Washington State Ventilation and Indoor Air Quality Code

Whole House Ventilation Systems Research Report

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Introduction

The Washington State Ventilation and Indoor Air Quality Code (VIAQ) has required the installation of whole house ventilation systems in new homes since July 1991. A variety of systems are allowed by the VIAQ. In 1998, telephone surveys and site evaluations were conducted to explore occupant interaction with the ventilation systems and to evaluate installed systems for code compliance, performance and energy use.

This report documents the processes and examines the data collected from telephone surveys and field audits of Washington State homes affected by the ventilation requirements. During a 15-minute telephone interview, 235 respondents were asked about indoor air quality (IAQ), repair records, alterations, inconveniences and benefits of their whole house ventilation systems. Field research, including measurements of duct and envelope air tightness, was conducted at 31 subject homes.

The data analysis compares homeowner interaction with ventilation systems, reveals code compliance and energy cost issues, provides a basis for improvements to code language and looks into the future of residential ventilation.

EXECUTIVE SUMMARY

The telephone survey revealed that people are concerned about indoor air quality and believe fresh air is important for health. However, people do not operate their ventilation systems nearly as often as recommended (3.4 hours per day average actual operation versus 8 hours per day recommended) and when they adjust their systems, they adjust them to provide even less fresh air. Ninety-nine percent of the people surveyed believed the air in their homes was good or average. People who have code mandated ventilation systems are typically not aware of all the system's components. While 20% of those surveyed consider noise, drafts and/or energy waste a problem with their system, 64% of those with ventilation systems would install the same system again.

The field research data reveals that the technical details of the whole house ventilation requirements are widely misunderstood. While all 31 homes evaluated were equipped with at least some system components, less than half (15) met the requirements either prescriptively or by performance. Simple exhaust ventilation systems complied with requirements much more frequently than integrated systems. Systems integrated with the forced air heating systems met requirements in only 29% (5/17) of the homes while non-integrated exhaust systems met code in 71% (10/14) of the homes.

Natural air leakage rates indicate that the winter use of automatic whole house ventilation is unnecessary in most homes and typically wastes energy. However, during periods of mild weather, natural infiltration rates are insufficient to meet the performance objectives of the code. Systems utilizing furnace blowers that are not equipped with automatic fresh air dampers (possibly 1/3 of all integrated systems installed in Washington State) are the most energy wasteful, costing homeowners more than twice as much to operate as exhaust ventilation systems.

STUDY DEVELOPMENT

The impetus for this study was based, in part, on the information gathered from energy code implementation efforts (See Appendix I.) The initial assumptions were as follows:

- Homeowners are unaware of, dislike, or don't understand how to use ventilation systems consistent with IAQ and energy conservation.
- Homeowners, in general, misunderstand IAQ, or are not concerned.
- Most homes are equipped with centrally ducted heating systems.
- Most centrally ducted systems are integrated with the ventilation system.
- Most integrated systems are performance based and enforcement of performance systems is ineffective.
- Most homeowner complaints are related to integrated ventilation systems.
- Untested integrated ventilation systems may waste large amounts of energy.
- Exhaust systems, while not immune from problems, generally comply to the prescriptive requirements and are not likely to waste large amounts of energy.
- Homeowners use exhaust systems more than integrated systems because the controls are easier to find. (Integrated systems timers are usually installed on the furnace, while exhaust system controls are usually in a bathroom.)

The above assumptions were used to develop the research design. Below is the research design, with italicized annotations added after the research analysis was complete.

Research Design

Hypothesis: The VIAQ results in whole house ventilation systems that are flawed. The VIAQ, as written, adds cost to new construction, wastes energy and/or does not provide IAQ benefits to a large majority of the occupants. *This study shows that systems are flawed and often waste energy. This study also shows that people believe their ventilation systems provide IAQ benefits. See Figures 1 and 2 of typical whole house ventilation systems.*

It is further hypothesized that:

The integrated systems:
- Overventilate; *Evidence supports this assertion.*
- Require excessive energy to operate; *Evidence supports this assertion.*

- Cause occupant discomfort/irritation; *Some evidence provided.*
- Are difficult for occupants to operate; *Evidence supports this assertion, for some systems.*
- Are often not installed according to code. *Evidence supports this assertion.*

The intermittent exhaust systems:

- Are not used, or, are altered by the homeowners. *Refuted, people use their systems.*
- Do not adequately ensure air distribution. *Beyond the scope of this study.*
- Are provided with controls that are typically removed or incapacitated by the occupant. *Not proven; mostly refuted. Some homeowners altered controls, but not typically. This may occur over time, however.*
- Are typically installed according to code. *Evidence supports this assertion.*

Goal of Research**:** To strengthen or refute the hypothesis; and to develop code language that would eliminate VIAQ elements not typically homeowner friendly, energy efficient and installed properly; focus on elements of the requirements that are installed, operated and performing as required. Study should result in a powerful argument for change, if change is needed.

TELEPHONE SURVEY

The phone survey served two major functions in this project. First, it provided user input from a modest sample of homeowners at a relatively low cost. Second, it provided subjects for the field survey portion of the study.

Methodology

The telephone survey process was remarkably efficient. Tasks for the project were divided between the WSU Energy Program and The WSU Social and Economic Sciences Research Center (SESRC). The Energy Program developed the basic questions, provided subject information and directed the focus of the questionnaire. SESRC insured success of the survey by recrafting the original questions into a research tool and developing a plan to secure interested subjects. The success rate was higher than expected. A total of 500 subjects were selected; of these, 235 participated in the survey. (The target was 200 completed surveys.) More amazing, 138 subjects volunteered their homes for the site survey portion of the project, more than 4 times the number of sites needed.

Sample Selection

Electronic real estate data was used to provide the minimal information needed to select the sample set. The sample was selected based on a variety of criteria:

- Three counties in the state were selected based on population size, population character and climate. The most populous county from each of the state's two climatic regions was selected. The most populous county and the most heavily sampled has a moderate climate and is mostly urban. The most populous county in the severe climate area has a population evenly divided among urban and rural

settings. A third county, the least sampled, is moderate in population and climate and is more rural in character. Two-thirds (66%) of the sample was taken from the moderate climate counties, where most of the state's population lives.

- The sample was selected based on heating system type. It was assumed that homes with forced air heating systems would usually have integrated with forced air ventilation systems. Those without forced air heating systems were assumed to have exhaust ventilation systems. Real estate data revealed that most homes had forced-air heating systems. Three-quarters of the sample were forced air systems. (See Figures 1 and 2 and Appendix II for descriptions of system types)

- All homes selected were built from 1992-1998, to ensure all would have been subject to the 1991 VIAQ. No effort was made to further manage the sample by year built.

- About 10% of the sample was selected based upon its' characterization within the real estate data as being a condominium within a multifamily building.

Questionnaire Development

The phone survey was designed to answer questions posed in the Research Design. A major obstacle to overcome was the technical nature of the questions. It was not known if the respondents would understand even a simple question like "How many hours per day does your ventilation system operate?" They might not be sure what a ventilation system was and may believe they have one when they don't. The research design also demanded differentiation between the various ventilation systems, which further burdened survey development with technical communication barriers.

The survey was designed to take no more than 15 minutes and consisted of mostly closed-end questions.

Telephone Survey Findings

As learned from previous studies, homeowner interaction is key to an effective ventilation system. Analyzed below are responses several key research questions that illuminate the factors that influence a homeowner's interaction with their ventilation systems. For details and analysis of each research question, see Appendix III.

Research Question: Are you aware that there is a ventilation system in your home?

Three quarters of the survey participants said their house had a ventilation system. But all homes in our sample were constructed after 1991 and therefore were required by code to be equipped with ventilation systems. Analysis into other survey questions sheds some light on this apparent incongruity.

Based on responses about specific ventilation system components, of those homes with central forced air heat, we estimated that 17% have an integrated with forced air system, 33% have an exhaust system, 31% have some combination of the two systems and 19% did not provide enough information to tell. In the code monitoring program, it was found

that most forced air systems were integrated with the ventilation system. (See Appendix I, Washington State Energy Code Program, for information about the code monitoring program.)

For homes without ducted heat, 65% of the respondents said they had an automatic exhaust fan, 74% said they had fresh air vents, but only 30% said they had all the components, including the fan, the timer and the fresh air vents. At least one component was identified by 81% of the respondents in this group. Although these homes did not have forced air furnaces, 15% said the furnace blower was one of the ventilation system components! Many of these homes have ductless, electric, forced air wall heaters, which may explain the confusion.

This research question reveals that homeowners are often not aware of the ventilation system components. Also, they may not differentiate between forced air heating system components and the ventilation system.

Research Question: Do you use the ventilation system? How often? Why?
Responses related to this topic reveal that 58% of the respondents have changed the settings on their timer and the average period of mechanical ventilation per day is 3.4 hours. The VIAQ requires the timer to be set at 8 hours per day at the time of final inspection. Homeowners who are aware of their systems and know how to adjust them tend to reduce the ventilation below recommended levels.

People who are not satisfied with their systems also reduce usage. Twenty percent of the respondents said drafts, noise, or energy consumption were a problem. Fifteen percent said these problems limited how much they use the system. Those who said they had severe or moderate problems in these three areas used their system an average of 30 minutes per day less than other respondents.

Research Question: Do you think your ventilation system provides any benefits?
Sixty-four percent of the respondents said they would install the same ventilation system if they built a new house and 81% said the air quality in their home was good. Sixty percent say they operate the system at least two hours per day. Only 7% say they don't use their system at all. In an open-ended question, homeowners were asked why it was important to get fresh air into homes. Nearly all the responses related to health concerns. (See Appendix IV.) These factors suggest that most homeowners perceive some benefit from their ventilation systems.

Research Question: Which systems are used and valued most by homeowners?
We hoped to gain insight to this research question, but homeowners' lack of knowledge about their systems, or, perhaps, the plethora of performance based systems and possibly non-compliant systems clouds the results.

A look into how often a person adjusts the system, an indication of system awareness, finds that those who adjust their system frequently operate it about the same number of

hours as those who do not adjust it at all. It was also found that those with forced air systems ventilate the same number of hours as those with other systems.

Those with integrated with forced air systems were the only ones to complain that their system needed repairs (8.3%), but the repairs they reported were associated with furnace problems in 10 of the 15 instances.

A look at how satisfied people are with their systems conflicts with the repair records. Sixty-seven percent of the respondents with forced air said they would install the same system again compared to 56% of those with other systems.

