

# Customer Acceptance and Performance of Installed Mechanical Ventilation

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## SUMMARY

This report summarizes the general opinions on the effectiveness of mechanical ventilation in homes treated by the Wisconsin Weatherization Program as expressed by occupants of those homes. As a performance check, the installed ventilation was inspected and the air flow rate was measured in 45 homes. The homes included in this 2015-2016 study were selected to look at more recently completed homes back to homes completed up to 10 years ago.

## FINDINGS

Five key findings identified from the results of the research are summarized below.

**Installed mechanical ventilation satisfaction** – 85 percent (232) of the occupants who responded to the survey question indicated that they were satisfied or very satisfied with the installed ventilation. Fewer than 10 respondents expressed dissatisfaction with the equipment.

**Persistence of installed ventilation use** – 88 percent (279) of the occupants responding to the survey confirmed the installed ventilation was still operational and in use. The installed ventilation was either whole house ventilation or local exhaust.

**Impacts on home humidity** – 49 percent (135) of the survey respondents believe the installed ventilation positively impacts humidity levels during the winter.

**Impacts on indoor air quality** – 50 percent (138) of survey respondents felt the installed ventilation positively impacted indoor air quality.

**Persistence of installed ventilation operation** – The durability of installed fans is demonstrated by the fact that air flow performance is not reduced in correlation with the age of the system. However, fans not well maintained exhibit reductions in measured air flow. The fan flow rates for 37 installations were measured in the field. Of the installations measured, 35 percent (13) measured at more than 10 percent lower than the reported installation rate, 38 percent (14) measured at +/- 10 percent of the reported installation rate, and 27 percent (10) measured at more than 10 percent above the reported installation rate.

## BACKGROUND

The Wisconsin Weatherization Program has been evaluating the impact of mechanical ventilation in weatherized homes for the past 15 years. Analysis was completed of collected data on natural ventilation based on blower door tests, mechanical ventilation flow rates and incidence rates of installation. In addition, field research in weatherized homes that looked at the impact of installed ventilation was also completed. This continual evaluation of mechanical ventilation has allowed Wisconsin to enhance program procedures to effectively install mechanical ventilation. Those homes that will benefit from ventilation receive the measure which helps keep overall program costs lower.

During the winter of 2005-2006, the Wisconsin Weatherization Program<sup>1</sup> completed a field study on 31 weatherized homes. The purpose of this study was to gather information on the effectiveness of the mechanical ventilation installed in weatherized homes using the ASHRAE 62.2 – 2004 standard. Twenty-one homes had installed ventilation based on the ASHRAE 62.2-2004 standard for whole house ventilation. Four of these homes were connected to a timer as part of the study to enable a repeatable on/off schedule for the ventilation at time period of 100 hours. Six of the homes did not have ventilation installed that was called for by the ASHRAE 62.2 – 2004 standard. Measurements collected in each of the homes included humidity level, temperature, CO<sub>2</sub> levels, outdoor temperature, and furnace air handler run times.

A high level summary of the 05-06 study findings included the following:

- Homes were found to not have high humidity in the winter.
- Homes with ventilation were more likely to have low humidity during colder weather.
- Exhaust only ventilation alone may not have a significant impact on humidity.
- CO<sub>2</sub> levels were lower in homes with ventilation, but differences were not statistically significant and CO<sub>2</sub> may not work as a good indicator to determine actual ventilation rates.

As a result of the study, the Wisconsin Weatherization Program refined its policy from installing whole house ventilation in every home that called for at least 1 cfm to not installing whole house ventilation at rates called for of 15 cfm or lower. A second policy change was to use the actual occupant count in the calculations instead of bedrooms plus one.

