambridge Bay, N.W.T.
X0E 0C0

Coppermine Housing Association Staff

Lucy Maniyogana
Coppermine Housing Association
Coppermine, N.W.T.
X0E 0E0

Jimmy Miyok
Tenant Relations Officer
Coppermine Housing Association
Coppermine, N.W.T.
X0E 0E0

Cambridge Bay Housing Association Staff

Steve Bedingfield
Manager
Cambridge Bay Housing Association
Cambridge Bay, N.W.T.
X0E 0C0

Sylvia Shaw
Cambridge Bay Housing Association
Cambridge Bay, N.W.T.
X0E 0C0

Gjoa Haven Housing Association Staff

Jacob Keanik
Tenant Relations Officer
Kikitak Housing Association
Gjoa Haven, N.W.T.
X0E 1J0

John Nahalolik
Maintenance Supervisor
Kikitak Housing Association
Gjoa Haven, N.W.T.
X0E 1J0

APPENDICES

APPENDIX 1

FORMS PACKAGE

REL-FORM.375

Date:_____

I, _____, consent to have my home to be used in an indoor air quality survey sponsored by the Government of the North West Territories (GNWT) and Canada Mortgage and Housing Corporation on the following terms.

1. I grant permission to Appin Solar Associates Inc to collect the required data (ELA measurements, various IAQ samples, takeoffs for HOT-2000) and to conduct the required tests (MAPP, combustion venting, natural air change tests).

2. Appin Solar Associates Inc agrees that Appin will at all times hereafter indemnify and save harmless the GNWT or Canada, Mortgage and Housing Corporation from all claims and demands, suits or actions or claims for contribution and indemnify howsoever brought in respect of or arising out of any action taken against Appin as a result of the attendance of Appin staff in my home.

3. This information has been gathered for research and educational purposes to be used to further knowledge on this subject and I grant a Royalty free right to the GNWT and Canada, Mortgage and Housing Corporation and to Appin Solar Associates Inc., the firm responsible to CMHC for this project, to publish this information and to use any photographs taken during the course of this project in reports, training courses and displays.

4. I understand that in return for my participation in this project that I will receive a copy of the results of any testing done.

5. I grant access to my energy consumption records for a period of one year before and after the date shown on this release form.

Signature:_____ (Housing Association/Authority)

Signature:_____ (tenant)

Address:_____

Unit No.:_____

Phone:_____

per_____
Authorised Signing Officer of
Appin Solar Associates Inc

ᐅᐸᓗᐊ:_____

ᐅᐱᖏ,_____, ᐊᖏᕐᓂᖏ ᐃᒪᓗᒃ ᐊᑐᕐᑕᐅᕐᓯᐸᓗᔪ ᐃᓗᐊᓂ ᓯᓚ ᖃᓚᐃᕐᑕᐊᒪᖏᓂᒃᑐᒃ ᖃᐅᔨᓴᕐᑕᐅᕐᓯᐸᓗᔪ ᑎᓕᓯᓱᒪᒃᑕ ᓚᓇᕐᑎᐊᐸ ᑲᑎᒪᓯᖏᓂ ᐊᒪᓚᓗ ᑲᓇᑕᐅᐸ ᐃᒪᓗᓕᔨᓴᕐᔪᐊᓯᖏᓂ ᐅᓯᐊᓂ ᐱᓕᕆᔨᖏᓂᕐᓂᑐᓂ.

1. ᑕᓯᐊᓂ ᐊᖏᕐᕋᒃ **Appin Solar Associates Inc.** ᐊᖏᕐᕋᒃᑐ ᖃᐅᔨᓴᕆᐊᖃᖏᕐᑕᓂᒃᑐᒃ ᖃᐅᔨᓴᓴᓯᐸᓗᑎᓂ ᐊᒪᓚᓗ ᐱᓕᕆᐊᕆᓚᓐᓂᕐᕈᒃ ᐃᒪᓗᐸ ᐃᓗᐊᓂᕐᑐᓂᒃ ᓯᓚ ᐊᒪᓚᓗ ᓯᓚ ᓯᓚᑎᕐᑐᓂᒃ ᖃᓚᓂᒃ ᐊᑕᐅᑎᖏᕐᕋᖏᓐᓂᕆᐊᖃᖏᓂᒃᑐᒃ.

2. **Appin Solar Associates Inc.** ᐊᖏᕐᕈᒪᔭᓂ ᑕᓯᐊᓂ **Appin**-ᓯᓂ ᖃᐅᔨᓴᓕᐅᕐᓗᑎᒃ ᐊᖏᐅᒪᖏᓂᑐᖃᖅᕐᓂ ᐊᓐᓂᕐᔪᓚᓯᐊᕐᓂᐊᖏᓚᓂ ᓚᓇᕐᑎᐊᐸ ᑲᑎᒪᓯᖏᓐᓂᒃ ᐅᑭᓗᓂᒃ ᑲᓇᕐᑕᐅᐸ ᐃᓗᐊᓂᕐᑐᓂᒃ ᐃᒪᓗᓕᔨᓴᕐᔪᐊᓯᖏᓐᓂᒃ ᑐᓴᕐᕋᕐᓗᑎᒃᓂᓐᓂᒃ ᐱᑎᐊᕐᓯᓗᑎᒃᓂᓐᓂᒃ, ᐃᖃᑐᐃᓚᓯᖏᑎᓐᓚᓚᓯᐊᕐᓂᐊᖏᓚᓂᓪᓗ ᖃᓄᑐᐃᓐᓇᖅ ᐅᑭᓗᓂᒃ ᑕᓯᐊᓂ ᓇᓗᓇᐃᕐᑐᐃᔪᓂ ᖃᐅᔨᓴᒥᓐᓂᒃ ᐱᓕᕆᔨᖏᓂᕐᓂᑐᓂᒃ ᐊᔪᕈᐃᑎᖅᑐᖃᖅᕐᓂᐊᖏᓚᓂ ᑕᒪᑭᓂ ᐃᓐᓇᓇᐃᕐᑐᐃᓐᓇᖅ.

3. ᑕᒪᓐᓇ ᑐᓴᒃᑲᒪᔨᔪᖅ ᑲᑎᒪᔨᖅᑐᖅ ᑲᐅᔨᓴᕈᑕᐅᓯᓗᓂ ᐊᒪᓚᓗ ᐃᓕᓐᓂᐊᕈᑕᐅᓂᖅᓯᑦ ᐱᓕᕆᖃᖅᓯᓂᓂ ᐊᖏᕈᐅᒪᓴᕐᓂᕐᓯᓯᐸᓗᑎᓂ ᑕᒪᓕᐊᑕᓂ ᐊᑐᑕᐅᓂᖅᑎᓂ ᐊᒪᓚᓗ ᐊᖏᕐᕋᒪᓕᖅᓂᖅᑐᖅ ᐃᑲᔪᕐᑐᖅᓯᓐᓂᒃ ᑕᓯᐊᓂ ᓚᓇᕐᑎᐊᐸ ᑲᑎᒪᓯᖏᓐᓂᒃ ᑕᒪᓕᐊᑕᓂ ᐊᑐᑕᐅᓂᖅᑎᓂ, ᐱᓕᕆᖃᖅᓯᓂᓂ ᑲᓇᕐᑕᐅᐸ ᐃᓗᐊᓂᕐᑐᓂᒃ ᐱᓕᕆᔨᖏᓂᕐᓂᑐᓂᒃ ᐃᓗᐊᓂᕐᑐᓂ, ᖃᐅᔨᓴᕐᓂᐊᓗᑎᒃ ᑐᓴᒃᑲᒪᔨᔪᖅ ᑎᑎᕋᓚᓂᕐᓗᔪ ᐊᒪᓚᓗ ᐊᑕᐅᓂᐅᓚᓚᓂᒃ ᐃᓕᓐᓂᐊᕈᑕᐅᓂᖅᑎᓂᒃᓂᓪᓗ ᑎᑎᕋᓚᓂᒃ ᑕᓯᐊᓂᕐᑐᓂᒃ ᐃᓐᓇᓇᐃᕐᑐᐃᓐᓇᖅ.

4. ᐊᖏᕐᕈᒪᔭᓐᓇᓗ ᐅᓚᕋᑎᓂᒃ ᐊᑐᖅᓂᐊᖅᓂᕆ ᖃᐅᔨᓴᕐᑕᐅᕐᓯᐸᓗᔪ ᐅᑭᐅᔪᑦ ᐊᑕᐅᓯᕐᔪᐅᕐᓗᑎᒃ ᑎᑭᓂᖅᓂᕐᓗᔪ ᐊᒪᓚᓗ ᖃᖅᑎᖅᑎᕐᓗᔪ ᑕᒃᓯᐅ ᑎᑎᕋᕐᕕᒃᓚᑎ ᑎᑎᕋᕐᕈᒪᓚ,ᓴᖅ ᐅᐸᓗᖅ.

ᐊᑎᓕᐅᕐᕋᐃᒃᑐ:_____ (ᓚᓇᓕᑦ ᐃᓗᐊᓂᕐᑐᓂᒃᑐᖅᓂᖅᑎᕐᑐᖅ)

ᐊᑎᓕᐅᕐᕋᐃᓕ:_____ (ᐃᓗᐊᖅᑎᕐᑐᖅ)

ᑐᕆᑎᐅᖅᑐᒃ:_____

ᐃᓗᐊᓂᑦ ᓓᓚᐅᑦ:_____

ᐅᖅᓗᑎᖅᑐᒃ:_____

ᐊᑦᑕᐅᓴᕐ_____
ᐊᑎᓕᐅᕐᕋᑎᐅᔪᖅᐊᑎᓕᐅᕐᕋᓗᓂ
Appin Solar Associates Inc.-ᓯᓚᓂᖅᑎᕐᑐᖅ

IAQ Test Control Form

1. Introduction to homeowner/explain test protocol

   Name_____

   Address_____

   Town_____ Postal code_____

   Phone (_____) _____

   QUEST START DATE_____ TIME_____

2. Get release form signed and generate Appin Survey number.

   Number_____ Release form signed_____

3. Test for CO_2 in living/kitchen space and note # of people, smoking.

   # smoking_____

   CO_2 test #1_____ppm location_____

   (If necessary)
   CO_2 test #2_____ppm location_____

4. Set up Psychrodyne RH and temperature measurements and note results. Set up recording thermograph if required.

   RH_____Room_____

   Tmp_____Room_____

   Recording Thermohygrograph #_____

5. Check layout of house and note house plan type.

   house plan type_____

6. Complete Occupant Interview and initial when done.

   Occupant Interview done_____

7. Complete Health Questionnaire and initial when done.

   Health Questionnaire done_____

   Short form_____ Long Form_____

8. Complete Pollutant Source Checklist and initial when done.

   Pollution Source Checklist done

9. Complete House Inspection form and Leak Location Checklist and initial when done.

   Inspection form done_____

   Leak Location Checklist done_____

10. Complete Combustion Spillage Pre-test and run full Venting Systems test if house fails pre-test.

    Pre-test done_____ Results_____

    Vent Systems test done_____Results_____

11. Test for NO_2 at furnace and note results.

    NO_2 test #1_____ppm

    NO_2 test #2_____ppm

12. Test for SO_2 at furnace and note results.

    SO_2 test #1_____ppm

    SO_2 test #2_____ppm

13. Test for CO at furnace and note results.

    CO test #1_____ppm

    CO test #2_____ppm

14. Test for CO_2 in sleeping area (if necessary).

    CO_2 test #1_____ppm

    CO_2 test #2_____ppm

15. Complete Blower door test (if possible).

    Blower door test results available____

16. Set up PFT/CATS air change system and note sampler numbers. Complete PFT/CATS forms.

    Start Date_____ Time_____

    Forms done_____

    Sampler number _____

    Sampler number

17. Set up Radon/Particulate tester and note pump number.

RAD pump number_____

Start Date_____ Time_____

Location in house_____

18. Set up Bioquest sampler (if required) and note sampler number.

Bioquest sampler number_____

Start Date_____ Time_____

Location in house_____

19. Set up BLP 7 day RH sampler and note id number.

BLP Id number_____

Start Date_____ Time_____

20. Set up HCHO sampler and note Appin survey number and location for both kits.

Kit #1 Loc_____ Kit #2 Loc_____

Start Date_____ Time_____

Forms done_____

21. Take RCS measurement and note start date.

RCS sample number_____

Start Date_____ Time_____

22. Take interior photos of moisture damage, pollution source problems and other house problems.

Initial when photos done_____

23. Take exterior photo of house.

Initial when photos done_____

24. Thank occupants for their time, get address and ask if they do not mind having further testing done. Try to get co-operation in all cases.

Occupant agrees to further tests_____

QUEST STOP TIME_____

Sample Collection Procedures

25. After 7 days, unplug the Radon/Particulate tester. Remove the filter with tweezers and put filter in the filter holder. Pack the pump back into its plastic bag. Note the stop date and time on this form.

Stop Date_____ Time_____

26. After 7 days, collect the Bioquest samplers, put the caps back on the samplers and tape the caps into place. Repack the samplers. Note the stop date and time on this form.

Stop Date_____ Time_____

27. After 7 days, collect the BLP RH sampler, put the caps back into place and repack into the container. Record the stop date and time on the package and on this form.

Stop Date_____ Time_____

28. After 7 days, collect the two HCHO samplers. Replace the caps which were kept on the back of the sampler. Record the stop date and time on the sampler and on this form.

Stop Date_____ Time_____

29. After 7 or 14 days (as specified by Appin), collect and pack the recording thermohygrograph.

Stop Date_____ Time_____

30. After 7 or 14 days (as specified by Appin), collect the PFT/CATS air change system. Cap the receivers and put into the plastic bags. Pack the emitters and put into SEPARATE plastic bags. Note the stop date and time on this form. **PACK AND SHIP RECEIVERS AND EMITTERS SEPARATELY.**

Stop Date_____ Time_____

31. **When you are finished collecting the samplers for your community,** please make a copy of this completed control form for your records and fax this form to Appin Associates at 204-488-4156. Please pack all the samplers in the cartons provided and return the original completed form with the samplers. PACK AND THE EMITTERS SEPARATELY.

FOR ALL SAMPLES: Carrier_____

Waybill number_____

FOR EMITTERS ONLY: Carrier_____

Waybill number_____

Thanks for your help. If you have any questions or problems, please call:

APPIN Associates
2nd floor, 472 Academy Rd
Winnipeg, R3N 0C7
Tel: 204-488-4207

John Hockman, B.E.S.
2nd Floor
472 Academy Road
Winnipeg, MB
R3N 0C7

Fax (204) 488-4156
Tel (204) 488-4207

APPIN

Sampler Collection Notes: PLEASE REMEMBER

1. The date and time of removal of the sampler must be written on the sampler or the plastic ziploc bag label.

2. The caps, especially the yellow and red ones, must be pushed on slowly. They must be pushed all the way in so that they will not fall off.

3. Make sure that the tops of the two glass bottles with screw caps are tightly sealed. These are the samplers that are inside the little brown envelopes. You will find the caps inside the envelopes. Please use the silver foil tape to tape the cap of the glass bottle with the liquid inside of it.

4. The little black pumps should be unplugged, and the aluminum top unscrewed so that the white circle of paper that is inside can be removed and placed inside the round, plastic holder. Please make sure that only the paper, not the rubber washer or the metal behind the paper, is placed inside the plastic holder. Try to keep all dust and dirt that is on the paper from falling off until the paper is placed inside the plastic holder. Tape the plastic holder shut with scotch tape.

5. The little glass tube with the two black rubber caps cannot be kept in the same bag as the little gold or red metal tubes. When collecting the glass tubes please remove the wire spring from the glass tubes, put the rubber caps on the tube and then place each tube in a separate plastic bag and label the time and date. Next, take down the red metal tubes and place them in a separate bag which should be kept out in the porch of each house. All the gold and all the red metal tubes can be kept in separate bags, but again it should be mentioned that these tubes cannot be in the same space as the glass tubes. After collecting the samplers from each house keep the small glass tubes and the other samplers in the office until they are ready to be shipped to the above address. Keep the bags of red and gold metal tubes outside of the office (It does not matter if they freeze). The red and gold metal tubes must be shipped back to **APPIN** two weeks after all the other samplers have been shipped.

Once all of the samplers have been collected from all the houses and you have checked that all of the dates and times are written on the bags, pack the samplers so that they will not get broken during shipping and then send them by air freight to **APPIN** at the above address.

RESPONSIBLE RETROFIT PROGRAM

OCCUPANT INTERVIEW

MOISTURE CONTROL

Number of people at home:

_____ Day _____ Night

Average indoor temperature in living areas:

_____ Day _____ Night

Average indoor temperature in basement:

_____ Day _____ Night

Is furnace blower or circulating pump of boiler operated continuously in winter?

☐ Yes ☐ No ☐ N/A or don't know

Is kitchen fan too noisy for regular use?

☐ Yes ☐ No ☐ N/A

Does house have a humidifier that works well?

☐ Yes ☐ No ☐ N/A

Are floors wet-mopped more than once per week?

☐ Yes ☐ No

Is clothing hung indoors to dry during winter?

☐ No ☐ Occasionally ☐ Frequently

Does the basement experience flooding in wet weather?

☐ No ☐ Occasionally ☐ Frequently

Tell Tale Signs Of Moisture Problems

Have you noticed any of the following:

Mould growth and dark staining on lower edge of glass?

☐ None ☐ Some ☐ Frequent

Moisture pooling on window sills or staining from moisture run-off?

☐ None ☐ Some ☐ Frequent

Fogging or icing on ⅓ or more of window surfaces during cold weather?

☐ None ☐ Some ☐ Frequent

History of paint peeling on the ceiling below the attic space?

☐ None ☐ Some ☐ Frequent

History of cracked ceiling drywall next to walls (truss uplift)?

☐ None ☐ Some ☐ Frequent

Damp spots around light fixtures or water collecting in light fixtures?

☐ None ☐ Some ☐ Frequent

Condensation at wall corners and on interior finishes?

☐ None ☐ Some ☐ Frequent

Mould and mildew growth on walls and ceilings?

☐ None ☐ Some ☐ Frequent

Musty smells in basement?

☐ None ☐ Some ☐ Frequent

Fogging or frosting between glass?

☐ None ☐ Some ☐ Frequent

Condensation more noticable on upstairs windows?

☐ None ☐ Some ☐ Frequent

Dry skin, chapped lips, bleeding noses, static electricity?

☐ None ☐ Some ☐ Frequent

(If exhaust fans are present)

Water stains around fan intake?

☐ None ☐ Some ☐ Frequent

History of grilles or ducts rusting?

☐ None ☐ Some ☐ Frequent

VENTILATION AND AIR QUALITY

Is bathroom fan quiet enough for regular use?

☐ Yes ☐ No ☐ Maybe

Is kitchen fan quiet enough for regular use?

☐ Yes ☐ No ☐ Maybe

Tell Tale Signs Of Ventilation And Air Quality Problems

Have you noticed any of the following:

Strong acrid odours from basement?

☐ Yes ☐ No ☐ Maybe

Fumes and dust from street gets indoors?

☐ Yes ☐ No ☐ Maybe

Eyes sting indoors?

☐ Yes ☐ No ☐ Maybe

Allergy symptoms indoors?

☐ Yes ☐ No ☐ Maybe

Respiratory health problems occur more frequently when living in this house?

☐ Yes ☐ No ☐ Maybe

COMFORT AND THERMAL EFFICIENCY

What work has already been done to improve insulation levels and eliminate drafts?

PORTION OF HOUSE	ACTION TAKEN	MATERIALS USED	YEAR	COMMENTS

CHIMNEY PERFORMANCE

Tell Tale Signs Of Combustion Gas Spillage

Have you noticed any of the following:

GAS FURNACE:

High indoor humidity?
☐ No ☐ Occasionally ☐ Frequently

Smoke from adjacent chimneys drawn into house?
☐ No ☐ Occasionally ☐ Frequently

Combustion odours next to furnace?
☐ No ☐ Occasionally ☐ Frequently

Stuffy air?
☐ No ☐ Occasionally ☐ Frequently

Smoke alarm operates for no obvious reason?
☐ No ☐ Occasionally ☐ Frequently

Regular headaches or health problems in heating season?
☐ No ☐ Occasionally ☐ Frequently

OIL FURNACE:

Sulphur-like odours in house, especially when furnace blower starts?
☐ No ☐ Occasionally ☐ Frequently

Rumbling noise from furnace/boiler during first minute of operation?
☐ No ☐ Occasionally ☐ Frequently

Heavy soot accumulations inside or around flue pipe and furnace room?
☐ No ☐ Occasionally ☐ Frequently

Higher than expected fuel bills?
☐ No ☐ Occasionally ☐ Frequently

WOOD BURNER:

Difficult to light fireplace?
☐ No ☐ Occasionally ☐ Frequently

Staining occurs on wall and mantle above fireplace?
☐ No ☐ Occasionally ☐ Frequently

Odours or smoke in house during fireplace use?
☐ No ☐ Occasionally ☐ Frequently

Sooty, acrid odours in mornings following fireplace use?
☐ No ☐ Occasionally ☐ Frequently

Health problems (eg. headaches) that might be related to use of fireplace?
☐ No ☐ Occasionally ☐ Frequently

HEATING AND COOLING SYSTEM

What percentage of time is a secondary heating system (eg. wood stove) used for heating the house?

☐ Never ____ Percent ☐ N/A

When was your gas/oil furnace/boiler last serviced **and** tuned?

☐ Within 2 years ☐ 2 to 5 years ☐ >5 years

When was your gas/oil water heater last serviced **and** tuned?

☐ Within 2 years ☐ 2 to 5 years ☐ >5 years

Tell-tale Signs Of Comfort And Heating Problems

Have you noticed any of the following:

Hard-to-heat rooms?

☐ Yes ☐ No ☐ Maybe

Basement can't get warm?

☐ Yes ☐ No ☐ Maybe

Basement is warmer than rest of house?

☐ Yes ☐ No ☐ Maybe

Fuel bills higher than last year?

☐ Yes ☐ No ☐ Maybe

Fuel bills higher than similar houses in neighbourhood?

☐ Yes ☐ No ☐ Maybe

Sudden increase in heating costs?

☐ Yes ☐ No ☐ Maybe

Cool drafts in sitting areas on main floor?

☐ Yes ☐ No ☐ Maybe

Floors are "too cold"?

☐ Yes ☐ No ☐ Maybe

House is uncomfortable and hard-to-live-in in coldest weather?

☐ Yes ☐ No ☐ Maybe

BUILDING UP-KEEP AND SAFETY

Have floors or ceilings shifted or cracked within the last 2 years?

☐ Yes ☐ No ☐ Maybe / don't know

What portion of the doors and windows open and close easily in their frames?

☐ All ☐ Most ☐ Some ☐ Only a few

How may years has it been since the gas/oil furnace/boiler was completely serviced (including safety devices)?

☐ Within 2 years ☐ 2 to 5 years ☐ >5 years

Does house suffer from creaking, sagging floors?

☐ Yes ☐ No ☐ Maybe

Have cracks appeared recently on interior surfaces?

☐ Yes ☐ No ☐ Maybe

Are windows and doors inoperable due to warped frames?

☐ Yes ☐ No ☐ Maybe

(If wood fireplace or wood stove is present)

How often is the fireplace used?

☐ Frequently ☐ Occassionally ☐ Rarely / not at all

Has the fireplace chimney been cleaned or inspected

☐ Within 2 years ☐ 2 to 5 years ☐ >5 years

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

COMMENTS:

AGE + YEAR OF HOUSE —

FLOOR AREA —

VOLUME OF HOUSE —

RETROFIT HISTORY —

APPIN Associates ■ Communications ■ Solar Associates Inc. ■

2nd floor, 472 Academy Road, Winnipeg, MB R3N OC7

RR responsible retrofit

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

BASEMENT/CRAWL SPACE FLOORS AND WALLS

MOISTURE CONTROL

- ☐ Basement drain or sump pit cover (airtight or vented to outdoors)
- ☐ Foundation drainage system (basement drain shows evidence of a drainage tile system around the foundation)
- * ☐ Outlet for venting a clothes dryer outdoors
- ☐ **Foundation wall composition (note % area)**
  - ☐ Exposed dirt, stone, or rubble (____)
  - ☑ Exposed concrete (____)
  - ☑ Covered with moisture resistant material (plywood, poly, vinyl, paint) (____)
- ☐ Moisture-free history (no efflorescence, recent staining, wet wood)
- ☐ **Basement/crawl space floor composition (note % area)**
  - ☐ Exposed dirt, stone, or rubble (____)
  - ☐ Exposed concrete (____)
  - ☐ Moisture resistant material (plywood, poly, vinyl, paint) (____)
- ☐ Slab-on-grade construction
- ☐ Crawl space vents
- ☐ Soil gas barrier (sealing of cracks in foundation below grade

COMFORT AND THERMAL EFFICIENCY

- ☐ **Foundation floor composition (note % area)**
  - ☐ Bare concrete, or soil (____)
  - ☐ Sleeper floor over concrete slab (____)
  - ☐ Insulated concrete slab
    - ☐ R4 ☐ R7 ☐ R10 ☐ R12
  - ☐ Carpet with foam or rubber backing (____)
  - ☐ Foam board insulation at least 12" deep around edge of slab-on-grade (____)
- * ☐ **Joist space**
  - ☐ Enclosed joist spaces
  - ☐ Insulated joist spaces
- ☐ Floor or slab sits directly on ground, or covers a well-enclosed crawl space or garage
- ☐ **Foundation wall composition (note % area)**
  - ☐ Masonry only (____)
  - ☐ Masonry with finished panelling (____)
- ☐ **Foundation wall insulation:**
  - ☐ Upper portions of wall
  - ☐ Lower portions
  - ☐ 1" expanded polystyrene
  - ☐ 1" extruded polysytrene
  - ☐ 2" expanded polystyrene
  - ☐ 2" extruded polystyrene
  - ☐ R7 batts
  - ☐ R10 batts
  - ☐ R15 batts
- * ☐ **Enclosed joist space**
  - ☐ Insulated
- * ☐ Sealing of joists and sill plate (flexible sealant or foam)
- * ☐ Sealing around plumbing and wiring penetrations
- ☐ Insulation around forced-air heating ducts in semi-heated/unlived-in areas
- ☐ Airtightness of forced-air ducts (foil tape or hard case)

* BUILDING UP-KEEP AND SAFETY

- ☐ Beam stability (free of twisting)
- ☐ Joist stability (free of sagging)
- ☐ Bearing wall stability (free of recent cracking)
- ☐ Post strength (no signs of bending or cracking)
- ☐ Wooden structural member strength (no signs of fungus growth, mould, or rotting)
- ☐ Adjustable metal posts in basement
- ☐ Foundation wall (free of cracks)
- ☐ Water line integrity (free of leaks)
- ☐ Sewage lines (free of leaks)
- ☐ Insulation on sewage or water lines outside house
- ☐ Frost protection for water lines (no lines above ground)
- ☐ Clearance if water lines next to concrete basement walls
- ☐ A water shut-off for house (easily accessible)
- ☐ Exposed wiring (good condition and properly supported

☑	Present and/or adequate	M	Present with marginal defects	S	Present with severe defects
X	Absent but required	?	Unknown	–	Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

LIVING AREAS

MOISTURE CONTROL

- ☐ Firewood stored outdoors if present in significant quantities (eg. ½ cord)
- ☐ R-Value of windows (double-glazing or better)
- ☐ R-Value of window frames (wood core, pvc, or thermally broken)
- ☐ Ventilation of closets against exterior walls (louvres or undercut doors)
- ☐ Continuous air / vapour barrier
- ☐ Sealing around pot lights
- ☐ Sealing around window, door, and upper wall trim (flexible caulking or seamless painting)
- ☐ Sealing around plumbing entrances/exits (under sinks)
- ☐ Operable exhaust fan in main bathroom
- ☐ Noise from bathroom fan (suitable for continuous operation)
- ☐ Operable exhaust fan in kitchen (vented to outdoors)
- ☐ Noise from kitchen fan (suitable for intermittent operation)
- ☐ Dehumidistat control of exhaust fan
- ☐ Airflow route from living areas to bathroom exhaust fan (eg. doors under-cut ½" or more)