FIELD STUDY

The purpose of the field study was to explore the relationship between homeowner/ventilation system interaction with site conditions. Several key questions identified in the research design were explored in the field. How well did the systems perform? Were they installed to code? Did the homeowners' responses to the phone survey match site conditions? Were the homes and their ducted systems "tight"?

METHODOLOGY

Sample Selection

The sites were selected on the basis of location, heating system type and square footage. Although over 130 people volunteered for the field survey portion of the project, only one unit within a multifamily building was available. The results of this study are most applicable to single family structures. Research data was collected at a total of 31 sites.

Fifteen sites were selected King County, the most populous county and most active in terms of new construction. Ten were selected in Spokane County, the most populous county where more severe weather conditions prevail. Six sites were selected in Thurston County, a rural, moderate growth area with a moderate climate similar to King County.

Twenty-one of the selected sites had ducted forced air heating systems. Ten had other types of systems. Ducted heating systems are prevalent in Washington's new residential construction.

Data Collection

Interview

Each homeowner was interviewed on site. The interview was designed to update information collected during the telephone survey, but was adjusted as new questions seemed pertinent. For example, after it was noted that the first few homeowners kept two or more large pets, the survey was changed to add number of pets as a variable for analysis.

Envelope Air Tightness
Blower door tests were conducted to determine average effective air leakage rate. The data collected was used to determine if there was a correlation between envelope tightness, homeowner behavior and perceptions regarding IAQ. In reality, air leakage performance varies widely around the average, depending on occupant behavior, climate and other factors.

Ducted Heating System Tightness
Pressure pan tests were conducted in homes with ducted heat to help determine whether inadvertent ventilation due to duct leakage affected homeowner behavior and perceptions regarding IAQ. These simple tests did not directly measure leakage, but they provided enough information to determine if the system could be considered well sealed or poorly sealed.

Ventilation System Tests
In each home, the ventilation system was tested for flow. No attempt was made to adjust the systems prior to testing. The control settings were noted to determine hours of actual use.

Ventilation Code Compliance Data
Each ventilation system was examined and all the components, including ducts, dampers, vents, fans and controls met the requirements of the code.

Energy Code Compliance
A survey of the home was taken to determine whether the home met the basic requirements of the Energy Code, including those for insulation and windows.

FIELD SURVEY FINDINGS

The field survey mostly confirmed assumptions derived from the telephone survey and other previous code programs. Overall, energy code compliance was good, except for air sealing. Compliance to the VIAQ whole house ventilation system requirements was poor, although every home surveyed contained some type of ventilation system. The variety of systems found is a significant finding: based on function and components, we found at least 6 different system types.

System Descriptions
Six types of ventilation systems were categorized. (See Figures 1 and 2 for basic types.)

- System #1: Prescriptively described exhaust ventilation system, consisting of a timer that activates a quiet exhaust fan. Fresh air is provided through window sash vents or wall ports. These systems met code more frequently than all other systems.

- System #2: A hybrid of prescriptive exhaust and integrated systems. Consists of a timer that activates an exhaust fan. A fresh air duct, which may or may not be

equipped with a manual damper, is connected to the return air plenum. The ducts are passive: the timer does not activate the furnace blower.

- System #3: A hybrid of prescriptive exhaust and integrated systems. Consists of a timer that simultaneously activates an exhaust fan and a mechanical damper. A fresh air duct is connected to the return air plenum, which is equipped with the mechanical damper. The ducts are passive: the timer does not activate the furnace blower.

- System #4: This is a code described prescriptive integrated system. Consists of a timer that simultaneously activates the furnace blower and a mechanical damper in the fresh air intake. The fresh air duct is connected to the return air plenum.

- System #5: This is a code described prescriptive integrated system, only with an exhaust fan added. Consists of a timer that simultaneously activates the furnace blower, the exhaust fan and the mechanical damper in the fresh air intake. The fresh air duct is connected to the return air plenum.

- System #6: This is a code described prescriptive integrated system, only this one requires calculations based on field conditions or performance tests. Consists of a timer that activates the furnace blower. No damper, or sometimes a fixed manual damper, is located in the fresh air intake. The fresh air duct is connected to the return air plenum.

Code Compliance Rate

To meet code, a system must meet either the prescriptive or the performance guidelines. The prescriptive requirements were designed to provide installers with a simple way to the performance targets in the code. Below, the data is analyzed to describe whether or not the homes in the field study complied with the letter of the code and also whether they met the intent, in terms of performance, of the code. In the cases described below, if a system met the prescriptive requirements, but failed the performance requirements, the system was found to provide an inadequate amount of fresh air.

The average ventilation rate provided by the mechanical system was 0.32 air changes per hour (ACH), or slightly less than the required minimum of 0.35 ACH. Fifteen homes did not meet the minimum ACH, including all systems using passive central ducts. Five systems over-ventilated. The range was from 0.0 ACH to 0.98 ACH.

Systems that contained all the proper (type and size) components, including fans, ducts, intakes, dampers, controls and other basic requirements were determined to meet the prescriptive requirements of the code. Systems that met the code's basic requirements for controls, air distribution and total airflow were assumed to meet the performance requirements.

At three sites, the homeowners revealed that they removed or disabled the system timers. For the compliance analysis, these systems were assumed to have timers in place and

functioning. No other evidence of system tampering was revealed during the site survey interviews.

Only 32% (10/31) of all systems surveyed met VIAQ performance requirements. Slightly more, 39% (13/31) met the prescriptive requirements. **In total, 52% (16/31) of all systems met code by either or both methods.**

Code Compliance Rate for Systems NOT Integrated with Central Forced Air Ducts
Exhaust systems met the prescriptive (System #1) requirements for the code 71% (10/14) of the time. No system that failed to meet the prescriptive requirements met the all the performance requirements. The 4 homes that failed to meet prescriptive system requirements did so because of insufficient door undercuts, improper fans and/or missing fresh air intakes. Systems meeting the prescriptive code also met the performance targets 60% (6/10) of the time. (Of the 4 that failed to meet the performance targets, 3 provided insufficient airflow and 1 exceeded maximum airflow.)

It is unclear how much of a role the fresh air intakes have in providing fresh air. It is quite probable that much, if not most of the air infiltrates into the home through envelope leaks near the exhaust fan.

Code Compliance for Integrated with Central Heating Systems
Only 29% (5/17) of the systems integrated with central heating systems (Systems 2,3,4,5,6) met either the prescriptive or performance requirements of the code.

Only 18% (3/17) of the integrated with central heating ventilation systems met the performance requirements of the code. Integrated systems also met the prescriptive requirements for the code 18% (3/17) of the time. (One system met both prescriptive and performance requirements.) Compliance issues specific to each system type are described below.

- Integrated - Exhaust Fan and Passive Ducts: None of these six systems complied with the performance or prescriptive requirements. These systems (Systems #2 and #3), though common, are not described in the code. They rely on an exhaust fan to draw fresh air through the heating system ducts connected to an outside air source. The controls for these systems do not activate the furnace blower, but none drew a measurable amount of outside air through the fresh air intake unless the furnace was on. When the furnace is off, these systems extract make-up air from duct leaks and envelope leaks, where the quality of air is questionable.

  Also, 4 of 6 of these systems lacked automatic dampers in the fresh air intake (the fresh air intake is always open) and therefore draw air whenever heating or air conditioning is needed. These 4 systems waste energy by providing increasing amounts of fresh air when it is needed the least.

  At best, Integrated -Exhaust Fan and Passive Ducts systems are ineffective and non-compliant; at worst, they decrease indoor air quality and increase energy costs.

- Integrated with Forced-Air, Automatic Damper (System #4): None of these systems met code requirements. This system is the basic prescriptive integrated with forced-air approach, not requiring field testing if the ducts are installed according to the tables in the code. The 4 systems in this survey, however, were not installed with prescriptively installed ducts. None of them met the performance requirements either: 3 exceeded fresh air limits and 1 provided insufficient air.

  The automatic damper allows the homeowner control over when the system will draw fresh air; use of the furnace blower ensures a reasonable amount of fresh air will be distributed, as long as the components (especially the ducts) are installed and functioning properly.

- Integrated with Forced Air, Automatic Damper and Exhaust Fan (System #5): Three of 5 of these systems met prescriptive and/or performance requirements. These systems utilized an exhaust fan to balance the system, which is not required by code. One system had both an automatic and a manual damper. Only two met the performance requirements for fresh air. Of the three that did not meet performance requirements for fresh airflow, one had a non-functioning (partially open) mechanical damper; one had an incorrectly set manual damper; and one had an excessively long and convoluted fresh air intake duct.

  The automatic damper allows the homeowner control over when the system will draw fresh air; use of the furnace blower ensures a reasonable amount of fresh air will be distributed, as long as the components are installed and functioning properly. This system utilizes two motors and therefore uses more electrical energy than other systems.

- Integrated with Forced Air, Manual Damper (System #6): One of two of these systems met code requirements. Systems with manual (fixed) dampers are allowed prescriptively by code, although testing and/or calculations are prescriptively required. However, neither of the two systems surveyed had prescriptively sized ducts. One system met the performance requirements. In both cases the homeowner complained that the system caused drafts.

  These systems provide fresh air anytime the air handler is on and therefore ventilate more when heating or cooling is needed. The homeowners were unaware of the fixed dampers and therefore can not prevent these systems from providing unnecessary ventilation, even if they disengage the timer.

Component Problems

There were a variety of inoperative systems, typically due to poor installation.

- Timers: Three (9.6%) homeowners disabled or removed timers and chose not to operate the systems. One was an integrated system.

- Mechanical Dampers: Two of 11 (18%) mechanical dampers were found to be non-functional. One appeared to be properly installed; the other was apparently never electrically connected.

- Duct Terminus: The code requires the fresh air duct to be a minimum of 8 inches in diameter. Typically, the terminus was the same size as the intake duct, which was often 6" or 7" in diameter. At least 4 of 17 (24%) otherwise prescriptive systems failed this requirement.

Air Tightness

Due to convection, homes naturally ventilate at greater rates as the temperature differential between indoors and outdoors increases. The average natural ventilation rate, therefore, exaggerates the rate during mild weather and underestimates during severe weather. Poorly sealed ducted heating systems, where the ducts are located outside the building envelope, exacerbate this effect. Therefore, homes need the least added mechanical ventilation in the most severe weather.