A separate field study was completed during the winter of 2008-2009 by the Wisconsin Weatherization Program<sup>2</sup> during the winter of 2008-2009. The purpose of this study was to gather information on 32 weatherized homes about the impact of mechanical ventilation when repeatedly disabling and enabling the installed ventilation. Each of the study homes received an installation of ventilation based on the ASHRAE 62.2-2007 standard for whole house ventilation as part of the weatherization process. Through the study, a timer was connected to the electrical supply to enable a repeatable on/off schedule for the ventilation at time periods of 100 hours and later at 200 hours. Humidity, temperature and CO<sub>2</sub> levels were measured in each of the homes during each of the time periods.

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<sup>1</sup> *A Field Study of Ventilation in Wisconsin Weatherization Assistance Program Homes*

<sup>2</sup> *Impacts of Mechanical Ventilation in Wisconsin Weatherization Homes*

The high level findings of the 08-09 study included the following:

- Humidity and CO<sub>2</sub> levels both showed statistically significant declines when mechanical ventilation was operational.
- Impacts of installed mechanical ventilation were not as high in homes with higher natural ventilation per person.
- Poor indoor air quality (IAQ) when mechanical ventilation was not operational generally correlated with ASHRAE 62.2 factors.

As a result of the study, the Wisconsin Weatherization Program refined its policy of installing whole building ventilation in all homes where the calculated rate is higher than 15 cfm to not installing whole house ventilation if the natural ventilation was at 20 cfm or higher per person.

One area not formally evaluated previously relates to the longevity and durability of installed ventilation. Field research was typically completed on recently weatherized units at the time of the study. Additionally, customer opinions concerning the impact of ventilation on indoor air quality has been primarily anecdotal as comments received during field research or as part of the program's quality assurance process.

As a result, the Division of Energy, Housing and Community Resources (Division) funded a research project as part of the Weatherization Training and Technical Assistance operating plan to be implemented by Wisconsin Energy Conservation Corporation (WECC). The research plan was developed by the Division and WECC with input from the Technical Development Work Group (TDWG) members.

## **APPROACH**

The intent of the research was twofold. Initially, customer feedback would be collected from a significant number of customers to gain a general perspective on their perceptions of the effectiveness of installed ventilation without limiting it to specific parameters. This was accomplished through a telephone survey. Additionally, a field assessment was performed for subset of those customers completing the telephone survey. The purpose of the field assessment was to examine the condition, current flow rates, and operation of the installed mechanical ventilation equipment.

## **SURVEY CUSTOMER IDENTIFICATION PROCESS**

The scope of the research was to identify homes that had received mechanical ventilation and were still occupied by the same individuals. Identification of customers and houses with installed ventilation and the same occupant currently residing in the house resulted in the potential to contact just over 1,485 customers. The dates corresponding to the installation of mechanical ventilation ranged from January 2007 through June 2013. Prior to July 2012, all ventilation work was reported under the same measure name. To identify houses where a new fan was installed and eliminate houses where the work was only repair of an existing fan, a minimum cost of \$300 was used to reduce the list to 1,200 potential customers.

## **SURVEY PROCESS AND RESULTS**

A survey tool was developed to track and compile responses to the identified questions asked of the customers. (See Appendix A to view the Survey Questions.) Customers were contacted via phone by WECC and TDWG staff to obtain information concerning the impact of weatherization with a focus on the installed ventilation. An attempt was made to contact over 600 (50 percent)

of the 1,200 customers meeting the research criteria. Of the 356 customers successfully contacted, 28 (8 percent) declined participation in the survey and another 13 (4 percent) did not recall receiving weatherization.

A total of 315 customers completed the survey in whole or in part. Over 85 percent of the customers were satisfied or very satisfied with the weatherization services. Table 1 summarizes the responses provided by the customers.

