

#12026

**TESTING OF RESIDENTIAL
HEATING AND VENTILATION
SYSTEMS OF THE
NORTHERN ENVIRONMENT**

DISCLAIMER

This study was conducted for Canada Mortgage and Housing Corporation (CMHC) under Part IX of the National Housing Act. The analysis, interpretations and recommendations are those of the consultant and do not necessarily reflect the views of CMHC.

**TESTING
OF RESIDENTIAL
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OF
THE NORTHERN ENVIRONMENT**

Testing of Residential Heating and Ventilation Systems for the Northern Environment

**A joint venture research and development project undertaken by
Canadian Home Builders Association – Yukon and Yukon
Housing Corporation**

Funding provided by Canada Mortgage and Housing Corporation

**CMHC Project Manager
Darrel R. Smith**

October, 1998

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Purpose

Heating and Ventilation have always been critical concerns of homeowners and the housing industry living and conducting business in the north.

With the rise in fuel prices in the mid 1970's there has been an ever increasing emphasis on energy efficiency. Along with the benefits of building dwellings in an energy efficient manner, come corresponding problems – the chief of those problems concerns maintaining a healthful level of indoor air quality.

Several heating and ventilation schemes have been developed to provide adequate fresh air to a dwelling, but none specifically for the Yukon environment. Equipment testing is generally not done below -20°C , which is sufficient for the larger Canadian market, but not for trouble free operation in the north with it's extended periods of -40°C or colder temperatures.

As well, the lifestyle of Northerners is different from those in more southerly climes. Many Yukoners do not venture out of the home during cold snaps, and tend to sit close to the heat source, with all sources of cold draughts sealed tight against the cold – often including designated sources of fresh air to the dwelling.

The 1995 National Building Code created a further complication for homeowners and builders alike. The air change rates, which are mandatory through the 1995 code –

even during times of severe cold – have been questioned by both builders/installers and knowledgeable homeowners as being excessive.

This report is the culmination of Phase 1, of a four phase project, which will attempt to provide answers to many of those questions by installing several different configurations of heating/ventilating systems, and monitoring them. This will provide an opportunity, as well, to validate or disprove the requirements of the code as it applies in a northern environment and possibly make recommendations to the NBC Standing Committee on Heating, Ventilating and Air Conditioning.

This report contains the results of Phase I of the project described above. The phases of the project are:

- Phase I – Scope of the Problem
- Phase II – Background Research and Study Design
- Phase III – Field Research
- Phase IV – Evaluation and Reporting

Phase I consisted of the administering of two questionnaires, one to homeowners, and another to industry stakeholders. Their replies

provide a true perspective of what problems and difficulties are being encountered with heating and ventilation systems and provides the project an understanding of where attention should be focussed.

Various complaints are heard from homeowners and housing professionals in the north regarding heating and ventilation systems. These complaints cover a range of concerns and problems which the questionnaire results would verify or dispel.

Phase 2 will be the compilation of ad hoc research done across the north, which will be reviewed by a review group for the project. This review group consists of the North Committee, CMHC, NRCan, NRC, Howell-Mayhew, Sask Research Council, to name a few. The purpose of this phase is to investigate the most likely heating/ventilation solutions for the northern environment, design work on those systems and the design of a testing regime which will produce useable information.

Phase 3 is the actual field work phase of the project and will include the installation of systems in test dwellings, the set up of testing apparatus, and the carrying out of monitoring/testing of those heating/ventilation installations chosen. This phase also includes the modification of installations after an appropriate amount of testing has been done, after which re-testing will take place.

Phase 4 of the project is the reporting phase of the project. It will include providing interim results of testing of heating/ventilation schemes to the outside review groups as well as reporting to them at the completion of monitoring /testing phase. The expertise of the outside review groups is considerable. They will be asked to assist in the evaluation of test results. After evaluation is complete, a final report including recommendations will be prepared for the use of the sponsor – CMHC.

ACKNOWLEDGEMENTS

The Project wishes to acknowledge the assistance and input of several contributors to this area of study, phase I of the project, as well as those who have already spent time and effort looking ahead to the next phases of the study.

Howell – Mayhew Engineering, Inc. and Geddes Enterprises. Their work in the CMHC report entitled “*An Investigation of Design and Appropriate Technologies for Space Heating and Ventilation Systems for Northern Housing*” is the foundation for this project and they have agreed to be part of the outside review group for this project.

CMHC for their funding of building science research, as well as their coaching and input regarding the refining of the scope of the project.

Yukon's building industry stakeholders. Yukon is a small, close knit community where the local designers, contractors, installers, and service technicians have proven to be willing to share their experiences and ideas with the project.

The North Committee. A group of housing professionals, who happen to be northerners as well, who are committed to finding solutions to housing related problems in the north. Their scrutiny helps assure that the project will be meaningful and the outcomes useable.

The Heating, Refrigeration and Air Conditioning Institute of Canada

(HRAI) for the training they have given the industry in northern locations, and the instructors, like John Hockley, who understand the root of the problems and have made themselves available to mentor the project.

Juergen Korn and the Industrial Research Assistance Program (IRAP). Juergen's interest in building science, and IRAP's technical network, have meant that extensive scientific resources are available to the project.

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EXECUTIVE SUMMARY

The CMHC study *"An Investigation of Design and Appropriate Technologies for Space Heating and Ventilation Systems for Northern Housing"* stated "This project has clearly indicated that there are a number of issues that impact significantly on the ultimate choice of a heating and ventilating system but which remain unresolved. Further research to address these issues will be required before it will be fully possible to design and specify systems that will work effectively and be accepted in the different communities throughout the North".

This questionnaire is the first step in satisfying the Howell – Mayhew recommendations.

A questionnaire was sent to all Yukon based architects, consulting engineers, heating and plumbing contractors, installers, general contractors, and heating system servicing contractors. A second questionnaire was sent to a random sample of homeowners. Replies were 53% from the industry, and 51% from homeowners (with a 76% return from R-2000 homeowners). This high percentage of return is possible in the Yukon due to the small market, which means industry stakeholders and homeowners are aware of both of the organizations involved and know those conducting the questionnaire follow-up.

Results of the questionnaires are included in the section "Review of Findings". Questionnaire findings

indicate that there is a need for continuance of the next phases of the project.

One section of the questionnaire to industry stakeholders dealt with the National Building Code (NBC) section covering heating and air conditioning. The responses showed, for instance, that only 48% of those completing the survey believe that the NBC section on ventilation does not apply to northern problems, with 75% affirming that a supplement to the NBC should be provided for the north. 76% also wanted more options for code approved heating and ventilation systems, with 76% of the industry stakeholders polled willing to participate in more testing. 61% of those responding indicated they had systems they wanted to test.

In another area of interest to the project – consumer education – 71% indicated that consumers do not understand the operation of their heating and ventilation systems. Almost all industry players stated consumers require more education in the use, and maintenance of heating and ventilation systems (74% replied that more consumer education was necessary).

The homeowner questionnaire included three general areas of data collection – general dwelling information, heating and ventilation system specifics, and information on the indoor air quality in the home.

Through the responses from all the homeowners selected, it became obvious that those homeowners who had a reasonable level of user knowledge about their heating and ventilation systems were in the minority. Those who had indoor air quality problems were more aware of the heating and ventilation system they had in their home.

Most homeowners had some knowledge of the materials used in the construction of their home. For instance 66% gave information on the insulation levels in the walls, 52% knew the level of insulation in the attic, and 74% knew what product was used as insulation in the attic of their home.

56% of those questioned have forced air heating systems in their home, 26% have a combination heating systems of various configurations, 9% have baseboard electric, and 9% have hydronic heating of some type. 42% of respondents heat with oil, and 21% have combination heating systems using two or more types of fuel. It should be noted that in Yukon, a combination heating system refers to two types of systems installed together to provide heat – usually one primary and one back up heating system. This does not refer to the combination space heating and domestic hot water system using an oil fired hot water tank and fan coil unit.

Only 29% of homeowners reported having an active ventilation system (a system which draws in fresh air and exhausts stale air with the use of fans). 28% either did not know or did not provide an answer regarding the type

of ventilation system they had in their home. 68% of all homeowners reported that their ventilation system was rarely or never maintained.

25% of homeowners reported that they had significant amounts of ice build up on their windows in winter. 45% indicated they had problems with the operation of the lock set on an entry door in winter, and an amazing 40% of homeowners reported having entry doors that refused to open at times in the winter. Only 28% reported having noticed any mold or mildew growing anywhere in their home.

Interestingly, 48% of homeowners indicated they turn on a kitchen or bathroom fan when they notice a humidity problem in the home. This result indicates an awareness of moisture problems on the part of the homeowner, and a willingness to take some action. 40% live with moisture problems in their home by mopping up water, melting ice, or washing off mold, etc. This again is a result which indicates that homeowners are willing to "do something" to alleviate moisture related problems.

A fairly high percentage of homeowners indicated that a household member had allergy problems (43%), with 1/3 of them reporting that the problems were worse in winter. Without exhaustive testing there is no way to determine the exact cause of the "allergy" problems reported here. This was beyond the scope of this project, however the high number of problems reported here does add strength to the argument that

there is an indoor air quality problem in many Yukon homes.