The average natural air leakage rate was .34 air changes per hour (ACH) for the homes in this sample. Homes ACH ranged from 0.1 to 0.68. The tightest homes had basements and interior ducts. All homes with ducts, except those with indoor ducts (basement homes) had leaky distribution systems where up to 30% or more heat is wasted.

During the winter, especially with the ducted heating systems operating, most of the homes in this sample would have an air change rate much greater than the average rate. During mild weather, where heating and cooling systems are not in use and natural convection is at a minimum, the homes would likely have much lower leakage rates.

Those homes with basements and interior ducts tended to be tightly constructed and many may not be able achieve a 0.35 air change rate without mechanical assistance during most of the year, even during the winter.

It is clear that homes with exterior ducts and no basements are over-ventilated during the heating season. In this sample, many homes in this category would have winter air change rates approaching 1.0 air change per hour. Most of these same homes, however, would have less than 0.35 air changes per hour most seasons of the year.

Energy Implications

Given the natural air leakage rates of the homes in this study, the winter use of automatic ventilation is often unnecessary and typically wastes energy. The least wasteful is System #1 (the exhaust system not integrated with the furnace) which provides the homeowner a great deal of control and uses a relatively energy efficient fan. The amount of energy wasted is greatest in homes that utilize furnace blowers and exterior-to-the-envelope ducts to distribute fresh air.

System #3, #4 and #5 (integrated with central heating ducts systems that employ an automatic damper within the fresh air intake) are all equipped with controls easily

understood by the homeowner. System #3, however, does not activate the furnace blower and therefore consumes the less energy during its operation. Unfortunately, System #3 does not function as designed. None of these systems drew air from the installed fresh air intake. (See Code Compliance.) Instead, these systems draw air through unintentional leaks in the envelope and ducts. This may actually reduce IAQ if air is drawn through crawlspaces, attics, or other unsavory locations.

Systems #2 and #6 (integrated with central heating ducts systems that do not employ an automatic damper within the fresh air intake) are the most energy wasteful systems. These systems provide the most fresh air when it is needed least, when heating and cooling is provided. These systems are not occupant friendly to operate. Only one in six of those with systems #2 or #6 said they adjusted manual damper and that person claimed to adjust it only once. The telephone survey supports the argument that these systems are not well understood by homeowners: only 2.6% said they have adjusted the fresh air damper.

Annual Operational Energy Costs of Ventilation Systems[1]

System Description	**Unintentional Ventilation Cost of Heated Air**	**Intentional Ventilation Cost of Heated Air**[2]	**Blower or Fan Costs**	**Total Costs as Used – 3.4 Hours Per Day**	**Energy Costs if Used 8 hours/day @.5ACH**[3]
System #1: Exhaust fan, through-the- wall vents (Code described.)	$0	$16 - $23	$ 3	$19 - $26	$61
System #2: Integrated with central heat: Exhaust fan, passive ducts, manual damper. (Not described in code)	$27 - $39	$16 - $23	$ 3	$46 - $65	$100
System #3: Integrated with central heat: Exhaust fan, passive ducts, mechanical damper. (Not described in code)	$0	$16 - $23	$ 3	$19 - $26	$61
System #4: Integrated with central heat: Blower and mechanical damper activated simultaneously. (Code described.)	$0	$16-23	$ 6	$22 - $29	$69
System #5: Integrated with central heat: Blower, exhaust fan and mechanical damper activated simultaneously. (Exhaust tie-in not required by code.)	$0	$16 - $23	$ 9	$25 - $32	$73
System #6: Integrated with central heat: Blower with fixed position manual damper (Code described.)	$27 - $39	$16 - $23	$ 6	$49 - $68	$108

1. Calculations were modeled on a WSEC compliant 2000 square foot gas-heated home in SeaTac.
2. **Energy loss due to duct leakage not included. Duct leakage may more than double energy losses in this column for systems 4, 5 and 6.**
3. The VIAQ requires that dampers be set to operate the ventilation system for 8 hours per day.

Other Analysis

Many comparisons were made between various fields of data. In the following cases, however, the number of possible variables overwhelms the small sample size. While trends may have been identified, no firm conclusions should be drawn without further study.

- No relationship between about hours per day of ventilation system use compared to system airflow rate was found.
- The more pets in a household, the more the ventilation system was used.
- The people who believe their home has good IAQ use their ventilation systems less.
- No relationship between natural air change rate and hours of ventilation system use was found.
- No relationship between a homeowner's perception of his home's IAQ and natural air change rate was found.
- No evidence was found to show installers tested systems to ensure airflow. Where these tests were required, calculations and "tested flows" were sometimes found, but the values indicated were not similar to flow tests conducted through this survey.

CONCLUSION

Homeowners believe ventilation is important for health and use their systems. However, due to inadequate homeowner education and poorly designed ventilation systems, energy is wasted and indoor air quality is compromised.

The winter use of automatic whole house ventilation in homes evaluated in this study is unnecessary and typically wastes energy. Systems utilizing furnace blowers that are not equipped with automatic fresh air dampers (1/3 of all integrated systems) are the most energy wasteful, costing homeowners at least $45 per year more than some other systems.

The field research data reveals that the technical details of the whole house ventilation requirements are widely misunderstood. Only 32% of all systems surveyed met VIAQ performance requirements. Exhaust systems not integrated with central heating were more compliant than other systems.

Exhaust systems not integrated with central heating complied with the code 71% (10/14) of the time (all prescriptively). Only 60% of those also met the performance airflow targets of the code.

Only 29% (5/17) of the systems integrated with central heating systems complied with either the prescriptive or performance requirements of the code.

SUGGESTED REMEDIES:

Problems identified in this study can be addressed through homeowner education, improving code language and educating builders and building officials.

- Homeowners can be provided with information on how to adjust their systems and when to use automatic ventilation. Homeowners should be made aware of energy and health issues related to whole house ventilation systems. Information can be distributed through building departments, utilities, builders and others through a public outreach campaign directed at new homebuyers.

- Code language can be improved by providing clearer specifications for each system type. The study reveals that many installed systems are not described in the code. Often, components from several system types are mixed and matched. The code should be made simpler. By eliminating the two options that do not require automatic dampers for integrated systems, energy will be saved and the code will be simplified.

- Additional research is needed to determine the effectiveness of the fresh air inlets for exhaust systems. While this study indicates that the prescriptive exhaust ventilation systems are the least energy intensive to operate and the most frequently installed according to code, this study does not conclude that these systems perform as designed. Other recent studies may be applicable.

- New code language should require that user instructions be provided with the HVAC information. Homeowners should be instructed how to use ventilation systems to provide good IAQ and reduce energy waste. A label could be applied near system controls.

- Training can be provided to builders and code enforcers. New curricula can emphasize energy implications as well as health concerns.

- A new direction in marketing ultra (beyond code) energy efficient homes might be considered. Perhaps a "healthy home" rating system, similar to Energy Star, might raise consumer IAQ awareness.

References

1) WSBCC 1991. *Washington State Ventilation and Indoor Air Quality Code (1991 Edition)*, Chapter 51-13 WAC. Department of Community, Trade and Economic Development, Washington State Building Code Council, Olympia, Washington.

2) WSBCC 1994. *Washington State Ventilation and Indoor Air Quality Code (1994 Edition)*, Chapter 51-13 WAC. Department of Community, Trade and Economic Development, Washington State Building Code Council, Olympia, Washington.

3) WSBCC 1997. *Washington State Ventilation and Indoor Air Quality Code (1997 Edition)*, Chapter 51-13 WAC. Department of Community, Trade and Economic Development, Washington State Building Code Council, Olympia, Washington.

4) ASHRAE, 1989. ANSI/ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality. Atlanta, Georgia

5) Persily, 1998. A Modeling Study of Ventilation, IAQ and Energy Impacts of Residential Mechanical Ventilation, Andrew Persily, National Institute of Standards and Technology, Prepared for the Electric Power Research Institute.

6) Rudd, 1998. Design/Sizing Methodology and Economic Evaluation of Central-fan-Integrated Supply Ventilation Systems, Armin F. Rudd, FSEC for the ACEEE Summer Study In Buildings 1998.

7) Lubliner, Stevens, Davis 1997. Mechanical Ventilation in HUD-Code Manufactured Housing in the Pacific Northwest, Michael Lubliner, Washington State University Energy Program, Don T. Stevens, Stevens and Associates, Bob Davis, Ecotope ASHRAE Transactions.

8) Robertson 1999. Multi-Port Supply Wins Big in LBNL Ventilation Assessment, Judy Robertson, Lawrence Berkeley National Laboratory for June 1999 Energy Design Update.

APPENDIX I
A Short History of the Washington State VIAQ

The Model Conservation Standards: In the early 1980s, Congress adopted the Northwest Power Planning Act, which authorized the formation of the Northwest Power Planning Council. Among other things, the Act instructed the NWPPC to evaluate and help implement residential new construction energy conservation programs and codes where the avoided cost of conservation was shown to be less expensive than building new electric power plants. In 1983 the NWPPC adopted the Residential Model Conservation Standards (MCS) and with the support of the Bonneville Power Administration (BPA), regional private and public electric utilities, and state offices, the Pacific Northwest embarked on aggressive residential energy conservation research and demand side management efforts. The MCS focused on lost opportunities in new construction, showing that building the homes more efficiently was much more cost effective than weatherizing after the fact. Lost opportunities included improved windows, increased insulation levels, building envelope airtightness at less 0.1 ACH and heat recovery ventilators (HRVs). The NWPPC encouraged BPA to conduct research to demonstrate and determine this lost opportunity potential of the MCS, with the goal of improving energy codes.

The Residential Standards Demonstration Program (RSDP):
In 1984-85, State Energy Offices and BPA conducted the RSDP, in which over 300 homes were constructed to the MCS standards and monitored extensively for energy use, ventilation rates, house tightness and radon and formaldehyde concentrations. BPA planned to provide financial incentives to participants in RCDP but required an environmental impact statement (EIS) that focused on indoor air quality. The EIS found no significant impact on IAQ in MCS homes where mechanical ventilation systems were installed. These systems were required to have automatic controls and the capacity to provide at least 0.35 air changes per hour.