CHIMNEY PERFORMANCE

- ☐ **Fireplaces or wood stove components**
  - ☐ Open firebox
  - ☐ Conventional glass or metal doors
  - ☐ Air-tight gasketed doors
  - ☐ Interior wall location
  - ☐ Exterior wall location
  - ☐ CO alarm nearby
- ☐ **Mechanical ventilation system**
  - ☐ Balanced ventilation only (eg. HRV)
- ☐ Exhaust fans – FLOW _____ L/s
  - ☐ Bath fans – FLOW _____ L/s
  - ☐ Clothes dryer vented outdoors
  - ☐ Range hood with 4" diameter duct _____ L/s
  - ☐ Range hood with larger duct
  - ☐ Down-draft cook-top fan
- ☐ Air supply to house ☐ 4" ☐ 5" ☐ 6"
- ☐ Air supply to return air plenum ☐ 4" ☐ 5" ☐ 6"
- ☐ Fail-safe system on supply fans

VENTILATION AND AIR QUALITY

- ☐ Fresh air supply via forced-air distribution system to all rooms
- ☐ Fresh air inlets into bedrooms
- ☐ Window air supply capability (leakage or adjustable dampers)
- ☐ Tempering of fresh air (draft free)
- ☐ Fresh air mixing and distribution (eg. ducts or interior doors throughout the house are undercut or otherwise capable of allowing an easy flow of air throughout the house)
- ☐ **House ventilation system**
  - ☐ Central exhaust ventilator (CEV) or heat recovery ventilator (HRV)
  - ☐ Operable kitchen or bathroom exhaust fan
  - ☐ Quiet kitchen or bathroom exhaust fan suitable for continuous operation
- ☐ Air flow through CEV, HRV, or exhaust fan(s) (at least 40 L/s (80 cfm) at highest speed)
- ☐ Operable windows in habitable rooms
- ☐ Automatic control for ventilation system (eg. dehumidistat or thermostat connected damper or fan)
- ☐ Adjustable control for ventilation rate (eg. speed control, accessible dehumidistat, accessible damper on air supply duct)
- ☐ **Gas-fired range**
  - ☐ Exhaust vent ducted to outdoors
  - ☐ Automatic spark ignition
- ☐ Sealing of any exposed particle board or decorative plywood used indoors (all sides and edges painted or coated
- ☐ Sealing between attached garage and house
- ☐ Sealing of penetrations and entranceways between house and attached garage
- ☐ Separately ventilated closet, shed, garage, or other location suitable for storing paint cans, cleaners, and cleaning products away from living areas

☑	Present and/or adequate	M	Present with marginal defects	S	Present with severe defects
X	Absent but required	?	Unknown	–	Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

LIVING AREAS
CONTINUED

COMFORT AND THERMAL EFFICIENCY

- ☐ Insulation in wall cavities
- ☐ **Sealing around interior trim**
  - ☐ Baseboards
  - ☐ Window casing
  - ☐ Door
  - ☐ Tubs
  - ☐ Cabinets

Window glass
- ☐ triple-glazed or double-glazed heat mirror
- ☐ double-glazed with ½" air space or better
- ☐ double-glazed with less than ½" air space
- ☐ single-glazed

Window frames
- ☐ Wood, PVC, or thermally broken
- ☐ Windows are effectively weatherstripped or shown to be airtight using a blower door and smoke pencil
- ☐ South-facing window overhangs or shade trees for blocking direct sunlight in summer
- ☐ Weatherstripping on door jambs
- ☐ Weatherstripping on door thresholds

Doors
- ☐ Metal or fibreglass with insulation
- ☐ Storm doors
- ☐ Wood and plywood
- ☐ Solid wood with a hollow core

HEATING AND COOLING SYSTEMS

- ☐ **Electric baseboards, wood stoves, or other non-distribution systems**
  - ☐ 2 to 4 rooms
  - ☐ 5 to 10 rooms
- ☐ **Room-sized air conditioning units**
  - ☐ Bedrooms
  - ☐ Other living areas
- ☐ **Programmable thermostat for house**
  - ☐ Heating
  - ☐ Cooling
- ☐ Thermostats for different zones of house
- ☐ Natural cooling system (at least two openable windows, located on opposite walls, and provided with insect screening and security features appropriate for leaving window open in neighbourhood)
- ☐ Permanent outdoor air supply duct(s) connected to a supply fan or blower and controlled by a switch or thermostat suitable for summer operation

BUILDING UP-KEEP AND SAFETY

- ☐ Joist strength (eg. crack-free plaster)
- ☐ Indoor stair board stability (solid and tightly nailed)
- ☐ Floor coverings (safe for walking)
- ☐ Foundation movement (floors appear reasonably level)
- ☐ Handrails on all interior stairways
- ☐ Window or door to outside in each bedroom
- ☐ Smoke alarm on each floor of the house
- ☐ Clearances for fireplace mantels and surrounds (at least 18" from the fireplace opening; wood stove flues at least 18" from wood finishes)
- ☐ Clean flue on all operational chimneys attached to wood burning appliances (cleaned within last 2 years; or less than ¼" thick layer of soot and creosote on inside of flue)
- ☐ Doors or spark screens on fireplaces and wood stoves
- ☐ Fire resistant ceiling and wall(s) next to kitchen stove
- ☐ Fire-resistant stove top and hood (free of grime and grease)

☑ Present and/or adequate	M Present with marginal defects	S Present with severe defects
X Absent but required	? Unknown	– Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

UTILITY ROOM MECHANICAL SYSTEMS

MOISTURE CONTROL

- ☐ Sill and joist materials (free of exterior water)
- ☐ **Operational humidifier on forced-air system**
  - ☐ Wick
  - ☐ Spray
  - ☐ Steam

CHIMNEY PERFORMANCE

- ☐ **Primary heating system**
  - ☐ Oil-fired
  - ☐ Gas-fired
  - ☐ Wood-fired
  - ☐ Non-combustion
  - ☐ Sealed combustion or outside envelope
  - ☐ Induced-draft
- ☐ **Oil-fired furnace or boiler**
  - ☐ High-pressure oil burner
  - ☐ Barometric damper on flue pipe
  - ☐ Delayed-action solenoid valve
- ☐ Seal around flue pipe (vent connector)
- ☐ **Chimney**
  - ☐ Factory-built, insulated
  - ☐ B-vent
  - ☐ Masonry
  - ☐ Interior wall
  - ☐ Exterior wall
  - ☐ Metal liner
  - ☐ Insulation
  - ☐ Airtight construction
- ☐ Spillage alarm or detector
- ☐ Venting fail-safe system
- ☐ **Domestic hot water system**
  - ☐ Oil-fired
  - ☐ Gas-fired
  - ☐ Wood-fired
  - ☐ Non-combustion
  - ☐ Sealed or outside envelope
  - ☐ Induced-draft
- ☐ **Oil-fired water heater or boiler**
  - ☐ High-pressure oil burner
  - ☐ Barometric damper on flue pipe
  - ☐ Delayed-action solenoid valve
- ☐ **Make-up air duct**
  - ☐ Connection to continuously operated return air plenum
  - ☐ 4" open area
  - ☐ 5" open area
  - ☐ 6" open area
- ☐ **Supply air fan on make-up air duct**
  - ☐ Fail-safe or alarm if fan fails to operate
- ☐ Clothes dryer vented to outdoors
- ☐ Warm air supply register open into furnace room

VENTILATION AND AIR QUALITY

- ☐ Fresh air supply to forced-air distribution system
- ☐ Fresh air tempering system (duct heater, HRV, mixing plenum)
- ☐ Fresh air filter (high-efficiency filtration)
- ☐ Filter for circulating air
- ☐ Continuous air circulation system
- ☐ Adjustment for fresh air supply opening (eg. damper on duct or speed control on a fan)

☑	Present and/or adequate	M	Present with marginal defects	S	Present with severe defects
X	Absent but required	?	Unknown	–	Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

UTILITY ROOM MECHANICAL SYSTEMS
CONTINUED

HEATING AND COOLING SYSTEMS

Space heating system:
- ☐ Electric or gas heat pump
- ☐ Electric resistance heaters (furnace, baseboard, or radiant)
- ☐ High-efficiency, condensing, gas-fired, or oil-fired appliances
- ☐ Mid-efficiency, induced-draft, gas-fired appliances

☐ **Standard gas-fired appliance**
- ☐ Spark ignition on gas burner
- ☐ Flue damper
- ☐ 75% combustion efficiency
- ☐ Proof of tuning or installation within last 5 years

☐ **Oil-fired appliance**
- ☐ High-pressure (eg. Riello) oil burner
- ☐ Retention-head burner
- ☐ Delayed-action solenoid valve
- ☐ Barometric damper

☐ **Wood-fired appliance**
- ☐ Airtight firebox and dampered air supply
- ☐ Catalytic burner
- ☐ Automatic combustion control regulator

☐ Control for circulation blower/pump (allows continuous operation during heating season)

☐ **Domestic hot water system:**
- ☐ Electric
- ☐ High-efficiency, condensing, gas-fired, or oil-fired appliance
- ☐ Mid-efficiency, induced-draft, gas-fired appliance

☐ **Standard gas-fired appliance with:**
- ☐ Spark ignition
- ☐ Flue damper
- ☐ 75% combustion efficiency
- ☐ Proof of tuning within last 5 years

☐ **Oil-fired appliance**
- ☐ High-pressure (eg. Riello) oil burner
- ☐ Retention-head burner
- ☐ Delayed-action solenoid valve
- ☐ Barometric damper
- ☐ 75% or better combustion efficiency
- ☐ Proof of being tuned within previous 2 years

☐ **System distribution**
- ☐ hot water on-demand
- ☐ hot water at point of use

☐ Water storage tank insulation (R10 or better)

☐ Hot water pipe insulation (first 3 feet from tank)

☐ **Central air conditioner**
- ☐ Installed before 1975
- ☐ 1976-86
- ☐ After 1986

BUILDING UP-KEEP AND SAFETY

☐ **Chimney condition**

☐ Clearance of flue connectors and chimneys from wood (at least 2")

☐ History of operation without sooting (no fresh soot stains)

☐ Metal chimney durability (free of rust)

☐ Masonry chimney stability (free of bricks in ash clean-out)

☐ Service record (appliance and flue connector has been inspected and serviced within last 5 years)

☑ Present and/or adequate	M Present with marginal defects	S Present with severe defects
X Absent but required	? Unknown	– Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

ATTIC

MOISTURE CONTROL

- ☐ **Intentional Air Barrier**
  - ☐ Polyethylene
  - ☐ Sealing along top plate
  - ☐ Sealing around plumbing and wiring penetrations
  - ☐ Sealing around pot lights
  - ☐ Sealing around attic hatch
  - ☐ Sealing around chimneys
  - ☐ Sealing floor cavities at knee wall
- ☐ **Vents**
  - ☐ Continuous soffit
  - ☐ Louvres/baffles for snow and rain
  - ☐ Cold weather closure
  - ☐ Open area of vent option
- ☐ **Ductwork**
  - ☐ Termination outside of attic
  - ☐ Taped/sealed
  - ☐ Insulated
- ☐ **Insulation over top of joists**
- ☐ **Moisture-free history (no evidence of problems)**
  - ☐ Rafters and trusses (dry with no evidence of recent staining or rot)
  - ☐ Sheathing (dry with no evidence of recent staining or rot)
  - ☐ Joists/floor material (dry with no evidence of recent staining or rot)
  - ☐ Insulation (dry and not matted or water damaged)

VENTILATION AND AIR QUALITY

- ☐ Exhaust duct work termination outside of house and attic

COMFORT AND THERMAL EFFICIENCY

- ☐ **Insulation quantity (note depth in inches ___)**
  - ☐ Depth (even; especially over perimeter)
  - ☐ Continuity (coverage)
  - ☐ Dryness and density
- ☐ **Attic hatch**
  - ☐ insulated
  - ☐ weatherstripped
  - ☐ latched
- ☐ **Intentional air barrier**
  - ☐ Polyethylene
  - ☐ Sealing along top plate
  - ☐ Sealing around plumbing and wiring penetrations
  - ☐ Sealing around pot lights
  - ☐ Sealing around attic hatch
  - ☐ Sealing around chimneys
  - ☐ Sealing of floor cavity at knee wall

HEATING AND COOLING SYSTEMS

- ☐ **Forced-air distribution ductwork**
  - ☐ Taped/sealed ducts
- ☐ Insulated ducts

BUILDING UP-KEEP AND SAFETY

- ☐ **Vents**
  - ☐ Screening
- ☐ Joist strength and condition
- ☐ Rafter strength and condition
- ☐ **Chimney #1**
  - ☐ 2" clearance to wood
  - ☐ 2" clearance to insulation (if factory-built metal chimney)
  - ☐ Masonry stability and strength
- ☐ **Chimney #2**
  - ☐ 2" clearance to wood
  - ☐ 2" clearance to insulation (if factory-built metal chimney)
  - ☐ Masonry stability and strength
- ☐ **Wiring condition**
  - ☐ Supports and covers are adequate (no frayed sections)

☑	Present and/or adequate	M	Present with marginal defects	S	Present with severe defects
X	Absent but required	?	Unknown	–	Not applicable

RESPONSIBLE RETROFIT PROGRAM

HOUSE INSPECTION FORM

EXTERIOR

MOISTURE CONTROL

- ☐ **Ground slope next to house**
  - ☐ Front
  - ☐ Back
  - ☐ Sides
- ☐ Gutter discharge
- ☐ Foundation wall exterior insulation
- ☐ Sealing around window frames
- ☐ Sealing around wall penetrations
- ☐ Flashing/caulking around windows
- ☐ Flashing around roof vents
- ☐ Flashing behind chimneys
- ☐ **Wall Ventilation**
  - ☐ Air vents or gaps top and bottom of wall cavities
- ☐ **Attic ventilation**
  - ☐ Soffit vents
  - ☐ Gable/ridge/mushroom vents

VENTILATION AND AIR QUALITY

- ☐ **Fresh air intake**
  - ☐ Open end of intake
  - ☐ Location (away from pollutant sources)
- ☐ **Exhaust outlets**
  - ☐ Open area

COMFORT AND THERMAL EFFICIENCY

- ☐ **Above-grade wall insulation**
  - ☐ Evidence of blown-in cavity insulation
  - ☐ Foam board insulation under siding
    - ☐ ½"
    - ☐ 1"
    - ☐ 2"
- ☐ **Door weatherstrip**
  - ☐ Front
  - ☐ Back
  - ☐ Side
- ☐ Air barrier over exterioir of house (Stucco , wrap, etc.)

HEATING AND COOLING SYSTEMS

- ☐ Exterior thermostat for boiler
- ☐ Solar panel summer water heating

BUILDING UP-KEEP AND SAFETY

- ☐ **Exterior Cladding**
  - ☐ Asphalt shingles (no curling, cracking)
  - ☐ Wood shingles (no curling, splitting, coming loose)
  - ☐ Flat roof (no blistering, showing bare patches, curling at edges)
  - ☐ Eavestroughs and downspouts (no signs of rust and corrosion, overflowing, soil erosion)
  - ☐ Wood siding or facia (no splitting, rotting, buckling, scaling paint)
  - ☐ Metal siding (no pitting, corroding, staining, dented, buckling)
  - ☐ Vinyl siding (no buckling)
  - ☐ Brick siding (no crumbling mortar, cracks, loose bricks, efflorescence or spalling)
  - ☐ Stucco siding (no cracks, chips, damaged areas)
- ☐ Insect and rodent screening on intentional openings in roof, cladding, and basement walls
- ☐ Protection from roots of fast growing trees within 10 feet of foundation walls
- ☐ Drain pipes around foundation wall footings
- ☐ Foundation wall stability (sound and uncracked)
- ☐ Exterior walls (no large deflections)
- ☐ Wooden structural member strength (no signs of fungus growth or rot)
- ☐ Water lines outside heated areas (insulated)
- ☐ Outdoor stair board stability (solid and tightly nailed)
- ☐ Outdoor stair hand rails
- ☐ Wood-burning chimney spark screens
- ☐ Masonry chimney (no signs of mortar being pushed out or crumbling bricks at top)
- ☐ Chimney clearance (2 feet above ridge of roof, or equipped with aerodynamic cap)

☑	Present and/or adequate	M	Present with marginal defects	S	Present with severe defects
X	Absent but required	?	Unknown	–	Not applicable

Indoor Air Pollution Source Checklist

Explain that this survey will be confidential when completed. IAQSOURC.375

Location and house number:_____
Date Survey done:_____
Survey Done By:_____

Quest start time_____

Interviewer please note: *Are there any unusual odours when first entering the house?*
If yes please note_____
_____

Interviewer please note: *Is house dusty?* If yes please note_____
_____

Occupant Activities
Animal skins prepared inside? No____ Yes____ If yes, how many?_____
products used in the process?_____

Guns cleaned inside? No____ Yes____ If yes, how many?_____ products used in the process?_____

Snowmobiles/vehicle motors serviced inside? No____ Yes____ If yes, how much?_____
_____

Photography/painting/silkscreening? No____ Yes____ If yes, how much?_____
products used in the process?_____

Woodworking/Soapstone carving? No____ Yes____ If yes, how much?_____
products used in the process?_____

Other (describe)_____ If yes, how much?_____
products used in the process?_____

Other (describe)_____ If yes, how much?_____
products used in the process?_____

Is there evidence of formeldhyde?
New carpets? No____ Yes____ If yes, how much?_____
New cabinets? No____ Yes____ If yes, how much?_____
New drapes? No____ Yes____ If yes, how much?_____
New furniture? No____ Yes____ If yes, how much?_____

Record results of spot formeldhyde readings here_____

Are any of the following stored inside?
Kerosene? No____ Yes____ If yes, how much?_____
Gasoline? No____ Yes____ If yes, how much?_____
Motor Oils? No____ Yes____ If yes, how much?_____
Paints, solvents, glues, varnishes, lacquers? No____ Yes____ If yes, how much?_____
brand name(s) or contents?_____
brand name(s) or contents?_____

Pesticides? No____ Yes____ If yes, how much?_____
brand name(s) or contents?_____

Cleaners containing ammonia? No____ Yes____ If yes, how much?_____
brand name(s) or contents?_____
_____

Cleaners containing chlorine? No____ Yes____ If yes, how much?_____
brand name(s) or contents?_____
_____

Furniture polish? No____ Yes____ If yes, how much?_____
brand name(s) or contents?_____
_____

Is there evidence of moulds?
Damp spots? No____ Yes____ If yes, location and size?_____Photos_____

Is house dust a problem? No____ Yes____ If yes, is testing required?_____

Exposed fibreglass insulation? No____ Yes____ If yes, how much?_____

Is there evidence of moisture sources?
Clothes dried inside? No____ Yes____ If yes, how much?_____
Clothes dryer vented to outside? No____ Yes____ If yes, is vent blocked?_____
Wood stored inside? No____ Yes____ If yes, how much?_____
Are there any humidifiers? No____ Yes____ If yes, how many?_____
bacteria/virus samples taken_____
Are there plants? No____ Yes____ If yes, how many?_____

Is there evidence of asbestos?
Pipe wrap? No____ Yes____ If yes, how much?_____Friable?_____
Fireproofing for combustion appliances? No____ Yes____ If yes, how much?_____
Friable?_____ Collect samples in plastic bags and wear PPE.

Are there any unvented gas heater(s)? No____ Yes____ If yes, how many?_____ Describe problem_____

Furnace Backdrafting/Spillage Problems? No____ Yes____
Take spot SO_2, NO_x, CO and record results on IAQ control Form

Are there any electrostatic or other air filters? No____ Yes____
If yes, how many?_____ Record Ozone spot test results here_____

Is garbage stored inside? No____ Yes____ If yes, how much?_____

Are there diaper pails? No____ Yes____

Are pets kept inside? No____ Yes____ If yes, how many?_____

THANK RESPONDENT FOR HIS/HER TIME

Quest stop time_____

Short Form Health Survey

Explain that this health survey will be confidential when completed. IAQHLTHS.375
Complete one form for the entire household.

Location and house number:_____
Date Survey done:_____
Survey Done By:_____

Quest start time_____

*Number of persons living in this house.*_____

List individuals living in this house (Circle the age of the respondent to this questionnaire)

Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____

ANSWER THESE QUESTIONS FOR THE INDIVIDUAL COMPLETING THIS SURVEY

Occupational History of individual completing this survey

Current Occupation_____ No of years _____
Please list your previous occupation and/or hobbies outside the home (Probe for any work or hobby activities that might have resulted in an toxic occupational exposure to dusts or fumes)_
_____
_____
_____
_____

1. Headaches, lightheadedness, fatigue

Do you suffer from headaches
No____ Yes____ If yes, describe problem (frequency, time of day, last time of occurrence?)_____
_____
_____
_____

Describe onset (i.e. time of day or week, patterns, is it seasonal?)
_____
_____
_____

Ameliorating factors (i.e. does going out reduce the symptoms?)
_____
_____
_____

Aggravating factors (i.e. greater while indoors?)
_____
_____
_____

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

_____

_____

_____

Do you suffer from lightheadedness

No____ Yes____ If yes, describe problem (faint, dizziness?)_____

_____

_____

_____

Describe onset (i.e. time of day or week, patterns, is it seasonal?)

_____

_____

_____

Ameliorating factors (i.e. does going out reduce the symptoms?)

_____

_____

_____

Aggravating factors (i.e. greater while indoors?)

_____

_____

_____

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

_____

_____

_____

Do you suffer from fatigue?

No____ Yes____ If yes, describe problem (really tired, more tired than you think you should be?)_

_____

_____

_____

Describe onset (i.e. time of day or week, patterns, is it seasonal?)

_____

_____

_____

Ameliorating factors (i.e. does going out reduce the symptoms?)

_____

_____

_____

Aggravating factors (i.e. greater while indoors?)

_____

_____

_____

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

_____

_____

_____

2. **Mucous membrane irritation**

Do you have eye irritation? No____ Yes____ If yes, describe (time of day, season, how long?)____

_____

_____

Do you have nasal problems No____ Yes____ If yes, describe (what makes you sneeze, congestion, running nose?)

_____

_____

_____

Do you have throat problems No____ Yes____ If yes, describe (irritation or dryness, scratchy throat?)

_____

_____

_____

Do you have skin problems No____ Yes____ If yes, describe (dry skin, itchiness, sores, winter only, time of day or situation?)

_____

_____

_____

3. **Illnesses**

How often do you or your family have "colds"? (describe number, season when colds occur) (specify age of persons affected)

_____

_____

_____

Have you or your family sought medical attention for colds (i.e. receipt of antibiotics?) specify age of persons affected

_____

_____

_____

Do you or your family have "allergies" or suspected allergies? No____ Yes____ If yes, to what?_

_____

_____

_____

Describe pattern (i.e. time of day, season, related to an activity) _____

_____

_____

_____

Have you seen a nurse or doctor about this problem? No____ Yes____ If yes, when was this, action recommended?

_____

_____

_____

4. Respiratory disease

Do you suffer from coughs? No____ Yes____ If yes, sputum?_____
How many months per year _____ how many years have you had this problem? _____

Do you wheeze? No____ Yes____ If yes, how much (i.e. sometimes, all the time?)_____

Do you have shortness of breath for your age? No____ Yes____ If yes, what triggers it (i.e. cold air, exercise, fumes, dusts?)

Have you ever been diagnosed by a nurse or doctor as having a chronic respiratory disease?
No_____ Yes____ If yes, what disease?_____

5. Family health history

Describe any illnesses of respondent and family members not included above

Measles (not German)	No____	Yes___	(At what age was it first diagnosed)___
Sinus trouble	No____	Yes___	(At what age was it first diagnosed)___
Bronchiolitis	No____	Yes___	(At what age was it first diagnosed)___
Bronchitis	No____	Yes___	(At what age was it first diagnosed)___
Asthma	No____	Yes___	(At what age was it first diagnosed)___
Pneumonia	No____	Yes___	(At what age was it first diagnosed)___
Whooping cough	No____	Yes___	(At what age was it first diagnosed)___
Croup	No____	Yes___	(At what age was it first diagnosed)___
Cystic fibrosis	No____	Yes___	(At what age was it first diagnosed)___

Have you suffered from any other diseases? (If yes, describe the disease and note at what age it was first diagnosed)_____

THANK THE RESPONDENT FOR HIS/HER TIME

Quest stop time_____

Other relevant notes

Long Form Health Survey

Explain that this health survey will be confidential when completed. IAQHLTHL.375

Location and house number:_____
Date Survey done:_____
Survey Done By:_____

Quest start time_____

*Number of persons living in this house.*_____

List individuals living in this house (Circle the age of the respondent to this questionnaire)

Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____
Age___ Sex: M F How much does this person smoke? No____ Yes____how much_____

ANSWER THESE QUESTIONS FOR THE INDIVIDUAL COMPLETING THIS SURVEY

Occupational History of individual completing this survey

Current Occupation_____ No of years _____
Please list your previous occupation and/or hobbies outside the home (Probe for any work or hobby activities that might have resulted in an toxic occupational exposure to dusts or fumes)_

_____
_____
_____
_____

1. Headaches, lightheadedness, fatigue

Do you suffer from headaches
No____ Yes____ If yes, describe problem (frequency, time of day, last time of occurrence?)_____

_____
_____
_____

Describe onset (i.e. time of day or week, patterns, is it seasonal?)

_____
_____
_____

Ameliorating factors (i.e. does going out reduce the symptoms?)

_____
_____
_____

Aggravating factors (i.e. greater while indoors?)

_____
_____
_____

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

Do you suffer from lightheadedness

No____ Yes____ If yes, describe problem (faint, dizziness?)_____

Describe onset (i.e. time of day or week, patterns, is it seasonal?)

Ameliorating factors (i.e. does going out reduce the symptoms?)

Aggravating factors (i.e. greater while indoors?)

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

Do you suffer from fatigue?

No____ Yes____ If yes, describe problem (really tired, more tired than you think you should be?)_

Describe onset (i.e. time of day or week, patterns, is it seasonal?)

Ameliorating factors (i.e. does going out reduce the symptoms?)

Aggravating factors (i.e. greater while indoors?)

Severity (i.e. taking medication, sought advice from doctor or health care worker?)

2. **Mucous membrane irritation**

Do you have eye irritation? No____ Yes____ If yes, describe (time of day, season, how long?)____

_____

_____

Do you have nasal problems No____ Yes____ If yes, describe (what makes you sneeze, congestion, running nose?)

_____

_____

_____

Do you have throat problems No____ Yes____ If yes, describe (irritation or dryness, scratchy throat?)

_____

_____

_____

Do you have skin problems No____ Yes____ If yes, describe (dry skin, itchiness, sores, winter only, time of day or situation?)

_____

_____

_____

STOP AND READ THE FOLLOWING INSTRUCTIONS

The short form of this health survey will be administered in all 15 Series 1 households. When administering the short form, one form is used for all household members.

In at least one household per community, the long form of this survey should be administered.

When using the long form please note the following:

If a long form respondent, ask questions 8A - 21C inclusive from the ADULT survey <u>for this person only</u>. Complete questions 1 and 2 from this survey plus questions 8A - 21C inclusive from the ADULT survey <u>for all adults living in this house</u> if there is time.

If a long form respondent, ask questions inclusive 14A - 33D from the CHILD survey <u>for each child</u>.

ADULT

PHLEGM

8A. Do you usually bring up phlegm from your chest?
(Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm.)
[If *no*, skip to 8C.]
1. Yes ____ 2. No ____

B. Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the *week?*
1. Yes ____ 2. No ____

C. Do you usually bring up phlegm at all on getting up, or first thing in the morning?
1. Yes ____ 2. No ____

D. Do you usually bring up phlegm at all during the rest of the day or at night?
1. Yes ____ 2. No ____

IF *YES* TO ANY OF THE ABOVE (8A, B, C, OR D), ANSWER THE FOLLOWING:
IF *NO* TO ALL, CHECK *DOES NOT APPLY* AND SKIP TO NEXT PAGE.

E. Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?
1. Yes ____ 2. No ____
8. Does not apply ____

F. For how many years have you had trouble with phlegm?
____
Number of years
88. Does not apply ____

EPISODES OF COUGH AND PHLEGM

9A. Have you had periods or episodes of (increased*) cough and phlegm lasting for 3 weeks or more each year?
*(For persons who usually have cough and/or phlegm)
1. Yes ____ 2. No ____

____ IF *YES* TO 9A:

B. For how long have you had at least 1 such episode per year?
____
Number of years
88. Does not apply ____

ADULT

WHEEZING

10A. Does your chest ever sound wheezy or whistling:

1. When you have a cold? 1. Yes ____ 2. No ____
2. Occasionally apart from colds? 1. Yes ____ 2. No ____
3. Most days or nights? 1. Yes ____ 2. No ____

IF *YES* TO 1, 2, OR 3 IN 10A:

B. For how many years has this been present? ____ Number of years
88. Does not apply ____

11A. Have you ever had an attack of wheezing that has made you feel short of breath? 1. Yes ____ 2. No ____

IF *YES* TO 11A:

B. How old were you when you had your first such attack? ____ Age in years
88. Does not apply ____

C. Have you had 2 or more such episodes? 1. Yes ____ 2. No ____
8. Does not apply ____

D. Have you ever required medicine or treatment for the(se) attack(s)? 1. Yes ____ 2. No ____
8. Does not apply ____

BREATHLESSNESS

12. If disabled from walking by any condition other than heart or lung disease, please describe and proceed to Question 14A.

Nature of condition(s): ____

13A. Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1. Yes ____ 2. No ____

IF *YES* TO 13A:

B. Do you have to walk slower than people of your age on the level because of breathlessness? 1. Yes ____ 2. No ____
8. Does not apply ____

C. Do you ever have to stop for breath when walking at your own pace on the level? 1. Yes ____ 2. No ____
8. Does not apply ____

D. Do you ever have to stop for breath after walking about 100 yards (or after a few minutes) on the level? 1. Yes ____ 2. No ____
8. Does not apply ____

E. Are you too breathless to leave the house or breathless on dressing or undressing? 1. Yes ____ 2. No ____
8. Does not apply ____

ADULT

CHEST COLDS AND CHEST ILLNESSES

14A. If you get a cold, does it usually go to your chest? (Usually means more than ½ the time.) 1. Yes ____ 2. No ____ 3. Don't get colds ____

15A. During the past 3 years, have you had any chest illnesses that have kept you off work, indoors at home, or in bed? 1. Yes ____ 2. No ____

IF *YES* TO 15A:

B. Did you produce phlegm with any of these chest illnesses? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. In the last 3 years, how many such illnesses, with (increased) phlegm, did you have which lasted a week or more? ____ Number of illnesses ____ No such illnesses 8. Does not apply ____

PAST ILLNESSES

16. Did you have any lung trouble before the age of 16? 1. Yes ____ 2. No ____

17. Have you ever had any of the following?

1A. Attacks of bronchitis? 1. Yes ____ 2. No ____

IF *YES* TO 1A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. At what age was your first attack? ____ Age in years 88. Does not apply ____

2A. Pneumonia (include bronchopneumonia)? 1. Yes ____ 2. No ____

IF *YES* TO 2A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. At what age did you first have it? ____ Age in years 88. Does not apply ____

3A. Hay fever? 1. Yes ____ 2. No ____

IF *YES* TO 3A:

B. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. At what age did it start? ____ Age in years 88. Does not apply ____

ADULT

18A. Have you ever had chronic bronchitis? 1. Yes ____ 2. No ____

IF *YES* TO 18A:

B. Do you still have it? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

D. At what age did it start? ____ Age in years 88. Does not apply ____

19A. Have you ever had emphysema? 1. Yes ____ 2. No ____

IF *YES* TO 19A:

B. Do you still have it? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

D. At what age did it start? ____ Age in years 88. Does not apply ____

20A. Have you ever had asthma? 1. Yes ____ 2. No ____

IF *YES* TO 20A:

B. Do you still have it? 1. Yes ____ 2. No ____ 8. Does not apply ____

C. Was it confirmed by a doctor? 1. Yes ____ 2. No ____ 8. Does not apply ____

D. At what age did it start? ____ Age in years 88. Does not apply ____

E. If you no longer have it, at what age did it stop? ____ Age stopped 88. Does not apply ____

21. Have you ever had:

A. Any other chest illness or allergies to pollen or dust? 1. Yes ____ 2. No ____
If *yes*, please specify ____

B. Any chest operations? 1. Yes ____ 2. No ____
If *yes*, please specify ____

C. Any chest injuries? 1. Yes ____ 2. No ____
If *yes*, please specify ____

THANK THE RESPONDENT FOR HIS/HER TIME

Quest stop time____

CHILD

These questions pertain mainly to your child's chest. Please answer *yes* or *no* if possible. If a question does not appear to be applicable to your child, check the *does not apply* space.

COUGH

14A. Does he/she usually have a cough with colds? 1. Yes ____ 2. No ____

B. Does he/she usually have a cough apart from colds? 1. Yes ____ 2. No ____

IF *YES* TO 14A OR 14B:

C. Does he/she cough on most days (4 or more days per week) for as much as 3 months of the year? 1. Yes ____ 2. No ____ 8. Does not apply ____

D. For how many years has he/she had this cough? ____ Number of years 8. Does not apply ____

CONGESTION AND/OR PHLEGM

15A. Does this child usually seem congested in the chest or bring up phlegm with colds? 1. Yes ____ 2. No ____

B. Does this child usually seem congested in the chest or bring up phlegm apart from colds? 1. Yes ____ 2. No ____

IF *YES* TO 15A OR 15B:

C. Does this child seem congested or bring up phlegm, sputum, or mucus from his/her chest on most days (4 or more days per week) for as much as 3 months a year? 1. Yes ____ 2. No ____ 8. Does not apply ____

D. For how many years has he/she seemed congested or raised phlegm, sputum, or mucus from his/her chest? ____ Number of years 8. Does not apply ____

16A. Does this child get attacks of (increased) cough, chest congestion, or phlegm lasting for 1 week or more each year? 1. Yes ____ 2. No ____

IF *YES* TO 16A:

B. For how many years? ____ Number of years 8. Does not apply ____

C. On average, how many chest colds per year does he/she get? ____ Average number per year 8. Does not apply ____

CHILD

WHEEZING

17. Does this child's chest ever sound wheezy or whistling:
    - A. When (he/she) has a cold? 1. Yes ____ 2. No ____
    - B. Occasionally apart from colds? 1. Yes ____ 2. No ____
    - C. Most days or nights? 1. Yes ____ 2. No ____

IF *YES* TO 17B OR 17C:

- D. For how many years has wheezing or whistling in the chest been present? ____ Number of years; 8. Does not apply ____

18A. Has this child ever had an attack of wheezing that has caused him/her to be short of breath? 1. Yes ____ 2. No ____

IF *YES* TO 18A:

- B. Has he/she had 2 or more such episodes? 1. Yes ____ 2. No ____
- C. Has he/she ever required medicine or treatment for the(se) attack(s)? 1. Yes ____ 2. No ____
- D. How old was this child when he/she had his/her first such attack? ____ Age in years; 8. Does not apply ____
- E. Is or was his/her breathing completely normal between attacks? 1. Yes ____ 2. No ____; 8. Does not apply ____

19. Does this child ever get attacks of wheezing after he/she has been playing hard or exercising? 1. Yes ____ 2. No ____

CHEST ILLNESSES

20A. During the past 3 years has this child had any chest illness that has kept him/her from his/her usual activities for as much as 3 days? 1. Yes ____ 2. No ____

IF *YES* TO 20A:

- B. Did he/she bring up more phlegm or seem more congested than usual with any of these illnesses? 1. Yes ____ 2. No ____; 8. Does not apply ____
- C. How many illnesses like this has he/she had in the past 3 years?
  1. Less than 1 illness per year ____
  2. 1 illness per year ____
  3. 2-5 illnesses per year ____
  4. More than 5 illnesses per year ____
  8. Does not apply ____
- D. How many of these illnesses have lasted for as long as 7 days? ____ Number of illnesses; 8. Does not apply ____

21. Was he/she ever hospitalized for a severe chest illness or chest cold before the age of 2 years?
  1. Yes, only once ____
  2. Yes, 2 times ____
  3. Yes, 3 or more times ____
  4. No ____

22. Did this child have any other severe chest illness or chest cold before the age of 2 years? 1. Yes ____ 2. No ____

CHILD

OTHER ILLNESSES

23. Has this child had any of the following illnesses, and if *yes*, at what age?

		First Diagnosed
A. Measles (not German)	Yes ____ No ____	At age ____
B. Sinus trouble	Yes ____ No ____	At age ____
C. Bronchiolitis	Yes ____ No ____	At age ____
D. Bronchitis	Yes ____ No ____	At age ____
E. Asthmatic bronchitis	Yes ____ No ____	At age ____
F. Pneumonia	Yes ____ No ____	At age ____
G. Whooping cough	Yes ____ No ____	At age ____
H. Croup	Yes ____ No ____	At age ____
I. Cystic fibrosis	Yes ____ No ____	At age ____

24. Did the doctor ever say that this child had eczema before the age of 2 years? 1. Yes ____ 2. No ____

25. Does or did this child have external ear (ear canal) infections (swimmer's ear)? 1. Yes ____ 2. No ____

26. Does or did this child have frequent ear infections (middle ear):
   - A. Between the age of 0 and 2? 1. Yes ____ 2. No ____
   - B. Between the ages of 2 and 5? 1. Yes ____ 2. No ____
   - C. Over age 5? 1. Yes ____ 2. No ____

27. Did this child ever require tubes to be placed in his/her ears to drain them? 1. Yes ____ 2. No ____

28. Did this child ever have an operation on his/her tonsils or adenoids? 1. Yes ____ 2. No ____

29A. Has a doctor ever said that this child had asthma? 1. Yes ____ 2. No ____

____ IF *YES* TO 29A: _____

- B. At what age did his/her asthma begin? ____ Age in years
- C. Does he/she still have asthma? 1. Yes ____ 2. No ____
- D. Does he/she currently take medicine or treatment for asthma? 1. Yes ____ 2. No ____

If *no* to 29C:

- E. At what age did his/her asthma stop? ____ Age in years

CHILD

30. Has this child ever had an operation on his/her chest? 1. Yes ____ 2. No ____

If *yes*, specify: _____

31. Has a doctor ever said that this child ever had heart disease? 1. Yes ____ 2. No ____

If *yes*, what did the doctor say it was: _____

32. When this child was born was he/she kept in the hospital after the mother went home? 1. Yes ____ 2. No ____

If *yes*, specify reason: _____

ALLERGY

33A. Has a doctor ever said that this child had an allergic reaction to food or medicine.

1. Yes, food only ____ 2. Yes, medicine only ____
3. Yes, both food and medicine ____ 4. No ____

33B. Has a doctor ever said that this child had an allergic reaction to pollen or dust? 1. Yes ____ 2. No ____

33C. Has a doctor ever said that this child had an allergic skin reaction to detergents or other chemicals? (Do not include poison oak or poison ivy.) 1. Yes ____ 2. No ____

33D. Did this child ever receive allergy shots? 1. Yes ____ 2. No ____

THANK THE RESPONDENT FOR HIS/HER TIME

Quest stop time_____

Other relevant notes

NAHB/NRC - AIMS
400 Prince Georges Center Boulevard
Upper Marlboro, MD 20772-8731
(301) 249-4000 ext. 647

DATA SHEET for Two-Zone Analysis

Name of User: _____ Company: _____

Address: _____

City: _____ State: _____ Zip Code: ☐☐☐☐☐

Telephone: _____

Project Title: ☐☐☐☐☐☐☐☐☐☐

House I.D.: ☐☐☐☐☐☐☐☐☐☐

Check all types of construction that apply:

1. House Age: ____ year(s)

2. Dwelling Type:

Ranch	____	1 Story	____
Colonial	____	2 Story	____
Cape Cod	____	w/ garage	____
Split Foyer	____	w/ basement (finished)	____
Townhouse	____	w/ basement (unfinished)	____
Apartment	____		

3. Heat Type:

Heat Pump	____
Gas Heat	____
Oil Heat	____
Electric Resistance Heat	____

4. Internal Features

Fireplace	____
Woodstove	____
Central Air	____
Ceiling Fan	____
Cathedral Ceiling	____

5. External Features

All brick	____
Brick front	____
Wood Siding	____
Aluminum Siding	____
Vinyl Siding	____

NAHB/NRC - AIMS
DATA SHEET for TWO-ZONE Analysis

Project Title: ☐☐☐☐☐☐☐☐☐☐
House I.D.: ☐☐☐☐☐☐☐☐☐☐

Start Date: ___/___/___ (mo day yr) Start Time: ___:___ (24 hr clock)

Stop Date: ___/___/___ (mo day yr) Stop Time: ___:___ (24 hr clock)

Zone #1-Description:_____
BEDROOM area; if not, please describe here.

# of PMCH-2E (RED) Emitters ____
# of Receivers ____

Avg. Temp. (°F): _____ Total Volume (ft^3): _____

Receiver ID#	Room	Receiver Placed On	Room	Emitter Placed On

Zone #2-Description:_____
Kitchen, Dining, Living; if not, please describe here.

# of PDCH-3E (GOLD) Emitters ____
# of Receivers ____

Avg. Temp. (°F): _____ Total Volume (ft^3): _____

Receiver ID#	Room	Receiver Placed On	Room	Emitter Placed On

Optional: On the spaces provided below you may wish to include/draw a floor plan indicating locations of emitters and receivers.

ZONE #1

ZONE #2

APPENDIX 2

SLIDES (under separate cover)

APPENDIX 3

TABULATED RAW DATA

APPIN ASSOCIATES
Winnipeg, MB

CMHC NWT Indoor Air Quality Survey

Date: 12-Aug-91

HOUSE			NUMBER OF PERSONS		FORMELDHYDE (HCHO)				PARTI-CULATES	RADON	RELATIVE HUMIDITY		CARBON DIOXIDE (CO2)								BIOQUEST		AIR CHANGE	BATH FAN		KIT FAN USAGE	PASSIVE VENT	COMBUSTION AIR INLET TO FURNACE/ BOILER ROOM	HEATING SYSTEM	OUTSIDE AIR AIR DUCT TO RETURN AIR PLENUM
STUDY ID	DESCRIPTION GNWT Type Name	Type Code	Total #	# Smokers	FIRST LOCATION	(ppm)	SECOND LOCATION	(ppm)	(mg/m3)	(WL)	avg %	spot %	# OF SMOKERS	FIRST LOCATION	CO2 ppm	SECOND LOCATION	CO2 ppm	THIRD LOCATION	CO2 ppm	gas	part	(ac/h)	USAGE	air flow (L/s)						
RANKIN INLET																														
RI 1-541B	2 BR DUPLEX	6	3	0	LR	0.034	HALL	0.032	29	0.001	23	26	0	LR		MBR	800					0.135	Rarely		Recirculating	No	6"x12" grill	Blr Rm	N/A
RI 2-517B	1984 1 BR QUADPLEX	9	1	1	LR	< 0.010	BR	< 0.010	23	0.001	11	17	1	LR	400	BR	600			88	99	0.688	Often		Recirculating	No	6"x12" grill	Shared Blr Rm	N/A
RI 3-517A	1984 1 BR QUADPLEX	9	2	2	LR	< 0.010	BR	0.014			13	24	0	BR #1	1,100	STAIRWAY	900					0.271	Intermittently		Recirculating	Yes	6"x12" grill	Shared Blr Rm	N/A
RI 3-517A	1984 1 BR QUADPLEX	9	2	2	LR	< 0.010	BR	0.011	37		15	26	2	LR	550	BR (UNOCC)	600			101	100	0.220	Intermittently		Recirculating	Yes	6"x12" grill	Shared Blr Rm	N/A
RI 4-400	4 BR WEBER 1986 RETRO	3	7	2	KIT	< 0.010	MSTR BR	< 0.010	102		19	20	1	KIT	700	BR	600			94	88	0.456	Rarely		Recirculating	No	No	F/A Furnace	Yes
RI 4-400	4 BR WEBER 1986 RETRO	3	7	2	LR	0.015	BR HALL	0.013			17	23	0	BACK BR	700					101	86	0.042	Rarely		Recirculating	No	No	F/A Furnace	Yes
RI 5-407	4 BR WEBER NON RETRO	1	10	4	KIT/LR	0.013	BR HALL	< 0.010		0.001	28	30	1	KIT	800	BR	600			100	93	0.574	Rarely		Recirculating	No	No	F/A Furnace	No
RI 6-401	4 BR WEBER RETRO	3	10	4	KIT	0.010	HALL	0.013			22	17	1	DR	700	HALL	600	BR	600	99	100	0.625	Rarely		Recirculating	No	No	F/A Furnace	Yes
RI 7-405	4 BR WEBER NON RETRO	1	12	5	KIT	< 0.010	HALL	< 0.010			22	23										0.470	Often		Recirculating	No	No	F/A Furnace	No
RI 8-541A	2 BR DUPLEX	6	1	0	KIT/LR	0.011	MSTR BR	< 0.010	67		9	14	0	KIT	500	MBR	500	FUR RM	600			0.298	Intermittently		Recirculating	No	6"x12" grill	Blr Rm	No
RI 8-541A	2 BR DUPLEX	6	1	0	LR	0.013	BR	< 0.010	44		BROKEN	22	0	BR	600	LR	600			99	98	0.284	Intermittently		Recirculating	No	6"x12" grill	Blr Rm	No
RI 9-515	3 BR #10 GRP	5	3	2	KIT	0.028	UP HALL	0.022		0.001	17	18	2	KIT	500	MBR	600	FUR RM	900			0.224	Rarely		Recirculating	See Note 1.	No	Blr Rm	See Note 1.
RI 9-515	3 BR #10 GRP	5	3	2	LR/KIT	0.042	UP HALL	0.052			25	23	0	LR	800	UP BR	800					0.435	Rarely		Recirculating	See Note 1.	No	Blr Rm	See Note 1.
RI 10-500	1980 4 BR WOOLFENDEN	1	5	2	KIT/LR	0.011	BR HALL	0.020			27	20	0	LR	900	BR	600			94	96	0.277	Rarely		Recirculating	No	No	F/A Furnace	No
RI 10-500	1980 4 BR WOOLFENDEN	1	5	2	BR HALL	0.027		B ROKEN			21	31	0	LR	750	SEWING RM	750			100	100	0.043	Rarely		Recirculating	No	No	F/A Furnace	No
ARVIAT																														
AR 1-378	1976 4 BR WEBER RETRO	1	6	4	KIT	0.024	BR	0.010	68	0.001	24	34	0	KIT	800	BR	800			96	99	0.292	Often		Recirculating	No	No	F/A Furnace	No
AR 2-379	1975 2 BR WEBER ROOF RETRO	2	5	2	KIT	0.013	HALL	< 0.010			28	29	0	KIT	500	BR	600			94	97	0.430	Rarely		Recirculating	No	No	F/A Furnace	No
AR 3-634B	1986 2 BR DUPLEX	7	4	2	LR	0.029		B ROKEN	85	0.001	39	43	1	LR 1	1,100	BR	1,250	UP HALL	1,400	97	99	0.080	Rarely		Recirculating	See Note 2.	Yes c/w damper	Shared Blr Rm	N/A
AR 4-634A	1986 2 BR DUPLEX	7	4	2	LR	0.017	BR	0.013			24	37	0	LR 1	1,200	MBR	1,200	BR	1,200			0.184	Rarely		Recirculating	See Note 2.	Yes c/w damper	Shared Blr Rm	N/A
AR 5-610	1985 4 BR 2 STRY	4	8	1	LR	0.011	BR	0.012	106	0.001	25	25	1	LR 1	1,200	MBR	1,300					0.424	Rarely		Recirculating	No	Yes c/w damper	Blr Rm	N/A
BAKER LAKE																														
BL 1-177	4 BR 1977 WEBER RETRO	3	6	4	LR	0.018	BR HALL	0.021			23	29	0	HR	600	KIT	800			100	96	0.952	Often (WL)		Intermittently	No	10" diam. (plugg	F/A Furnace	Yes
BL 2-175	4 BR 1977 WEBER ROOF RETRO	2	8	0	LR	0.012	BR HALL	0.010	30		29	30	0	BACK BR	800	LR	1,000					0.167	Rarely		Recirculating	No	No	F/A Furnace	No
BL 3-220B	1986 2 BR DUPLEX	7	2	0							21	14	0	UP BR	600	LR	800	FUR RM	500	100	78	0.172	Rarely		Rarely	No	Yes	Shared Blr Rm	N/A
BL 4-174	4 BR 1977 WEBER ROOF RETRO	2	9	7	LR	0.018	BR HALL	0.019			34	32	1	LR	1,300	BR (UNOCC)	1,500	FUR RM	1,300			0.467	Rarely		Rarely	No	No	F/A Furnace	No
BL 5-215A	2 BR DUPLEX	6	4	2	LR	0.012	UP HALL	0.015	29		20	17	0	LR	400	UP BR (UNOCC)	900	LR (2 PERS)	700	99	93	0.484	Rarely	7.0-9.0	Rarely	Yes	Blr Rm	N/A
BL 6-176	4 BR WEBER RETRO	3	6	2	LR	0.021	BR HALL	0.019			20	23	0	LR	900	BR	1,100					0.660	Often (WL)		Intermittently	No	Yes (plugged)	F/A Furnace	No
BL 7-225B	1 BR QUADPLEX	8	3	2	LR	0.046	BR	0.055			39	34	0	HR HALL	1,600	BR	1,600			99	92	0.136	Rarely		Rarely	Yes	Yes	Shared Blr Rm	N/A
BL 8-215B	2 BR DUPLEX	6	3	2	LR	< 0.010	BR	< 0.010	48		17	38	0	LR	900	BR	1,300					0.509	Often	7.0-9.5	Intermittently	Yes	Yes	Blr Rm	N/A
CHESTERFIELD INLET																														
CI 1-067	3 BR WEBER RETRO	3	4	2	LR	0.020	BR HALL	0.014	82		23	23	1	LR	600	BR	600					0.319	Often		Recirculating	No	No	F/A Furnace	5" diam.
CI 2-088	1985 4 BR 2 STRY (see Note below)	4	5	1	LR	0.030	BR HALL	0.031	43		33	36	0	LR	1,300	BR	1,400	FUR RM	1,300	100	95	0.166	Rarely	11.0-13.0	Recirculating	No	Yes (plugged)	Blr Rm	N/A
CI 3-092B	1989 1 BR QUADPLEX	8	2	1	LR	0.081	BR	0.088			46	34	1	LR	2,000	BR	2,000					0.076	Disconnected	10.5-12.0	Intermittently	Yes	Yes	Shared Blr Rm	N/A
CI 4-070	2 BR WEBER RETRO	3	5	1	LR	< 0.010	BR	0.013	60		24	26	0	LR/DR	1,000	BR	1,000					0.303	Intermittently		Recirculating	No	No	F/A Furnace	Yes
CI 5-085	1985 4 BR 2 STRY	4	8	1	LR	< 0.010	MBR	< 0.010	79		18	19	0	LR	600	UP BR	700	FUR RM	500			0.576	Rarely	9.0-11.0	Recirculating	See Note 3.	Yes (plugged)	Blr Rm	N/A
CI 6-090B	2 BR DUPLEX	7	3	2	LR/KIT	0.018	MBR	0.015	23		22	28	1	LR	600	BR (UNOCC)	600			102	94	0.162	Rarely		Recirculating	Yes	Yes	Shared Blr Rm	N/A
CI 7-086	1985 4 BR 2 STRY	4	4	2	LR	0.032	BR HALL	0.039			25	27	3	LR	800	MBR	800			96	98	0.256	Rarely		Recirculating	No	Yes	Blr Rm	N/A
CI 8-084	1983 4BR #10GRP	5	7	2	LR	0.016	UP BR	0.016	99	<0.001	23	31	2	LR	900	BR	1,500					0.345	Disconnected		Recirculating	See Note 1.	Yes	Blr Rm	See Note 1.
COPPERMINE																														
CM 1-129	5 BR WEBER ROOF RETRO	2	4	3	LR	0.025	BR HALL	0.025	167	<0.001	24	25	1	LR	900	BR (1 PER)	1,100	KIT FLR GRILL	1,000	100	96	0.290	Often (WL)		Recirculating	No	No	F/A Furnace	3" diam.
CM 2-124	4 BR WEBER RETRO	3	8	6	LR	0.031	BR HALL	0.031	117		38	29	1	LR	800	KIT GRILL	1,100	BR	800	101	99	0.260	Often		Intermittently	Yes	10" diam. (plugg	F/A Furnace	4" diam.
CM 3-215	1987 2 BR DUPLEX	7	5	2	LR	0.038	BR HALL	0.028	BROKEN	<0.001	31	30	1	HR	900	MBR	900	BLR RM	700	100	99	0.244	Disconnected		Intermittently	Yes	Yes	Shared Blr Rm	N/A
CM 4-122	1975 4 BR WEBER ROOF RETRO	2	8	5	LR	0.010	BR HALL	< 0.010			22	28	0	HR	700							0.716	Rarely		Recirculating	No	No	F/A Furnace	No
CM 5-201	1986 1 BR QUADPLEX	8	4	1	LR	0.020	BR	0.022	22	<0.001	35	18	0	KIT	700							0.231	Intermittently		Intermittently	Yes	Yes	Shared Blr Rm	N/A
CM 6-098	1975 4 BR WEBER ROOF RETRO	2	6	3	LR	0.021	BR	0.021	70	<0.001	27	24								99	97	2.204	Rarely		Recirculating	No	No	F/A Furnace	No
CM 7-144	1977 2 BR WEBER ROOF RETRO	2	4	1	BR HALL	0.010	LR	0.016	132		29	28										0.136	Rarely		Intermittently	No	No	F/A Furnace	No
CM 8-123	4 BR WEBER RETRO	3	4	2	LR	0.022	BR	0.025			27	30										0.349	Intermittently		Rarely	No	10" diam. (plugg	F/A Furnace	4" diam.
CAMBRIDGE BAY																														
CB 1-224	1985 3 BR 2 STRY	4	4	2	LR	0.027	UP HALL	0.040	140		26	26	0	HR (UNOCC)	500	MBR	600			102	97	0.127	Intermittently	11.0-13.5	Rarely	No	Yes (plugged)	Blr Rm	N/A
CB 2-141	3 BR WEBER ROOF RETRO	2	5	1	LR	BROKEN	BR HALL	0.017			21	28	1	HR	1,000							0.272	Intermittently		Intermittently	No	No	F/A Furnace	4" diam.
CB 3-134	1976 4 BR WEBER ROOF RETRO	2	9	3	LR	< 0.010	BR HALL	< 0.010	123		33	33								98	100	0.285	Intermittently		Rarely	No	No	F/A Furnace	No
CB 4-125	1978 3 BR WEBER ROOF/WNDO R	2	2	1	LR	0.016	BR HALL	0.012	71		23	24										0.148	Intermittently	17.0-19.5	Intermittently	No	No	F/A Furnace	No
CB 5-133	1976 4 BR WEBER ROOF RETRO	2	6	4	LR	0.011	BR HALL	0.017	105		25	28	1	LR	1,000					98	96	0.217	Intermittently		Intermittently	No	No	F/A Furnace	No
CB 6-231	1 BR QUADPLEX	8	2	2	LR	0.032	BR	0.027	BROKEN		32	35	0	HR	1,200							0.102	Often	6.5-11.0	Intermittently	Yes	Yes	Shared Blr Rm	N/A
CB T-226B	1 BR QUADPLEX	8	2	2	LR	0.048	BR	0.050			41	41	1	LR	1,000	BR (UNOCC)	1,300			101	97	0.113	Rarely	4.0-5.5	Intermittently	See Note 4.	Yes	Shared Blr Rm	See Note 4.
CB 8-227B	1 BR QUADPLEX	8	1	1	LR	0.029	BR	0.024			34	23	2	HR (UNOCC)	800	LR	900					0.054	Intermittently	6.0-7.5	Intermittently	Yes	Yes	Shared Blr Rm	N/A
GJOA HAVEN																														
GH 1-061	4 BR WEBER RETRO	3	6	2	LR	0.014	BR	0.016			23	32	2	LR	1,600	BR (OCC)	1,500			101	99	0.335	Rarely	9.5-10.0	Intermittently	4" diam.	10" diam.	F/A furnace	4" diam.
GH 2-060	4 BR WEBER RETRO	3	9	1	LR	0.030	BR	0.027			26	26	0	LR	800	BR (UNOCC)	1,000					0.361	Rarely	12.0-14.0	Intermittently	No	10" diam. (plugg	F/A furnace	4" diam.
GH 3-077	3 BR WEBER ROOF RETRO	2	6	3	LR	0.014	BR	< 0.010			19	19	1	LR	700	BR	600			102	53	0.307	Intermittently	5.5-7.0	Rarely	No	No	F/A furnace	4" diam.
GH 4-073	2 BR WEBER NON RETRO	1	4	2	LR	0.014	BR HALL	0.015			21	24	0	LR	800	BR (UNOCC)	600					0.420	Rarely		Not Working	No	No	F/A furnace	No
GH 5-087	2 BR WOOLFENDEN DUPLEX	10	4	2	LR	0.021	MBR	0.017	111		33	18	0	LR	500	BR	500					0.475	Intermittently	8.5-10.5	Not Working	No	No	F/A furnace	5" diam.
GH 6-118	1985 4 BR 2 STRY	4	9	4	LR	< 0.010	UP HALL	0.013	166		31	32	0	LR	1,100	BR (UNOCC)	1,400			98	98	0.308	Intermittently	19.0-22.0	Recirculating	Yes	Yes	Blr Rm	N/A
GH 7-088	2 BR WOOLFENDEN DUPLEX	10	6	1	LR	0.014	MBR	0.018			32	20	0	KIT	800	MBR	800			97	98	0.403	Rarely		Rarely	No	No	F/A furnace	5" diam.
GH 8-114	4 BR 2 STRY	4	8	3	LR	0.023	BR	0.021	136	<0.001	31.5	29	0	LR	1,000	BR (UNOCC)	1,100			102	96	0.224	Rarely		Recirculating	No	Yes	Blr Rm	N/A

Note: this unit unoccupied for last 5 test days

Explanation of House Type Codes

1. Weber and other - non-retrofits.
2. Weber and other - roof retrofits.
3. Weber and other - full retrofits.
4. Single family - two storey.
5. Single family - one and one-half storey.
6. Two storey duplex unit - separate boiler room.
7. Two storey duplex unit - common boiler room.
8. Quadplex - one storey.
9. Quadplex - one and one-half storey.
10. Woolfenden duplex - one storey.