**Table 1 – Customer Satisfaction with Weatherization Services**

Level of Satisfaction	Count	Percent	Combined Percent
<b>Very dissatisfied</b>	<b>13</b>	<b>4%</b>	<b>9%</b>
<b>Dissatisfied</b>	<b>15</b>	<b>5%</b>	
<b>Don't know</b>	5	1%	5%
<b>Neither</b>	13	4%	
<b>Satisfied</b>	<b>124</b>	<b>39%</b>	<b>86%</b>
<b>Very Satisfied</b>	<b>145</b>	<b>46%</b>	

A sampling of the general comments expressing satisfaction with the weatherization services provided can be found below:

- Client is very happy with all of the work completed.
- Homeowner is very satisfied with the weatherization work completed, including the ventilation system (bath fan) installed.
- Customer was happy with weatherization services and regularly uses ventilation equipment.
- Customer was very happy with the work that was done. Stated that when the bath fan runs you can't even hear it.
- Everyone was great to work with!
- Overall, the customer was satisfied with the changes made in the home.
- The customer has been very satisfied and everything is still working properly.
- Very happy with the weatherization service; professional work crews.
- Very satisfied with everything and noticed a huge difference in heating and electric bills
- Very satisfied with the work that was done. Grateful to have the window fixed that leaked all the time. Insulation is wonderful.

Only one comment was collected related to dissatisfaction with a ventilation measure.

After establishing the satisfaction level of the overall weatherization project, customers were surveyed specifically about the installed ventilation. The starting focus was to inquire as to whether or not the installed ventilation was operational. If the installed ventilation was reported as operational, the customer was asked if the ventilation was being used and how often it was being used. Over 88% (279) of the survey respondents indicated that the installed ventilation was still operational and was being utilized. Slightly over 55 percent (154) of the installed ventilation was reported as operational only when it was turned on indicating the installed ventilation was most likely intended to provide local exhaust. The effectiveness of the installed local exhaust is dependent on how often the customer turns it on. Another 34 percent (95) of customers stated the installed ventilation system operated either on an intermittent timed



schedule or continuously, indicating the installation of whole house ventilation. The remaining 10% of customers were unsure of the operational run times for the equipment.

Customers were then asked to identify their level of satisfaction with the installed ventilation if operational. Of the 279 customers who responded the ventilation was still operational, five did not fully complete the survey, leaving 274 responses remaining for this area. Overall 85% of customers were very satisfied or satisfied with the installed ventilation. Satisfaction levels closely tracked between weatherization services and installed ventilation. Table 2 summarizes the level of satisfaction of the installed ventilation.

**Table 2 – Customer Satisfaction with Installed Ventilation**

Level of Satisfaction	Count	Percent	Combined Percent
<b>Very dissatisfied</b>	<b>12</b>	<b>4.4%</b>	<b>7%</b>
<b>Dissatisfied</b>	<b>7</b>	<b>2.6%</b>	
<b>Neither</b>	23	8.4%	8%
<b>Satisfied</b>	<b>127</b>	<b>46.4%</b>	<b>85%</b>
<b>Very Satisfied</b>	<b>105</b>	<b>38.3%</b>	

Additional questions asked of the customers related to location of ventilation, type of control, and number of occupants did not result in any trends related to how customers perceived changes related to the installed ventilation.

To assess the impact of the installed ventilation, customers were asked a series of questions about comfort, air quality, humidity concerns, and noise levels.

### **Comfort Levels**

Customers were asked to identify general comfort levels in the home related to the installed ventilation. Table 3 and Table 4 summarize the responses concerning comfort in winter and in summer respectively. In both cases, more than 50 percent of the customers felt that the installed ventilation improved indoor comfort while between 35-40 percent felt there was no change. Perceived change closely tracked with weatherization satisfaction. It should be noted that some customers who were not satisfied with weatherization identified improvement in comfort levels. In houses with no perceived comfort change, conditions in the home may have been deemed ‘comfortable’ prior to weatherization. The non-ventilation related installed measures may influence the feeling of comfort more than that of the installed ventilation. Comments by customers stating ‘house is warmer’ or ‘less drafty’ tend to support insulation and air sealing as having a greater impact on comfort.