The results were sufficient to show that there are heating and ventilation system related problems being encountered by homeowners. With the technical information reported by industry stakeholders indicating that work is needed on systems, along with education/training for both the industry and homeowners alike.

SOMMAIRE

Dans l'étude de la SCHL intitulée «Investigation de la conception et des technologies appropriées pour les installations de chauffage et de ventilation des habitations du Nord» on dit : «Ce projet a indiqué nettement qu'il y a certains facteurs qui influent énormément sur le choix de systèmes de chauffage et de ventilation, mais qu'on n'a pas répondu à toutes les questions. Il faudra approfondir les recherches pour être en mesure de concevoir et de spécifier des installations qui fonctionneront de manière efficace et seront acceptées par les différentes collectivités du Nord».

Ce questionnaire est un premier pas pour satisfaire aux recommandations Howell-Mayhew.

Un questionnaire a été envoyé à tous les architectes, ingénieurs conseils, entrepreneurs en plomberie et chauffage, installateurs, entrepreneurs généraux et spécialistes de l'entretien des systèmes de chauffage du Yukon. Un second questionnaire a ensuite été envoyé à un échantillon aléatoire de propriétaires. Le taux de réponse était de 53 % pour l'industrie et de 51 % pour les propriétaires (celui des propriétaires d'habitations R-2000 a atteint 76 %). Ce pourcentage élevé est possible au Yukon parce que le marché n'est pas vaste, de sorte que les intervenants de l'industrie et les propriétaires sont au courant des deux organismes en cause et connaissent ceux qui font le suivi des questionnaires.

On trouvera les résultats des questionnaires sous la rubrique «Examen des constatations». Ils ont révélé qu'il est nécessaire de passer aux prochaines phases du projet.

Une partie du questionnaire destiné aux intervenants de l'industrie portait sur la section du Code national du bâtiment (CNB) ayant trait au chauffage et à la climatisation. Les réponses ont montré notamment que seulement 48 % des répondants estiment que la section du CNB qui traite de la ventilation ne s'applique pas aux problèmes nordiques, alors que 75 % affirment qu'un supplément au Code devrait être rédigé pour le Nord. De plus, 76 % voulaient plus d'options concernant les systèmes de chauffage et de ventilation; la même proportion d'intervenants de l'industrie seraient disposés à participer à des essais plus poussés. Au nombre des répondants, 61% ont indiqué avoir des systèmes à tester.

Dans un autre domaine d'intérêt — l'éducation du consommateur — 71 % ont indiqué que les consommateurs ne comprennent pas le fonctionnement de leurs installations de chauffage et de ventilation. Presque tous les intervenants de l'industrie estiment que les consommateurs ont besoin d'être mieux informés sur l'utilisation et l'entretien des systèmes de chauffage et de ventilation (74 % ont répondu qu'une meilleure éducation était requise).

Le questionnaire destiné aux propriétaires d'habitations englobait trois domaines généraux de collecte de données : généralités sur le logement, détails sur les systèmes de chauffage et de ventilation, information sur la qualité de l'air intérieur.

Il était clair, d'après les réponses de tous les propriétaires sélectionnés, que ceux qui possédaient des connaissances raisonnables sur leurs systèmes de chauffage et de ventilation étaient

minoritaires. Ceux qui subissaient des problèmes de qualité de l'air étaient mieux familiarisés avec ces systèmes.

La plupart des propriétaires avaient quelque idée des matériaux employés dans la construction de leur maison. Ainsi, 66 % ont donné de l'information sur le niveau d'isolation des murs, 52 % connaissaient le niveau d'isolation de l'attique, et 74 % savaient quel type d'isolant se trouvait sous les combles.

Une proportion de 56 % des répondants ont un système de chauffage à air pulsé, 26 % ont des systèmes hybrides de diverses configurations, 9 % ont des plinthes chauffantes et 9 % un système à eau chaude. Parmi eux, 42 % chauffent au mazout et 21 % ont des systèmes hybrides utilisant deux carburants ou plus. Signalons que, au Yukon, un système hybride se définit comme une installation comportant deux systèmes propres à apporter de l'air chaud, normalement un système principal et un système d'appoint. Il ne s'agit pas d'une installation combinée de chauffage de l'air et de l'eau au moyen d'un chauffe-eau au mazout et à ventilo-convecteur.

Seulement 29 % des propriétaires ont indiqué avoir un système de ventilation actif (système tirant de l'air neuf de l'extérieur et évacuant l'air vicié au moyen de ventilateurs); 28 % l'ignoraient ou n'ont pas répondu. Quelque 68 % de tous les propriétaires ont signalé que leur système de ventilation est rarement entretenu ou jamais.

Une accumulation de givre importante en hiver a été mentionnée par 25 % des propriétaires; 45 % ont indiqué avoir de la difficulté à faire fonctionner le verrou de la porte d'entrée en hiver, et une proportion étonnante (40 %) ont une porte d'entrée impossible à ouvrir à certains moments de la saison hivernale. Seulement 28 % ont remarqué de la moisissure ou du mildiou dans la maison.

Fait intéressant, 48 % ont indiqué qu'ils mettent un ventilateur de cuisine ou de salle de bains en marche lorsqu'ils remarquent un problème d'humidité chez eux. Ce résultat indique qu'ils sont conscients des problèmes d'humidité et leur volonté de prendre des mesures; 40 % doivent par exemple éponger de l'eau ou de la glace fondue à la serpillière, nettoyer de la moisissure, et ainsi de suite. Ceci montre également qu'ils sont disposés à «faire quelque chose» pour atténuer les problèmes causés par la moisissure.

Un pourcentage assez élevé de propriétaires ont indiqué des allergies chez les membres de leur ménage (43 %), dont le tiers ont des symptômes plus graves en hiver. Faute de tests exhaustifs, il est impossible d'en déterminer la cause exacte. C'était au-delà du mandat de ce projet, mais le nombre élevé signalé ici vient étayer l'argument qu'il existe un problème de qualité de l'air intérieur dans de nombreuses habitations au Yukon.

Les résultats étaient suffisants pour démontrer qu'il y a effectivement des problèmes causés par les installations de chauffage et de ventilation. À la lumière de l'information technique fournie par les intervenants de l'industrie, il faut étudier ces systèmes plus à fond et informer/former l'industrie et les propriétaires.

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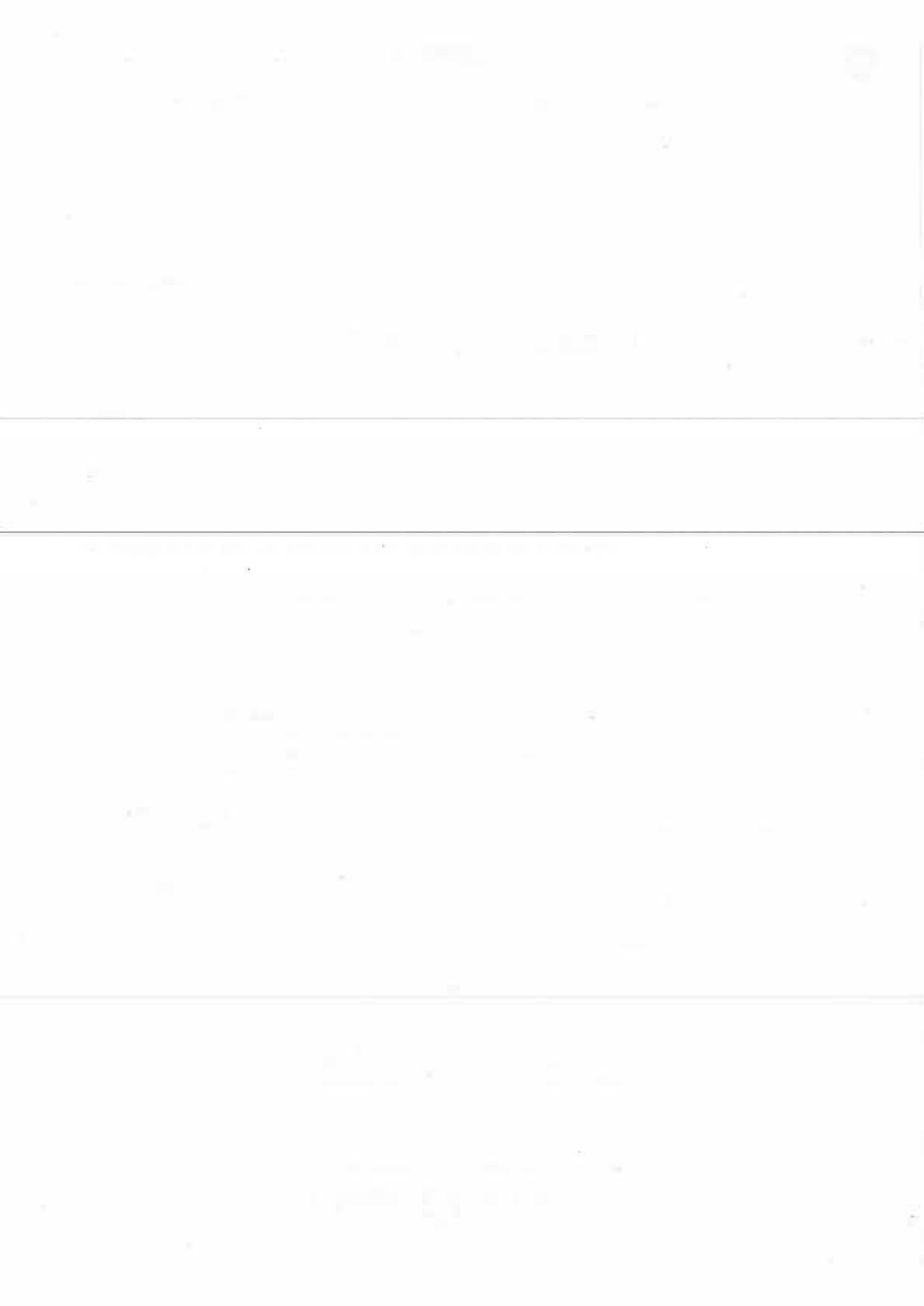