NOTES:
Note 1. Destratification/Recirculation fan with O/A intake that is not working.
Note 2. Destratification/Recirculation fan with O/A intake that is not used.
Note 3. Destratification/Recirculation fan with O/A intake that is used rarely.
Note 4. Has 2 extra exhaust fans added due to high humidity.

APPENDIX 4

RESULTS OF RCS MICROBIAL SAMPLING

Agriculture Canada

Research Branch | Direction générale de la recherche

PLANT RESEARCH CENTRE
CENTRAL EXPERIMENTAL FARM
OTTAWA, ONTARIO
K1A 0C6

CENTRE DE RECHERCHES PHYTOTECHNIQUES
FERME EXPERIMENTALE CENTRALE

PHONE: (613) 995-3700
FAX: (613) 992-7909

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January 3, 1990

0240-1

Robin Sinha
Canada Mortgage and Housing Corporation
682 Montreal Road
Ottawa, Ontario
K1A 0P7

RE: RCS samples brought to my laboratory December 6, 1989.

Sample ID	$CFUm^{-3}$	species
1. second bedroom unit 400	0	
2. main bedroom unit 400	50	non sporulating isolates *Penicillium decumbens*
3. furnace room/porch unit 400	119	*P. decumbens*
4. living room unit 400	31	*P. decumbens*
5. back room unit 400	81	*P. decumbens*
6. furnace room R122	0	
7. kitchen R122	0	
8. LRM R122	0	

The sample strips were not properly sealed (with strong tape) but this was not so serious as to interfere with the data. Generally, these samples were within normal limits. The "decision tree" used to handle these kind of data would direct the investigator to look for the source of *P. decumbens*. This mold is rather common in house dust in Canada, and is not considered toxigenic.

J. David Miller Ph.D.
Research Scientist

Canada

Sample ID	$CFUm^{-3}$	Species
CI 4 bath	0	
CI 4 kit	0	
CI 4 bdrm	0	
CI 4 bath	69	P. brevicompactum
CI 5 kit	438	Penicillium species
CI 5 bdrm	469	Penicillium species
CI 5 bdrm	0	Penicillium species
CI 6 bdrm	0	
CI 6 bdrm	25	P. jenseni
CI 7 bath	0	
CI 7 bdrm	0	
CI7 lrm	6	non sporulating isolate
CH 6 - 118 bath	0	
CH 7 - 88 bath	13	unknown
CH 7 - 88 bdrm	0	
CH 8 - 114 bath	0	
CH 8 - 114 kit	0	
CH 6 - 118 bdrm	0	
CH 6 - 118 kit	0	

Species are listed in descending order of frequency. Where Penicillium isolates are given to genus, the culture was not identifiable to species; Alternaria - A. alternata, Cladosporium - C. cladosporioides. Excepting samples CI5 (3), in my opinion these data are within normal limits. The CI5 samples are qualitatively and quantitatively outside the normal values for Canadian houses. If the samples are representative, I would advise locating and eliminating the source of the Penicillium that resulted in such high spore airborne spore counts. P. brevicompactum is considered to be an undesirable species in indoor air (Can. J. Public Health 78:Si-32).

J. David Miller Ph.D.
Senior Research Scientist

Agriculture
Canada

Research Branch | Direction générale de la recherche

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OTTAWA, ONTARIO
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PHONE: (613) 995-3700
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Votre référence Your file

Notre référence Our file

April 18, 1990

Mr. Robin Sinha
Project Implementation Division
Canada Mortgage and Housing Corporation
682 Montreal Road
Ottawa, Ontario
K1A OP7

0240-1

Re: RCS samples received in March and April 1990.

Sample ID	$CFUm^{-3}$	Species
RI 1 kit	0	
RI 1 bath	0	
RI 9 bath	0	
RI 9 kit	6	Cladosporium
BL 174 bath	275	Cladosporium non sporulating isolates Penicillium species (2)
BL 174 bdrm	188	as above
BL 174 kit	213	as above
BL 175 kit	25	P. viridicatum Cladosporium
BL 175 bdrm	13	Cladosporium non sporulating isolate
BL 175 bath	38	Alternaria P. viridicatum Penicillium species unknown
BL 177 bath	0	
BL 177 bdrm	0	
BL 177 kit	0	
BL 176 kit	25	Alternaria non sporulating isolates
BL 176 bath	50	Cladosporium non sporulating isolates
BL 176 bdrm	13	Cladosporium Penicillium species

.../2

Agriculture
Canada

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CENTRAL EXPERIMENTAL FARM
OTTAWA, ONTARIO
K1A 0C6

CENTRE DE RECHERCHES PHYTOTECHNIQUES
FERME EXPERIMENTALE CENTRALE

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Notre référence Our file

PHONE: (613) 995-3700
FAX: (613) 992-7909

April 30, 1990

Mr. Robin Sinha
Project Implementation
Canada Mortgage and Housing Corporation
682 Montreal Road
Ottawa, Ontario
K1A 0P7

Re: RCS strips sent to my laboratory; delayed in transit.

Sample ID	CFU m^{-3}	Species
1. CB7-225B lrm	0	
2. CB7-225B bdrm	0	
3. CB3-134 bath	0	
4. CB3-134 kit	0	
5. CB5-133 kit	25	non sporulating isolate
6. CB5-133 bath	6	Penicillium species
7. CB5-133 bdrm	6	non sporulating isolate
8. CM4-122 bdrm	0	
9. CM4-122 kit	unreliable	Cladosporium
10. CM4-122 bath	unreliable	Penicillium species non sporulating isolate Cladosporium
11. CM5-201 bath	0	
12. CM5-201 kit	6	Penicillium species
13. CM5-201 bdrm	unreliable	yeasts
14. CB8-227B bdrm	unreliable	Penicillium species 1 non sporulating isolate Cladosporium
15. C38-227B kit	unreliable	Penicillium species 2 Cladosporium

In my opinion these samples are within normal limits.

J. David Miller Ph.D.
Senior Research Scientist

Canada

APPENDIX 5

HOUSE PROFILES

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study GH4

House Type 1 - Weber Non-Retro

Gjoa Haven, NWT

OVERALL COMMENTS

House in reasonable condition. This was one of the oldest houses in the survey. House is scheduled for a retrofit.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	21
HCHO Living Room (ppm)	.014
HCHO Upper Hall (ppm)	.015
CO_2 Spot Level (ppm)	700
Air Change Rate (ac/hr)	0.420

HOUSE CHARACTERISTICS

- 1976 2 bedroom Weber, non-retrofitted.
- Occupants living in the house for previous 6 months.
- 4 people during the day and at night.

Heating

- Heating: standard efficiency oil burner on a forced-air furnace. Some chimney corrosion with minor corrosion on bottom of chimney "tee".
- Hot water: Electric DHW tank.
- Minor signs of combustion gas spillage at flue pipe breeching.

Ventilation

- Bathroom fan used only to remove smell after sewage pump out.
- Kitchen fan not working.
- No passive vent.
- No outside air duct to return air plenum.
- No combustion air duct.

POLLUTION SOURCES

- Odours: meat, cooking, garbage in porch.
- Not dusty.
- No animal skins, snow machines or crafts worked on inside.
- No gun cleaning done inside.
- One small dog kept inside (only house in survey with an animal kept inside).
- Standard cleaners used.
- No new furniture or carpets.

HEALTH SURVEY

- 4 occupants, 2 of whom smoke 12 - 15 cigarettes per day.
- Adult male has bronchitis.
- Children have had pneumonia.
- Adult male reports having headaches twice per month.
- Adult female reports feeling lightheaded at least twice per week in winter.
- Reports of dry, plugged nose and dry throat.
- Family rarely gets colds.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Furnace, laundry tub and DHW tank.

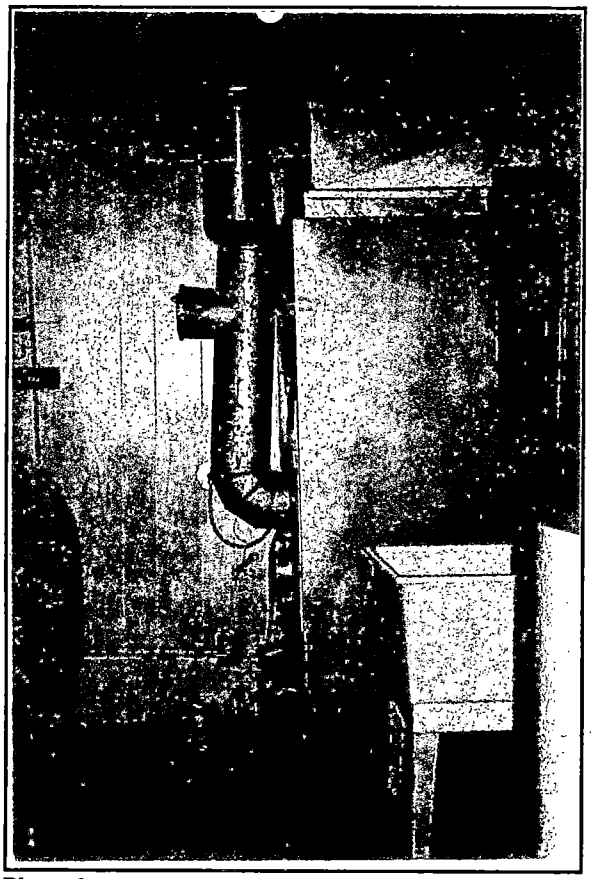


Photo 1.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study BL4

House Type 2 - Weber Wall/Roof Retro
Baker Lake, NWT

OVERALL COMMENTS

House in reasonable condition. There is no shifting of the structure apparent. The floors have missing and lifted tiles. Ceiling was extensively stained prior to roof retrofit. Windows are deteriorated. Some panelling has sprung from walls.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	34
CO_2 Spot Level (ppm)	1,500
Air Change Rate (ac/hr)	0.467

HOUSE CHARACTERISTICS

- 1977 4 Bedroom Weber - roof retrofit only.
- Occupants living in house for 2 years.
- 10 people at night, 5 - 6 home during the day.

Heating

- Standard oil burner on a forced-air furnace. Fan compartment cover was off furnace and return air was drawn from porch.
- No combustion air inlet.
- No signs of combustion gas spillage.
- Hot water: electric DHW tank.

Ventilation

- Bathroom fan: older fan, not often used.
- Kitchen fan: Only used occasionally.
- No passive vent.
- Dryer vented into house.
- No outside air duct to return air plenum
- No signs of combustion gas spillage.

POLLUTION SOURCES

- No unusual odours.
- No excess dust.
- No animal skins, snow machines worked on inside.
- Small amount of soapstone carving done.
- Standard household cleaners used.

HEALTH SURVEY

- 10 occupants.
- Oldest male feels tired during the day when in the house.
- Oldest male gets chest colds, 2 times per year for 2 weeks.
- He smoked up until 1 year ago.
- He currently has a urinary track infection.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Snow drifting under porch door and tiles lifted from floor.

2. Oil furnace and electric DHW tank in back porch area.

Photo 1.

Photo 2.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study CI4

House Type 3 - Weber Full Retro
Chesterfield Inlet, NWT

OVERALL COMMENTS

House in good condition. The house appears stable with no evident shifting. There are a few drywall screw pops on some interior walls.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	24
Bioquest Gas	N/A
Bioquest Particulates	N/A
CO_2 Spot Level (ppm)	1,000
Air Change Rate (ac/hr)	0.303

HOUSE CHARACTERISTICS

- 1975 2 Bedroom Weber - total retrofit 2 years ago.
- Occupants living in the house for 10 years.
- 5 people at night, 3 home during the day.

Heating

- Standard oil burner on a forced-air furnace.
- Hot water: Electric DHW tank.
- No combustion air inlet.
- No signs of combustion gas spillage

Ventilation

- Bathroom fan: newer, vented to outside, used rarely.
- Kitchen fan: newer, vented to outside, used occasionally.
- No passive vent.
- Dryer vented to inside.
- 4" outside air duct to return air plenum.

POLLUTION SOURCES

- No unusual odours.
- No dust, except in summer.
- No animal skins, snow machines or crafts worked on inside.
- Gun cleaning and oiling in summer only.
- Standard cleaners used.

HEALTH SURVEY

- 5 occupants, 2 adults, 3 children.
- 1 adult smoker- 5-6 cigarettes per day.
- Some eye irritation in summer.
- Throat gets dry at night.
- He gets headaches once every six months.
- She gets headaches once a month.
- Youngest daughter, 4 years old, had meningitis when she was 1 year old.
- Youngest daughter also regularly gets a runny nose.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study CB1

House Type 4 - 1985 3-4 Br, 2 Storey
Cambridge Bay, NWT

OVERALL COMMENTS

House in very good condition. There is no evidence of movement. House was very clean and well looked after.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	26
HCHO Living Room (ppm)	.027
HCHO Upper Hall (ppm)	.040
Bioquest Gas	102
Bioquest Particulates	97
Particulates ($\mu g/m^3$)	140
CO_2 Spot Level (ppm)	550
Air Change Rate (ac/hr)	0.127

HOUSE CHARACTERISTICS

- 1984/85 3 Bedroom 1¾ storey, new construction.
- Occupants living in the house for 3 months.
- 4 people at night, none at home during the day.

Heating

- Heating: standard oil burner on oil-fired boiler.
- Hot water: DHW from boiler.
- Combustion air damper disconnected.
- Minor combustion gas spillage at barometric damper on startup.
- Adjustable weight on barometric damper missing.

Ventilation

- Bathroom fan flow 11.0 - 13.5 L/s (used intermittently).
- Kitchen fan used rarely.
- No passive vent.
- Dryer vented to inside.

POLLUTION SOURCES

- No unusual odours.
- No animal skins, snow machines or crafts worked on inside.
- No gun cleaning done inside.
- Standard cleaners used.
- Newer upholstered couch.

HEALTH SURVEY

- 4 occupants, 2 adults smoke 10 - 15 cigarettes per day.
- Adult female reported chest infection/bad flu in January of testing year.
- Reports of dry/dusty nose and throat.
- Adult male and children have dry skin.
- Adult female reports fatigue on a regular basis.
- Adult female reports 3 - 4 morning headaches per month.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Combustion air damper (disconnected and closed)

2. Barometric damper (no weight) and flue damper above (not wired) but open.

Photo 1.

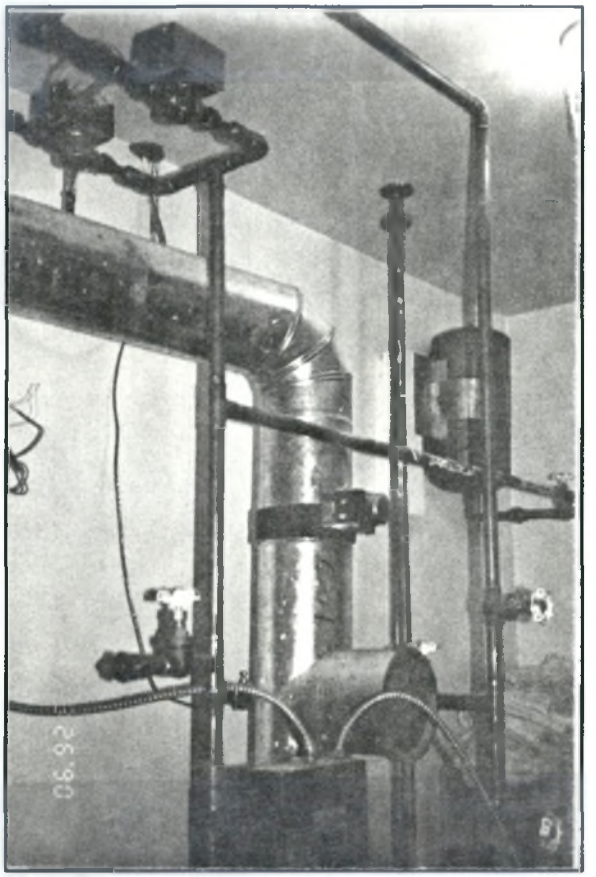


Photo 2.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study CI8

House Type 5 - 1983 3-4 Br, 1½ Storey
Chesterfield Inlet, NWT

OVERALL COMMENTS

House in reasonable condition. Some problems with temperature control and noisy recirculation ar fan.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	23
HCHO Living Room (ppm)	.016
HCHO Upper Hall (ppm)	.016
Particulates (µg/m^3)	99
CO_2 Spot Level Living Room (ppm)	900
CO_2 Spot Level Bedroom (ppm)	1,500
Radon (WL)	<.001
Air Change Rate (ac/hr)	0.345

HOUSE CHARACTERISTICS

- 1983/4 4 Bedroom 1½ storey, #10 GRP design, metal panel construction.
- Occupants living in the house for 3 years.
- 7 people at night, 2-3 at home during the day.

Heating

- Heating: Riello oil burner on boiler.
- Hot water: DHW from boiler.
- Boiler turned off, house too hot.
- There is combustion air to boiler.
- Thermostat not working, no spares.
- No sign of combustion gas spillage.

Ventilation

- Recirculating kitchen fan.
- destratification/recirculation/outdoor air fan pulls air fro the upper floor and the warm attic and mixes with the outdoor air.
- This fan disconnected in boiler room.
- No passive vent.

POLLUTION SOURCES

- Some cooking, garbage and diaper odours.
- House was dusty.
- Occasional wolf skin treated inside.
- Snow machine serviced in porch.
- No carving, crafts, etc done inside.
- Standard cleaners used.
- No new furniture/carpets.
- Exposed glass fibre insulation.

HEALTH SURVEY

- 7 occupants, 2 smoke 10 - 15 cigarettes per day each.
- Baby has bronchitis.
- Adult female reported headaches once in a long while every 4-5 months.
- Reports of sore eyes in winter due to cold wind.
- Reports of dry throat in winter.
- Family rarely gets colds.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study BL5

House Type 6 - 1985 2 Br duplex c/w separate boiler rooms.
Baker Lake, NWT

OVERALL COMMENTS

House in good condition, except for substantial staining (mould) on the upper floors of the house end wall and ceiling. Some rusting of drywall corner bead through compound. No condensation observed during site visit.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	20
HCHO Living Room (ppm)	.012
HCHO Upper Hall (ppm)	.015
Bioquest Gas	99
Bioquest Particulates	93
Particulates ($\mu g/m^3$)	29
CO_2 Spot Level Living Room (ppm)	400
CO_2 Spot Level MBRM (ppm)	900
Air Change Rate (ac/hr)	0.484

HOUSE CHARACTERISTICS

- 1985 2 Bedroom duplex with individual boiler rooms.
- Occupants living in the house for 2 years.
- 4 people at night, 1 at home during the day.
- House cold and drafty in really cold weather.
- Some bedrooms too hot.

Heating

- Heating: standard oil burner on oil-fired boiler.
- Hot water: DHW from boiler.
- Combustion air inlet to boiler room partially plugged.

Ventilation

- Bathroom fan flow 7.0 - 9.0 L/s (used rarely).
- Kitchen fan used rarely.
- Passive vent in house.

POLLUTION SOURCES

- Reports of occasional sulphur smell.
- No unusual odours or dust.
- No animal skins, crafts or carvings worked on inside.
- Snow machine serviced inside.
- Guns and tools on outside porch.
- Standard cleaners used.
- No newer furniture/carpets.

HEALTH SURVEY

- 4 occupants, 2 adults smoke 1½ pack of cigarettes per day.
- Adult female reports headaches every 3-4 weeks.
- Adult female reports lightheadedness each morning.
- Adult female reports eye irritation, plugged nose and dry throat.
- Family gets colds only once per year.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1.Boiler with controls cover removed on oil burner.
2. Combustion air inlet.
3. Wall/ceiling staining.

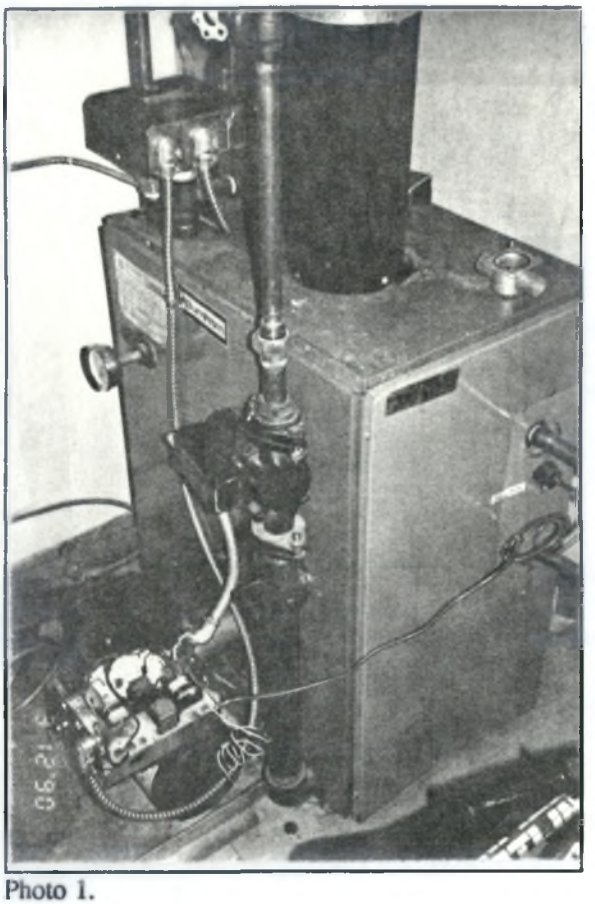


Photo 1.

Photo 2.

Photo 3.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study RI2

House Type 9 - 1 Br 4plex 1½ storey.
Rankin Inlet, NWT

OVERALL COMMENTS

House in very good condition. Low occupancy and low pollution source levels. Boiler room door does not close, resulting in snow drifting in the room and melting. Water and humidity damage are evident in boiler/laundry room.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	11
HCHO Living Room (ppm)	<.010
HCHO Bedroom (ppm)	<.010
Bioquest Gas	88i
Bioquest Particulates	99-
Particulates ($\mu g/m^3$)	23
CO_2 Spot Level Living Room (ppm)	400
CO_2 Spot Level MBRM (ppm)	600
Air Change Rate (ac/hr)	0.688

HOUSE CHARACTERISTICS

- 1984 1 Bedroom, 1½ storey 4plex - #10 GRP.
- Built and occupied one year prior to testing.
- 1 occupant who is out during the day.
- Occupant lived in house for three months.
- Metal insulated panel construction.
- House in not considered drafty.
- There is a small amount of foundation shifting.
- Washer and dryer next to boiler.

Heating

- Heating: Standard oil burner for all four units.
- Boiler room not accessible from units.
- Hot water: Electric DHW tank.
- Minor spillage at barometric damper.
- 6" x 12" combustion air grille to boiler room.

Ventilation

- Bathroom fan used often.
- Kitchen fan recirculating type - used ??.
- No passive vent installed.

POLLUTION SOURCES

- No unusual odours and not noticeably dusty.
- No animal skins, crafts, carvings, gun cleaning or snow machine serviced inside.
- Standard cleaners used.
- Mosquito spraying in summer.
- No newer furniture/carpets.

HEALTH SURVEY

- 1 adult smokes 1 pack of cigarettes per day.
- No headaches, lightheadedness, or fatigue reported.
- No eye, nose, throat problems reported.
- No coughing, wheezing or shortness of breath.
- No respiratory disease reported.
- Colds 2-3 times per month.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Vent to warm attic storage space off stairs.
2. Vent to upper warm attic space.
3. Paint peeling above combustion air inlet.
4. Boiler room.

Photo 1.

Photo 2.

Photo 3.

Photo 4.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study BL5

House Type 7 - 1986 2 Br duplex with common boiler room.
Coppermine, NWT

OVERALL COMMENTS

House in excellent condition. Major problem in icing of windows in winter so they cannot be opened.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	31
HCHO Living Room (ppm)	.038
HCHO Bedroom Hall (ppm)	.028
Bioquest Gas	100
Bioquest Particulates	99
Radon (WL)	<.001
CO_2 Spot Level Kitchen (ppm)	900
CO_2 Spot Level MBRM (ppm)	900
CO_2 Spot Level Boiler Room (ppm)	900
Air Change Rate (ac/hr)	0.244

HOUSE CHARACTERISTICS

- 1987 2 Bedroom duplex with shared boiler rooms.
- Built and occupied one year prior to testing.
- 5 people at night, 3 at home during the day.
- Frost and ice on windows in really cold weather.
- Kitchen fan leaks cold air in winter.

Heating

- Heating: Riello oil burner on oil-fired boiler.
- Hot water: DHW from boiler.
- Combustion air inlet to boiler room.

Ventilation

- Bathroom fan disconnected.
- Kitchen fan used intermittently.
- Passive vent installed in Kitchen/eating area (1½" ABS plastic)
- Destratification fan over upstairs storage loft.

POLLUTION SOURCES

- No unusual odours but dust from sewing materials.
- No animal skins, crafts, guns or snow machine serviced inside.
- Standard cleaners used.
- No newer furniture/carpets.

HEALTH SURVEY

- 5 occupants, 2 adults smoke ½ pack of cigarettes per day.
- Adult male worked as a crusher operator at mining company.
- Adult female complains of constant headaches, possibly due to eyesight. (doctor opinion??)
- No reports of lightheadedness or fatigue or respiratory diseases.
- Dry skin and nose reported.
- Family reports no unusual colds.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Passive vent beside beam in eating area.
2. Destratification fan in storage loft.
3. Boiler room with combustion air duct insulation coming off in background.
4. Moisture/ice buildup on porch door.

Photo 1.

Photo 2.

