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**Field Survey of Residential Heat Recovery Ventilation  
Systems: Occupant Interactions**

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**TITLE:****FIELD SURVEY OF RESIDENTIAL HEAT RECOVERY VENTILATION SYSTEMS:  
OCCUPANT INTERACTIONS****SYNOPSIS:**

The installation of packaged heat recovery ventilation (HRV) systems has recently become common practise in new homes in Canada. Despite improvements in product quality and reliability, HRV systems are only capable of providing safe, continuous, efficient and effective ventilation if homeowners have a understanding of the basic operation and maintenance procedures and the system's interaction with other house systems. Furthermore, homeowners must be able to perceive the value of HRV systems if they are expected to operate them.

Canada Mortgage and Housing Corporation initiated a research project to determine the degree to which homeowners are capable, or willing, to interact with HRV systems. HRV systems within fifty-eight, regionally representative houses of various age were inspected to characterise the condition and performance of the systems as found. Interviews were conducted with the occupants to determine their understanding of the operation and maintenance requirements of their HRV systems and their perceptions of system value, effectiveness and efficiency.

While most occupants reported an understanding of the operation and maintenance needs of their HRV systems certain disparities exist. For instance, more than half of the systems surveyed had immediate service requirements such as filter, heat recovery core and intake grille cleaning. More than half of the systems had unbalanced supply and exhaust air flows. Ventilation rates were found to be substandard in 60% of the homes surveyed. The occupants of tract built homes demonstrated the least appreciation of the operating and maintenance requirements of HRV systems. The configuration of the HRV systems ductwork and the availability of controls also was found to have an influence on occupant interactions. This investigation demonstrated that most homeowners appear willing and able to interact with HRV systems. More consumer education and refined (user-friendly) control and maintenance strategies are required to ensure the successful adoption of HRV systems within Canadian homes.

**1.0 INTRODUCTION**

In Canada, heat recovery ventilators (HRV) are commonly installed in new homes to meet building code ventilation requirements or in existing homes to improve indoor air quality. Although HRV systems have been routinely installed in energy efficient and custom homes for the past 15 years, their application in conventional homes is a relatively new phenomenon. While the evolution of the design, fabrication and installation processes has significantly improved the reliability and performance of HRVs, questions remain unanswered concerning the impact of occupant-system interactions and HRV installation configurations on the ability of the systems to safely, efficiently and effectively ventilate homes.

Recent surveys have indicated that homeholders that dwell in new homes with HRV systems are very knowledgeable about the operation of their ventilation systems and are generally very satisfied with the performance (1). However, HRV systems are relatively complex for homeholders to understand, operate and maintain, particularly when compared with more familiar approaches to ventilation such as operable windows and localised exhaust-only systems. Many components such as motors, filters, heat recovery cores, air intake grilles require routine service. Field investigations of HRV systems have found that homeholder interactions, or a lack thereof, can be problematic as poorly maintained HRVs can fail to operate properly (2).

Additionally, homeholders must be able to control the ventilation system in order to meet ever changing needs. Control strategies often include combinations of manual and automatic switches that are either remotely located (e.g.; in kitchens and bathrooms) or are mounted on the HRV itself (which are usually found in relatively inconvenient locations such as basements or service rooms). Occupants must also be aware of how HRV systems interact with central forced air heating/cooling systems, combustion venting systems and the building envelope if the systems are to be operated in a safe, efficient and effective manner. The failure of occupants to properly operate and maintain HRV systems could cause indoor air quality problems due to inadequate ventilation and combustion venting failures due to unbalanced air flows. Building envelope durability could also suffer due to high indoor humidity levels and forced exfiltration due to insufficient and unbalanced ventilation, respectively.

The objective of this study is to assess the ability of homeholders to interact with residential HRV systems and the subsequent impacts on system performance, system condition and occupant perceptions of indoor air quality, and the overall value of HRV systems.