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TABLE 10-10

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BACKGROUND

The CMHC Report entitled *An Investigation of Design Criteria and Appropriate Technologies for Space Heating and Ventilation Systems for Northern Housing* identified issues specific to northern housing. Those issues have long been understood, by both the housing/heating & ventilation industry and the home owning public, as having an impact in the northern environment. It is the knowledge of these issues which has provided the desire to undertake this project of which this report is a part.

The project entitled "Testing of Heating and Ventilation Systems for the Northern Environment" was first suggested by Canadian Home Builders Association – Yukon and agreed to by Yukon Housing Corporation. A rough proposal was drafted and reviewed by Canada Mortgage and Housing Corporation, and tentative (verbal) recognition of the project's validity was given.

The proponents entered into a memorandum of understanding to conduct the project, and worked on the application process together. The first phase of the project was approved, the questionnaire mailed out in May, with telephone follow up in May and June.

Both proponents have spent considerable time and effort working with the local industry in upgrading skills and knowledge in the areas of energy efficiency, heating,

ventilation and indoor air quality. That effort has included R-2000 and EnerGuide training and certification, HRAI credit

courses, oil burner mechanic courses, the introduction of new heating and ventilation schemes, and specification of new products as a method of introducing them to the industry.

The Yukon's housing industry responds quickly to new innovations and improvements. For instance, fan coil/HRV heating systems were introduced to the Yukon through two demonstration houses in Dawson City. Within one year of that introduction, at least three heating and ventilation suppliers/installers were promoting their use in appropriate retrofit situations as well as for new construction.

The problems encountered from time to time by all industry players are also shared. That sharing of problems and the search for solutions often take the form of a consultation with inspectors, government lenders or through trade associations.

This same willingness to communicate will be an asset in the completion of the project, and the development of appropriate heating and ventilation systems for the northern environment.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. This is essential for ensuring the integrity of the financial data and for providing a clear audit trail.

2. The second part of the document outlines the various methods used to collect and analyze data. These methods include both qualitative and quantitative techniques, which are used to gain a comprehensive understanding of the subject matter.

3. The third part of the document describes the results of the research. These results show that there is a significant correlation between the variables being studied, and that the findings are consistent with previous research in this area.

4. The fourth part of the document discusses the implications of the research. These implications suggest that the findings have important practical applications, and that they may lead to further research in this field.

5. The fifth part of the document concludes the research. It summarizes the key findings and highlights the strengths and limitations of the study. It also provides recommendations for future research and for the practical application of the findings.

6. The sixth part of the document provides a detailed description of the methodology used in the study. This includes information about the sample size, the data collection methods, and the statistical techniques used to analyze the data.

7. The seventh part of the document discusses the ethical considerations of the research. It outlines the steps that were taken to ensure that the research was conducted in a responsible and ethical manner, and that the rights and privacy of the participants were protected.

8. The eighth part of the document provides a list of references for the research. These references include books, articles, and other sources that were consulted during the research process, and they provide a starting point for further research in this area.

9. The ninth part of the document discusses the limitations of the study. These limitations include the fact that the study was conducted in a specific context, and that the findings may not be generalizable to other contexts.

10. The tenth part of the document provides a summary of the research. It highlights the key findings and the implications of the research, and it provides a clear and concise overview of the entire study.

11. The eleventh part of the document discusses the future research agenda. It identifies the areas that need further research, and it provides recommendations for how this research should be conducted.

12. The twelfth part of the document provides a list of acknowledgments. These acknowledgments thank the individuals and organizations that provided support and assistance during the research process.

13. The thirteenth part of the document provides a list of appendices. These appendices contain additional information that is relevant to the research, but that is not included in the main text of the document.

14. The fourteenth part of the document provides a list of references for the research. These references include books, articles, and other sources that were consulted during the research process, and they provide a starting point for further research in this area.

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OBJECTIVES

The objective of phase I of the 4 phase project was to verify that a heating and ventilation problem really did exist in this environment, and then to have a method of defining the problem more clearly.

The Yukon Territorial Government has committed itself to energy efficiency in housing. Unfortunately the energy efficiency solution brings with it an inherent problem of poor indoor air quality. It is this issue of the management of indoor air quality which is the primary motivator for the overall project.

That problem is recognized universally in Canada. It is because of the concerns with indoor air quality, that the ventilation section of the National Building Code applying to residential dwellings was amended in 1995. That amendment caused some problems. The problems caused were not necessarily with the provision of a system which would satisfy the code requirements, but rather the provision of a system that would satisfy the code plus be acceptable to the consumer, and operate continually (and appropriately) through a Yukon winter.

Therefore the key objective of the project is to find a heating and ventilation system, or a tool box of such systems, which could satisfy the intent of the code as well as being compatible to the northern environment. It is not enough to just

satisfy the code. These systems must be user friendly enough that northern homeowners can operate them and conduct routine maintenance themselves.

It is recognized that through the testing of such systems in situ, evidence may be gathered which would allow the proponents to request an amendment or a relaxation of the code requirements in this environment. An alternative to having the National Building Code changed, would be to have a modified version of the heating and ventilation code adopted by the authorities having jurisdiction in the Yukon.

The questionnaire phase (Phase I) was seen as an opportunity to gather concrete information from both the housing industry, and consumers on heating and ventilation problems from their perspective, and to open the door to having them cooperate with the project in it's later stages.

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PROCEDURE

The questionnaires were structured in areas of interest to the project.

The first section contained identifying information, which would enable the project to contact the stakeholder or homeowner if follow-up information, clarification or other input were required.

In the industry questionnaire, the second section requested information on the type of heating systems supplied or specified by the stakeholder. The preferred type of fuel and system, as reported, would allow the project to concentrate its energies in solutions which include those areas – or at least ensure that appropriate attention is paid to the normal industry practice.

The third section, in the industry questionnaire, was concerned with the ventilation side of heating and ventilation systems, following that were sections on the residential ventilation code, consumer education, some questions regarding possible future involvement with the project.

The homeowner questionnaire had sections including dwelling information – year of construction, energy efficiency levels, etc., questions on heating and ventilation systems in the home, a section on indoor air quality, and two questions regarding possible future involvement in the project.

The questionnaire was conducted in four parts.

The first was a census questionnaire to all general contractors, heating and ventilation contractors and suppliers, heating and ventilation designers/specifiers, installers, and heating and ventilation servicers/maintainers.

The second was a census questionnaire to the homeowner/occupant of every R-2000 dwelling built in the Yukon – 17 in all. The original intent was to collect information from more R-2000 homeowners than 17. However this is the sum total of actual certified R-2000 dwellings registered in the Yukon. Local information is that many R-2000 clones have been built, but there is no way for the project to obtain a listing of these dwellings.

The third was a stratified random sample of homeowners at large. This sample was assembled by choosing random addresses from the different subdivisions in Whitehorse. These subdivisions were available for construction of dwellings at different time periods, and provided a good cross section of houses built to different codes.

The fourth was a sampling of the houses built in the rural communities in Yukon. This was accomplished by asking each first nation in the communities to complete both an industry questionnaire (they typically have a housing division that

maintains and renovates the dwellings belonging to the band), and requesting that they have two occupants complete homeowner questionnaires. Non-first nation housing in the communities was polled by asking those responsible for staff and social housing in the community to complete the same homeowner questionnaires.

In each case, the questionnaire was mailed to the stakeholder/homeowner. The questionnaire was accompanied by a cover letter introducing the project, and a stamped envelope in which to return the questionnaire. Follow up telephone calls were made to those who did not respond in a reasonable time period, and the questionnaires were completed over the phone if the respondents agreed. The telephone follow up was continued until respondents either completed the questionnaire, or indicated that no response would be forthcoming.

REVIEW OF FINDINGS

A total of 66 industry stakeholder questionnaires were mailed, with 131 questionnaires being sent to homeowners. 102 questionnaires were returned, or completed via phone. 35 from the industry and a total of 67 from homeowners (13 -

R-2000 and 54 – random homeowners)

The reply rate from the industry was 53%. The rate of reply from R-2000 homeowners was 76% and rate of reply from random homeowners was 59%.