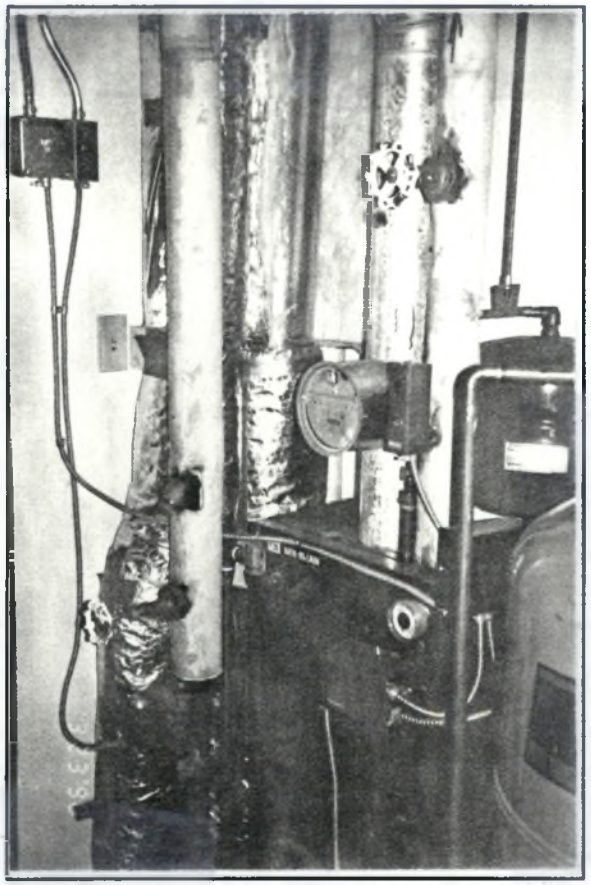


Photo 3.

Photo 4.

Elevation View of the House

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study CB7

House Type 8 - 1 Br 4plex bungalow.
Cambridge Bay, NWT

OVERALL COMMENTS

House in very good condition. There have been complaints about high humidity, icing of windows in cold weather, pooling of water on window sills. There were complaints of draftiness from the front door.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	41
HCHO Living Room (ppm)	.048
HCHO Bedroom (ppm)	.050
Bioquest Gas	101
Bioquest Particulates	97
CO_2 Spot Level Living Room (ppm)	1,000
CO_2 Spot Level MBRM (ppm)	1,300
Air Change Rate (ac/hr)	0.113

HOUSE CHARACTERISTICS

- 1987 1 Bedroom, 4plex.
- 2 occupants, both home day and night.
- High RH has been a problem.
- House in very air tight.
- Laundry not done in this home.

Heating
- Heating: Standard oil burner for all four units.
- Boiler room not accessible from units.
- Hot water: Electric DHW tank.
- Combustion air grille to boiler room.

Ventilation
- Bathroom fan used rarely.
- Kitchen/living room fan used intermittently.
- Kitchen hood is recirculation type.
- Extra exhaust fan added in Living Room.
- 2 passive air inlets added in Living Room.
- All fans are manually controlled.

POLLUTION SOURCES

- No unusual odours and not noticeably dusty.
- No animal skins, crafts, carvings, gun cleaning or snow machine serviced inside.
- Standard cleaners used.
- No newer furniture/carpets.

HEALTH SURVEY

- 2 adults smoke 1 pack of cigarettes per day each.
- No headaches, lightheadedness, or fatigue reported.
- No eye, nose, throat problems reported.
- Adult male worked underground as a crusher operator in 1984.
- No respiratory disease reported.
- Colds 2 times per year.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1. Additional new exhaust fan in living room on top of box.
2. Exhaust fan outlet.
3. Passive vent in living room.
4. Passive vent hood outside living room.

Photo 1.

Photo 2.

Photo 3.

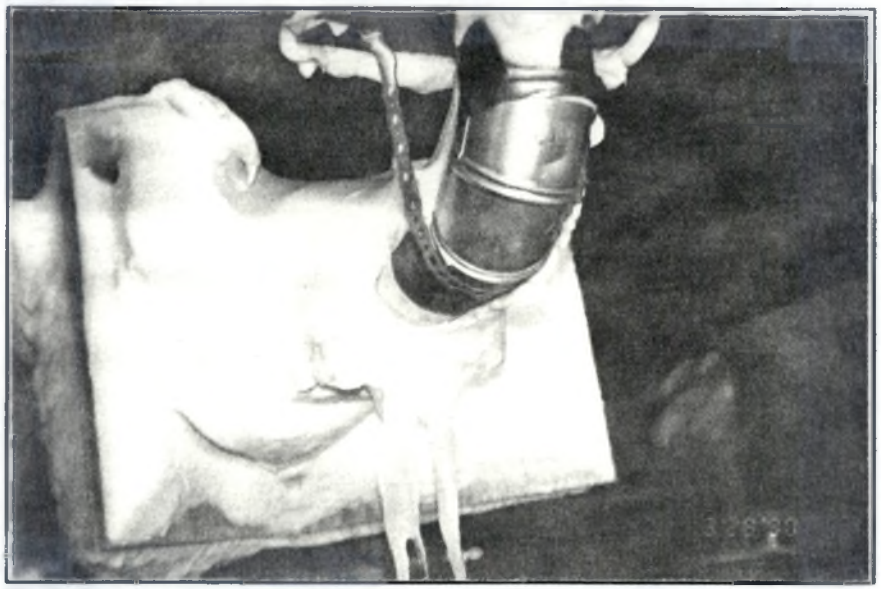
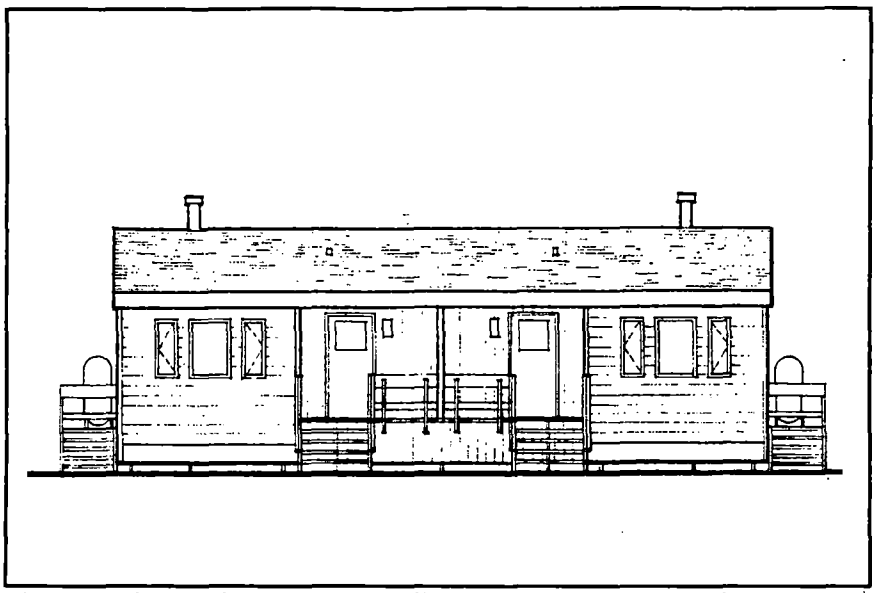


Photo 4.



Elevation View of the House not available due to blizzard conditions.

HOUSE PROFILE

CMHC/NWTHC Residential Indoor Air Quality Survey

Case Study GH5

House Type 10 - 2 Br Woolfenden.
Gjoa Haven, NWT

OVERALL COMMENTS

This older house has been kept in very good condition. Some potential air leakage locations could be sealed. Fans are not always used. They are controlled manually.

INDOOR AIR QUALITY RESULTS

Relative Humidity (%)	33
HCHO Living Room (ppm)	.021
HCHO Bedroom (ppm)	.017
Particulates ($\mu g/m^3$)	111
CO_2 Spot Level Living Room (ppm)	500
CO_2 Spot Level BRM (ppm)	500
Air Change Rate (ac/hr)	0.475

HOUSE CHARACTERISTICS

- 1979 2 bedroom, side-by-side duplex.
- Occupants in house for 2 years.
- 4 people at night, 1 during the day.
- Moisture pools on windows in the spring and the fall.
- Frost on baseboards and nails in coldest weather.
- Some drafts on the back bedroom on common wall.

Heating

- Heating: Standard oil burner on forced-air furnace.
- Standard efficiency oil burner.
- Hot water: Electric DHW tank.
- No visible spillage.
- 5" outside air duct to return air plenum.
- No combustion air duct.

Ventilation

- Bathroom fan air flow - 8.5 to 10.5 L/s - used intermittently.
- Kitchen fan not working.
- No passive vent installed.
- Occasional sulphur smell in house.

POLLUTION SOURCES

- No unusual odours and not noticeably dusty.
- No animal skins, crafts, carvings, gun cleaning or snow machine serviced inside.
- Standard cleaners used.
- Some newer furniture.

HEALTH SURVEY

- 4 occupants, 2 adults smoke ½ pack of cigarettes per day.
- Adult female reports headaches twice per week.
- No reports of lightheadedness.
- No eye, nose, throat problems reported.
- Both adults report eye irritation and plugged nasal passages in morning.
- Both adults report dry skin.
- Adult female reports frequent colds - 10 times per month.
- Adult female reports bronchitis 3-4 years ago.

ADDITIONAL PHOTOS OF HOUSE (on reverse side)

1.Oil-fired forced air furnace.
2. View through doorway into bathroom and wall mounted fan.

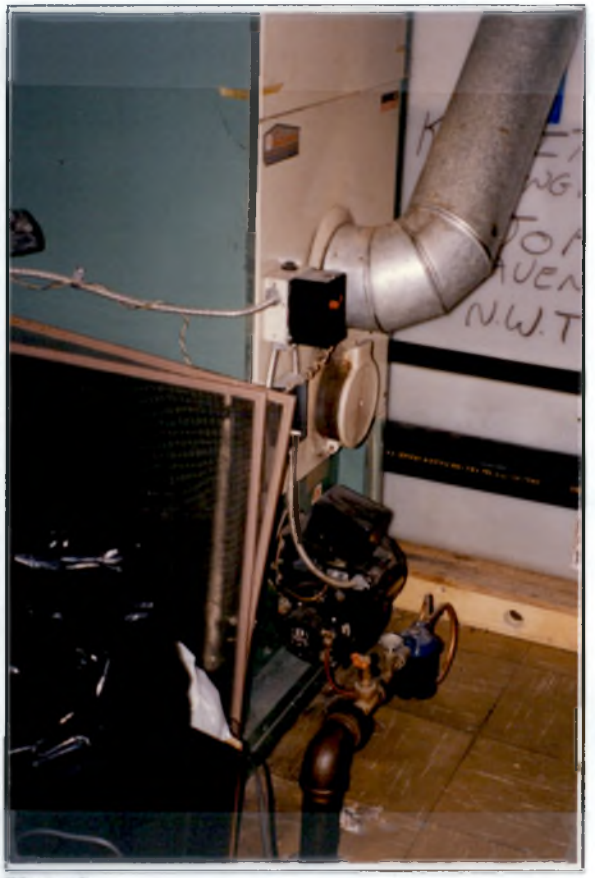


Photo 1.

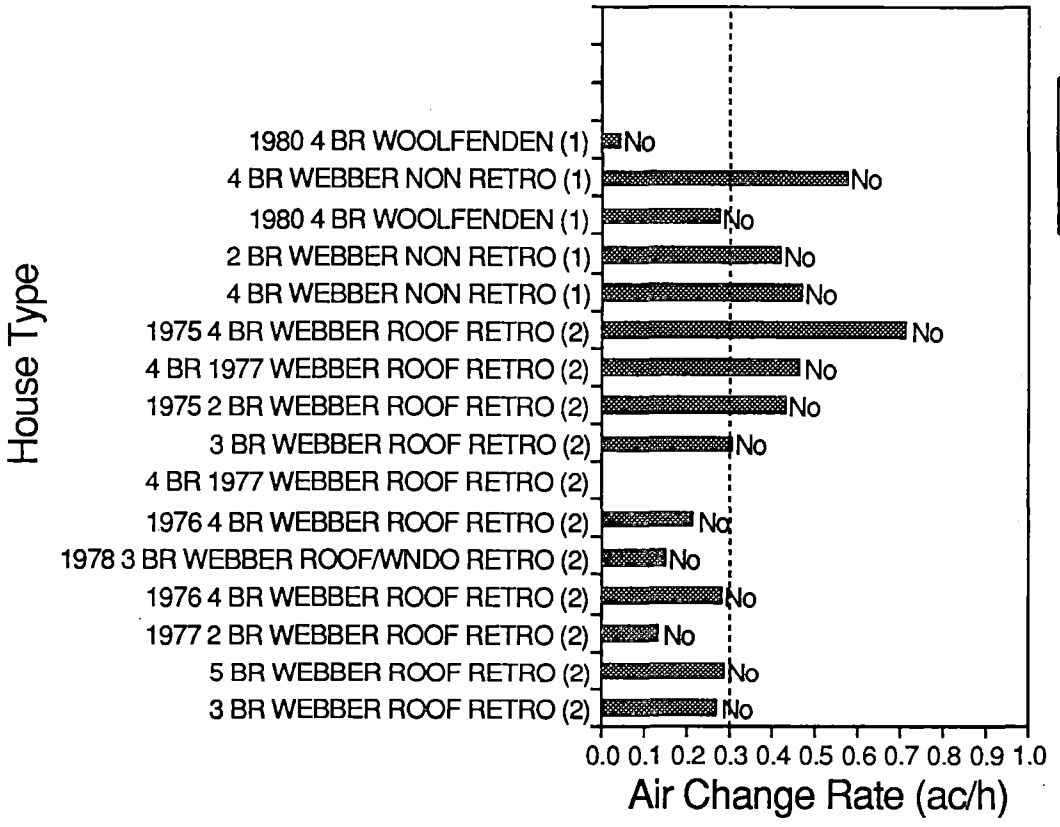
Photo 2.

APPENDIX 6

GRAPHS (in full size)

CMHC NWT Indoor Air Quality Study

Air Change Rate vs House Types #1 and 2



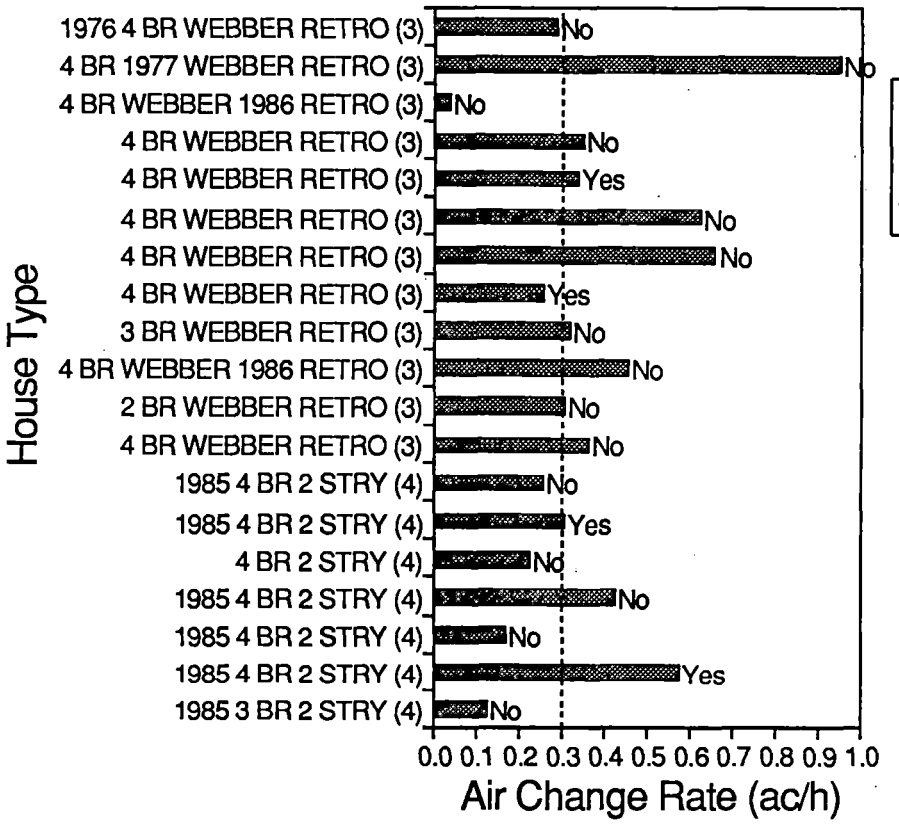
Note: Yes means that the House has a Passive Vent.

File: 375-IAQ4.WO1

Graph 1

CMHC NWT Indoor Air Quality Study

Air Change Rate vs House Types #3 and 4



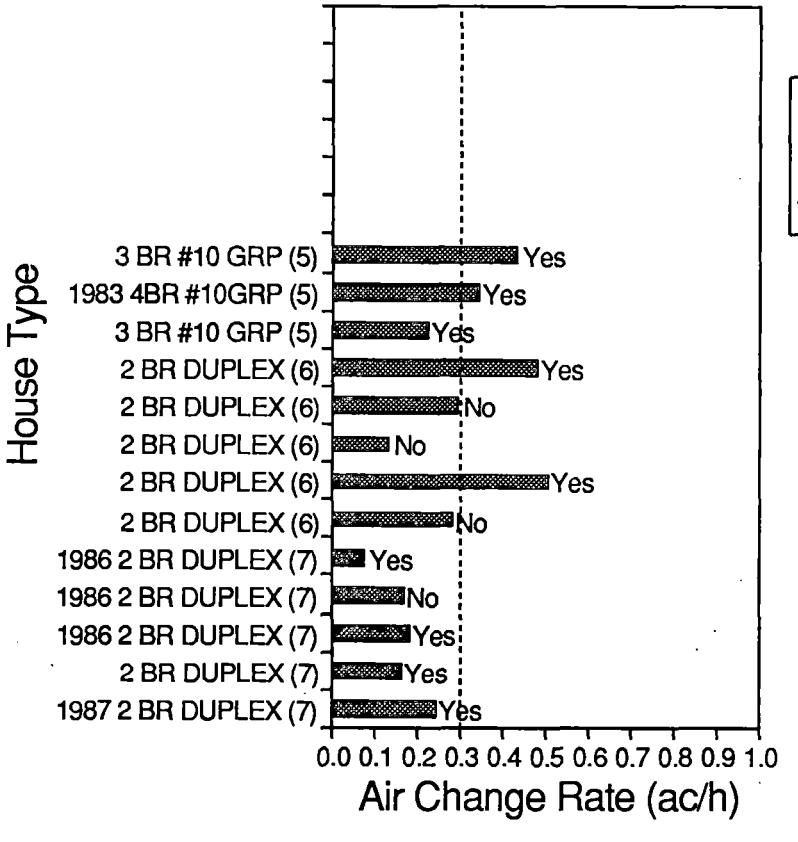
Note: Yes means that the House has a Passive Vent.

File: 375-IAQ4.WQ1

Graph 2

CMHC NWT Indoor Air Quality Study

Air Change Rate vs House Types #5,6&7



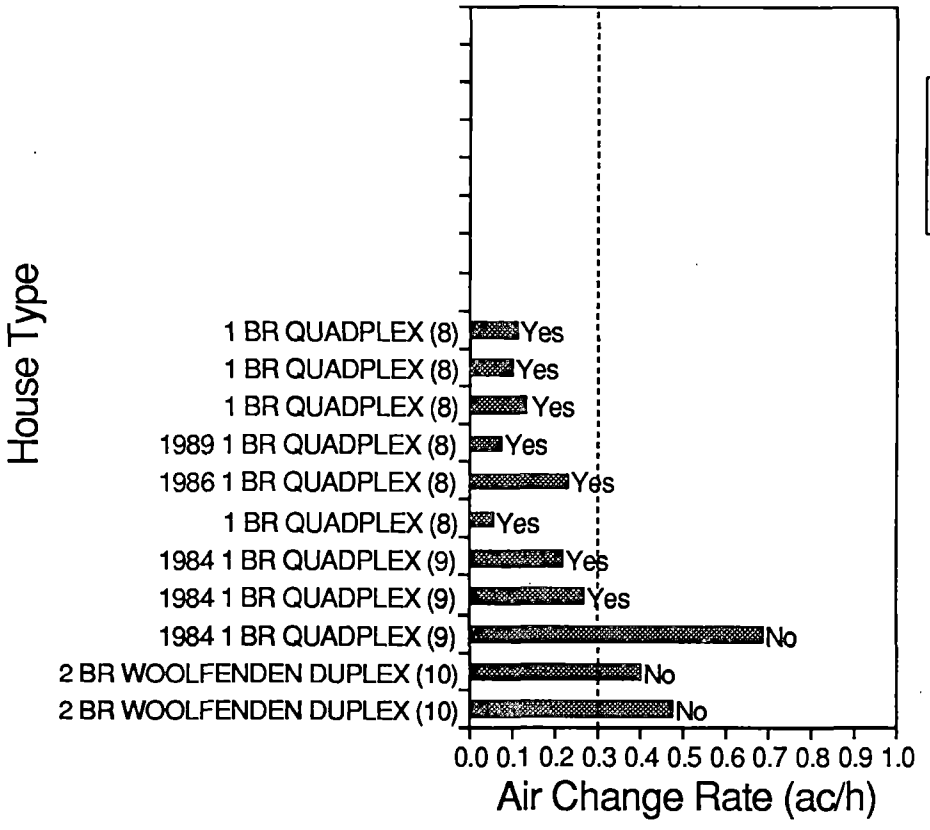
Note: Yes means that the House has a Passive Vent.

File: 375-IAQ4.WQ1

Graph 3

CMHC NWT Indoor Air Quality Study

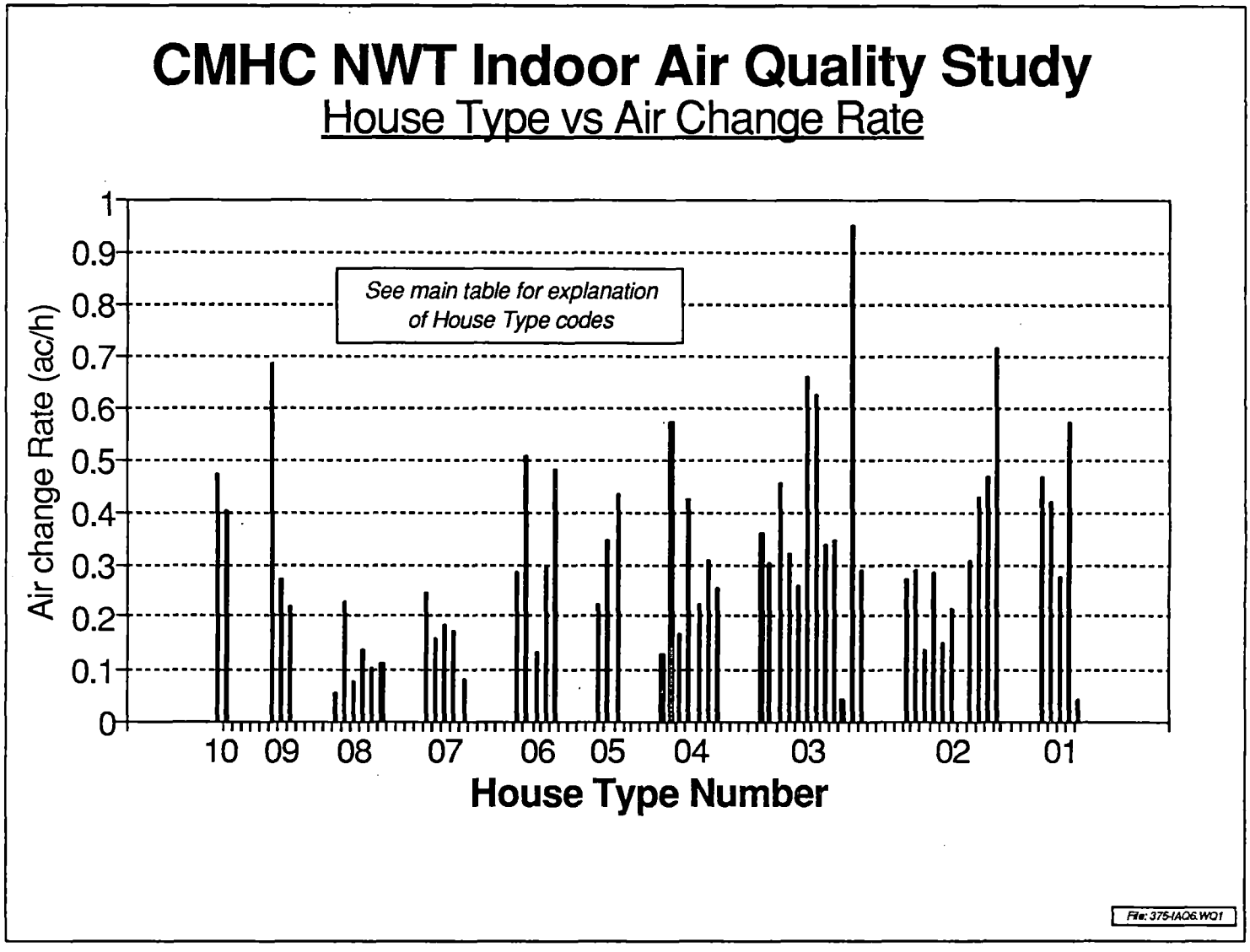
Air Change Rate vs House Types 8,9&10



Note: Yes means that the House has a Passive Vent.