## 2.0 METHOD:

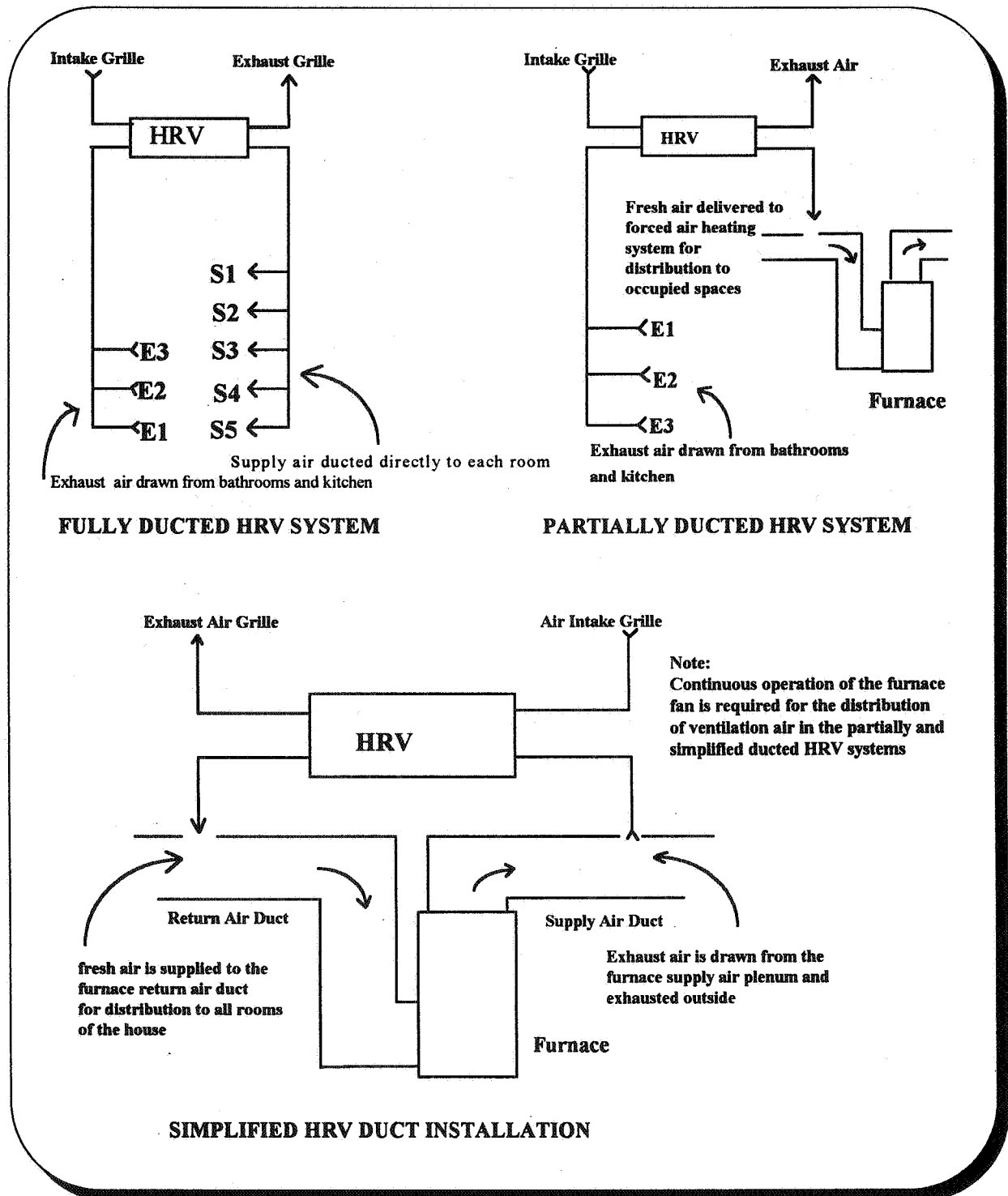
Fifty-eight houses located in the central, Western and maritime regions of Canada were selected for the field investigation to characterise regional differences in installation practises, occupant awareness and market penetration of HRV systems (Table 1).

Type	Region	2-4 years old	5-7 years old	8 years and older	Subtotal
Fully ducted	Western	3	4	2	
	Central	4	0	1	
	Eastern	3	2	4	
Subtotal					23
Partially Ducted	Western	3	3	0	
	Central	7	1	4	
	Eastern	4	1	1	
Subtotal					24
Simplified Ducting	Central	11	0	0	
Subtotal					11
Total		35	11	12	58

Table 1.0: HRV System Type, Region and Age Distribution

The HRV systems selected were representative of the three most prevalent types of installation configurations: fully ducted, partially ducted and simplified systems (Figure 1). The sample set of houses contained HRV systems that were between 2 and 15 years old.