While perceived improvement in health was not collected from customers, comfort improvements identified by customers may also relate to changes in health conditions. This improvement to health may be attributable to the ability of ventilation to remove pollutants that may cause respiratory issues. Additional field research is needed to determine an actual correlation between improvements in health related to ventilation.

**Table 3 – Comfort Levels during Winter Months**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>1</b>	<b>.4%</b>	<b>3%</b>
<b>A Little Worse</b>	<b>8</b>	<b>2.9%</b>	
<b>No Difference</b>	98	35.8%	39%
<b>Not Sure</b>	10	3.6%	
<b>A Little Better</b>	<b>91</b>	<b>33.2%</b>	<b>57%</b>
<b>A Lot Better</b>	<b>66</b>	<b>24.1%</b>	

Customers were also asked to report use of air conditioning in their home. Nearly 90 percent of customers reported air conditioning use. With more homes ‘closed up’ even during the summer, whole building mechanical ventilation provides the air exchange not provided naturally through opening windows.

**Table 4 – Comfort Levels during Summer Months**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>0</b>	<b>0%</b>	<b>1%</b>
<b>A Little Worse</b>	<b>3</b>	<b>1.1%</b>	
<b>No Difference</b>	109	39.8%	42%
<b>Not Sure</b>	6	2.2%	
<b>A Little Better</b>	<b>95</b>	<b>34.7%</b>	<b>57%</b>
<b>A Lot Better</b>	<b>66</b>	<b>22.3%</b>	

### Humidity Levels

Humidity levels in the home related to the installed ventilation were investigated with customers. Table 5 and Table 6 summarize the responses related to perceived humidity levels in winter and summer. Similar to general comfort, nearly 50 percent of the customers felt that the installed ventilation improved humidity levels while between 40-45 percent reported no change. Perceived change closely tracked with weatherization satisfaction, although some customers who were not satisfied with weatherization reported improved humidity levels. In houses with no reported perceived change, humidity levels in the house may have been deemed acceptable prior to weatherization. The reduction in natural ventilation may have been offset by the installation of mechanical ventilation, keeping humidity levels acceptable with no perceived change. The largest impact on humidity level improvement is the installation of local exhaust to remove high levels of moisture especially in bathrooms during showers.

Customers often use dehumidifiers and humidifiers to control humidity levels in their houses. Responses from the survey indicated that overall 50 percent of houses run a dehumidifier with 12 percent also receiving continuous whole house ventilation. Overall 33 percent of survey respondents run a humidifier, with 6 percent also receiving continuous whole house ventilation.

**Table 5 – Winter Humidity Levels**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>1</b>	<b>.4%</b>	<b>4%</b>
<b>A Little Worse</b>	<b>9</b>	<b>3.3%</b>	
<b>No Difference</b>	115	42.0%	47%
<b>Not Sure</b>	14	5.1%	
<b>A Little Better</b>	<b>88</b>	<b>32.1%</b>	<b>49%</b>
<b>A Lot Better</b>	<b>47</b>	<b>17.2%</b>	

**Table 6 – Summer Humidity Levels**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>2</b>	<b>.7%</b>	<b>2%</b>
<b>A Little Worse</b>	<b>4</b>	<b>1.5%</b>	
<b>No Difference</b>	116	42.3%	46%
<b>Not Sure</b>	11	4.0%	
<b>A Little Better</b>	<b>93</b>	<b>33.9%</b>	<b>51%</b>
<b>A Lot Better</b>	<b>48</b>	<b>17.5%</b>	

### Indoor Air Quality

Customers were asked to report on general indoor air quality in the home as it related to the installed ventilation. Table 7 summarizes the responses concerning indoor air quality. Similar to humidity responses, nearly 50 percent of the customers reported the installed ventilation improved indoor air quality levels while between 40-45 percent felt there was no change. Perceived change closely tracked with weatherization satisfaction, although some customers who were not satisfied with weatherization felt indoor air quality did improve. In houses with no perceived change, indoor air quality in the house may have been acceptable prior to weatherization. The reduction in natural ventilation may have been offset by the installation of mechanical ventilation, keeping indoor air quality acceptable with no perceived change.