File: 375-IAQ4.WO1

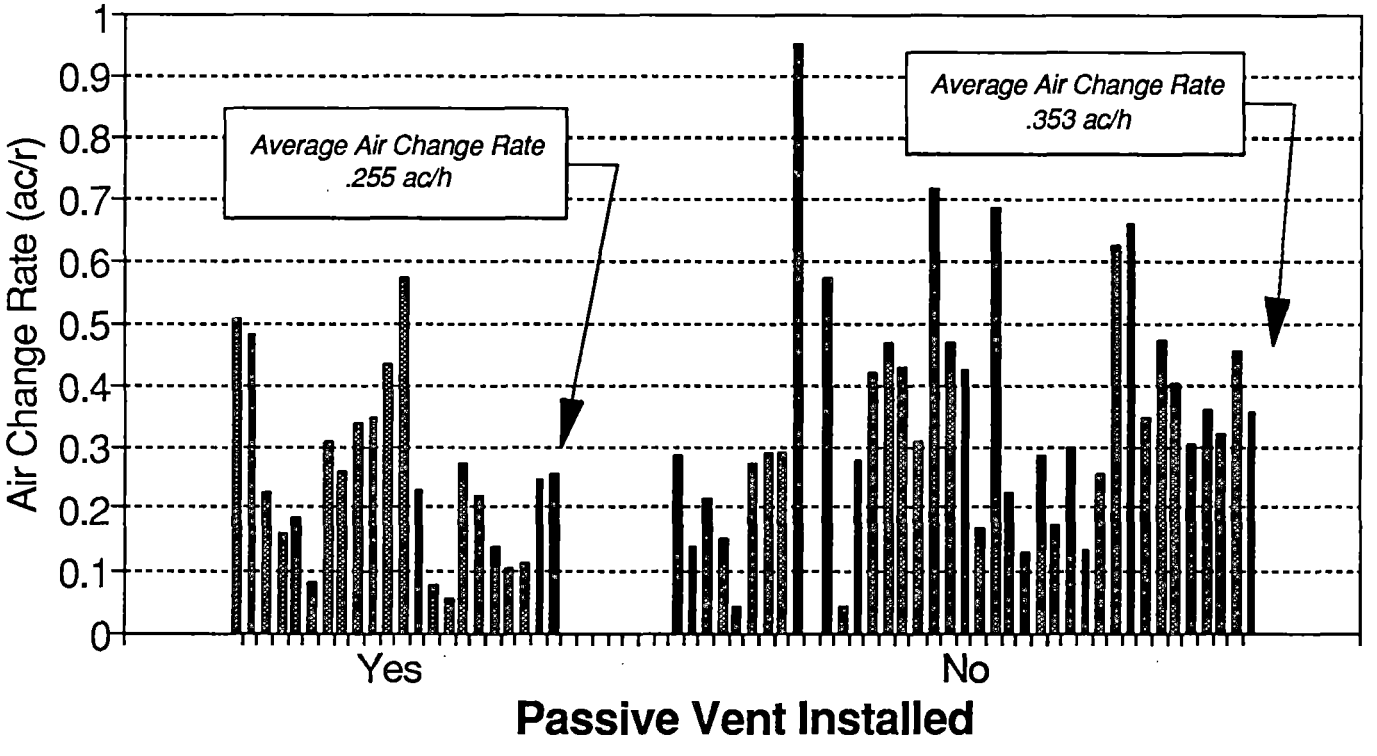
Graph 4


CMHC NWT Indoor Air Quality Study
House Type vs Air Change Rate
Air change Rate (ac/h)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
See main table for explanation of House Type codes
10 09 08 07 06 05 04 03 02 01
House Type Number
File: 375-IAQ6.WO1

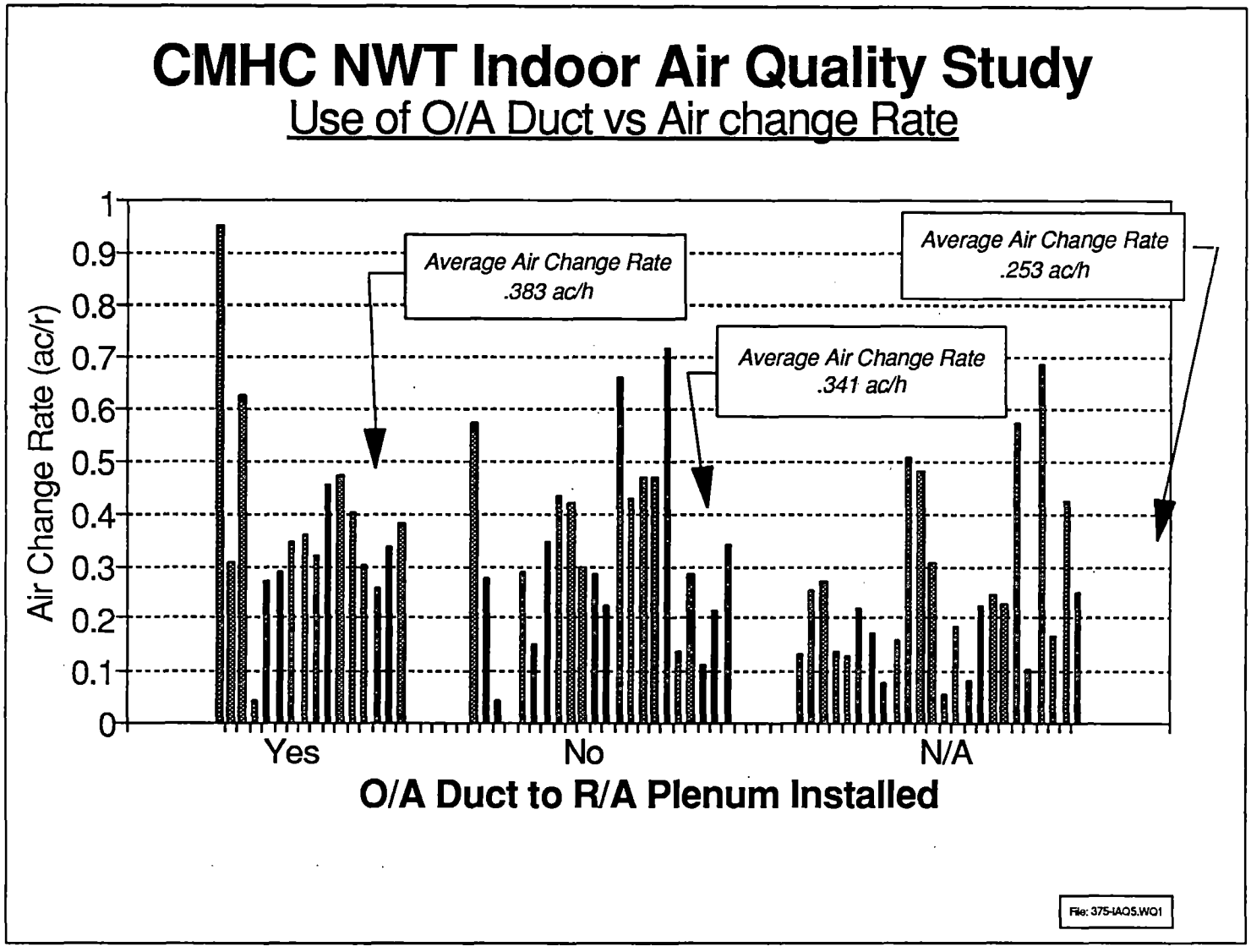
Graph 5

CMHC NWT Indoor Air Quality Study

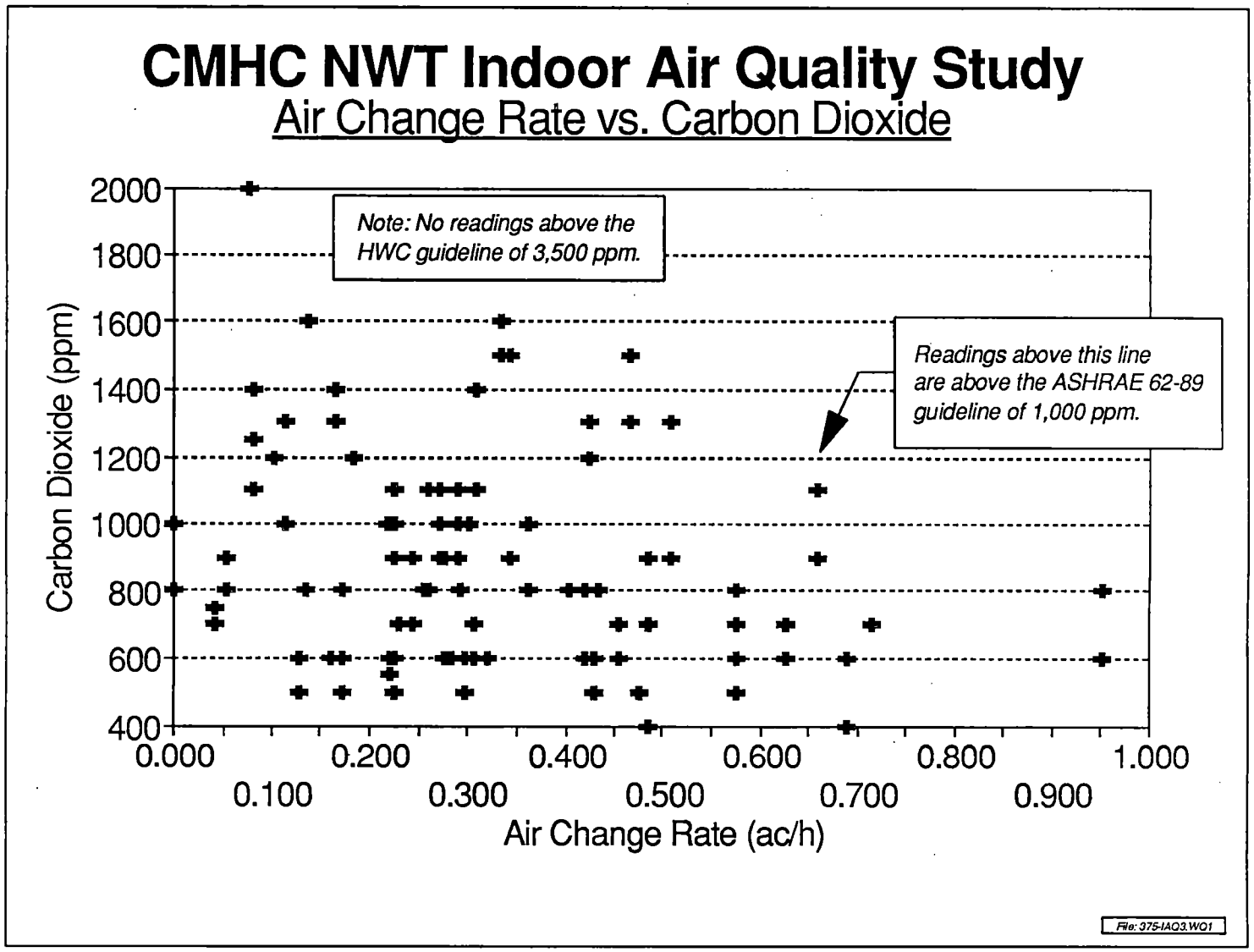
Use of Passive Vents vs Air Change Rate



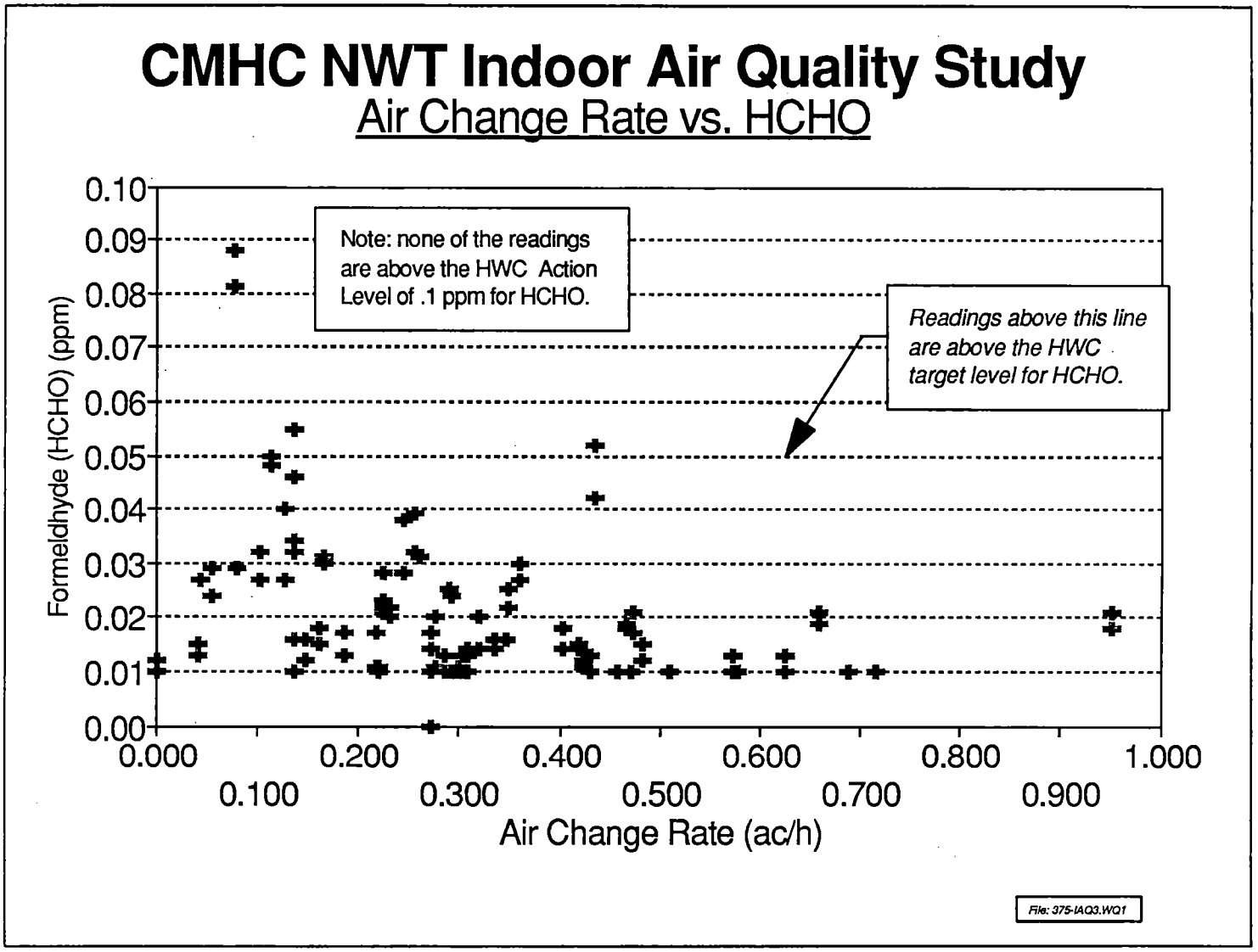
Graph 6


CMHC NWT Indoor Air Quality Study
Use of O/A Duct vs Air change Rate
Air Change Rate (ac/r)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Average Air Change Rate
.383 ac/h
Average Air Change Rate
.253 ac/h
Average Air Change Rate
.341 ac/h
Yes
No
N/A
O/A Duct to R/A Plenum Installed
File: 375-IAQ5.WQ1

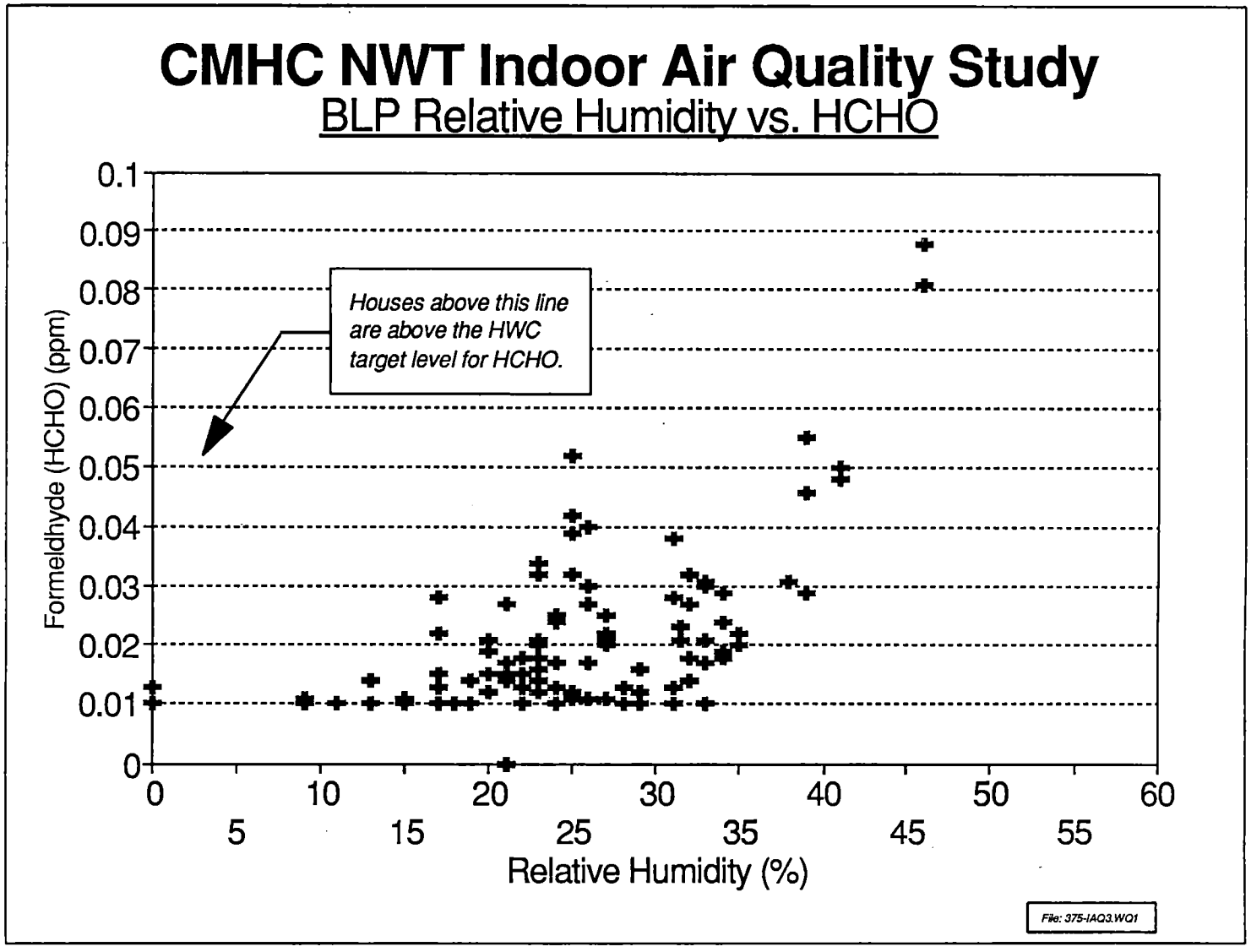
Graph 7


CMHC NWT Indoor Air Quality Study
Air Change Rate vs. Carbon Dioxide
Note: No readings above the HWC guideline of 3,500 ppm.
Readings above this line are above the ASHRAE 62-89 guideline of 1,000 ppm.
Carbon Dioxide (ppm)
2000
1800
1600
1400
1200
1000
800
600
400
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Air Change Rate (ac/h)
File: 375-IAQ3.WQ1

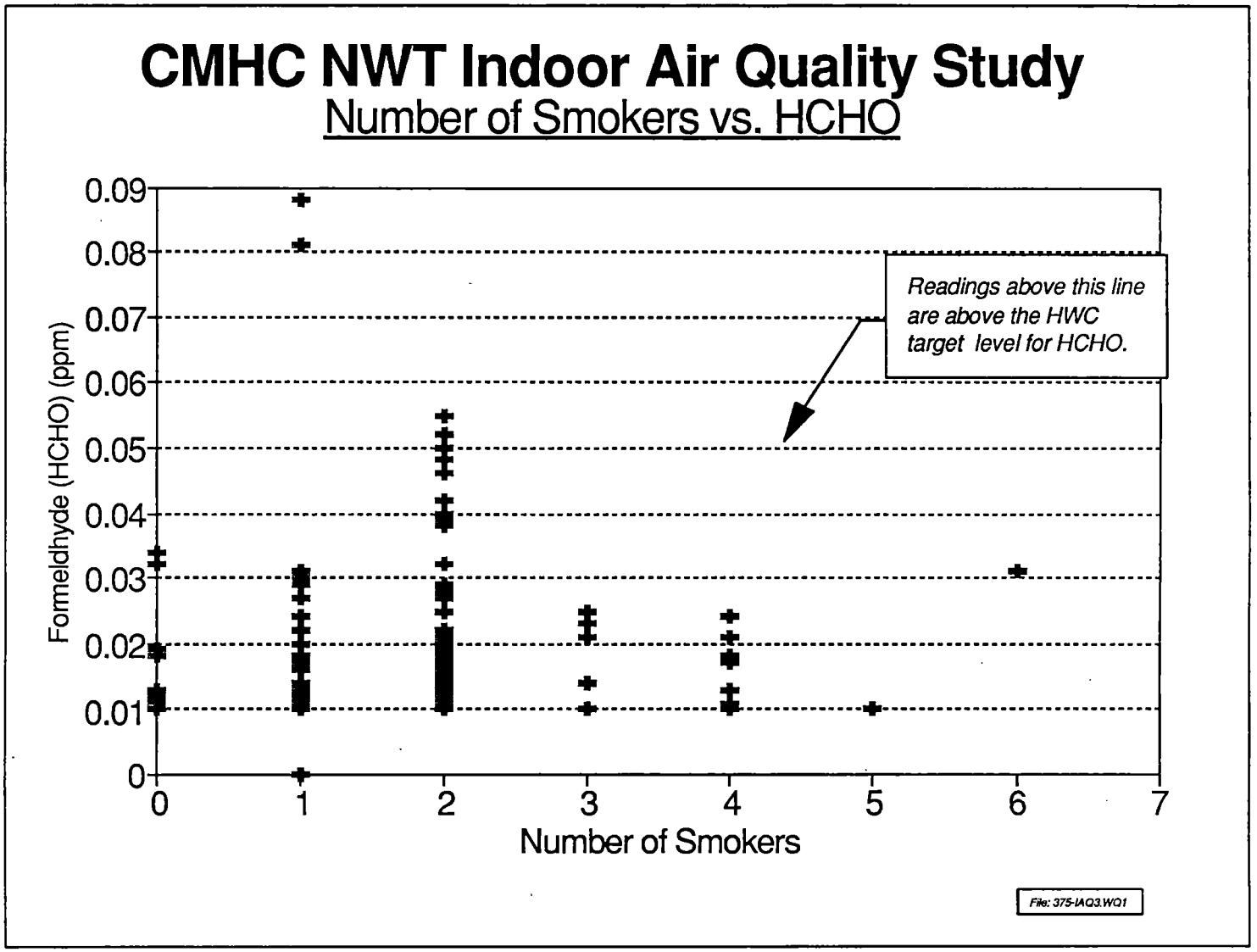
Graph 8


CMHC NWT Indoor Air Quality Study
Air Change Rate vs. HCHO
Note: none of the readings are above the HWC Action Level of .1 ppm for HCHO.
Readings above this line are above the HWC target level for HCHO.
Formeldhyde (HCHO) (ppm)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Air Change Rate (ac/h)
File: 375-IAQ3.WQ1

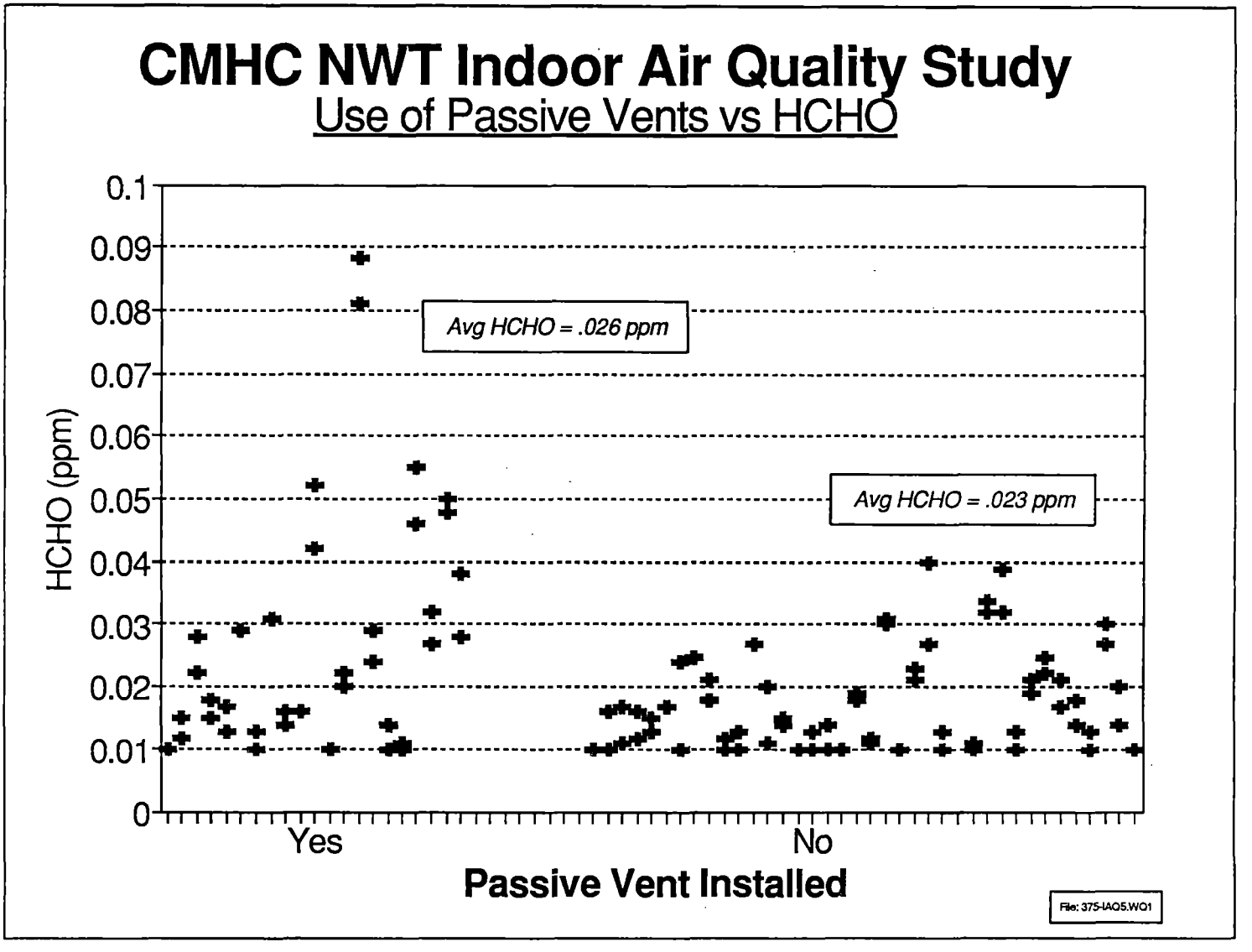
Graph 9


CMHC NWT Indoor Air Quality Study
BLP Relative Humidity vs. HCHO
Houses above this line are above the HWC target level for HCHO.
Formeldhyde (HCHO) (ppm)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
45
50
55
60
Relative Humidity (%)
File: 375-IAQ3.WO1

Graph 10


CMHC NWT Indoor Air Quality Study
Number of Smokers vs. HCHO
Formeldhyde (HCHO) (ppm)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
1
2
3
4
5
6
7
Number of Smokers
Readings above this line are above the HWC target level for HCHO.
File: 375-IAQ3.WQ1

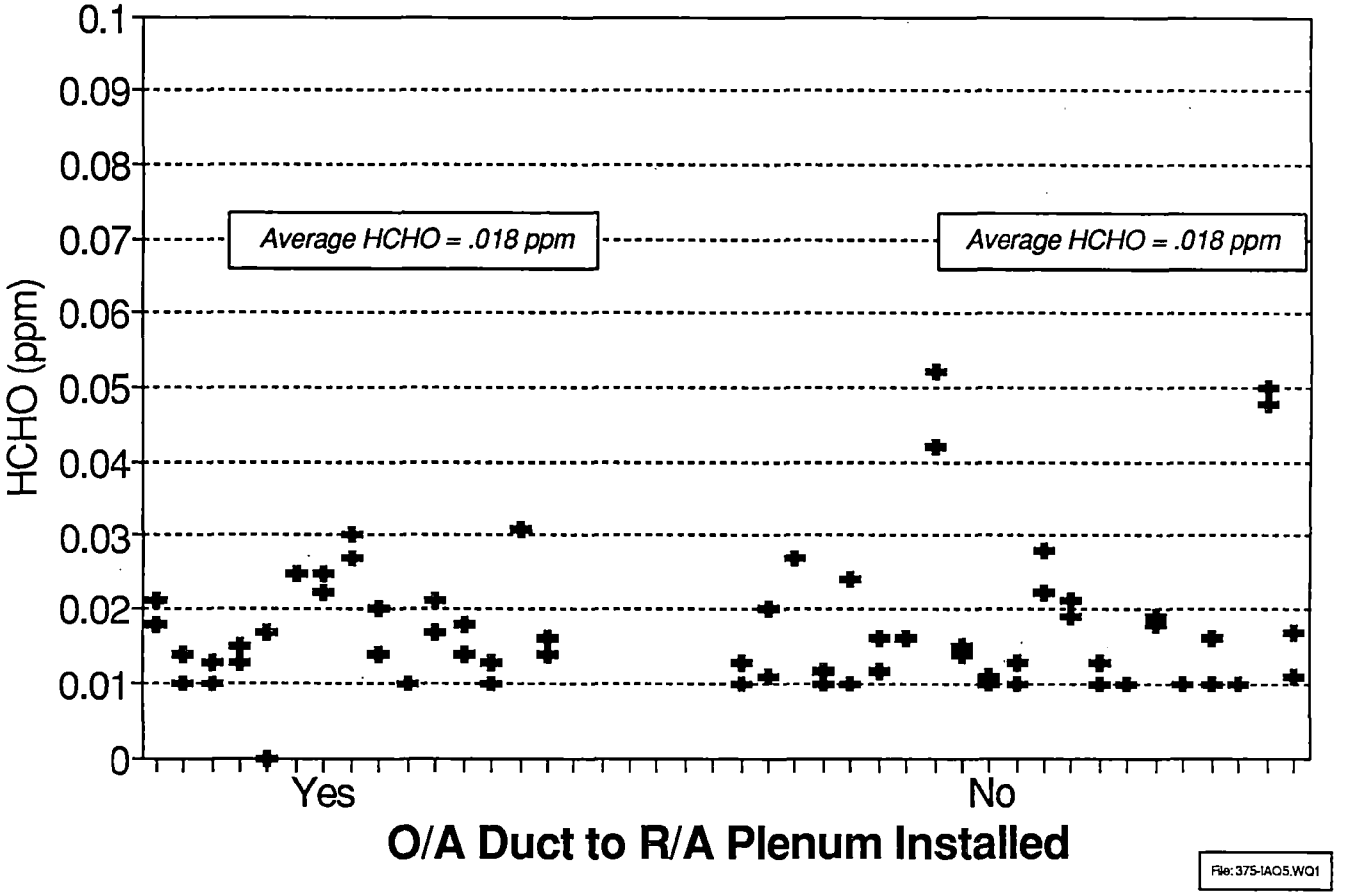
Graph 11


CMHC NWT Indoor Air Quality Study
Use of Passive Vents vs HCHO
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
HCHO (ppm)
Avg HCHO = .026 ppm
Avg HCHO = .023 ppm
Yes
No
Passive Vent Installed
File: 375-IAQ5.WQ1