Industry Questionnaire

Following is a summary of questions and answers gathered from the industry questionnaire – not including identifiers:

Total of 35 Respondents

Type of Residential Heating System Specified, Supplied or Installed		
Question	Possible Answers	Responses
Q5. What type of fuel do the systems you (specify/supply/install/build) use? Check all appropriate answers		
	Oil	30
	Wood	16
	Propane	15
	Electric	13
	Solar	4
	Other	0
Q6 What type of heating fuel do you prefer to (specify/supply/install/build)?		
	Oil	30
	Propane	3
	Wood	3
	Electric	0
	Other	1
Q7. What type of heating equipment do you (specify/supply/install/build)? Check all appropriate answers		

	Boiler – Hydronic Heating System	18
	Forced Air System	26
	Space Heating System	12
	Electric Baseboard System	8
	Hybrid	6
Q8. What type of heating equipment do you prefer to (specify/supply/install/build)?		
	Boiler	14
	Forced Air	20
	Hybrid – FA plus Hot Water	6
	Space Heating	3
	Electric Baseboard	0
Q9. If secondary heating system is part of the design or installation, what type of secondary heating equipment do you (specify/supply/install/build)?		
	Boiler	3
	Forced Air	8
	Hybrid – FA plus Hot Water	4
	Space Heating	6
	Electric Baseboard	9
	Other	11
Residential Ventilation System		
Q10. What form of ventilation do you (specify/supply/install/build)?		
	Passive Ventilation	4
	Heat Recovery Ventilator	12
	Fresh Air Intake as part of F A system	21
	Some other form of mechanical ventilation	12
	A ventilation system with F326 conformance (w/letter of assurance)	5

Consumer Education		
Q21. Do the consumers, you have contact with, understand the operation of their heating and ventilation systems?		
	Yes	9
	No	22
	No Answer Provided	4
Q22. What should be done to improve the ability of the consumer to operate the system? Check all appropriate answers		
	Provide more Consumer Education	26
	Install simpler systems which are easier for the consumer to understand and operate	15
	Install systems which are maintenance free	8
	Install systems which are sealed to the consumer	2
	Provide better operation and maintenance manuals to the consumer	16
	Install ventilation systems which contain self diagnostics that prompt the user or maintainer	10
Q23. Is more Consumer Education required?		
	Yes	31
	No	3
	No Answer Provided	1
Q24. Who should provide the consumer education?		
	The supplier	14
	The Installer	15

	The General Contractor	9
	A private sector organization (College, CHBA, etc.)	12
	The Government	10
Q25. Do you commission your clients on the operation and maintenance of their heating and ventilation system?		
	Yes	21
	No	9
	No Answer Provided	5
Q26. Have you had call backs in regard to ventilation problems in homes where you have (specified/supplied/installed/built) the heating and ventilation system?		
	Yes	19
	No	14
	No Answer Provided	2
Q27. If you had a call back, what problem did you encounter during the call back? Check all appropriate answers --		
	Lack of consumer knowledge of operation of the system	16
	Consumer lack of understanding - an expectation problem with the consumer	13
	Consumer tampering, or mis-operation	12
	No problem with the system, but a lifestyle problem with the consumer	10
	Icing problems	9
	System component failure	7
Further Research Questions		

Q28. Do you have blower door tests conducted on your units to check for air tightness?		
	Yes	4
	No	26
	No Answer Provided	5
Q29. Would you like to see more options for code approved heating and ventilation systems?		
	Yes	23
	No	10
	No Answer Provided	2
Q30. Would you, or your staff, be willing to participate in testing, or test installations of heating and ventilation systems?		
	Yes	26
	No	8
	No Answer Provided	1
Q31. Do you, or your staff, have heating and ventilation system designs you have developed, which are untested for approval, but you feel would be adequate systems for use in the northern environment?		
	Yes	8
	No	25
	No Answer Provided	2
Q32. Would you like to see these systems installed and tested for conformance to heating and ventilation requirements?		
	Yes	17
	No	11
	No Answer Provided	7

R-2000 Homeowner Questionnaire

Following is a summary of questions and answers gathered from the homeowner questionnaire delivered to residents of R-2000 homes:

Total of 13 Respondents

Dwelling Information		
Question	Possible Answers	Responses
Q7. How long have you lived in the dwelling?	Less than one year	1
	More than one year, but less than two years	0
	More than two years, but less than 5 years	4
	More than 5 years	8
	No Answer	0
Q8. Do you know what year your home was constructed?	Pre 1950	0
	1951 to 1960	0
	1961 to 1975	0
	1976 to 1985	0
	1986 to new	13
	Unknown/No Answer	0
Q9. Has your dwelling ever been modernized, improved or had an addition added to it?	Yes	2
	No	10
	Unsure/Unknown/No Answer	1
Q10. Were any energy efficiency items upgraded during that modernization or improvement?	Yes	2
	No	8

	Unsure/Unknown/No Answer	3
Q11. What types of windows do you have in your home?		
	Double glazed (2 layers of glass)	2
	Triple glazing (3 layers of glass)	7
	Double glazed Low -E	2
	Sliders	0
Note: Two respondents chose both casement and another response.	Casement windows (hinged opening)	2
	Unsure/Unknown/No Answer	2
Q12. What type of doors do you have in your home?		
	Steel insulated doors	9
	Wooden doors	2
	Unsure/Unknown/No Answer	2
Q13. How much insulation do you have in the walls of your home?		
	Unsure/Unknown	3
	R12 or less (4 inch thick walls)	0
	More than R12, but less than R20 (4 inch thick walls plus additional insulation on exterior or interior)	0
	R20 (6 inch thick walls)	4
	More than R20 (6 inch thick walls)	6
	No Answer	0
Q14. What type of insulation was used to insulate the walls of your home?		
	Unsure/Unknown	7
	Fiberglass	5

	Fiberglass and another product	0
Note: Rigid insulation is not common in Yukon, therefore was not included as a response.	Another Product	1
	No answer	0
Q15. How much insulation do you have in your attic or ceiling?		
	Unsure/Unknown	7
	R10 or less	0
	More than R10, but less than R20	0
	R20	0
	More than R20, but less than R40	0
	R40	4
	More than R40	2
	No answer	0
Q16. What type of insulation do you have in your attic?		
	Unsure/Unknown	7
	Shavings	0
	Cellulose	1
	Blowing wool (chopped fiberglass)	1
	Fiberglass batts	4
	No answer	0
Heating and Ventilation System Specifics		
Q17. What type of heating system do you have in your home?		
	Forced Air	4
	Space Heat	0
	Electric Baseboard Radiant Heat	5
	Hot Water System	1
Note: Combination heating in the northern environment is the installation of two separate heating systems. This does not refer to a hot water tank used for heating and DHW.	Combination (of the above)	3

	No answer	0
Q18. What fuel type does your heating system use?		
	Oil	3
	Propane	1
	Electricity	5
	Wood	0
	Solar	0
	Combination	4
	No Answer	0
Q19. How much do you pay for heat per year?	This information was not gathered for statistical purposes, only if we did follow-up with the homeowner.	Average cost of \$2497/4yr
Q20. Does the amount include the cost of heating your domestic hot water as well?		
	Yes	9
	No	2
	No answer/Unknown	2
Q21. What is the heated area of your home?	This information was not gathered for statistical purposes, only if we did follow-up with the homeowner.	Average size of 2555 sq ft heated space
Q22. What type of ventilation system do you have in your home?		
	None	0
	Active – a fan system exhausting air plus a fan drawing fresh air in	9
	Passive – no fans for moving air	0

	Hybrid – partly passive, partly active (a fan either pushing air out or drawing air in but not both – example: a powered exhaust vent used in conjunction with a passive fresh air intake)	1
	Unsure/Unknown	3
	No answer	0
Q23. Was your ventilation system set up (balanced) professionally?		
	Yes	6
	No	1
	Unsure/Unknown	6
	No answer	0
Q24. How frequently is your ventilation system maintained? (do not include changing furnace filters)		
	Never	2
	Rarely – only when something is not working	3
	Regularly – at the beginning of each heating season	3
	Often – at the beginning and end of each heating season	4
	No answer/Unknown	1
Q25. Who does the maintenance on your ventilation system?		
	Self	9
	A heating/ventilation contractor	1
	A friend	0
	No one	2
	No Answer	1
Q26. Do you shut the ventilation system off at times during the year?		