**FIGURE 1: HRV INSTALLATION CONFIGURATIONS**



The field investigation consisted of an inspection of each HRV system and an interview with the associated homeowner. The HRV inspection included a general assessment of the condition of the HRV and duct system, measurement of air flows to and from the house, and the compliance of the system with appropriate codes and standards. The interview was performed to assess the occupant's understanding of the HRV operation and maintenance needs, control strategies, interaction with other house systems, and the implications of improper system operation and maintenance on health and safety and building durability. The occupant's perceptions of indoor air quality were also solicited.

The investigation was conducted during January, February and March to assess the performance of HRV systems during extreme conditions. Given cold outdoor air temperatures, closed windows and high occupancy levels, homeowners would be more likely to be conscious of poor indoor air quality conditions. Additionally, under such conditions, any failure on the part of homeowners to properly operate and maintain their HRV systems would be more noticeable to the investigators.

### **3.0 RESULTS:**

The results of the study can be presented in terms of the occupant survey results, HRV system inspection results and the apparent relationships between occupant interactions with the HRV systems and subsequent system performance and condition.

#### **3.1 Occupant Survey Results:**

Of the 58 occupants interviewed:

- 69% reported having had their system explained to them,
- 84% had reported having manuals for the HRV (although only 67% indicated that they had read them),
- HRV service agreements were not at all common,
- 77% reported to understand the purpose and operation of their HRV systems,
- 26% reported indoor air quality problems (95% of the problems reported concerned overly dry indoor air)
- 81% indicated that they performed regular maintenance on the HRV systems,
- while 70% reported that they understood the HRV system controls, only 42% understood the automatic humidity controls,
- all respondents used the HRV system high speed activation switches located in bathroom and kitchen areas when they were provided,
- controls mounted on the HRV cabinet were the least likely to be used or understood,
- 81% reported operating the HRV system continuously during the winter (the apparent lack of need, energy concerns and cold drafts were primary reasons for deactivation in the winter),
- 50% reported operating the HRV continuously during the summer (a preference for opening windows for ventilation during the summer was the most common reason for the deactivation of the HRVs at this time),

- 66% of the occupants with partially ducted systems understood the importance of operating the fan of the forced air heating system to distribute the ventilation air,
- 33% of the occupants with simplified systems understood the importance of operating the fan of the forced air heating system to distribute the ventilation air.

### **3.2 HRV Inspection Results:**

Of the 58 HRV systems inspected:

- 71% were installed in accordance with good practise guidelines,
- simplified HRV systems were mostly likely to be improperly installed and commissioned,
- 75% had remote controls in the living area while the remaining 25% had controls mounted on the HRV only,
- 50% of the systems had airflow balancing equipment installed,
- 60% of the system airflow rates are below current Canadian ventilation standards, 7% were found to be too high.
- 55% of the systems had unbalanced supply and exhaust air flows (29% of the systems were unbalanced by more than 40%)
- 50% of the systems had filters, heat recovery cores, HRV cabinet interiors that required cleaning,
- 14% of the systems inspected had exterior air intake grilles that were loaded with debris,
- Of the systems integrated with forced air heating systems, only 45% of the occupants reported operating the fan of the forced air system continuously to distribute the ventilation air,
- Of the 15% of the systems that had major repair or service performed, all were greater than 4 years old and 50% were greater than 7 years old.

### **3.3 Occupant Interactions with the HRV Systems:**

Of the occupants who reported that they understood their HRV systems (77%):

- 50% had HRV systems that were unbalanced
- 60% had substandard ventilation
- 52% of occupants with partially ducted or simplified HRV systems were not aware of the need to operate the fan of the forced air heating system.

Of the occupants who reported indoor air quality problems (26%):

- 60% had substandard ventilation
- 62% had unbalanced HRV system supply and exhaust air flows
- 56% had HRV systems with dirty filters, heat recovery cores, HRV cabinets.