Graph 12

CMHC NWT Indoor Air Quality Study

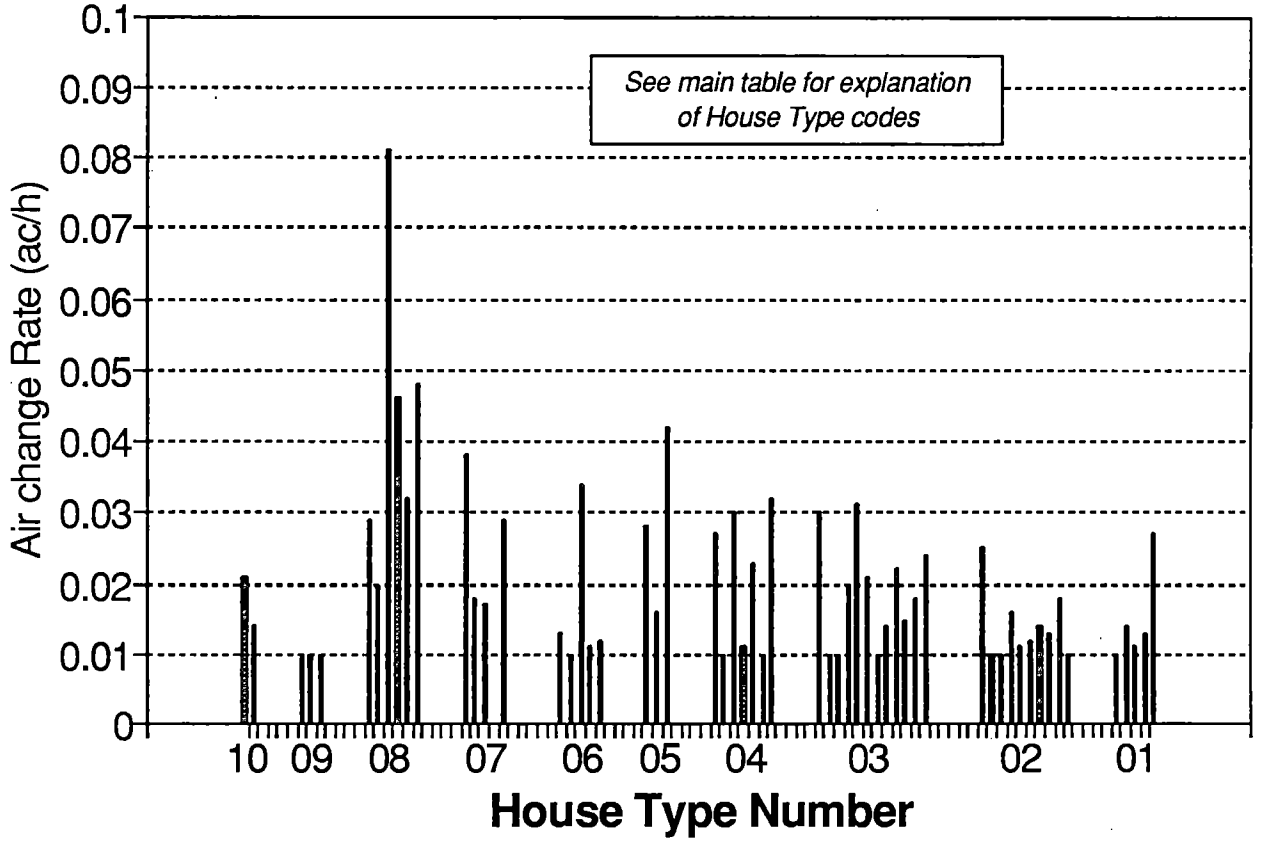
Use of O/A Duct vs HCHO



Graph 13

CMHC NWT Indoor Air Quality Study

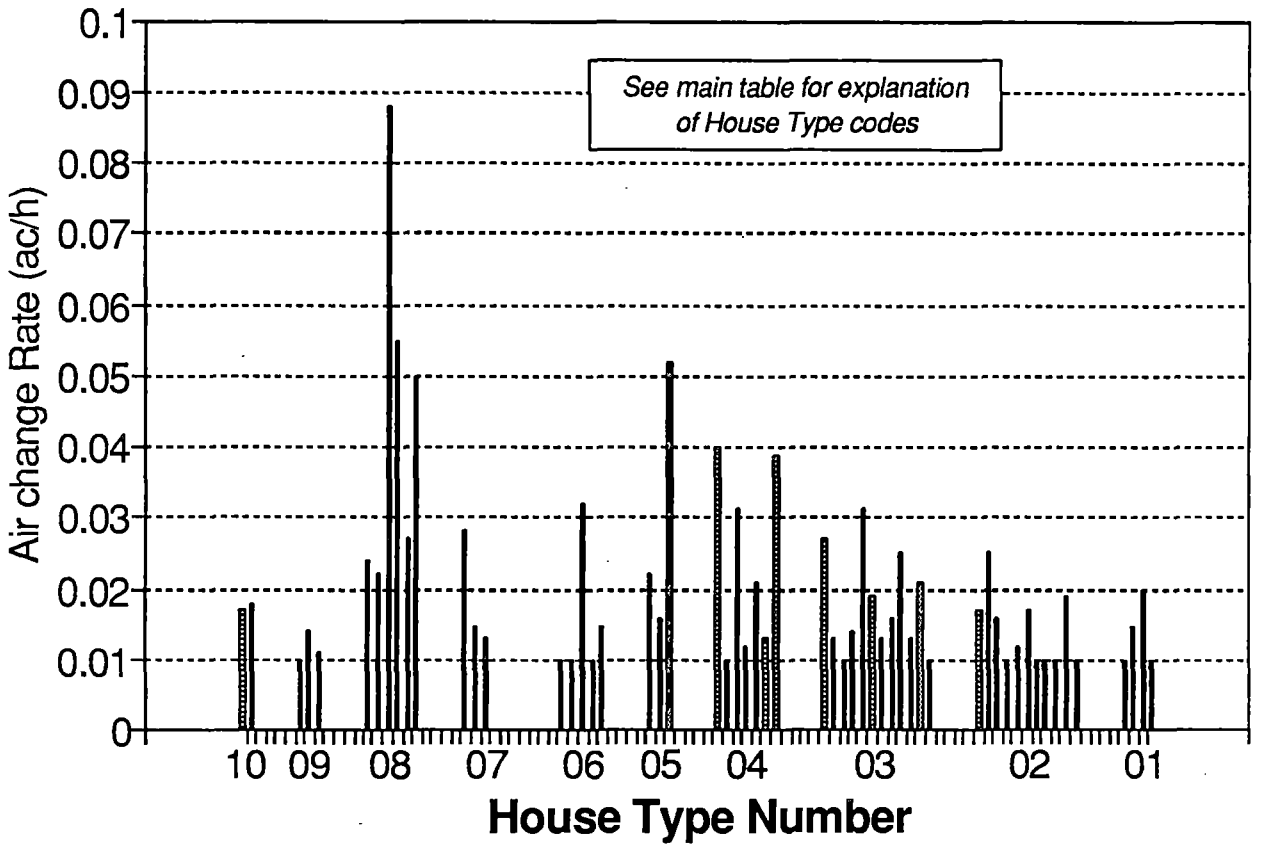
House Type vs HCHO (Location #1)



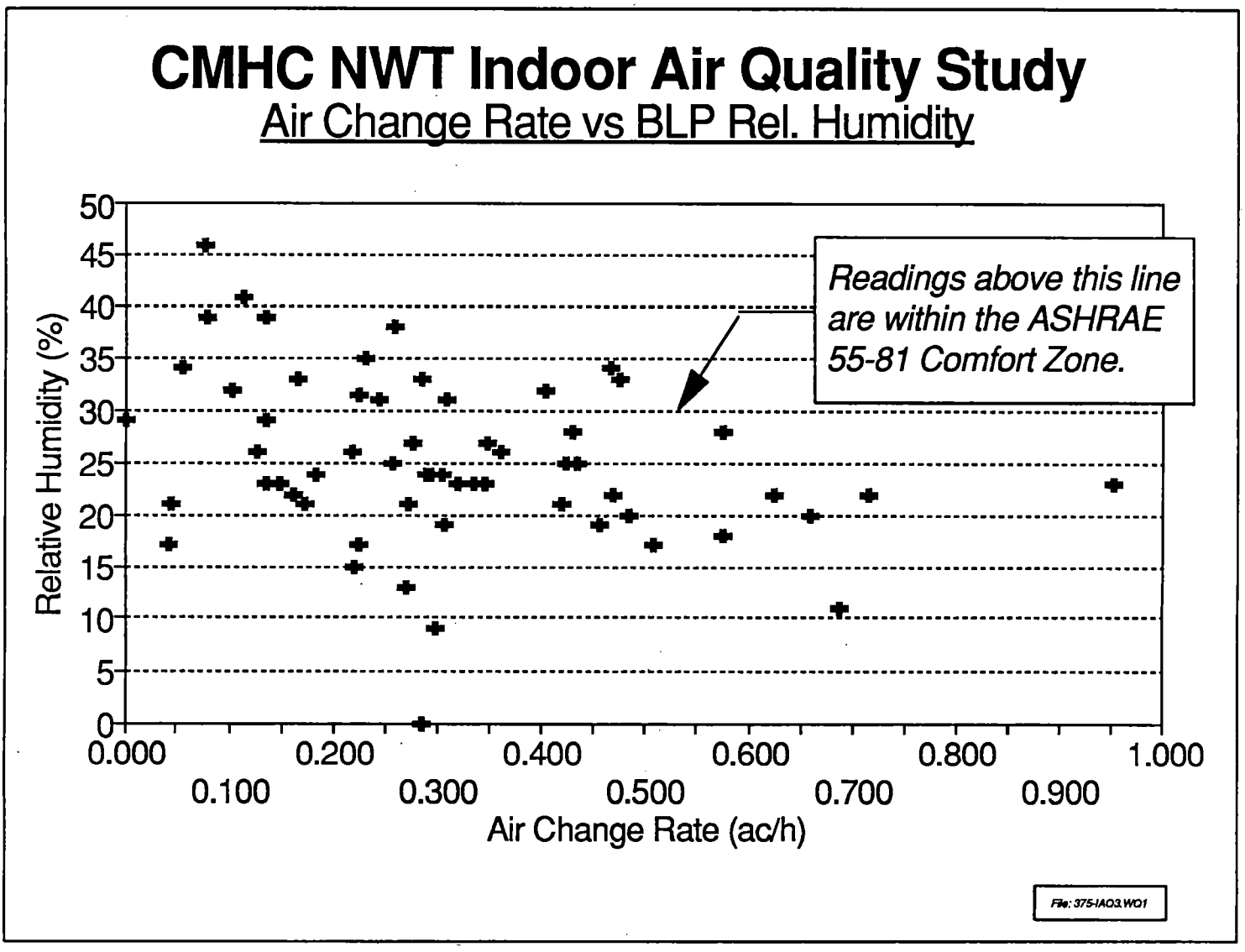
Graph 14

CMHC NWT Indoor Air Quality Study

House Type vs HCHO (Location #2)



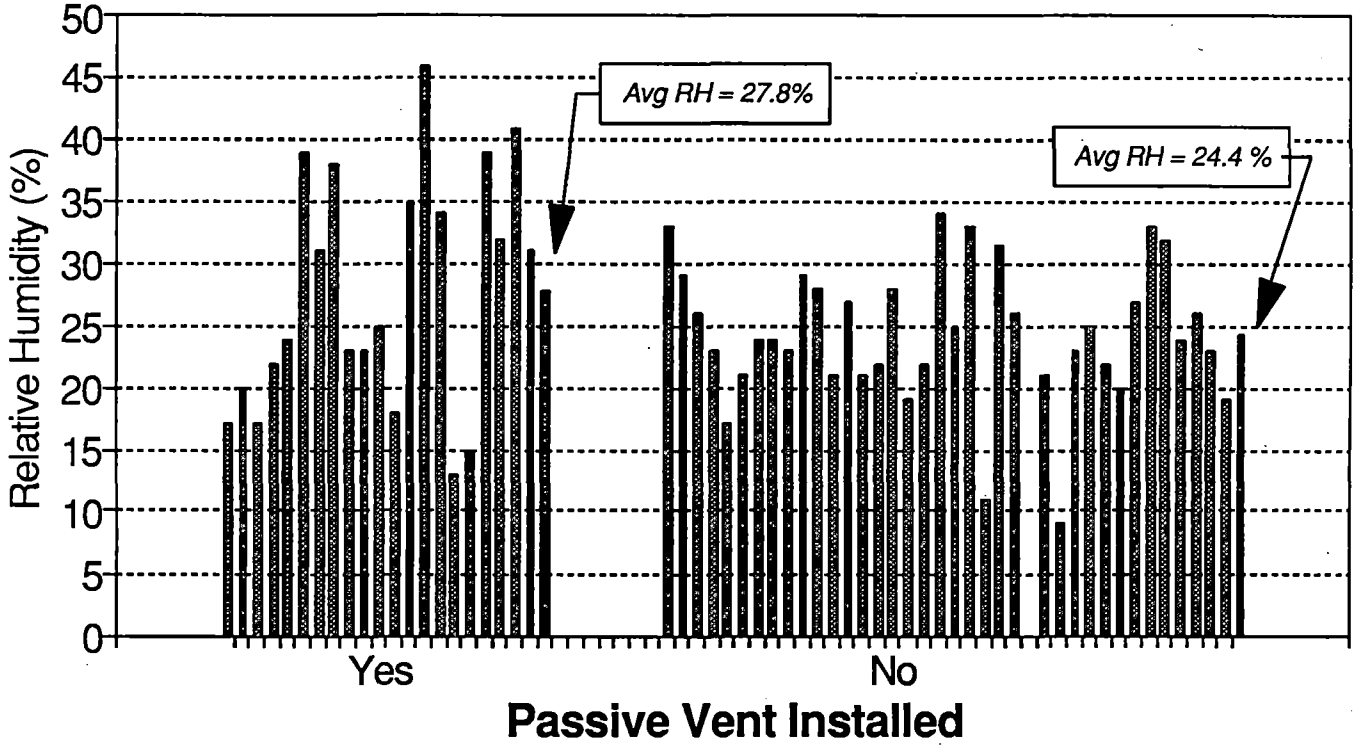
Graph 15


CMHC NWT Indoor Air Quality Study
Air Change Rate vs BLP Rel. Humidity
Relative Humidity (%)
50
45
40
35
30
25
20
15
10
5
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Air Change Rate (ac/h)
Readings above this line are within the ASHRAE 55-81 Comfort Zone.
File: 375-IAQ3.WQ1

Graph 16

CMHC NWT Indoor Air Quality Study

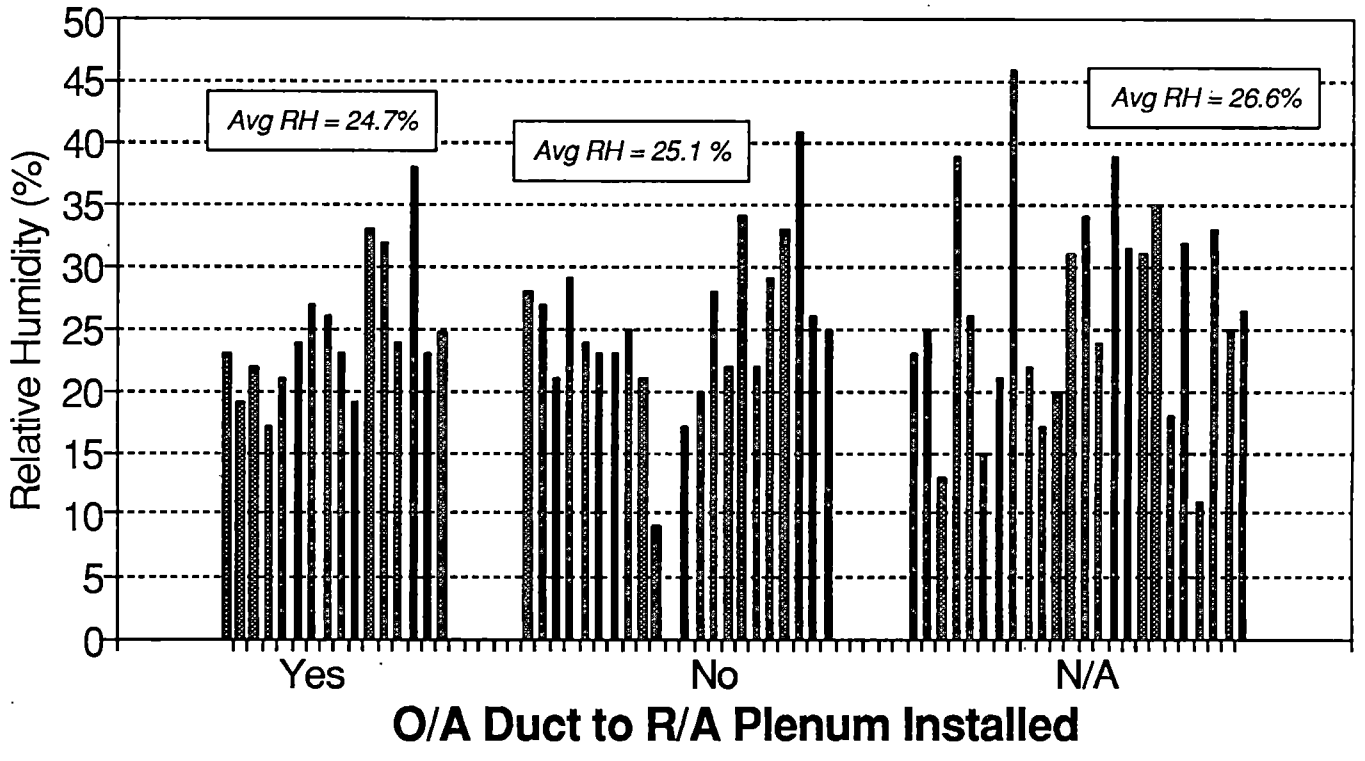
Use of Passive Vents vs BLP RH



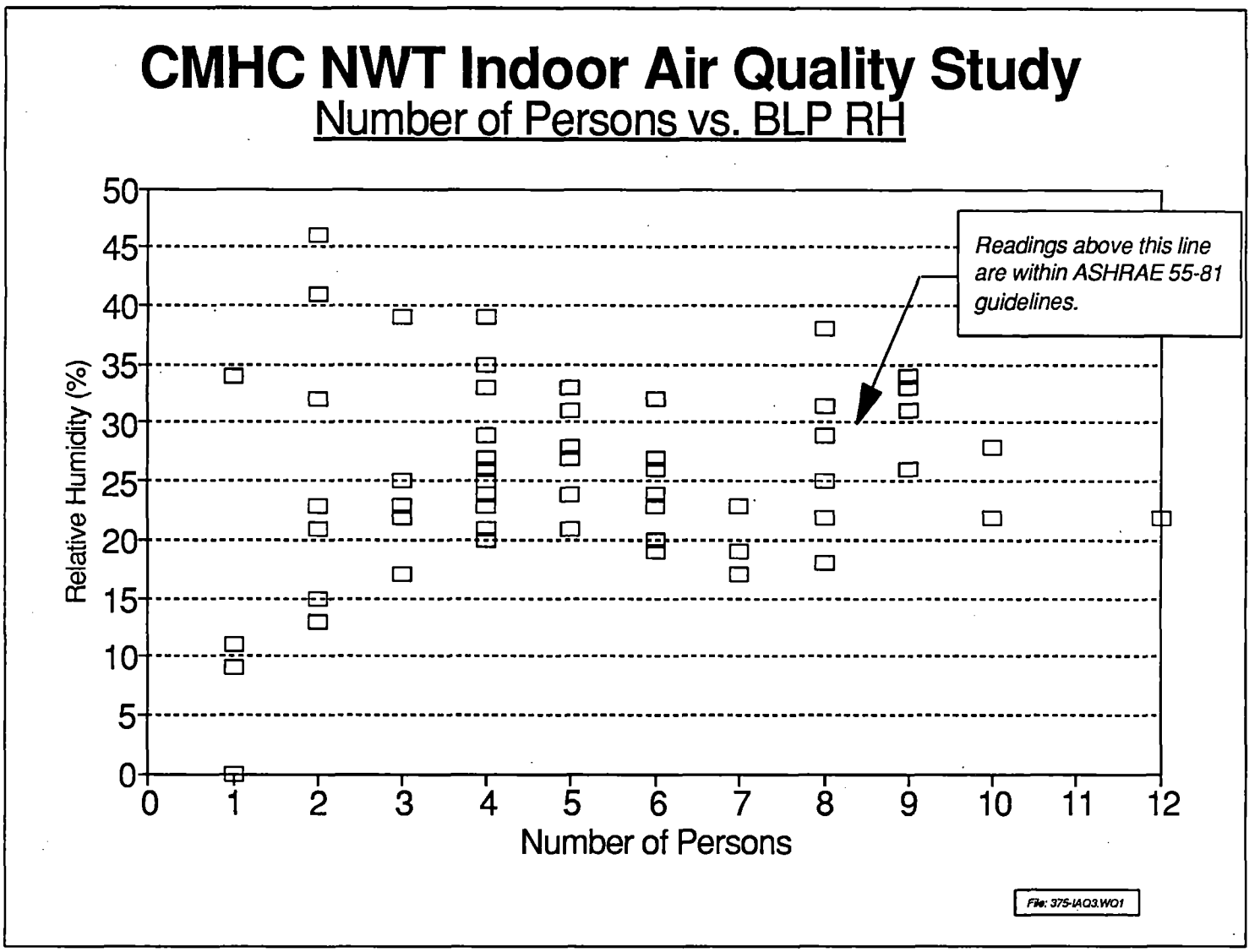
Graph 17

CMHC NWT Indoor Air Quality Study

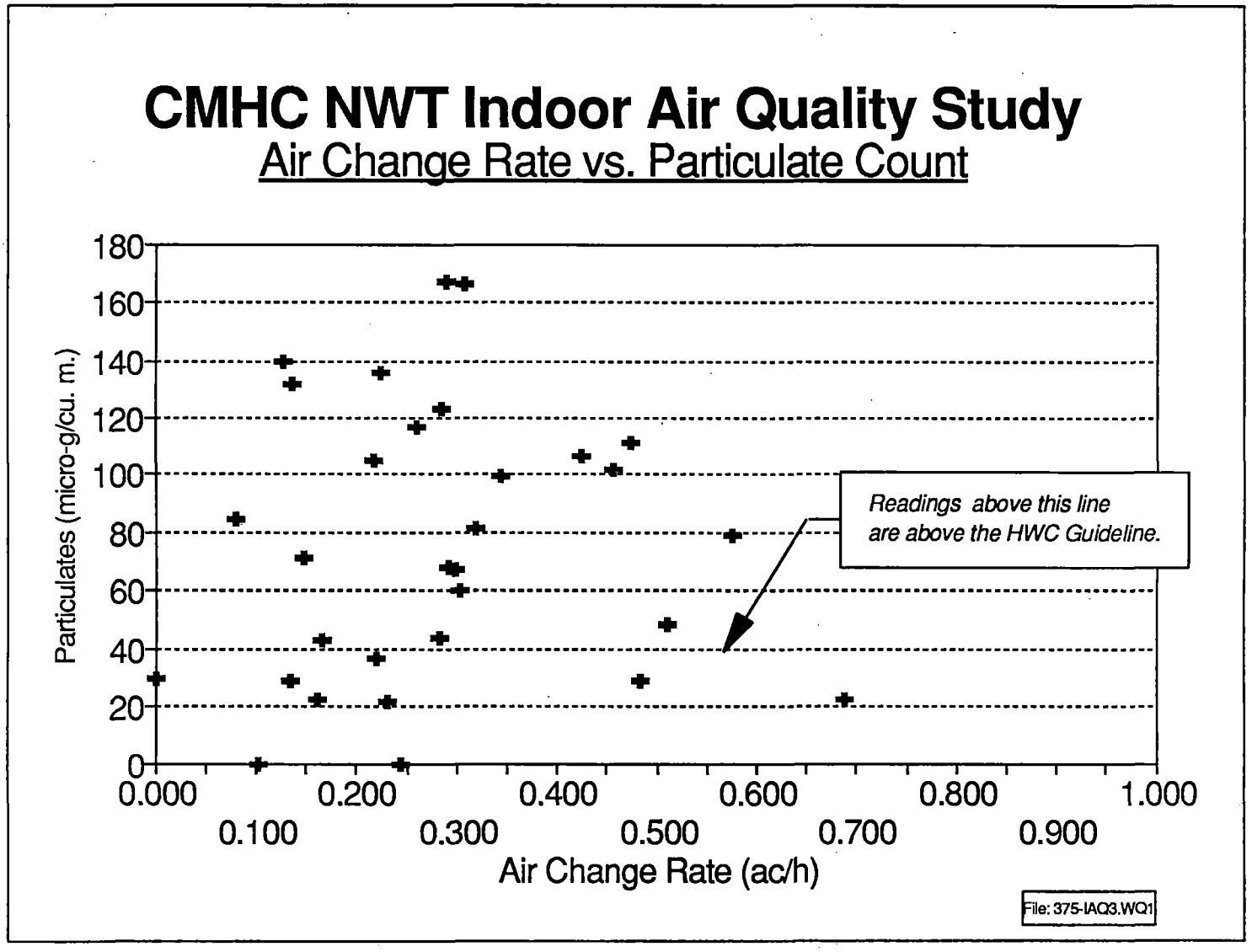
Use of O/A Duct vs BLP RH



Graph 18


CMHC NWT Indoor Air Quality Study
Number of Persons vs. BLP RH
Relative Humidity (%)
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
Number of Persons
Readings above this line are within ASHRAE 55-81 guidelines.
File: 375-IAQ3.WO1

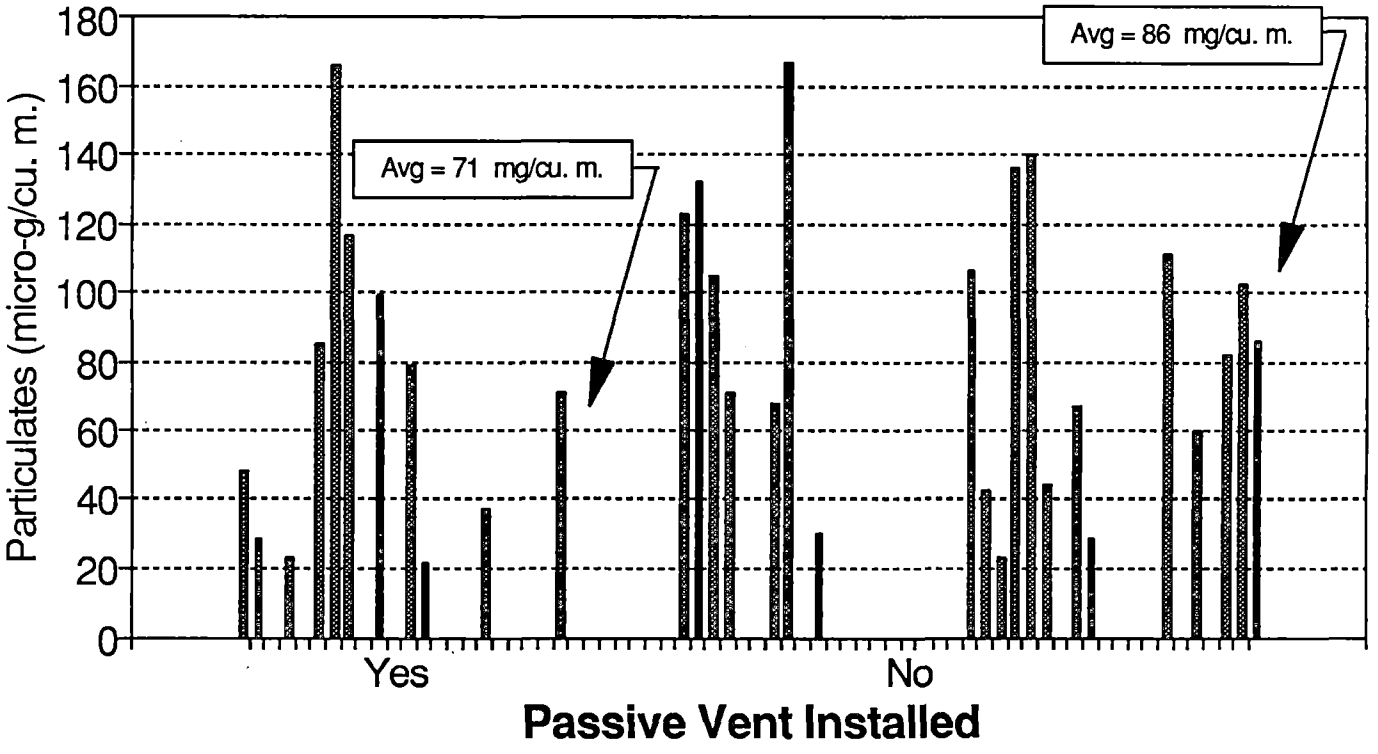
Graph 19


CMHC NWT Indoor Air Quality Study
Air Change Rate vs. Particulate Count
Particulates (micro-g/cu. m.)
180
160
140
120
100
80
60
40
20
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Air Change Rate (ac/h)
Readings above this line
are above the HWC Guideline.
File: 375-IAQ3.WQ1