	Yes	4
	No	8
	No Answer/Not Applicable	1
Q27. Has your ventilation system ever needed repair?		
	Yes	2
	No	10
	Don't know	0
	No answer/Not Applicable	1
Q28. How difficult was it to have the repairs completed?		
	Easy – just a call to a contractor, or picking up the parts	0
	Not too easy – had to hunt for a repair person, or parts	2
	Difficult – almost impossible to find a repair person or parts	0
	Impossible – still not repaired, not operating, or had to change major components as no repairs were possible	0
	No Answer	11
Q29. Who were the repairs completed by?		
	This information was not gathered for statistical purposes, only if we did follow-up with the industry.	
Condensation Levels/Problems in the Home		
Q30. How many plants do you have in your home?		
	None	1
	5 or less	4
	6 to 10	2
	More than 10	6
	No Answer	0

Q31. How much ice build up do you have on your windows in winter?		
	None	4
	A minor amount - less than 1 inch of ice (25 mm) showing on the bottom of the window glass	7
	Ice forms on the glass and part of the window sill and sash at times	1
	Extensive icing at times, with the whole sill covered with ice, and forms at other locations on the window sash or frame	0
	No Answer	1
Q32. Does the ice build up last all or most of the winter?		
	Yes	2
	No	10
	No Answer	1
Q33. Can you operate your windows all winter – open and close them?		
	Yes	12
	No	0
	No Answer	1

Q34. On winter days, do your windows fog up when someone showers? (other than the bathroom window)		
	Yes	1
	No	11
	No Answer	1
Q35. On winter days, do your windows fog up when meals are being prepared?		
	Yes	5
	No	7

	No Answer	1
Q36. How long does the foggy condition remain?		
	No Fog	4
	Only a few minutes	5
	A few hours (3 to 4 hours)	1
	Until the sun shines on the window	0
	Never un-fogs until the temperature goes up in the spring	0
	No Answer	3
Q37. Do you ever have problems operating the front or back door lock set?		
	Yes	7
	No	5
	No Answer	1
Q38. Have your entry doors ever refused to open in the winter?		
	Yes	5
	No	7
	No Answer	1
Q39. Have you ever noticed staining from rust on the door and door jamb around the hinges on your doors?		
	Yes	2
	No	10
	No Answer	1
Q40. If you have identified moisture problems in your home, what have you done about them? – Mark all appropriate boxes -		
	You live with them – mop up water, melt ice, wash off mold, etc.	5

	You cover windows with winter coverings (storm windows, poly coverings, caulking, etc)	1
	You have done some repair and upgrading to windows and doors (weather stripping, sealing, caulking, etc)	3
	You turn on your kitchen or bathroom ventilation fans	5
	You have hired a contractor to do upgrading and repairing	1
	You have thought about, or actually changed components to minimize problems	0
	You have done, or are thinking of doing, major repairs/renovations.	0
	You have installed more ventilation	0
	No Answer	3
Q41. Have you noticed any mold or mildew growing anywhere in your home?		
	Yes	2
	No	11
	No Answer/Not Applicable	0
Q42. Do you notice any strange odors that persist at times throughout the year?		
	Yes	2
	No	10
	No Answer/Not Applicable	1
Q43. Do members of your household have allergy problems?		
	Yes	7

	No	6
	No Answer	0
Q44. Have you noticed whether those problems are worse in the winter?		
	Yes	3
	No	6
	No Answer/Not Applicable	4
Q45. Would you be interested in having someone inspect your home for indoor air quality, air tightness, and energy efficiency?		
	Yes	10
	No	3
	No Answer	0
Q46. If selected, would you be willing to become part of a heating and ventilation testing program? This would include testing of you home over a period of time.		
	Yes	9
	No	4
	No Answer	0

Random Homeowner Questionnaire

Following is a summary of questions and answers gathered from the stratified random sample, homeowner questionnaire:

Total of 54 Respondents

Dwelling Information		
Question	Possible Answers	Responses
Q7. How long have you lived in the dwelling?	Less than one year	8
	More than one year, but less than two years	5
	More than two years, but less than 5 years	13
	More than 5 years	28
Q8. Do you know what year your home was constructed?	Pre 1950	1
	1951 to 1960	0
	1961 to 1975	10
	1976 to 1985	14
	1986 to new	26
	Unknown (replied did not know year of construction)	3
Q9. Has your dwelling ever been modernized, improved or had an addition added to it?	Yes	24
	No	29
	Unsure/Unknown	1
Q10. Were any energy efficiency items upgraded during that modernization or improvement?	Yes	19
	No	25
	Unsure/Unknown	10

Q11. What types of windows do you have in your home?		
	Double glazed (2 layers of glass)	29
Note: Responders answered in more than one category.	Triple glazing (3 layers of glass)	20
	Double glazed Low -E	1
	Sliders	2
	Casement windows (hinged opening)	9
	Unsure/Unknown	2
Q12. What type of doors do you have in your home?		
	Steel insulated doors	43
Note: Two responders indicated they had wooden and steel doors.	Wooden doors	12
	Unsure/Unknown	1
Q13. How much insulation do you have in the walls of your home?		
	Unsure/Unknown	19
	R12 or less (4 inch thick walls)	2
	More than R12, but less than R20 (4 inch thick walls plus additional insulation on exterior or interior)	6
	R20 (6 inch thick walls)	21
	More than R20 (6 inch thick walls)	4
	No Answer	2
Q14. What type of insulation was used to insulate the walls of your home?		
	Unsure/Unknown	14
	Fiberglass	30
	Fiberglass and another product	5
	Another Product	4
	No answer	1

Q37. Do you ever have problems operating the front or back door lock set?		
	Yes	23
	No	30
	No Answer Provided	1
Q38. Have your entry doors ever refused to open in the winter?		
	Yes	21
	No	33
	No Answer Provided	0
Q39. Have you ever noticed staining from rust on the door and door jamb around the hinges on your doors?		
	Yes	13
	No	41
	No Answer Provided	0
Q40. If you have identified moisture problems in your home, what have you done about them? – Mark all appropriate boxes - .		
	You live with them – mop up water, melt ice, wash off mold, etc.	16
	You cover windows with winter coverings (storm windows, poly coverings, caulking, etc)	8
	You have done some repair and upgrading to windows and doors (weather stripping, sealing, caulking, etc)	12
	You turn on your kitchen or bathroom ventilation fans	23
	You have hired a contractor to do upgrading and repairing	5

	You have thought about, or actually changed components to minimize problems	1
	You have done, or are thinking of doing, major repairs/renovations.	1
	You have installed more ventilation	4
	No Answer Provided	15
Q41. Have you noticed any mold or mildew growing anywhere in your home?		
	Yes	16
	No	37
	No Answer Provided	1
Q42. Do you notice any strange odors that persist at times throughout the year?		
	Yes	4
	No	50
	No Answer Provided	0
Q43. Do members of your household have allergy problems?		
	Yes	22
	No	31
Q44. Have you noticed whether those problems are worse in the winter?		
	Yes	5
	No	38
	No Answer Provided	11
Q45. Would you be interested in having someone inspect your home for indoor air quality, air tightness, and energy efficiency?		
	Yes	37
	No	17

Q46. If selected, would you be willing to become part of a heating and ventilation testing program? This would include testing of you home over a period of time.		
	Yes	39
	No	15

SUMMARY OF FINDINGS

Industry Questionnaire

Types of Residential Heating Equipment Specified, Supplied or Installed

The preferred primary heating system installation in the north is an oil fired forced air system. In past interviews with installers, this preference is primarily due to the dependability of the equipment, and the relatively trouble free nature of fuel oil at sustained low temperatures. Secondary heating systems are a common safeguard, especially in rural locations where power is not dependable, and the common secondary heating systems are wood (logs or pellets), and oil space heaters.

Residential Ventilation System

Over half of the industry respondents indicated they use the forced air system to provide ventilation to the home (60%). 34% specify heat recovery ventilators as part of the heating /ventilation system, and 34% use some other form of mechanical ventilation. The indication (from Q14) is that the other preferred method of ventilation commonly used is range hood and bathroom fans to depressurize the house and remove stale/moist air.

Questions 11, 12, 13 and 28 deal with heating and ventilation system design. The responses here contain an startling contradiction. The

answer to Q11 indicates that 85% of installation are designed for the application, however only 38% of installations include a heat loss calculation (Q12), only 34% of installations include a ventilation calculation (Q13), and 13% of installations include a blower door (air change) test (Q28).

Residential Ventilation Code

This section contained some interesting responses as well. Just over 14% of industry responders indicated they understand the ventilation section of the National Building Code thoroughly, with 57% stating they had only a fair understanding.

Only slightly more than half stated that the Code applies to ventilation problems in the north (52%), and 75% stated that a supplemental code should be provided.

Another contradiction occurred in this area. 76% indicated that the heating and ventilation systems available to them were adequate to fulfil the need, but 76% indicated that more research needed to be done to find systems which work well in the northern environment. 70% indicated they would like to see more options for systems which could satisfy the requirements of the code (Q29).

Consumer Education

The consensus of opinion from the housing industry, is that consumers don't understand the operation of their heating and ventilation systems (even after walking the client through the operation of the system, i.e. commissioning), and that more education is required. That role, they indicated, should be fulfilled by the installer, supplier, and general contractor – in that order. The results indicate a place for private sector organizations (CHBA, Yukon College) and government as well.

Summary

The industry answers on design of ventilation systems contain a significant contradiction – an appropriate design can not happen without a heat loss and ventilation need calculation, and these, to be accurate, must include some form of air change rate determination. It is obvious that no more than 1/3 of heating/ventilation installations are designed and tested to ensure performance and compliance to the requirements of the NBC or F326.