Of the occupants who reported that they performed regular maintenance (81%):

- 42% had systems with dirty filters, cores, cabinets
- 15% had blocked air intakes
- 46% had unbalanced HRV system supply and exhaust air flows

Of occupants who reported having read the HRV operation and maintenance manuals (32%):

- 43% had dirty filters, cores, cabinets
- 49% had unbalanced HRV supply and exhaust air flows
- 40% operated the HRV systems at recommended ventilation rates

Of the occupants who reported that they did **not** read the HRV manuals (68%):

- 77% had dirty filters, cores, cabinets
- 63% had unbalanced HRV supply and exhaust air flows
- 17% operated the HRV systems at recommended ventilation rates

Of the HRV systems that had been provided with remote controls in the living areas:

- 80% of the occupants understood how to use the controls

Of the HRV systems that had been provided with no remote controls:

- 36% of the occupants understood how to use the controls

#### **4.0 DISCUSSION:**

In Canada, the increased airtightness of houses, growing occupant awareness of indoor air quality and more demanding regulatory requirements have created a need for effective and efficient residential ventilation systems. While packaged residential heat recovery ventilation systems represent one of the most promising means of meeting this need, little was known about the ability, or desire, of homeowners to properly operate and maintain these relatively new and sophisticated systems. However, based on the results of this investigation, it has been demonstrated that, for the most part, homeowners are willing to operate and maintain HRV systems even though they often lack the technical knowledge to properly do so. Nevertheless, the majority of the homeowners surveyed are satisfied with their HRV systems and the high level of indoor air quality the systems provide.

The results of the occupant interview and HRV system inspection are representative a wide cross section of homeowner demographics, regional differences, system configurations and age. Accordingly, the results presented do not identify specific concerns or observations that pertain to certain aspects of HRV installations. For instance, of the occupants surveyed, it was discovered that knowledge of HRV system operation and maintenance requirements was greater for those who live in custom homes as opposed to those who live in tract built housing. Custom homeowners usually were responsible for the decision to install their HRV systems and were more likely to appreciate the value of the systems. Homeowners living in tract housing often moved into homes where HRV systems had been already provided with little or no discussion regarding the value of the systems.

The type of HRV installation was also found to have bearing on homeowner use and maintenance patterns. Simplified systems were far less likely to be understood, operated or maintained by homeowners, particularly when no remote controls in the living areas were provided. The absence of a day to day presence of simplified systems tended to promote an "out of sight, out of mind" attitude on the part of homeowners. These observations are of significant concern as the

application of HRV systems in tract built housing represents the fastest growing market for HRV systems in Canada.

While homeholders tend to believe that they understand the purpose and operating principles of their HRV systems, the control strategies were generally less well understood. Dehumidistat controls were found to be the most poorly understood control mechanism. Improper settings may have been responsible for homeholder complaints of uncomfortably dry indoor air. It was noted that in many of the houses where the homeholders complained of dry air, humidification equipment had been subsequently installed. This corrective action may not have been necessary if the homeholders had a better understanding of the relationships between the dehumidistat setting, HRV continuous airflow speed setting and the relative humidity of the indoor air. Furthermore, few homeholders understood the interaction of their HRVs with other house systems. The need to operate the fan of the forced air heating systems when simplified and extended ducting configurations are used was not readily apparent to most homeholders. The potential impact of unbalanced airflow rates on the venting of other household combustion appliances and the building envelope was also unknown. This lack of understanding could be detrimental to the health of unsuspecting homeholders and the durability of the building envelope although no evidence of either concern was noted during the inspections.

In general, the successful maintenance of HRV systems is not beyond the capabilities of the average homeholder. However, there is a concern that maintenance activities are not as rigorous or frequent as required. Dirty filters, cores and intake grilles were found in many installations where the homeholder was under the impression that his maintenance activities were sufficient. There was also a general lack of awareness concerning HRV defrost systems and motor oiling requirements. In the majority of cases, homeholders are not provided with the means to balance and/or verify the HRV system's air flows. This was evident in the number of systems that were found to be unbalanced and /or operating at substandard ventilation rates. While formal repair and service agreements could help alleviate many of these concerns, most homeholders do not recognise that such arrangements may be necessary.

Given the successful evolution of the packaged residential heat recovery ventilator, the delivery of comprehensive HRV system design and installation courses for contractors and the pending adoption of specific performance and installation related requirements for ventilation systems in the 1995 National Building Code of Canada, problems relating to product quality and installation practise can be expected to occur less frequently. Homeholder related operational and maintenance related concerns will continue to occur and possibly increase as HRVs proliferate in the conventional housing stock. HRV manufacturers and installing contractors must continue to develop and refine the information transfer processes used to educate homeholders about HRV systems. Additionally, operation and maintenance strategies must be refined to make them more obvious and accessible for the average homeholder. As this technology improves and becomes more common in housing, the occurrence of many of the operation and maintenance related problems noted in this investigation should decrease dramatically.



## **ACKNOWLEDGEMENTS:**

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