As a result of the RSDP research, BPA did the following:

- Provided options for non-heat recovery ventilation systems with a higher envelope ACH tightness target;
- Required radon monitoring and source mitigation in high radon areas;
- Continued to research innovative building air sealing and ventilation systems;
- Provided better information to occupants on IAQ and their ventilation systems;
- Focused on ductwork sealing details as well as the building envelope;
- Developed a prescriptive path for sizing ventilation system ductwork.

Residential Construction Demonstration Project Cycles 1-4: In 1986-1989 the RCDP program investigated other ventilation technologies including exhaust air water heater heat pumps, quiet exhaust fans w/passive air inlet vents and ventilation systems that utilized the furnace system. Improvements were made as a result of RCDP in all areas except occupant operation. Like RSDP, RCDP showed that typical occupant operation of the mechanical systems did not result in an average of 0.35 ACH. An interesting finding

was that most occupants were satisfied with their perception of IAQ at levels well below .35 ACH. RCDP research on multifamily systems suggested that apartment units were significantly tighter and may potentially have the highest levels of IAQ pollutants due to their higher occupancy levels, smaller volumes, less exposed surface areas, and significant inter-apartment leakage.

NORIS Phase 1 & 2: While RSDP and RCDP focused on new energy efficient construction, NORIS focused on the airtightness of typical new homes compared with MCS level homes. NORIS determined that many typical homes were indeed tight and that they also would require additional ventilation to ensure a minimum average seasonal ventilation rate of 0.35. The NORIS study of RCDP homes suggested that these homes could meet the 0.35 ACH ventilation rates if occupants were to operate their ventilation systems more frequently. Once again, the study found that most people were satisfied with their perception of IAQ well below 0.35 ACH. The study also suggested educational efforts might help occupants understand and operate ventilation systems. Quieter systems, better labeling, occupant instructions, and continuously operating control strategies were suggested as ways to improve operation. The study also called into question the effectiveness of passive air inlet vents in providing improved spatial ventilation effectiveness. Another finding was that ventilation systems that brought outside air into the building via the furnace blower used significantly more energy to provide ventilation than did the exhaust only systems.

Washington Ventilation and Indoor Air Quality Code: In its commitment to the MCS implementation using energy codes, BPA supported the adoption of the Washington State Energy Code (WSEC) for electrically heated homes and provided financial incentives for new WSEC homes built to the 1991 state energy code. Since BPA provided funding, they required that these homes have mechanical ventilation systems to satisfy their EIS. As a result, the State Building Code Council adopted the VIAQ requirements for whole house mechanical ventilation and radon mitigation efforts. In 1991, the VIAQ code was adopted to complement the energy code.

Washington State Energy Code Program

BPA contracted with the Washington State Energy Office (WSEO) to monitor energy and ventilation code compliance from 1992 until 1996. During this period, over 1200 single and multifamily residential structures were monitored for VIAQ compliance. Data collected indicates that homes equipped with ducted forced air heating systems scored significantly worse for VIAQ compliance than other homes. Observations in the field also indicated that enforcement of the required performance testing was ineffective. Some building departments required HVAC installers to provide paperwork documenting performance testing, but few, if any, consistently observed the testing process.

Concurrent with the code compliance monitoring study, a 1-800 hotline served to provide technical assistance to energy and ventilation code users. This service responded to over 500 inquiries related to the VIAQ between 1992-1997. The hotline tracking data indicated that a higher percentage of hotline inquiries were directly related to integrated

systems than to exhaust only systems. Homeowners complained that integrated systems caused the heat registers blow cold air.

APPENDIX II

Whole House Mechanical Ventilation Requirements

The provisions of the VIAQ allow a builder the choice of five "prescriptive" whole ventilation systems or any custom system that meets the "performance" requirements of the code. Other systems, including continuous ventilation systems are allowed, but are uncommon in practice.

The following is edited from the July 1997 Energy Code Examiner, a Washington State University publication funded by the Northwest Energy Efficiency Council.

Prescriptive Intermittent Exhaust System

The intermittent whole house exhaust system is the most common and the most easily understood ventilation strategy. *How it works:* A clock timer activates an exhaust fan. Fresh air is pulled through operable fresh air inlets located in habitable spaces. Fans and ducts are sized according to tables within the code. Fans are further restricted for noise (maximum 1.5 sone.) *Comments: This system relies on the timer to activate the quiet exhaust fan; theoretically, fresh air enters the home through the fresh air inlets. The exhaust fan must communicate with the fresh air inlets through door undercuts or other means. Installer problems with this system usually occur when the windows are purchased without considering the need for air inlets. Operationally, these systems are relatively quiet and more energy efficient than other systems.*

Prescriptive, Integrated with Forced Air Systems

The code describes requirements for three types of prescriptive Integrated-with-forced-air ventilation systems. These systems utilize the forced air heating system ducts to distribute the fresh air. They all include a fresh air intake duct connected to the return air plenum of the forced air distribution system. All three systems rely on specified intake air duct sizes and automatic controls. The only difference between the systems is how (and when) they control the fresh air intake. Of the three, only system 1 is purely “prescriptive” - descriptions of systems 2 and 3 both include field testing requirements.

1. **Integrated System - Automatic Damper**
   How it works: A timer controls an electric fresh air intake damper and the furnace blower. The blower pulls air past the open damper. *Comments: This system provides the occupant with the greatest control, since the system only adds fresh air when the timer opens the damper. This is the only integrated system without specific field testing requirements.*
2. **Integrated System - Set Damper**
   How it works: A timer controls the furnace blower. The blower pulls air past the damper which has been set to meet specified flow rates. A flow test is required to properly set the damper. Calculations are required to ensure the flow rate will result in .35 to .5 air changes per hour. *Comments: This system provides fresh air whenever the furnace blower is on. On very cold days, these systems may result in cold drafts, even with the timer shut off. Word on the street is that when HVAC contractors get complaints about inadequate heat, they shut the damper. Ideally, the contractor will instruct the homeowner as to the proper damper setpoint, prior to closing it.*
3. **Integrated System - Automatic Flow Device**

How it works: A timer controls the furnace blower. An automatic flow device regulates airflow (cfm) by reacting to pressure changes - as pressure increases, the device constricts to deliver a specified flow. The devices can deliver consistent flow rates at the typical pressures created with residential forced air systems. Testing is not critical if the device is installed within 4 feet of the air handler, as required in Section 303.1.2. Calculations are required to ensure flow will result in .35 to .5 air changes per hour. Fresh air intake ducts are sized per Table 3-5. *Comments: The code doesn't require it, but these systems would be a lot more occupant friendly if a shut-off damper was installed in the fresh air duct.*

Prescriptive Heat Recovery Ventilation Systems:

How it works: A timer controls the heat recovery ventilator (HRV). The unit must be capable of meeting minimum fresh air requirements, but there is no maximum limit. *Comments: These systems, like the others, must be able to distribute air to all habitable spaces. This can be accomplished by integrating the HRV with the ducted heating system, by installing through the wall HRV units throughout home, or with a dedicated HRV duct system. These systems are rarely installed, probably due to cost.*

Intermittent Performance Systems

Most intermittent whole house "Performance systems" are little more than slight variations of the Prescriptive Systems. The important distinction is that they should all be field tested to ensure they deliver the required airflow. The systems must not be loud (sone requirements for exhaust fans apply) nor should they energize energy consuming appliances. The systems must distribute fresh air to all habitable spaces. Installers of these systems are not required to follow the duct sizing requirements, but the system must have an automatic control.

APPENDIX III

Telephone Survey Results & Analysis

1. How important or unimportant do you think getting fresh air into houses is?

VERY IMPORTANT	187	79.6%
SOMEWHAT IMPORTANT	43	18.3%
SOMEWHAT UNIMPORTANT	3	1.3%
DON'T KNOW	2	0.9%
REFUSED		

2. Why do you think it is important to get fresh air into houses?

General Health	50
Specific Ailments	11
Stale air/odors	44
Germs/colds/flu	9
Mold/mildew	7
Radon	5
Tight house	8
Outgassing/chemicals/fumes	24

Analysis: This was an open-ended question designed to expose the general public's concerns about indoor air quality. The answers received ranged from humorous (so we won't suffocate) to the to the obvious (it's healthier). The majority of the responses reflected concerns about health in general, and some were related to specific health problems of the occupant, such as allergies or asthma. Many participants simply cited odor issues (stale air, cat smells); others were concerned about unhealthy contaminants (radon, CO2). The table lists a count of times certain comments and phrases were used by 224 survey participants. (See Appendix IV for the complete list of comments.)

Now I am going to read a list of ways people get fresh air into their houses.

3. Please tell me, on average, how many days per month do you open the windows and doors in your house during warm weather months?

Days	Count	Percent	Cumulative	**Days**	Count	Percent	Cumulative
0	3	1.3	1.3	**12**	2	0.9	9.9
1	1	0.4	1.7	**15**	8	3.4	13.4
2	1	0.4	2.2	**20**	20	8.6	22.0
3	1	0.4	2.6	**22**	1	.04	22.4
4	2	0.9	3.4	**24**	1	0.4	22.8
5	6	2.6	6.0	**25**	13	5.6	28.4
6	3	1.3	7.3	**28**	2	0.9	29.3
7	1	0.4	7.8	**30**	112	48.3	77.6
10	3	1.3	9.1	**31**	52	22.4	100.0

Analysis: *This table shows that over 90% of the households surveyed say they open windows 15 or more days during each warm weather month.*

4. On average, how many days per month do you open the windows and doors in your house during the cold weather months?

Days	Count	Percent	Cumulative	**Days**	Count	Percent	Cumulative
0	61	26.0	26.0	**8**	3	1.3	68.8
1	17	7.2	33.2	**10**	15	6.4	75.2
2	31	13.2	46.4	**15**	16	6.8	82.1
3	14	6.0	52.4	**20**	1	0.4	82.5
4	14	6.0	58.4	**25**	3	1.3	83.8
5	16	6.8	65.3	**30**	26	11.1	94.9
6	1	0.4	65.7	**31**	12	5.1	100.0
7	4	1.7	67.4				

Analysis: *This table shows that 17.9% of the households surveyed say they open windows 15 or more days during each cold weather month. One household (of 235) did not know how often they open windows or doors for fresh air.*

5. On average, how many days per month do you turn on an exhaust fan?

Days	Count	Percent	Cumulative %	**Days**	Count	Percent	Cumulative %
0	37	16.7	15.9	**12**	5	2.1	30.2
1	5	2.1	18.0	**13**	1	0.4	30.6
2	2	0.9	18.9	**14**	1	0.4	31.0
3	4	1.7	20.7	**15**	11	4.7	35.7
4	2	0.9	21.6	**16**	1	0.4	36.1
5	1	0.4	22.0	**20**	10	4.3	40.5
6	7	3.0	25.0	**25**	2	0.9	41.4
7	2	0.9	25.9	**30**	90	38.5	80.2
8	1	0.4	26.3	**31**	46	19.8	100.0
10	4	1.7	28.0				

Analysis: *This table shows that more than half of the households surveyed say they operate exhaust fans 30 or more days a month. Three households (of 235) did not say how often they operate fans.*

6. Does your house have a ventilation system to bring in outside air?

Response	Number	Percentage
Don't Know	16	6.8
Yes	179	76.2
No	40	17.0

Analysis: *It is unlikely that 17% of those surveyed did not have ventilation systems. However, 23% of those surveyed also said they did not have a timer or other automatic control in response to question #10. It is possible, especially in the case of an integrated*

with forced air system, where all the elements of the system are in either the garage or the utility room, that the homeowner may be completely unaware his ventilation system. This question was asked to determine whether or not the occupant was aware of the ventilation system.