Graph 20

CMHC NWT Indoor Air Quality Study

Use of Passive Vents vs Particulates

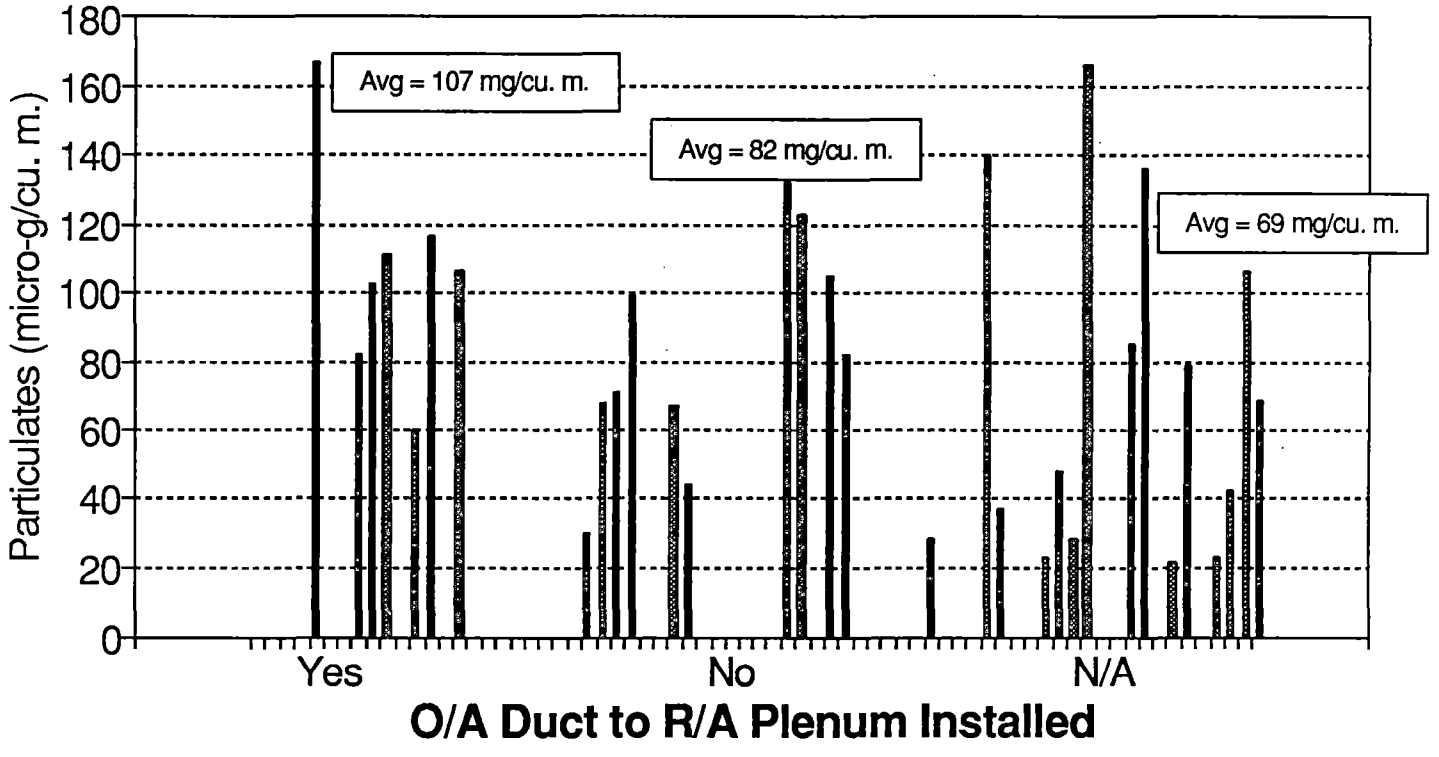


File: 375-IAQ5.WQ1

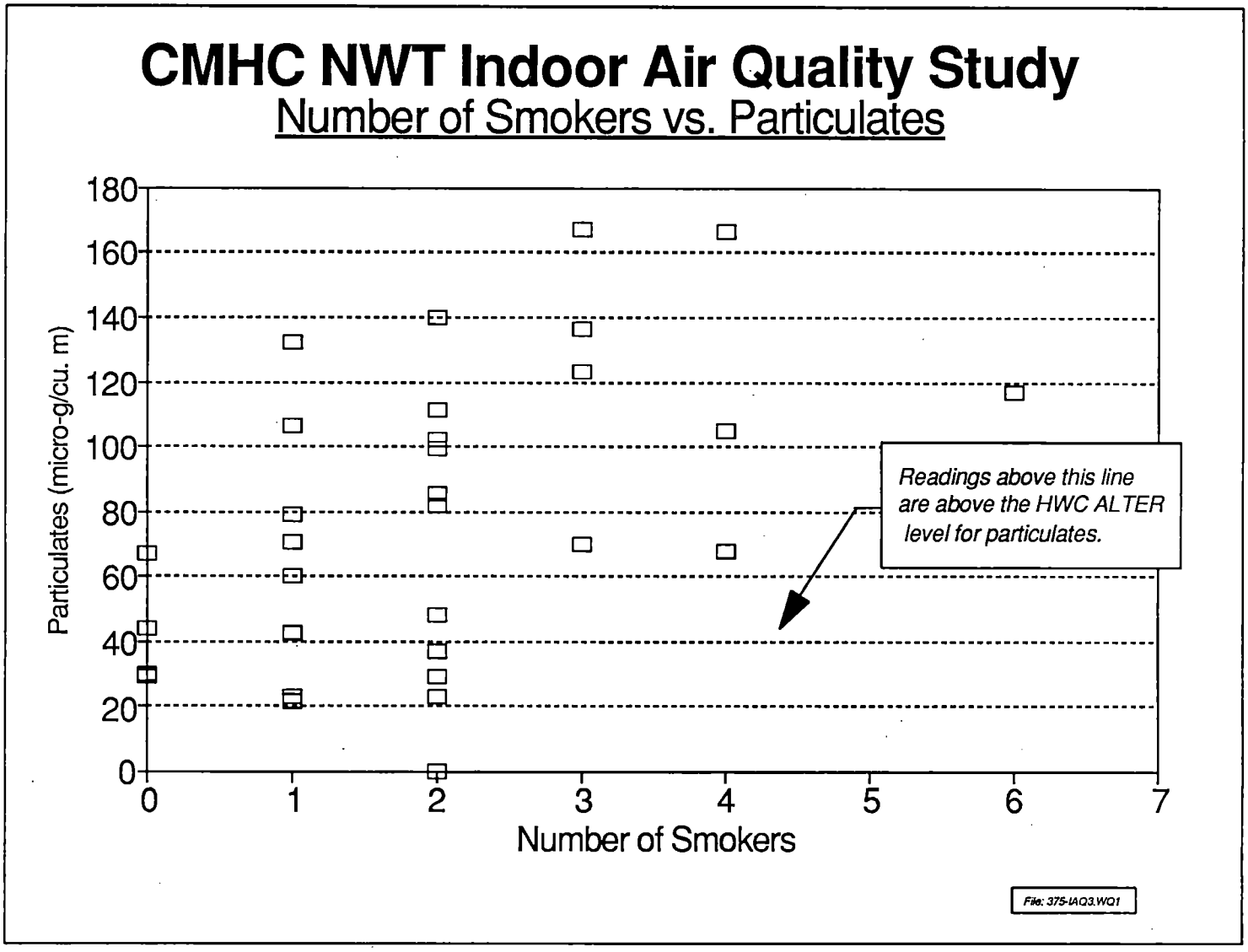
Graph 21

CMHC NWT Indoor Air Quality Study

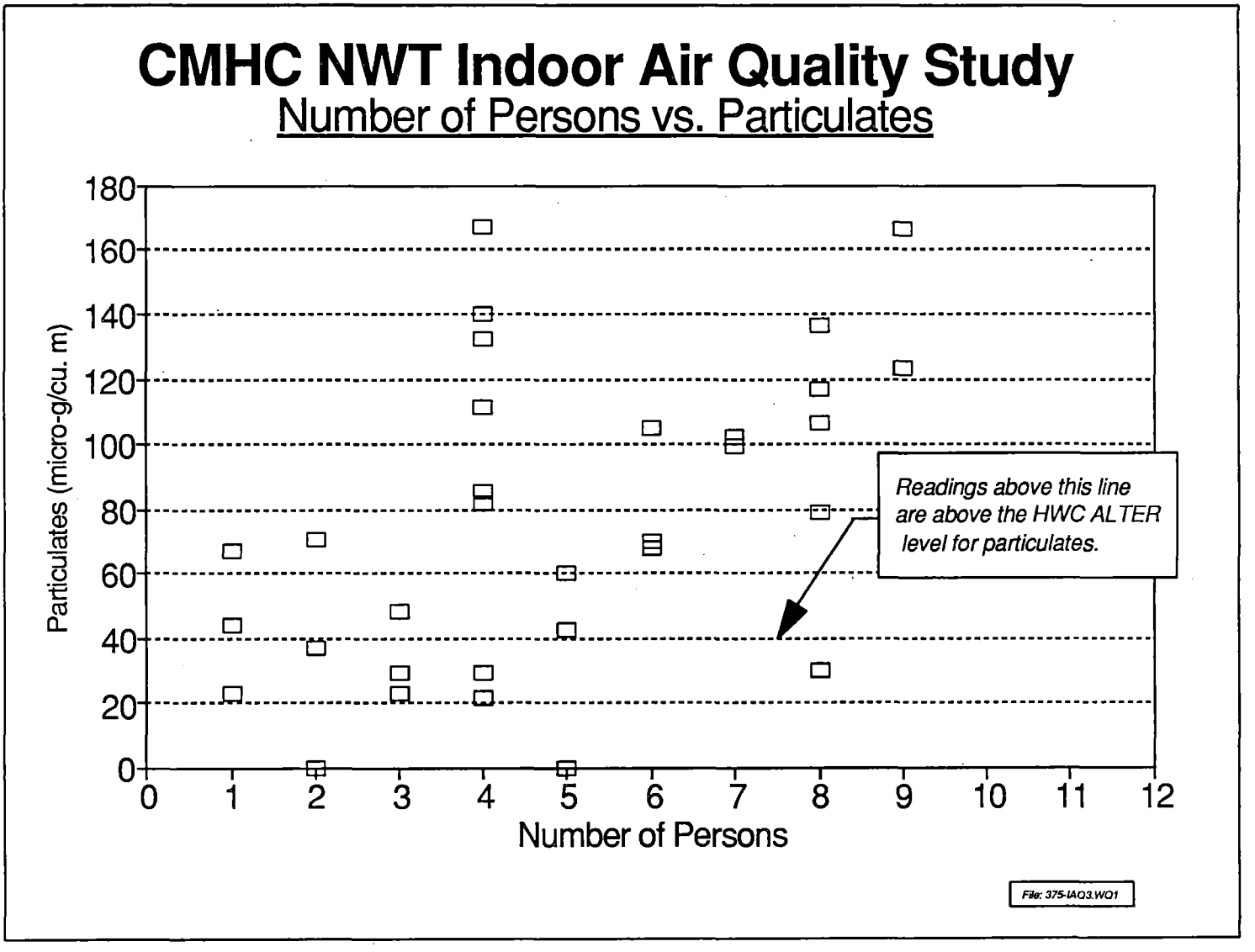
Use of O/A Duct vs Particulates



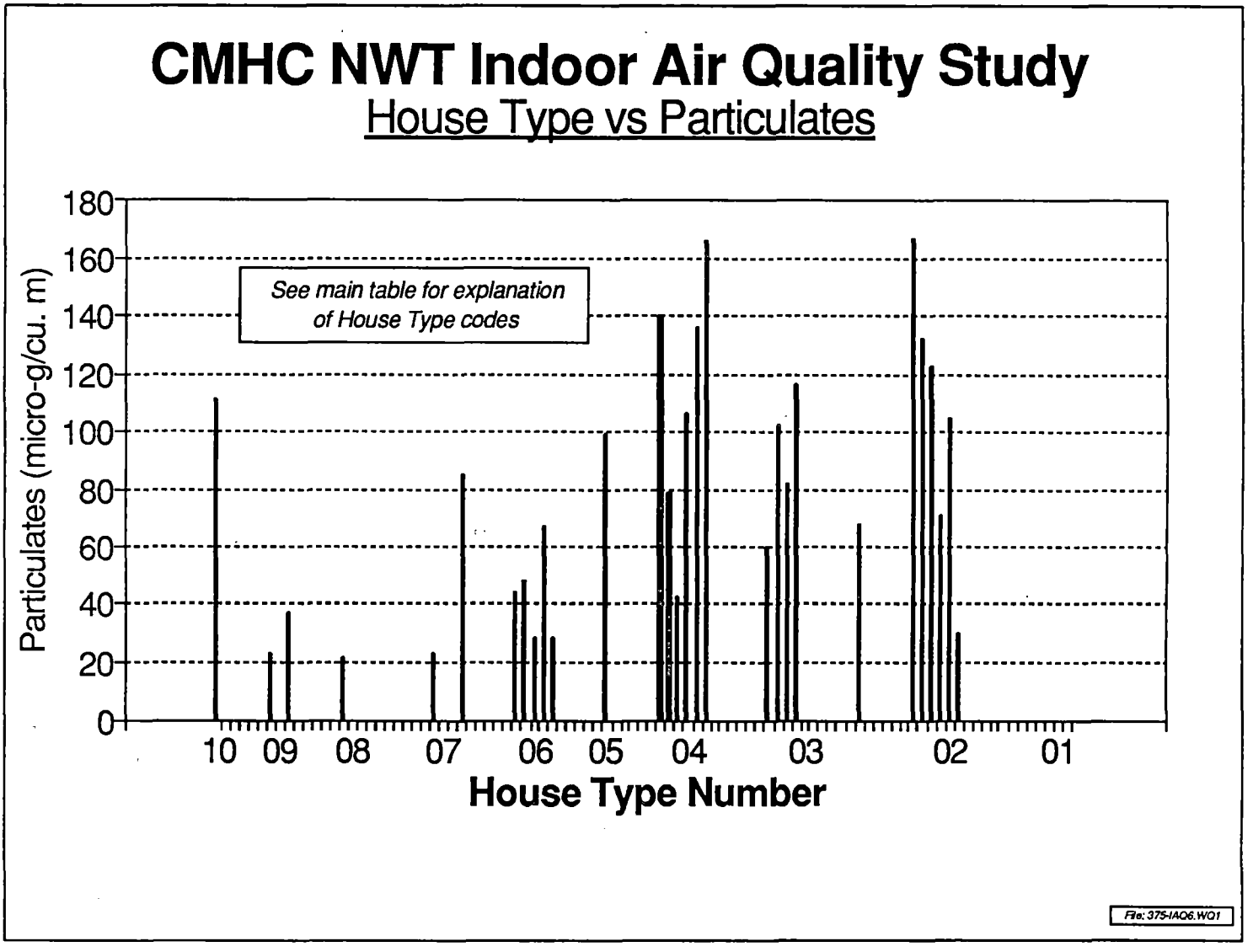
Graph 22


CMHC NWT Indoor Air Quality Study
Number of Smokers vs. Particulates
Particulates (micro-g/cu. m)
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
Number of Smokers
Readings above this line are above the HWC ALTER level for particulates.
File: 375-IAQ3.WQ1

Graph 23


CMHC NWT Indoor Air Quality Study
Number of Persons vs. Particulates
Particulates (micro-g/cu. m)
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Number of Persons
Readings above this line are above the HWC ALTER level for particulates.
File: 375-IAQ3.WQ1

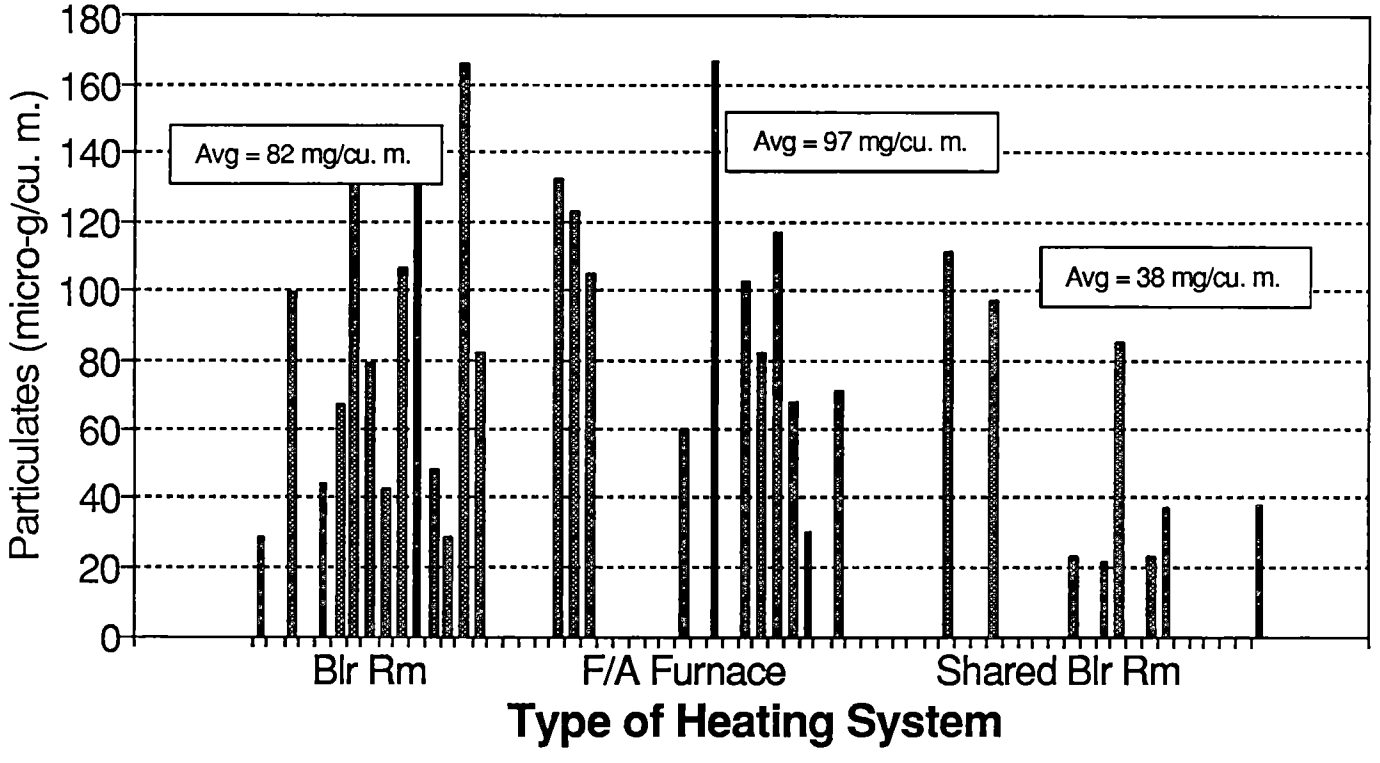
Graph 24


CMHC NWT Indoor Air Quality Study
House Type vs Particulates
Particulates (micro-g/cu. m)
180
160
140
120
100
80
60
40
20
0
See main table for explanation of House Type codes
10 09 08 07 06 05 04 03 02 01
House Type Number
File: 375-IAQ6.WO1

Graph 25

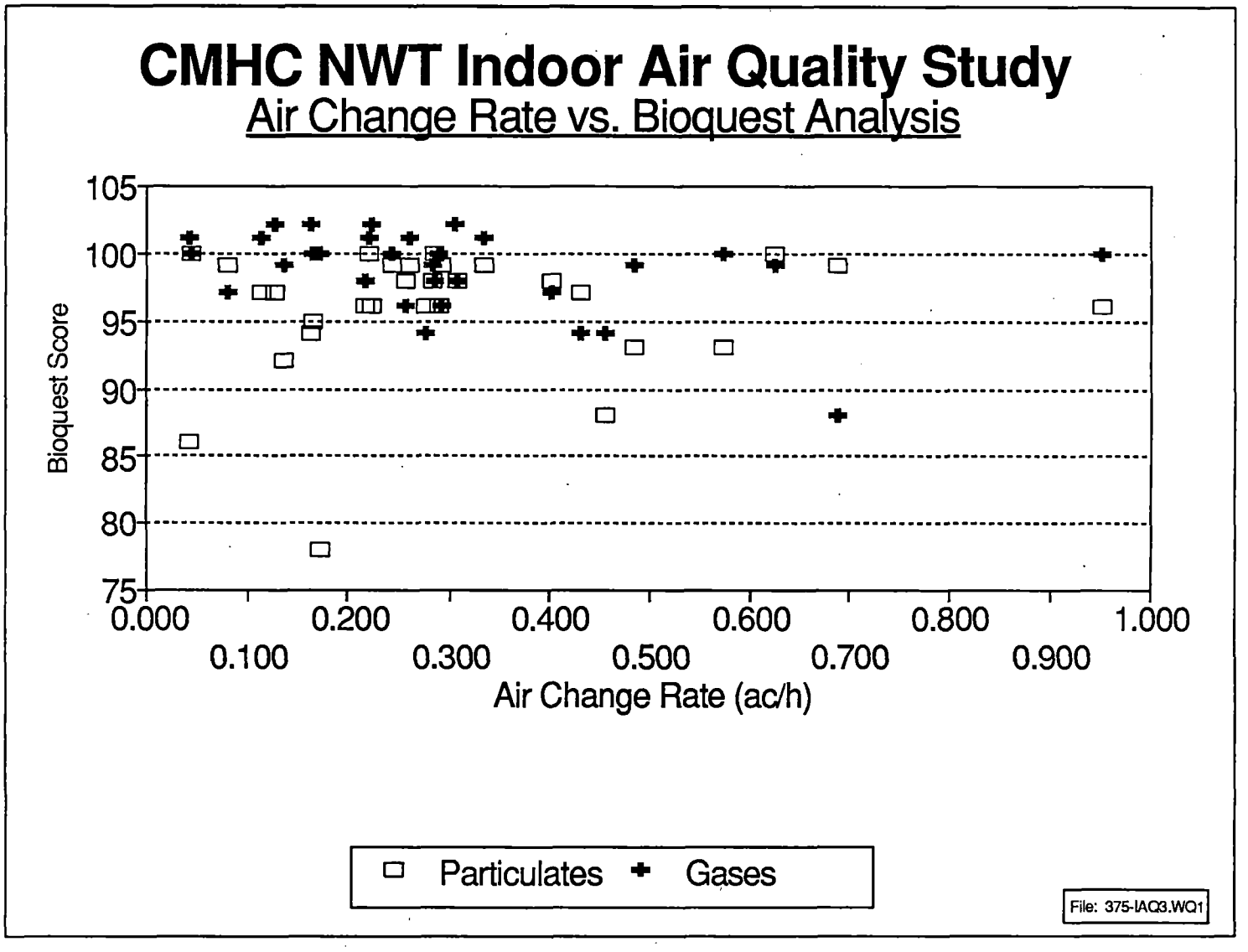
CMHC NWT Indoor Air Quality Study

Heating System Type vs Particulates



File: 375-IAQ5.WQ1

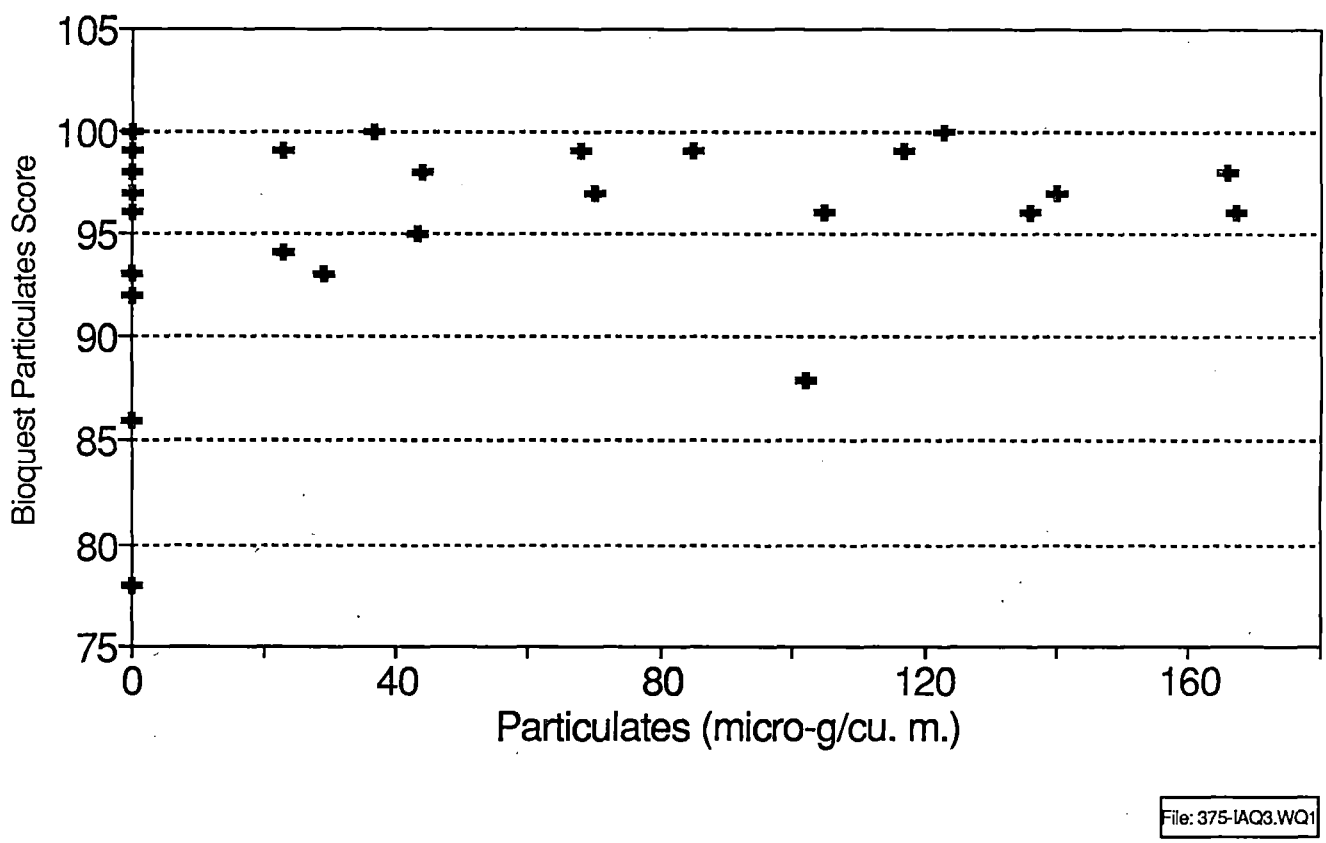
Graph 26


CMHC NWT Indoor Air Quality Study
Air Change Rate vs. Bioquest Analysis
Bioquest Score
105
100
95
90
85
80
75
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
1.000
Air Change Rate (ac/h)
Particulates
Gases
File: 375-IAQ3.WQ1

Graph 27

CMHC NWT Indoor Air Quality Study

Particulates vs. Bioquest Particulate



Graph 28