Contractors/suppliers/installers do not have designing the optimum

system for energy efficiency and air quality as their primary concern. Rather, their first order of business, after ensuring they turn a profit, is to install a system that will result in minimal callbacks. Some education is needed here, but more importantly the industry needs the tools which it can use to conveniently provide an optimized system. Pre-designed, workable, consumer acceptable systems, and a testing/tuning process which is readily available would provide an answer.

From the responses in the code section of the questionnaire, it is obvious some work needs to be done in this area. From the results, the local industry is not at ease with the 1995 National Building Code section on ventilation, and is having some problems with the application of the code in the field – making use of available equipment to satisfy the requirements of the code. This result highlights a need for both industry training and the testing of systems and components to be used by the industry.

In the area of consumer education the message is loud and clear - more education is required, and everyone needs to play a part.

R-2000 Homeowner Questionnaire

Dwelling Information

R-2000 Homeowners tend to be more knowledgeable than the average homeowner in terms of

understanding the energy efficient features of their dwellings. It came as a surprise to the project, to find that 23% of this group did not know what levels of insulation they had in the walls of their homes and 57% did not know the level of insulation in the ceiling of their homes. This compares to 32% and 46% respectively, from the random group of homeowners.

Heating and Ventilation Specifics

Some interesting findings came in this section as well. 38% of the R-2000 homes polled were outfitted with baseboard radiant heat, while only 31% had forced air heating systems. 69% of these homeowners reported having active ventilation systems, with 23% answering either unsure/unknown or no answer on the type of ventilation system in the dwelling. Only 54% knew whether their ventilation system had been balanced or not, with 58% answering that they service their ventilation system regularly or often. The majority (75%) maintained the ventilation system themselves (the same per cent that indicated they had active ventilation systems). 83% answered that they have never needed to repair their ventilation system.

Condensation Levels in the Home

Icing on the windows of the R-2000 dwellings surveyed was not a major problem with 91% of the responders – the others did not answer. Only 8% had icing problems at times during

the winter. In every case the windows remained operable. Any fogginess on the windows disappeared in only a few minutes at the longest, according to this group.

A measure of medium to high humidity levels in the home combined with a somewhat positively pressurized dwelling often causes problems with exterior doors freezing shut. 58% of the R-2000 homeowners answered they had problems operating the lock set, 42% had doors actually freeze shut, with only 17% having noticed rust staining around hinges on the entry door systems. 50% lived with what ever moisture problems they were experiencing, with another 50% using bathroom or range hood fans to help eradicate excess moisture in the dwelling.

Only 15% of R-2000 homeowners reported having mold or mildew problems in their homes (locations included bathrooms, windows, and corners). 54% of these responders had someone in the household with allergy problems (42% of random homeowners reported allergy problems), with 1/3 of those responding stating that the allergy problems worsen in winter.

Summary

This group of responders would be expected to have purchased R-2000 homes because of the higher level of energy efficiency, and improved heating and ventilation systems. In fact it appears that a significant

percentage of these homeowners do not know the pertinent features of their R-2000 dwelling. For instance, slightly less than 1/4 don't even know what type of ventilation system they have.

Icing, mildew and mold growth, were not a problem with this group. This indicates that the systems designed for use in these homes do work (required for certification under R-2000). This type of "enforcement" of certain critical systems of the home could provide a means of solving the type of air quality problems reported by the random homeowners.

The statistic showing that electric heat was the predominant heating

method is explainable. When most of these dwellings were built – in the 1980's – electricity was an inexpensive energy source in Yukon. Electric baseboard radiation was also much cheaper to install than the more common forced air heating system (about half the capital cost). High efficiency oil burning forced air systems were not yet available – or just beginning to become available – and oil is the preferred fuel source in Yukon. Propane had only limited acceptance at that time due to vaporization problems in winter. The R-2000 homeowners are looking at retrofitting heating systems in the current environment of high power costs.

Random Homeowner Questionnaire

Dwelling information

22% of homeowners randomly chosen stated they lived in dwellings built prior to 1976. 27% lived in dwellings built from 1976 to 1985 and 51% lived in dwellings built since 1986. 45% of those homeowners have conducted some modernization and improvements on their dwelling or built an addition. 43% stated that energy efficiency upgrading was done as part of an upgrading project.

38% of these homeowners indicated they had triple glazed window systems in their homes, 81% had

steel insulated door systems. 48% reported they had insulation levels of at least R-20 in their walls and 36% reported they had ceiling insulation levels of at least R-40.

Heating and Ventilation Specifics

Forced air heating systems comprise 62% of heating systems in these dwellings, with oil the heating fuel in 52% of the dwellings polled. A combination heating system (often oil or propane, plus wood heat) is the second most popular heating system (26%).

45% of homeowners stated they either had no ventilation system or a

passive ventilation system. Only 18% had an active ventilation system (fans exhausting, and bringing in fresh air), and 14% had a hybrid system (a fan either exhausting stale air, or bringing in fresh air but not both).

Only 27% acknowledged that their ventilation system was set up professionally. 74% revealed that they rarely (or never) maintain their ventilation system. When maintenance is done, it is done by the homeowner or a friend 31% of the time and a heating/ventilation contractor 33% of the time. 84% of homeowners have never had a need to repair their ventilation system.

37% of the homeowners shut their ventilation systems off at times during the year.

Condensation Levels/Problems in the Home

67% of responders indicated they have ice forming on parts of the window – either the glass of the window and window sill. 9% had extensive icing problems on windows and sills. 28% stated that the icing conditions last most of the winter, and 32% of the random homeowners stated they could not open or close windows in the winter.

43% of responders had problems operating a door lock in winter, and 39% reported they had doors that refused to open in winter. Only 24% had moisture build ups severe

enough to cause rust staining around the door hinges.

In dealing with moisture problems, the random homeowners used the following methods: 59% turned on kitchen or bathroom fans; 41% lived with moisture problems by mopping up water, melting ice, and washing molds that formed due to moisture; 31% actually took some action by doing repairs, or upgrading parts of the dwelling; only 10% added more ventilation.

30% of this group reported mold or mildew growing in areas of the home.

Summary

The high level of retrofitting that is evident from the dwelling information statistics is likely a result of two factors, the high cost of energy in the north and the resultant increase in heating costs, and the availability of government financing programs for energy efficiency upgrading.

The fact that only 33% of dwellings belonging to this group have an active ventilation system is a concern. Energy efficiency upgrading is taking place, without attention to the crucial matter of indoor air quality. It also follows that education of homeowners and renovation contractors, in indoor air quality matters, is a large part of the answer to this dilemma – as is the design of suitable, proven ventilation systems for the retrofit market.

The window icing problems reported are not unnatural in the north, but severe icing, and icing which lasts all winter is a problem. It is especially a problem when

windows will not open, as reported by 32% of these homeowners, and windows are a means of egress in event of fire. For those homeowners who use combination heating systems, which normally includes a wood burning appliance, this information takes on special significance – poorly maintained wood burning appliances are a cause of fires in Yukon in winter. The problem of frozen windows can be solved, to a great extent, with proper ventilation.

The information on doors with freeze up problems, not operating and freezing closed, is also a safety concern. This condition indicates fairly airtight dwellings, with high moisture levels and positive interior pressure (as would be the case with a forced air furnace system when the blower fan is operating). This situation is often found in retrofit situations when new windows are installed and the building envelope is wrapped, and when newer housing is built tightly without attention paid to ventilation of the homes. Again, an

appropriate ventilation scheme is needed.

It is interesting to note that homeowners are willing to physically turn on a fan when moisture becomes a problem. This speaks to the type of ventilation system, or equipment, which may be acceptable to a homeowner. It is also interesting to note that the northern housing industry (from the industry questionnaire) considers range hood and bathroom fans as part of the ventilation scheme in a dwelling.

With the new information that is available on the consequences of mold and mildews in the home, the statistic regarding mold/mildew levels is a flag indicating that consumers need to have more information on the subject of indoor air quality available to them. Then, once the consumer realizes that proper ventilation is the solution, the industry must be ready to respond with knowledge and understanding and systems which can fill the need.

RECOMMENDATIONS

From the information gathered from the industry and homeowner questionnaires, the following recommendations are proposed:

1. A number of heating and ventilation schemes need to be developed for both retrofit situations and new construction. These systems should be compatible with the construction methods/systems used in northern construction, and the heating system/fuel sources available or preferred by the consumer. The systems developed should be:
 - Able to be tuned for optimal performance in each specific case;
 - Acceptable to the consumer – that is the consumer is confident with both the operation and routine maintenance of the system;
 - Designed to satisfy the need for healthful indoor air quality.
2. Find and test heating/ventilation components which operate properly in the critical northern environment.
3. Catalogue, for industry use, the equipment (generically) and methods to be used to optimize performance of heating and ventilation systems.
4. If it proves necessary, develop a supplemental ventilation code for the northern environment (cold/dry winter conditions).
5. Prepare an appropriate education/awareness approach to both industry and consumers in the area of indoor air quality. The proponents of this project (CHBA – Yukon and YHC) are the most likely champions for such an initiative.