**Table 7 – Overall Indoor Air Quality**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>3</b>	<b>1.1%</b>	<b>3%</b>
<b>A Little Worse</b>	<b>4</b>	<b>1.5%</b>	
<b>No Difference</b>	119	43.4%	47%
<b>Not Sure</b>	10	3.6%	
<b>A Little Better</b>	<b>89</b>	<b>32.5%</b>	<b>50%</b>
<b>A Lot Better</b>	<b>49</b>	<b>17.9%</b>	

### Noise Levels

Finally, customers were asked about the noise levels in the home related to the installed ventilation. Table 8 summarizes the responses related to noise levels. Customers were asked to report any concerns about the additional noise created by operating fans. In homes with no perceived change, noise levels in the home may have been acceptable prior to weatherization.

**Table 8 – Noise Levels**

Perceived Change due to Installed Ventilation	Count	Percent	Combined Percent
<b>A Lot Worse</b>	<b>0</b>	<b>0%</b>	<b>4%</b>
<b>A Little Worse</b>	<b>12</b>	<b>4.4%</b>	
<b>No Difference</b>	175	63.9%	67%
<b>Not Sure</b>	8	2.9%	
<b>A Little Better</b>	<b>53</b>	<b>19.3%</b>	<b>29%</b>
<b>A Lot Better</b>	<b>26</b>	<b>9.5%</b>	

### CUSTOMER SURVEY CONCLUSIONS

The overall finding is that customers are satisfied with weatherization services and installed mechanical ventilation. The installed mechanical ventilation is perceived as improving conditions in the home for around 50% of the homes or at least maintaining current conditions for around 40% of the homes. Customers are generally satisfied with the performance of installed ventilation and are utilizing not only local exhaust but also whole house ventilation systems as installed.