7. If you have forced air heat, does your furnace blower sometimes come on automatically, even when the heat or air conditioning is turned off?

Response	Number	Percentage
Don't Know	11	4.7
Yes	95	40.4
No	93	39.6
Not applicable to system	36	15.3

8. Do any exhaust fans in your home run continuously or come on automatically?

Response	Number	Percentage
Don't Know	2	0.9
Yes	152	64.7
No	80	34
Not applicable to system	1	0.4

9. Are there outdoor vents in some of the rooms in your home? These vents usually come through the wall or are part of the window frame.

Response	Number	Percentage
Don't Know	7	3.0
Yes	109	46.4
No	117	49.8
Not applicable to system	2	0.9

Analysis: The above three questions were designed to help determine the type of system. A code compliant integrated system would activate the furnace blower. Vents in walls and windows are indicative of an exhaust ventilation system. A comparison of this table to the previous table hints that about 18% of the homes may have hybrid systems.

10. Do you have a permanently mounted timer installed on or near your furnace, in your bathroom, or near your thermostat? (This device looks similar to a plug in lamp timer, but is permanently mounted.)

Response	Number	Percentage
Yes	180	76.6
No	55	23.4

Analysis: If we take the respondents response as fact, but assume the home meets code 23% live in homes with no system, or with continuous systems. A better assumption might be that some of the people surveyed do not know they have a control.

11. Where is it located in your home?

Furnace	Garage,base	Hallway	Bathroom	Near	Laundry	Other	unclear

	ment, or mechanical/ utility room			Thermostat		rooms	
57	20	26	32	7	12	13	4

12. Does you ventilation system run all of the time?

Response	Number	Percentage
Yes	56	23.8
No	169	71.9
Don't Know	5	2.1
Not applicable	5	2.1

Analysis: The response here is consistent with the response to question #10 about whether they have automatic controls.

13. Is your ventilation system working as well now as when you moved in?

Response	Number	Percentage
Yes	224	95
No	9	4
Don't Know	2	1

Analysis: Eight of the nine who said their system was not operating as well responded to the follow-up question "Why is it not working as well?" Three responded by saying they didn't have a system; one said it needed to be vacuumed; one put in a different timer; one said the timer went bad and they didn't repair it because they got enough fresh air; one said it was no longer coordinated with the furnace; and one said it was disconnected.

14. Has your ventilation system been repaired?

Response	Number	Percentage
Yes	15	6.6
No	219	97.3
Don't Know	1	.4

15. What part or parts needed repair?

Part needing Repair	Number
Fan	4
Timer	1
Other	3
Central Heat Related	7

Analysis: Of the fifteen that cited problems, probably only eight were related to the ventilation system.

Next, I'm going to read a list of ways people modify their ventilation systems. Please tell me if you have ever made this modification to your system.

16. Have you ever adjusted the system's timer to change the hours the system operates?

Response	Number	Percentage
Yes	137	58.3
No	96	40.9
Don't Know	2	0.9

17. How many times have you made the adjustment to your system? Would you say…

Response	Number	Percentage
1 time	37	27.2
2 to 4 times	62	45.6
5 to 7 times	16	11.9
8 to 10 times	6	4.4
More than 10 times	15	11.0

Analysis: Typically, these timer controlled systems should be adjusted after each power outage, which occur 2-4 times per year in all three surveyed counties.

18. Have you ever adjusted the fresh air intake damper near the furnace?

Response	Number	Percentage
Yes	6	2.6
No	195	83.0
Don't Know	3	1.3
Not Applicable	30	12.8
Refused	1	0.4

19. How many times have you made this adjustment to your system? Would you say . . .

Response	Number
Skipped	229
1 time	2
2 to 4 times	3
More than 10 times	1

Analysis: No homeowner literature was distributed that described adjustment to the fresh air intake damper for an integrated system. The response to questions #17 and #18 were expected, because a fairly sophisticated understanding of the equipment is necessary to identify this device. The small number of respondents said they adjusted this device reveals that most homeowners know little about their systems, or that the device is typically not installed.

20. Have you ever adjusted wall or window vents?

Response	Number	Percentage
Yes	53	22.6
No	131	55.7
Don't Know	2	0.9
Not applicable	49	20.9

21. How many times have you made this adjustment to your system? Would you say . . .

Response	Number
Skipped	182
1 time	5
2 to 4 times	28
5 to 7 times	7
8 to 10 times	3
More than 10 times	10

Analysis: In response to question nine, 109 people said they had wall or window vents. Here, we find out that on 53, or less than 50% of those who are aware of them, ever adjusted them. It may be that homeowners expect them to be in the correct position when they purchase the home.

22. Have you made any other adjustments or modifications to your ventilation system?

Response	Number
Yes	21
No	213
Don't Know	1

23. How many times have you made this adjustment to your system? Would you say . . .

Response	Number
Never	1
Skipped	214
1 time	13
2 to 4 times	5
8 to 10 times	1
More than 10 times	1

Analysis: A follow-up question to #22 was, "What was the adjustment or modification you made to your system?" Most of the respondents demonstrated they weren't clear in grasping what the surveyor meant by the question: seven said they installed new filters; four said they installed air conditioning; one said they adjusted the thermostat; and one added a ceiling circulation fan. Other respondents really did something about the system: one disconnected the system; four disabled the timer; one said they adjusted fan speed; and one added a screen to the intake vent.

24. Have you ever disconnected the timer?

Response	Number	Percentage
Yes	30	12.8
No	203	8.6
Don't Know	2	.09

Analysis: Most of the people who responded "yes" to this question may not have understood question # 22, which also gave them an opportunity to volunteer this

information. It is possible many of these 30 consider "disconnecting the timer" as turning the system off.

25. On average how many hours a day does your system run?

Response	Number	Percentage
Don't Know	13	-
Not at all	17	7.7
Less than 2 hours	64	28.8
2 to 4 hours	86	38.7
5 to 7 hours	24	10.8
8 to 10 hours	12	5.4
More than 10 hours	19	8.6

People sometimes have problems with their ventilation systems. For each problem please tell me how much of a problem it is for you or your family in this house.

26. **The first problem is. . . Your ventilation system causes drafts. Is this a severe problem, moderate problem, somewhat of a problem, or not a problem for you or your family in this house?**

Response	Number	Percentage
Don't Know	2	-
Severe problem	4	1.7
Moderate problem	11	4.7
Somewhat of a problem	16	6.9
Not a problem	202	86.7

27. **Does this problem limit how much you use your system?**

Response	Number	Percentage
Yes	12	38.7
No	19	61.3
Skipped	204	-

Analysis: Throughout code implementation projects, HVAC installers were rumored to block the fresh air intakes to limit callbacks due to this problem. This survey does not seem to corroborate the rumor that these systems typically cause drafts. Code monitoring did not reveal any intentionally blocked systems. Of those people who complained the system caused drafts, it is possible the systems provide too much outside air, or that registers are in locations that exacerbate the problem. Adjustments to the timer or to the intake volume control may solve this discomfort issue.

28. **The next problem is . . Your ventilation system is noisy. Is this a severe problem, moderate problem, somewhat of a problem, or not a problem for you or your family in this house?**

Response	Number	Percentage
Don't Know	1	-
Severe problem	7	3.0

Moderate problem	16	6.8
Somewhat of a problem	42	17.9
Not a problem	169	72.2

29. **Does this problem limit how much you use your system?**

Response	Number	Percentage
Yes	19	29.2
No	46	70.8
Skipped	170	

Analysis: While 28% of the respondents said noise was a problem, only about 9% claimed it was severe enough to effect their use of the system.

30. **The next problem is . . Your ventilation system wastes energy. Is this a severe problem, moderate problem, somewhat of a problem, or not a problem for you or your family in this house?**

Response	Number	Percentage
Don't Know	13	
Severe problem	1	0.5
Moderate problem	19	8.6
Somewhat of a problem	25	11.3
Not a problem	177	79.7

31. Does this problem limit how much you use your system?

Response	Number	Percentage
Yes	13	28.9
No	32	71.1
Skipped	190	

Analysis: Almost 20% of the respondents consider the balance between energy use and ventilation needs to be a problem, although only about 6% let it influence their use of their system.

32. **I would like to conclude this survey with some general questions about your home. Are you the first occupants of your home?**

Response	Number	Percentage
Yes	224	95.3
No	11	4.7

33. **Would you describe the air quality in your home as good, fair, or poor?**

Response	Number	Percentage
Don't Know	1	-
Good	190	81.2
Fair	42	17.9
Poor	2	0.9

34. If you were to build another house, would you choose to install the same ventilation system you currently have in your home?

Response	Number	Percentage
Don't Know	14	-
Refused	1	-
Yes	151	68.6
No	69	31.4

As part of this research, Washington State University is conducting a field survey on energy conservation and indoor air quality. The survey will take one to two hours and includes an air leakage test of your home. If you participate in this survey, you will receive a free energy analysis of your home and an analysis of your heating and ventilation systems. Information provided will include do-it-yourself projects and free materials for saving energy.

35. Would you like to participate in the field survey?

Response	Number	Percentage
Yes	138	59.0
No	96	41.0
Don't Know	1	-

SURVEY CROSS-TAB ANALYSIS

Some of the questions were cross-tabbed with other questions or imported data. Imported data included heating system type (forced air or other) and county of residence. Current county real estate records, felt to be accurate, provided this information.