The systems tested would likely include those systems specified by Howell-Mayhew/Geddes on page 55 of the CMHC study *“An Investigation of Design and Appropriate Technologies for Space Heating and Ventilation Systems for Northern Housing”*.

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APPENDIX

A1 – Industry Questionnaire Cover Letter

A2 – Industry Questionnaire

B1 – Homeowner Questionnaire cover letter

**B2 – Homeowner Questionnaire (the same questionnaire used for both
R-2000 and Random Homeowners)**

1. The first part of the report is a general introduction to the subject of the study. It discusses the importance of the research and the objectives of the study. It also provides a brief overview of the methodology used in the study.

2. The second part of the report is a detailed description of the methodology used in the study. It discusses the data sources, the data collection methods, and the data analysis methods. It also provides a detailed description of the research design and the research instruments used in the study.

3. The third part of the report is a detailed description of the results of the study. It discusses the findings of the study and the implications of the findings. It also provides a detailed description of the statistical analysis of the data and the results of the statistical tests.

4. The fourth part of the report is a detailed description of the conclusions of the study. It discusses the main findings of the study and the implications of the findings. It also provides a detailed description of the limitations of the study and the directions for future research.



Canadian
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**TESTING OF RESIDENTIAL HEATING
AND VENTILATION SYSTEMS
FOR THE NORTHERN ENVIRONMENT**



Y U K O N

Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

April 20, 1998

Name of Contact Person

Name of Contractor

Address 1

Location

Postal code

Dear xxxxx,

Attached is a questionnaire which we would like your assistance in completing.

The purpose of the questionnaire is to gather information on the **residential** heating/ventilation systems you design, specify, supply or install in dwellings. The Canadian Home Builders Association - Yukon and the Yukon Housing Corporation receive calls continually, from homeowners, about indoor moisture problems, mold build up, and moisture on windows.

As well, we have been part of the local housing industry stakeholders wrestling with the satisfaction of the new, more stringent, National Building Code. Most of these problems seem to be related to finding systems which operate well in our harsh northern environment while satisfying the fresh air, and indoor air quality, needs of our clients – and doing this in a manner that is acceptable to the consumer.

We have also learned, from past experience, that our local designers, suppliers, installers and contractors are quite capable at finding technological solutions that work in the north. We are interested in how you are handling heating and ventilation on your projects.

The questionnaire will ask questions related to the type of heating and ventilation systems you specify, supply and install; how you deal with the new ventilation requirements under the 1995 National Building Code; customer acceptance of the systems you install; and problems you have become aware of.

The information we gathered will be compiled into a summary of information on heating and ventilation systems from the housing industry point of view. Depending on the findings, we may be working on alternate heating/ventilation systems for use in the north, and possibly be providing input to the Committee responsible for the review of the NBC, with a view to having a supplemental code prepared for northern climates. We may discover some other initiatives which may need to be pursued along the way – such as seminars or information sessions.

We plan on keeping all of you informed every step along the way. The information gathered is considered **confidential**, and will not be used for any other purpose.

Due to the small number of designers, specifiers, suppliers, installers, and contractors in the Yukon we need input from all those sent questionnaires. This means we will be following up on every questionnaire sent. If you have not had time to return the survey by May 8, our survey team will be contacting you to complete the survey. We plan to conduct this follow up by phone, and if necessary in person.

Your assistance is greatly appreciated!

Yours truly,

Canadian Home Builders Association – Yukon Bob Lucas, President, Phone: 668-6206

Yukon Housing Corporation Allyn Lyon, A/Director Tech Services, Phone 667-5759



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Industry Questionnaire

Identifiers

1. What is the name of your Company/Business?

2. For follow up information or explanations who could we contact?

3. Could you give us the mailing address, phone number, fax number, and e-mail address of your company?

Address

Phone Number:

Fax Number:

E-Mail Address:

4. Are you a: (check all appropriate answers)

System Designer/Specifier

Supplier

Installer

Contractor/Builder

Other α Please explain _____



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Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

Type of Residential Heating Equipment Specified, Supplied or Installed

5. What type of fuel do the systems you (specify/supply/install/build) use?

- Check all appropriate answers -

- Oil
- Wood
- Propane
- Electric
- Solar
- Other, Please describe: _____
- _____
- _____

6. What type of heating fuel do you prefer to (specify/supply/install/build)?

- Oil
 - Propane
 - Wood
 - Electric
 - Other
- Why do you prefer this type of heating fuel?

- α Please Explain _____

7. What type of heating equipment do you (specify/supply/install/build)?

- Check all appropriate answers -

- Boiler – Hydronic Heating System
- Forced Air System
- Space Heating System
- Electric Baseboard System
- Hybrid α Please Explain _____

8. What type of heating equipment do you prefer to (specify/supply/install/build)?

- Boiler
 - Forced Air
 - Hybrid – FA plus Hot Water
 - Space Heating
 - Electric Baseboard
- Why do you prefer this type of equipment?



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Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

9. If a secondary heating system is part of the design or installation, what type of secondary heating equipment do you (specify/supply/install/build)?

- Boiler
- Forced Air
- Hybrid – FA plus Hot Water
- Space Heating
- Electric Baseboard
- Other α Please Explain _____

Residential Ventilation System

10. What form of ventilation do you (specify/supply/install/build)?

- Passive Ventilation
- Heat Recovery Ventilator (Air to Air Heat Exchanger)
- Fresh Air Intake as part of a forced air heating system
- Some other form of mechanical ventilation
- A ventilation system with F326 Conformance (letter of assurance)

11. Is every installation you (specify/supply/install/build) specifically designed for the individual application in which it is used?

- Yes
- No

12. Does every installation include a heat loss calculation?

- Yes
- No

13. Does every installation include a balanced ventilation calculation (air changes required, exhaust air vs fresh air), and layout?

- Yes
- No



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14. Do you consider the following components as part of the ventilation system, and include them in your ventilation system design?

Range Hood Fan

- Yes
- No

Bathroom Fan

- Yes
- No

15. For the ventilation components listed, which equipment (manufacturer and model) do you typically specify?

- Heat Recovery Ventilator _____
- Range Hood Fan _____
- Bathroom Fan _____
- Remote Fan _____
- Mechanical Venting Equipment _____
- Control Dampers _____
- Humidity Sensors/Controls _____

Residential Ventilation Code

We would like to ask some questions regarding the section of the 1995 National Building Code regarding ventilation.

16. Regarding the ventilation section of the National Building Code, would you say that you and your staff –

- Understand the code thoroughly
- Have a fair understanding of what the code requires
- Have some questions about what the code requires
- Have problems with understanding and/or applying the code
- Do not have a very good understanding of the code and what it requires



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17. Does the National building code apply to ventilation problems which occur in the north?

- Yes
 No, If no please answer the following question

Why is that your opinion?

18. Should a supplement to the ventilation section of the National Building Code be provided for Northern Regions?

- Yes
 No

19. Does more research need to be done to find heating and ventilation systems which work well in the northern environment?

- Yes
 No

20. Are the heating and ventilation systems currently available to you, adequate to satisfy the requirements for homes built in our Northern Environment?

- Yes
 No

Consumer Education

21. Do the consumers, you have contact with, understand the operation of their heating and ventilation systems?

- Yes
 No



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**22. What should be done to improve the ability of the consumer to operate the system?
-- Check all appropriate answers --**

- Provide more Consumer Education
- Install simpler systems which are easier for the consumer to understand and operate
- Install systems which are maintenance free
- Install systems which are sealed to the consumer
- Provide better operation and maintenance manuals to the consumer
- Install ventilation systems which contain self diagnostics that prompt the user or maintainer

23. Is more Consumer Education required?

- Yes
- No

24. Who should provide the consumer education?

- The Supplier
- The Installer
- The General Contractor
- A private sector organization (College, CHBA, etc.)
- The Government

25. Do you commission your clients on the operation and maintenance of their heating and ventilation system?

- Yes
- No

26. Have you had call backs in regard to ventilation problems in homes where you have (specified/supplied/installed/built) the heating and ventilation system?

- Yes
- No



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27. If you had a call back, what problem did you encounter during the call back?

-- Check all appropriate answers --

- Lack of consumer knowledge of operation of the system
- Consumer lack of understanding - an expectation problem with the consumer
- Consumer tampering, or mis-operation
- No problem with the system, but a lifestyle problem with the consumer
- Icing problems
- System component failure

Further Research Questions

28. Do you have blower door tests conducted on your units to check for air tightness?

- Yes
- No

29. Would you like to see more options for code approved heating and ventilation systems?

- Yes
- No

30. Would you, or your staff, be willing to participate in testing, or test installations of heating and ventilation systems?

- Yes
- No

31. Do you, or your staff, have heating and ventilation system designs you have developed, which are untested for approval, but you feel would be adequate systems for use in the northern environment?

- Yes
- No



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32. Would you like to see these systems installed and tested for conformance to heating and ventilation requirements?

- Yes
- No

Thank you for assisting with this questionnaire.



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FOR THE NORTHERN ENVIRONMENT**



Y U K O N

Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

April 20, 1998

Name of Home Owner

Address 1

Location

Postal code

Dear name of homeowner,

As far as winter's go, this last one was pretty easy. But this is the Yukon, and most winters tax the heating and ventilation systems of our homes to the maximum.