- People who said the system wasn't working as well as new, or who had it previously repaired, used the system 3.26 hours per day. Those who thought the system was at least somewhat related to noise, drafts or wasted energy used it 2.78 hours. Those who thought the system caused severe noise, drafts, or energy waste used it 2.06 hours per day. The average for the survey is 3.4 hours per day.

- People with forced air heating systems said they used their ventilation systems an average of 3.28 hours per day. Those with other type of heat said 3.41 hours per day. However, people with forced air are inclined to want the same type of ventilation system again, 66.9% to 55.6%.

Cross-tab by County for selected questions

	Metro county, mild climate	Metro county, severe climate	Rural county, mild climate	All
USE of System (3.4 hour average)	%	%	%	%
Majority said they used system 2 -4 hours	35	35	42.3	36.6

Don't know how much they use	4.9	3.8	9.6	5.5
Not at all	5.8	8.8	7.7	7.2
Less than 2 hours	24.3	30	28.8	27.2
8 or more	19.4	8.8	7.7	13.2
Working as well as when new?				
Yes	96.1	96.3	92.3	95.3
No	2.9	2.5	7.7	
Don't know	1	1.2	0	
System been repaired?	6.8	7.5	3.8	6.4
Yes				
Drafts, noise or waste. . .				
Not a problem	57.3	57.5	57.7	57.5
A severe problem	4.9	2.5	7.7	
A least somewhat a problem	42.7	42.5	42.3	
Drafts not a problem or don't know				87
Noise not a problem or don't know				72.3
Energy waste not a problem or don't know				80.8
Install same system ?				
Yes				64.3
No				29.4
Air quality is				
GOOD				80.9
POOR				0.9

APPENDIX IV

Survey Responses to Open Ended Questions

Question: Why do you think it is important to get fresh air into houses?

1. WE LIVE IN THEM AND TOOK ALOT MEASURES FORVENTILATION BEFORE WE MOVED IN HEALTH
2. AVOID DISEASE
3. FRESH AIR IS GOOD. LIKE IT ALL THE TIME
4. TO GET RID OF DUST AND OTHER PARTICLES IN THE AIR
5. HEALTHY
6. IMPROVES THE AIR QUALITY OF EXCHANGE IN THE LUNGS, GETS RID OF TOXINS & LOWERS CO2 PORPORTION IN AIR; GENERALLY HEALTHIER
7. DON'T LIKE STALE AIR
8. ASHMA AND MAKES HOUSE SMELL AND FEEL CLEANER
9. HELP FILTER FUMES - KEEPS AIR CIRCULATING
10. BECAUSE WE BREATH OXYGEN
11. I LIKE IT
12. VENTILATION TO GET RID OF TOXIC FUMES
13. AIR IN THE HOUSE IS STALE PHEMALDYHYDES
14. HEALTH REASONS
15. GERMS AND BEST QUALITY OF BREATHING AND SLEEPING
16. R LIKES FRESH AIR.
17. BLOWS OUT THE OLD GERMS
18. GET THE STALE AIR RE-CIRCULATED
19. NOT SMELLING IMITIONS FROM OTHER THINGS IN THE HOUSE
20. HEALTH
21. GOOD HEALTH
22. CLEANS OUT AIR IN THE HOUSE GODD CIRCULATION AND FRESHNESS
23. R HAS ALERGIES.
24. HEALTH OF THE FAMILY
25. FOR EVERYBODY
26. QUALITY OF AIR
27. BECAUSE THE SAME AIR GOING AROUNG AND AROUND IS GOOD
28. SEEMS FRESHER WILL BE HEALTHIER BETTER HYGINE SMELLS CLEANER
29. SO IT DOESN'T STINK
30. AIR BECOMES STALE TAKES ON THE QUALITY OF OTHER THINGS
31. SO YOU DON'T GET SICK; GERM BUILDUP (COLD)
32. SO YOU DON'T GET SICK; GERM BUILDUP (COLD)
33. SHE HAS ALLERGY PROBLEMS
34. HEALTH
35. LIVE AND BREATHING
36. IMPT TO HAVE FRESH CLEAN AIR (ESP W/ NEW BABY)
37. GETS STAIL AND MUSTY
38. TO AVIOD LOW LEVELS OF OXYGEN
39. HIGH DUST & MOLD CONTENT - LOW AIR QUALITY
40. LIKE TO BREATH IT
41. GET RID OF THE BAD STUFF.
42. CLEAN AIR
43. FOR GOOD HEALTH
44. STALE AIR BUGS CREATED IN THERE BREATHING PROBLEMS
45. WITH ALL THE NEW MATERIALS (PLASTICS) OUT, WE NEED TO REPLACE THE INTERIOR AIR BECAUSE NEW CONSTRUCTION IS AIR TIGHT1
46. AIR IN HOUSE WILL GET STALE; DIRT SETTLES

47. TO PREVENT THE ACCUMILATIONS OF RADON CARBON MONOXIDE AND OTHER NOXIOUS GASSES
48. BETTER FOR THAN STALE AIR
49. TO ENSURE WE AREN'T BREATHING DUST CO2
50. BREATHING
51. TIGHTER SEAL SO THERE ISN'T AS MUCH LEAKAGE
52. HEALTHIER
53. WANTS TO BREATH FRESH AIR; ALSO, SO THE CARPETS DON'T GET STAINED
54. HEALTH
55. EASIER TO BREATH; LESS DUST, MITES, COLDS; HEALTHIER
56. HEALTHIER
57. CIRCULATES AND KEEPS FRESH SMELL AND OXYGEN IS VITAL TO OUR EXISTENCE
58. RENEWS THE STALENESS FEELS GOOD
59. DONT KNOW
60. SMELLS BETTER THAN CAT
61. FOR CIRCULATION AND TO MAKE THE HOUSE SMELL GOOD.
62. IT HELPS KILL GERMS, KEEPS DOG & CAT ODORS DOWN. KEEPS YOU HEALTHY.
63. THE MOLD AND BACTERIA CAN GET INTO HOUSE. HELP PREVENT COLDS
64. ALLERGIES & AIR QUALITY
65. TO KEEP THINGS RECIRCULATING AND NOT HAVE STALE STUFF
66. JUST TO GET RID OF RADON AND ANY OTHER BAD THING THAT IS IN THE HOUSE
67. IT'S A MATTER OF KEEPING CARBON DIOXIDE AND CARBON MONOXIDE OUT. KEEP CHEMICALS OUT
68. HEALTH ISSUE, IF YOU DONT YOU CAN HAVE ORDERS AND HUMIDITY BULIDUP.
69. BETTER THAN STAGNANT AIR, CIRCULATION IS GGOD
70. BECAUSE YOU NEVER WANT TO BREATH STALE AIR
71. NEED THE OXYGEN. ELDERLY PEOPLE NEED A LOT OF OXYGEN. IT INCREASES THE OXYGEN. SHE IS VERY ACTIVE
72. FOR HEALTH
73. IT IS GOOD FOR YOUR HEALTH
74. BECAUSE OF ALL THE CHEMICALS IN MATERIALS ARE PURGED OUT BY FRESH AIR. NEED FRESH AIR TO GET OUT STALE AIR
75. HEALTH
76. HEALTH REASONS (MOSTLY) ALSO TO RELEASE FUMES FROM HOUSE
77. HEALTH REASONS
78. STAGNANT AIR ISN'T GOOD FOR A PERSON
79. EASIER TO BREATH AND LESS DUST
80. BECAUSE WE BREATH IT
81. I REQUIRE A LOT OF FRESH AIR FOR ALLERGY REASONS AND FOR CLEANLINESS
82. FOR HEALTH
83. STAGNANT AIR IS NO GOOD
84. KEEPS AIR QUALITY IN HOUSE BETTER. BASIC HEALTH REASONS
85. MAKES IT SMELL CLEANER, GETS RID OF GERMS IN THE HOUSE
86. BECAUSE OF CHEMICALS INSIDE OF HOUSE
87. BREATHING GET STALE AIR OUT
88. TO GET ALL OF THE HOUSHOLD FUMES OUT OF THE HOUSE.
89. FOR GENERAL HEALTH OF THE OCCUPANTS
90. FOR HEALTH REASONS TO STAY HEALTHY TO GET FRESH AIR
91. AIR ISN'T STALE, ALSO FRESHER SMELL IN HOUSE, HEALTHIER
92. FOR HEALTH REASONS
93. BECAUSE YOU FEEL BETTER WHEN YOU GET FRESH AIR

94. JUST, PLEASURE OF BREATHING
95. FOR CLEANNESS
96. HEALTHIER
97. GOOD TO CIRCULATE OUTDOOR AIR INTO INSIDE. FIRMLY BELIEVE IN AIRING OUT HOUSE. GETS GERMS OUT
98. NEED A HOUSE BREEZE TO AVOID MILDEW AND MOLD
99. A SO YOU CAN BREATH WELL
100. IT KEEPS YOU FROM GETTING COLD OR FLU FROM AIR BEING STAGNANT
101. USE NATURAL GAS, RADON PROBLEMS.
102. WHEN ONE GOES IN AND OUT OF YOUR HOUSE IT HELPS WITH AIR QUALITY. I BELIEVE THIS IS GOOD ENOUGH WHEN YOU GO IN AND OUT SEVERAL TIMES A DAY.
103. KEEPS AIR FLOW KEEPS THE AIR QUALITY BETTER, NO STANGNANT AIR GET FRESH AIR
104. HEALTHY
105. TO CIRCULATE AND GET OUT STALE AIR
106. HEALTH
107. MOVE OUT THE SICK STUFF; GET IT FILTERED THROUGH
108. TO AIR RE-CIRCULATED
109. TURN THE AIR OVER NICE TO HAVE FRESH SMELL
110. SUFFICATION POSSIBLE
111. FOR HEALTH REASONS
112. BECAUSE OF FIBERS AND DIFFERANT STUFF IN NEW HOME
113. BECAUSE WE BREATH AIR
114. BETTER FOR HEALTH, BREATH BETTER, FRESH AIR
115. LIKE TO BREATHE FRESH AIR, KEEPS YOU HEATLTHY
116. THE HOUSES NOW DAYS ARE BUILT SO TIGHT THAT THEY NEED FRESH AIR BROUGHT IN TO KEEP FROM SWEATING AND DRY ROT
117. GET STATIC ELECTRICTY IN HOUSE AND GET FRESH AIR IN HOUSE
118. BECAUSE THERE ARE THING THAT MAKES THE AIR STUFFY
119. BECAUSE OF RADON AND OTHER AIR BORN MATERIALS
120. SO IT DOESN'T STALE, NO ALERGY ATTACKS.
121. MORE HEALTHY
122. OXYGEN LEVEL, MAKES A HEALTHER CLIMATE INSIDE THE HOUSE
123. OXYGEN IN IT
124. NEED AIR CHANGES
125. FOR THE SMELL ESPECIALLY IN THE BEDROOMS AND FOR THE AIR QUALITY
126. NEED AIR CIRCULATION
127. CIRCULATE OLD AIR OUT
128. ASTHECALLY IS NICER, FRESHER SMELLING, CIRCULATION FLOW MAKES NICER AIR QUALITY LESS PARTICULATES
129. FRESH AIR
130. DIFFERENT CHEMICALS IN AIR
131. FOR GENERAL HEALTH
132. SO YOU ARE NOT BREATHING BAD AIR
133. HEALTHY
134. TO KEEP THE HOUSE FRESH AND VENTILATION CODE
135. STALE AIR TRAPS ALOT OF THINGS
136. HEALTH REASONS
137. BREATHING FRESH AIR
138. YOUR IN THE HOUSE WHILE YOUR BODYS RESTING AND YOU NEED FRESH AIR TO REJUVINATE DURING THE SLEEPING HOURS
139. SO WE STAY HEALTHY.
140. SMELLS BETTER HEALTHY