Those of us involved in the housing industry try to satisfy the need that you the homeowner has for safe, convenient heat, and, even more importantly, for adequate levels of fresh air to ensure that the indoor air you breath is of high quality.

We need your help to do that. We don't know how well or poorly your home operates in the heating season – only you do. We don't know if you ventilation system is easy to operate, works wonderfully, or is totally hopeless – only you know that.

As housing professionals are charged with the responsibility of designing, supplying, installing and servicing heating and ventilation systems for you, we need your input.

You can satisfy that need by completing the attached questionnaire. It is designed to gather information on the construction of your dwelling, about the heating and ventilation system in your home, and the type of moisture problems you have (moisture problems, or lack of them, are a valuable indicator of air quality).

This information will be used by the Canadian Home Builders Association - Yukon and the Yukon Housing Corporation to determine if homeowners are having problems, what areas those problems are in, and where we need to spend our energies looking for solutions.

We expect that the look for solutions will take some time, and we need to know which direction to look a couple of years. We are only surveying a limited number of homeowners, so we will be following up on every questionnaire sent. If you have not had time to return the survey by xxxxx, our survey team will be contacting you Wednesday May xxxxx, after 7:00 PM to complete the survey by phone.

Your assistance is greatly appreciated!

Yours truly,

**Canadian Home Builders Association – Yukon
Yukon Housing Corporation**

**Bob Lucas, President, Phone: 668-6206
Allyn Lyon, A/Dir Tech Services, Phone 667-5759**



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Home Owner Questionnaire

Client Information

1. What is the name of the homeowner or renter?

2. What is your mailing address?

3. What is your phone number? _____

4. If you have a Fax line what is that number? _____

5. Do you have an e-mail address where we can contact you? _____

6. Is the location of your home the same as the mailing address?

Yes

No, give details α

Where is the home located?

NOTE: Information provided in questions 1 through 7 will not be entered into the data base information. This personal information will be used for follow – up purposes if you indicate that by answering yes to question 45 or 46.



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Dwelling Information – You may not have access to some of this information, please complete as much of it as you can.

7. How long have you lived in the dwelling?

- Less than one year
- More than one year, but less than two years
- More than two years, but less than 5 years
- More than 5 years

8. Do you know what year your home was constructed?

- Yes α Year of construction:
- No
 - Pre 1950
 - 1951 to 1960
 - 1961 to 1975
 - 1976 to 1985
 - 1986 to new

9. Has your dwelling ever been modernized, improved or had an addition added to it?

- Yes α What year did the renovations take place? _____
- No
- Unsure/Unknown

10. Were any energy efficiency items upgraded during that modernization or improvement?

- Yes
- No
- Unsure/Unknown

11. What typed of windows do you have in your home?

- Double glazed (2 layers of glass)
- Triple glazing (3 layers of glass)
- Double glazed Low -E
- Sliders
- Casement windows (hinged opening)
- Unsure/Unknown



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12. What type of doors do you have in your home?

- Steel insulated doors
- Wooden doors
- Unsure/Unknown

13. How much insulation do you have in the walls of your home?

- Unsure/Unknown
- R12 or less (4 inch thick walls)
- More than R12, but less than R20 (4 inch thick walls plus additional insulation on exterior or interior)
- R20 (6 inch thick walls)
- More than R20 (6 inch thick walls)

14. What type of insulation was used to insulate the walls of your home?

- Unsure/Unknown
- Fiberglass
- Fiberglass and another product α What product _____
- Another Product α What product _____

15. How much insulation do you have in your attic or ceiling?

- Unsure/Unknown
- R10 or less
- More than R10, but less than R20
- R20
- More than R20, but less than R40
- R40
- More than R40

16. What type of insulation do you have in your attic?

- Unsure/Unknown
- Shavings
- Cellulofibre
- Blowing wool (chopped fiberglass)
- Fiberglass batts



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Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

Heating/Ventilation System Specifics – All homes have a heating system of some kind. Usually, but not always, this heating system has a ventilation system combined with it. This ventilation system might be as simple as a fresh air intake attached to the cold air intake duct on a forced air furnace, or a separate fan powered intake and exhaust air system. We would like some information on the system you have, please provide us with the information you can.

17. What type of heating system do you have in your home?

- Forced Air
- Space Heat
- Electric Baseboard Radiant Heat
- Hot Water System
- Combination α Please describe what type of combination system you have

18. What fuel type does your heating system use?

- Oil
- Propane
- Electricity
- Wood
- Solar
- Combination α Please describe what the combination consists of

19. How much do you pay for heat per year?

Amount _____

Note: If you burn wood and collect it yourself, estimate the cost by calculating the number of cords you use at \$150 per cord.

If you heat with electricity take your summer power bills as the cost of operating the house without heat - then all the power costs above that amount, over the year, are your heating costs for the year.

20. Does that amount include the cost of heating your domestic hot water as well?



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- Yes
- No

21. What is the heated area of your home? (answer in sq. ft. or m² , whichever you find easier to use)

Basement _____
 Crawl space _____
 Main floor _____
 2nd level _____
 3rd level _____
 Heated Garage _____
 Others Areas _____

Total _____

22. What type of ventilation system do you have in your home?

- None
- Active – a fan system exhausting air **plus** a fan drawing fresh air in
- Passive – no fans for moving air
- Hybrid – partly passive, partly active (a fan either pushing air out or drawing air in but not both – example: a powered exhaust vent used in conjunction with a passive fresh air intake)
- Unsure/Unknown

23. Was your ventilation system ever set up (balanced) professionally?

- Yes
- No
- Unsure/Unknown

24. How frequently is your ventilation system maintained? (do not include changing furnace filters)

- Never
- Rarely – only when something is not working
- Regularly – at the beginning of each heating season
- Often – at the beginning and end of each heating season



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25. Who does the maintenance on your ventilation system?

- Self α How did you come to understand how to do your own maintenance?
- A heating/ventilation contractor 1
- A friend 1
- No one

Please Answer here _____

26. Do you shut the ventilation system off at times during the year?

- Yes α Why , and for how long _____
- No _____

27. Has your ventilation system ever needed repair?

- Yes α What type of repair? _____
- No _____

- Don't know _____

28. How difficult was it to have the repairs completed?

- Easy – just a call to a contractor, or picking up the parts
- Not too easy – had to hunt for a repair person, or parts
- Difficult – almost impossible to find a repair person or parts
- Impossible – still not repaired, not operating, or had to change major components as no repairs were possible

29. Who were the repairs completed by? _____



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We would like to gather information relating to condensation levels in your home.

30. How many plants do you have in your home?

- None
- 5 or less
- 6 to 10
- more than 10

31. How much ice build up do you have on your windows in winter?

- None
- A minor amount - less than 1 inch of ice (25 mm) showing on the bottom of the window glass
- Ice forms on the glass and part of the window sill and sash at times
- Extensive icing at times, with the whole sill covered with ice, and forms at other locations on the window sash or frame

32. Does the ice build up last all or most of the winter?

- Yes
- No

33. Can you operate your windows all winter – open and close them.

- Yes
- No

34. On winter days, do your windows fog up when someone showers? (– other than the bathroom window)

- Yes
- No

35. On winter days, do your windows fog up when meals are being prepared?

- Yes
- No



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36. How long does the foggy condition remain?
- No Fog
 - Only a few minutes
 - A few hours (3 to 4 hours)
 - Until the sun shines on the window
 - Never un-fogs until the temperature goes up in the spring
37. Do you ever have problems operating your front or back door lock set?
- Yes
 - No
38. Have your entry doors ever refused to open in the winter?
- Yes
 - No
39. Have you ever noticed staining from rust on the door and door jamb around the hinges on your outside doors?
- Yes
 - No
40. If you have identified moisture problems in your home, what have you done about them? -- Mark all appropriate boxes --
- You live with them – mop up water, melt ice, wash off mold, etc.
 - You cover windows with winter coverings (storm windows, poly coverings, caulking, etc)
 - You have done some repair and upgrading to windows and doors (weather stripping, sealing, caulking, etc)
 - You turn on your kitchen or bathroom ventilation fans
 - You have hired a contractor to do upgrading and repairing
 - You have thought about, or actually changed components to minimize problems
 - You have done, or are thinking of doing, major repairs/renovations.
 - You have installed more ventilation



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Canadian Home Builders Association – Yukon/ Yukon Housing Corporation Joint Venture

41. Have you noticed any mold or mildew growing anywhere in your home?

- Yes α If yes, where _____
- No

42. Do you notice any strange odors that persist at times throughout the year?

- Yes α If yes, can you describe the odor to the best of your ability
 - No
- _____
- _____
- _____

43. Do members of your household have allergy problems?

- Yes
- No

44. Have you noticed whether those problems are worse in the winter?

- Yes
- No

45. Would you be interested in having someone inspect your home for indoor air quality, air tightness, and energy efficiency?

- Yes
- No

46. If selected, would you be willing to become part of a heating and ventilation testing program. This would include testing of your home over a period of time?

- Yes
- No

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