141. BECAUSE OUR HOUSES ARE THE POLLUTED PLACES WE CAN BE IN YOU DUST AND STUFF OUT OF THE HOUSE,
142. THIS PARTICULAR HOUSE IS AN AIRTIGHT HOUSE AND IT'S GOOD BECAUSE IT HAS FRESH AIR.
143. FOR BETTER BREATHING
144. HEALTH AND COMBUSTION
145. GOOD HEALTH AND A PERSON IN HOUSE HAS LUNG PROBLEMS
146. BECAUSE SOME OF THE HOUSES GET STAGNENT SMELLS AND RADON GASES
147. EVERYTHING IN IT GIVES OFF FUMES THE AIR EXCHANGE HELPS OUT THE BUILDINGS MATERIALS
148. CLEAN OUT THE BAD AIR
149. DILLUTE THE IN HOUSE CONTANIMENTS AND RADON.
150. TO CIRCULATE
151. RADON AND STALE AIR IS BAD FOR YOU.
152. FOR THE HEALTH OF THE PEOPLE WHO LIVE THERE
153. TO GET TOXIC FUMES OUT.
154. NO SCIENTIFIC REASON JUST LIKE FRESH AIR
155. DON'T WANT TO BREATH BAD AIR
156. SO YOU CAN BREATH
157. HELP GET CLEAN IN TO YOUR BODY
158. TO MINIMIMIZE INDOOR AIR POLLUTION
159. HEALTH
160. BECAUSE IT REMOVES FUMES. PROVIDES FRESH OXYGEN.
161. GENERAL HEALTH
162. AIR QUALITY
163. LIVE IN A HOME THAT IS INSULATED TIGHTLY GAS BURNING APPLIANCES
164. THE WAY THE HOUSES ARE BUILT NOW THEY ARE SO TIGHT THAT YOU NEED TO GET AIR TO CIRCULATE THE WALLS ARE REALLY TIGHT
165. IMPORTANT CUZ I LIKE THE SMELL OF IT, ITS STALE IF YOU DONT LET SOME FRESH AIR
166. FOR THE KIDS SAKE
167. CLEAR OUT STAGNANT AIR, MORE HEALTHY
168. FOR HEALTH REASONS
169. DONT LIKE THE MUSTY COOPED U-P FEELING FRESH AIR SMELLS GOOD
170. SO IT IS NOT SO STUFFY....I WOULD NOT WANT TO BREATH BAD AIR
171. JUST MAKES IT SMELL BETTER DOESNT FEEL SO STALE
172. TO BE HEALTHIER
173. CHEMICALS IN NEW CONSTRUCTION FROM CARPET PAINTS & WOOD
174. TO GET RID OF STALE AIR AND GERMS
175. HEALTH
176. W/OUT SOME AIR IT WOULD GET STALE
177. NATURAL RESPONSE
178. BETTER AIR QUALITY; HEALTHIER
179. HEALTH REASONS ACCUMULATION STAGNANT AIR PETS
180. KEEP THE CO2 DOWN
181. AIR QUALITY; AVOID STAGNANT AIR
182. AIR IN HOUSE GETS STALE
183. MAKE PEOPLE FEEL BETTER.
184. DON' KNOW; IT IS JUST IMPORTANT
185. DON'T KNOW
186. STALE AIR IS UNHEALTHY
187. STAGNANT AIR SMELLS AND TASTES BAD
188. HELPS WITH KIDS ALLERGIES

189. HOUSES GET STALE GET MILDEW WE ALL HAVE ALLERGIES. ELIMINATES PET ODORS AND DUST FROM SHEET ROCK
190. LIKE IDEA OF BREATHING FRESH AIR NEW CODES SEAL HOUSES VERY TIGHT SO YOU MUST RECYCLE STALE AIR
191. GET OLD AIR OUT
192. THE AIR IN THE HOUSE WILL NOT CIRCULATE & ANY CONTAMINANTS WILL NOT GET OUT.
193. OUT GASING OF THE MATERIALS TO BUILD THE HOUSE
194. BIGGER BUILD UP OF GERMS
195. FRESH BEATS STALE
196. NEW HOMES DO NOT VENT AS WELL AS OLDER HOMES BECAUSE OF THE GOOD SEAL
197. TO GET FRESH OXIGEN
198. LIKE FRESH AIR
199. WORK IN MEDICAL FIELD RECYCLED AIR IS NOT GOOD FOR LUNGS; UNHEALTHY AIR IS NOT GOOD MEDICALLY.
200. TO BE ABLE TO BREATHE BETTER AND GET THE DUST OUT. WHEN YOU OPEN TWO WINDOWS IT GOES RIGHT THROUGH.
201. AIR QUALITY EVACUATION OF VAPOR AND MOISTURE SMELLS,
202. IT TAKES AWAY ODORS IN HOUSE AND HEALTH
203. THINK AIR CAN GO STALE
204. LIKE FRESH AIR AND NEED GOOD AIR BECAUSE OIF ALERGYS
205. HEALTH REASONS
206. THINKS THAT IT HELPS GETS TOXIC FUMES OUT OF HOUSES.
207. SMELLS BETTER--HIGHER QUALITY
208. TO EXCHANGE AIR
209. MORE HEALTHY
210. LONG TERM ENVIROMENTAL EFFECTS
211. FOR HEALTH QUALITY
212. SO IT IS NOT STINKY, RATHER HEALTHY
213. VENTILATION; AIR FLOW; STUFFIENESS
214. HEALTH REASONS; LIKES FRESH AIR
215. HEALTH CONCERN, CARPETS AND WALLS ARE OUTGASING AND FRESH AIR GETS THIS OUT
216. MOSTLY BECAUSE WHAT HOUSES ARE BUILT WITH THESE DAYS FOR CIRCULATION
217. DEPEND ON IT TO LIVE I BREATH IT
218. BETTER HEALTH REASONS TO HAVE GOOD AIR QUALITY
219. MAINLY TO AIR THE PLACE OUT
220. BECAUSE OF ASBESTOS SCARE WITH NEW CARPET AND PAINT IS HEALTHIER TO BREATHE FRESH AIR
221. HEATH WISE
222. R DOES AIR AND HEATING SYSTEM INSTALLS FOR A LIVING SO R KNOWS THE VALUE OF THEM.
223. KEEP MOLD DOWN & CIRCLATION
224. AIR QUALITY, PREFER BREATHING FRESH AIR

Question: Where is the ventilation system timer located in your house?

1. KITCHEN
2. IN THE HALLWAY
3. IN THE GARAGE
4. IN THE BATHROOM
5. CENTRAL HALL
6. BATHROOM
7. IN LIVING ROOM AND IN HALLWAY UPSTAIRS

8. BATHROOM
9. IN BATHROOM UPSTAIRS
10. IN GARAGE
11. BATHROOM
12. GARAGE
13. BETWEEN THE KITCHEN AND THE BATHROOM
14. IN THE HALLWAY
15. MAIN HALLWAY BETWEEN LIVING ROOM AND FAMILY ROOM
16. IN GARAGE
17. BATHROOM
18. IN THE HALL BY THE THERMOSTAT
19. ON THE FURANCE
20. THERMOSTAT AND FURNACE
21. BY THERMOSTATE
22. IN GARAGE
23. DINING ROOM
24. MASTER BATH
25. THERMOSTAT- IN THE HALL
26. BY FURNACE IN GARAGE
27. CLOSET
28. THERMOSTAT
29. BATHROOMS
30. IN HALLWAY
31. NEXT TO FURNACE
32. FURNACE
33. LAUNDRY ROOM
34. GARAGE
35. DINING ROOM LIVING ROOM AREA
36. IN FURNACE
37. SMALL BATHROOM CENTRALLY LOCATED
38. BATHROOM ON MAIN FLOOR
39. IN THE LAUNDRY ROOM
40. NEAR THE FURNACE IN THE GARAGE
41. FURNACE
42. THE FURNACE
43. FURNACE
44. ON THE FURNACE GARAGE
45. ON THE FURNACE
46. ONE OF THE UPSTAIRS BATHROOMS
47. FURNACE IN THE GARAGE
48. FURNACE
49. BATHROOM
50. IN THE HALLWAY
51. IN BATHROOM
52. DINNING ROOM
53. THE FURNANCE
54. OUTSIDE THE MASTER BEDROOM
55. HAS A TIMER (WALL MOUNTED THAT RUNS A FAN)_ IN THE LAUNDRY ROOM.
56. IN THE BATHROOM
57. 2ND FLOOR IN BATHROOM
58. IN A CLOSET IN THE HALL
59. IN THE HALL WAY IN LIVING ROOM
60. IN THE UTILITY AREA IN GARAGE
61. BATHROOM
62. ONE BY THERMOSTAT, ONE BY HEATER

63. IN THE GARAGE
64. IN THE HALL
65. IN THE HALL
66. HALL WAY
67. IN EVERY ROOM
68. BY FURNACE
69. BY THE FURNACE
70. ON THE FURNACE
71. IN LIVING ROOM AND BATHROOM CLOSET
72. THERMOSTAT
73. MAIN HALLWAY
74. IN THE HALLWAY
75. BY THE FURNACE
76. ONE IN EACH BATHROOM & ONE IN THE MAIN PART OF HOUSE
77. BATHROOM
78. NEAR FURNACE IN BASEMENT
79. ON THE FURNACE
80. MASTER BATH
81. BASEMENT
82. FURNACE ROOM
83. IN FRONT ROOM
84. DOWNSTAIRS, LIVING ROOM
85. FURNACE
86. ON THE MAIN FLOOR
87. FURNACE ROOM
88. RIGHT NEXT TO FURNACE
89. IN BATHROOM/WASHROOM
90. BY FURNACE
91. NEAR THE FURENCE.
92. IN ATTIC AND IN MECHANICAL ROOM
93. NEAR THE FURNACE
94. IN THE LAUNDRY ROOM
95. NEAR THE FURNACE
96. WITH WALL SWITCH
97. DOWNSTAIRS
98. MECHANICAL ROOM
99. THE FURANCE ROOM
100. LAUNDRY ROOM
101. BASEMENT BATHROOM
102. IN THE LAUNDRY ROOM
103. BASEMENT
104. THE FURNACE; THE BASEMENT
105. NEXT TO FURNACE
106. NEAR THE FURNCE
107. BY THE FURNACE.
108. LAUNDRY ROOM
109. IN THE BATHROOM
110. BY THE FURNACE
111. FURNACE
112. ONE IN EACH BATHROOM
113. NEAR THE FURNACE
114. ON THE FURNACE
115. BATHROOM
116. NEAR FURNACE
117. FURNACE
118. BY THE FURNACE

119. PART OF THE THERMOSTAT.
120. BY THE FURNACE
121. UTILITY ROOM
122. IN THE UTILITY ROOM
123. IN THE BATHROOM
124. BY AIR CONDITIONING
125. BATHROOM
126. LIVING ROOM
127. NEAR THE FURNACE
128. ATTACHED TO THE FURNACE
129. FURNACE
130. FURNACE
131. IN THE LAUNDRY ROOM
132. FURNACE IN THE BASEMENT
133. IN BASEMENT
134. FURNACE ROOM
135. ON THE FURNACE
136. OUTSIDE ON HEATER
137. 0UTSIDE NEXT TO FURNACE OUTSIDE GARAGE DOOR
138. LIVING ROOM
139. MAIN FLOOR NEAR FAMILY ROOM
140. CLOSET IN THE MASTER BEDROOM
141. LAUNDRY ROOM
142. HALLWAY
143. NEAR THE THEROMSTAT
144. HALLWAY
145. IN GARAGE
146. IN THE BATHROOM
147. IN GARAGE
148. UPSTAIRS HALL
149. UPSTAIRS BY MASTER BEDROOM
150. IN LAUNDRY ROOM\
151. ON THE FURANCE
152. ON FURNACE
153. IN THE HALL
154. BY THE FURNACE
155. IN THE HALLWAY
156. IN THE LAUNDRY ROOM
157. LAUNDRY ROOM
158. GARAGE
159. IN THE SMALL BATH
160. HALLWAY
161. ON THE FURANCE
162. KITCHEN
163. THE UTILITY CLOSET
164. BATHROOM
165. NEAR THERMOSTAT
166. IN THE UTILITY ROOM
167. BATHROOM
168. FURNACE ROOM
169. FURNACE UTILITY ROOM
170. UPSTAIRS HALLWAY
171. BY THE THERMOSTAT
172. BATHROOM
173. THE BATHROOM
174. UPSTAIRS IN BEDROOM, NEAR BATHROOM

Question: Why is your ventilation system not working as well now as when you moved in?

1. DOES NOT HAVE A VENTILATION SYSTEM
2. WAY IT WAS INSTALLED BY BUILDER
3. PUT IN DIFFERENT TIMER
4. DOES NOT HAVE ONE
5. SHE DOESNT' HAVE ONE
6. IT NEEDS TO BE VACUMMED
7. IT IS NOT CORRDINATED - THE EXHAUST FAN HASN'T BEEN SET IN TIME WITH THE FURNACE BLOWER.
8. THE TIMER WENT BAD, MAKING A WIERD NOISE IN THE MOTOR UNIT THOUGHT THERE WAS ENOUGH AIR EXCHANGE
9. HIS IS THE WINDOWS; THEY WORK.... THEIRS IS THE FAN. THAT IS NOT HOOKED UP.

Question: What part or parts needed repair?

1. AIR FILTER, CLEANER
2. BLOWER MOTOR WENT OUT
3. THE AIR INTAKE INTO FURNACE HAD BECOME DISCONNECTED
4. THE FURNACE
5. ELECTRONIC COMPONENTS
6. DUCT WORK CHANGED TO GET MORE RETURNED AIR AND POSITION OF FURNACE CHANGED TO GET MORE AIR UPSTAIRS
7. LINE FOR THE FURNACE NEEDED CLEANING
8. A BLOWER MOTER
9. A VACUME THAT GETS CLOGGED WITH WHITE POWDER FROM DUCT WORK; R CAN DO IT HIMSELF

Question: Have you made any other modifications to your ventilation system?

1. JUST DISCONNECTED IT
2. INSTALLED AIR CONDITIONING DUST INHIBITOR
3. PURCHASED TWO AIR FILTERS
4. PUT IN AIR CONDITIONING
5. AIR FILTER CLEANER
6. GOT RID OF THE TIMER
7. ADJUST THE THERMOSTAT
8. DISABLING TIMER
9. REPLACING FILTERS
10. SCREEN OVER EXTERIOR VENT
11. SLOWED FAN DOWN AND SPED IT UP.
12. DISENGAGE THE TIMER
13. THE HEAT THE COMES OUT; THEY HAVE PUT FILTERS ON THE VENTS
14. WE UNHOOKED THE TIMER THAT AUTOMATICALLY BRINGS FRESH AIR IN
15. AIR CONDITIOING
16. ADDED AIR CONDITIONING
17. INTAKE IN HALL CEILING NO FILTER TOOK DOWN GRATE PUT FILTER BEHIND THE GRATE
18. CELING FAN HELPS CIRCULATE
19. HAS A COMBUSTION AIR FILTER NEAR FURNACE

Question: Do you have any additional comments?

1. PEOPLE DO NOT REALIZE THAT THE MATERIALS THEY USE HAVE AN EFFECT ON AIR QUALITY IN THE HOME. WAS INTERESTED IN THE NEW TRENDS COMPARED TO THE VENTILATION SYSTEM THEY USED WHEN THEY BUILT THEIR HOME. THEY TRIED TO AVOID PARTICLEBOARD DUE TO HINDERING AIR QUALITY.
2. R WISHES THAT R DID NOT HAVE TO PUT IN A SYSTEM BECAUSE OF REGULATIONS.
3. SHE FELT SHE DID NOT REALLY KNOW ABOUT THE SYSTEM TO REALLY ANSWER THE QUESTION BUT SHE HOPES IT HELPS
4. R HAS A CONCERN THAT HIS HOUSE IS TOO AIR TIGHT; IN CERTIAN
5. PARTS OF THE HOUSE, THE EDGES OF THE CARPET ARE STAINED
6. BLACK; HE HAS BEEN TOLD THAT THIS IS DUE TO AIR
7. EQUILIBRIATION DUE TO DIFFERENCES IN AIR PRESSURES BETWEEN
8. INDOOR AIR AND OUTSIDE AIR.
9. DRAFTS ARE CREATED THROUGHOUT THE HOUSE IT BLOWS REALLY COLD AIR THEY TURN THE SYSTEM OF ALL TOGETHER FOR THAT
10. REASON. THEIR NEW FIREPLACE DOES NOT VENT HE WONDERS IF THAT
11. AFFECTS AIR QUALITY. HE HAS CEMENT FLOORS UNDER THE CARPET
12. AND A WATER BUILDUP PROBLEM ON HIS WINDOWS. HIS DEHUMIDIFIER
13. TAKES AROUND TWO GALLONS OF WATER A DAY. HE WONDERS WHAT IS
14. THE PROBLEM, AND IF THE AIR IS GOOD.
15. SHE SAID SHE WAS GLAD THE LETTER WAS SENT BECAUSE SHE GETS A LOT OF PRANK CALLS AND SOLICITORS
16. WANTS PUBLIC REPORTS FROM SURVEY
17. IF THE SURVEY CAN RESULT IN NOT HAVING TO HAVE THE HOME VENTILATION SYSTEM THAT WOULD BE GREAT THEY ARE A WASTE OF MONEY AND ENEGRY.
18. WHEN THEY PUT IN THEIR FURNANCE FOUR YEARS AGO THE FURNANCE IS REQUIRED TO BE TESTED BUT THEY DO NOT TEST THE AIR VENTS USUALLY THE AIR VENTS ARE WHAT CAUSE THE PROBLEMS FOR PEOPLE WITH ATHSMA OR LUNG PROBLEMS.
19. IT WAS A VERY COMPRHENSIVE SURVEY AND I DIDN'T MIND DOING IT AT ALL
20. DURING THE WINTER AND SUMMER YOU ARE DRAWING UNCONDITIONED AIR INTO YOUR FURNACE. IT IS A WASTE OF ENERGY.
21. WANTED TO KNOW A LIL MORE ABOUT THE FIELD SURVEY
22. HAS A PROBLEM WITH VENTELATION SYSTEM ADVERSLY EFFECTS THE WOOD STOVE IN YOUR HOME
23. DOES NOT WANT TO DO FIELD SURVEY BECAUSE MOVING AT THE END OF THIS SCHOOL YEAR
24. NOT FILTERING THE AIR DOESN'T SEEM TO DO ANYTHING FILTERS DON'T DO THE JOB AIR IS NOT CLEAN ALLERGY PROBLEMS
25. SURVEY LACKED ON HEATING AND HEATING PROBLEMS
26. HER VENHILATION SYSTEM HAS BEEN AN ANNOYANCE; THIS SURVEY HAS MOTIVATED HER TO TAKE CARE OF THE PROBLEM
27. DRAFTS COLD AIR GETS SUCKED IN WASTING ALOT OF ENERGY.
28. FUN SURVEY