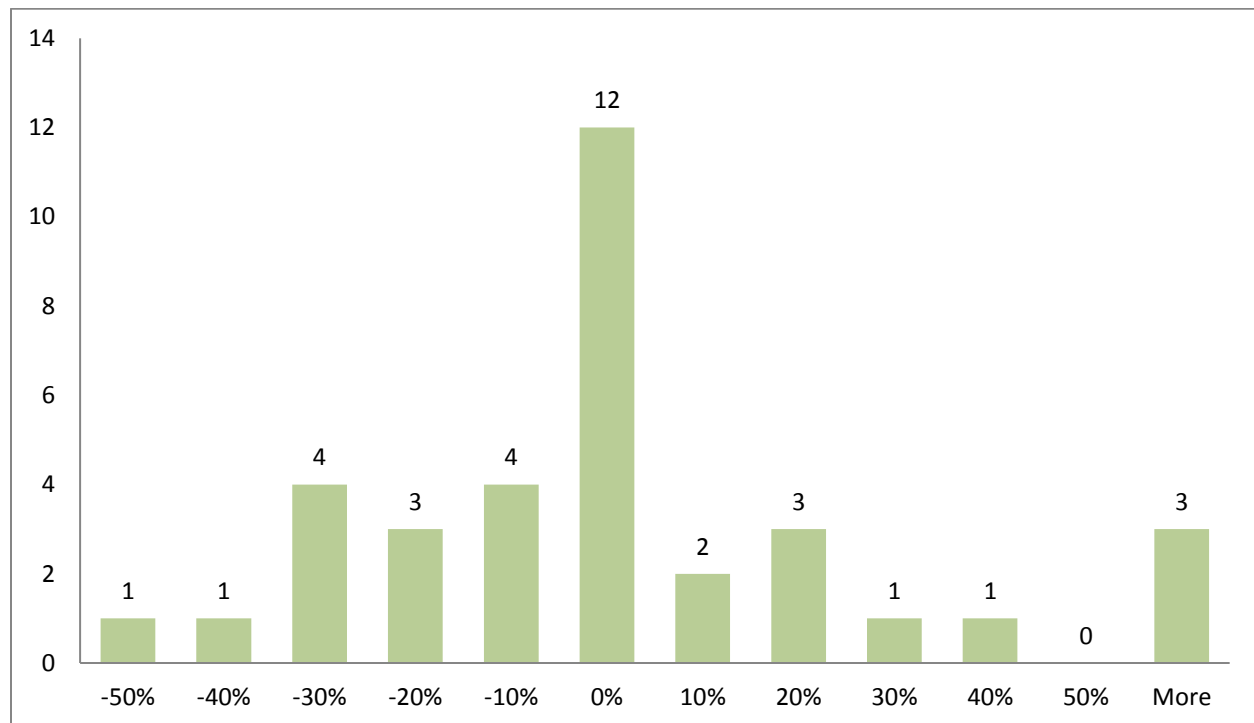
## FIELD ASSESSMENT PROCESS AND RESULTS

WECC and the Division, with input from the TDWG, developed the field assessment process. The TDWG members were tasked with completing the field data collection portion of the research. A goal of 5 site visits per TDWG member was set to reach a total of 40 completed field assessments. Houses were identified from the list of surveyed customers to be contacted for a field visit to inspect the installed ventilation. To obtain a wide variety of houses, installed systems, age of system, installed flow rates, and location of installed ventilation, no selection parameters were used in the identification of houses other than assuring that the occupant in residence during weatherization still occupied the home. Field assessment participants were randomly selected by each TDWG member from the list provided. Customers received two compact fluorescent and two LED bulbs for participating.

Key data points collected as part of the field research included measuring the ventilation air flow rate, performing a visual inspection of the ventilation equipment, and completing an assessment of the condition of the equipment. A total of 35 field assessments were completed during the spring of 2016 that allowed a comparison of measured flow rates.

The average change in flow rates was documented as an increase of .8 percent, which is influenced by the highest difference of +205 percent. Removing the highest flow rate as an outlier, the average change was a decrease in flow of 5.2 percent with a standard deviation of 28.7 percent. The distribution of the change in flow rates is shown in Figure 1. Table 9 identifies all measured flow rates, percent difference and the inspector reported condition of the fan.

**Figure 1 – Change in Flow Rates of Installed Ventilation**



**Table 9 – Measured Flow Rates of Installed Ventilation and Condition of Fan**

<b>Flow @ Install</b>	<b>Current Flow</b>	<b>% of Install.</b>	<b>Fan Condition</b> <i>(as reported by inspector)</i>
49	15	30.6%	Clean
32	17	53.1%	Good
53	33	62.3%	Dirty
34	22	64.7%	Good
80	52	65.0%	Dirty
64	43	67.2%	Good
35	25	71.4%	Fan greasy
67	52	77.6%	Clean
43	34	79.1%	Clean
130	105	80.8%	Dirty
44	36	81.8%	Very dirty
50	42	84.0%	Very dirty
59	53	89.8%	Clean
20	18	90.0%	Dirty
34	31	91.2%	Good
117	107	91.5%	Good
76	73	96.1%	Fair
70	68	97.1%	Fair
78	76	97.4%	Excellent/clean
40	39	97.5%	Very dirty
56	56	100.0%	Clean
48	48	100.0%	Dirty
30	30	100.0%	Dirty
50	50	100.0%	Dirty
30	30	100.0%	Good
39	42	108%	Good
34	37	109%	OK/Needs cleaning
40	45	113%	Good
48	54	113%	Good
30	35	117%	Dirty/Cleaned grill
86	104	121%	Good
30	40	133%	Good/Cleaned grill
19	29	153%	Clean
28	53	189%	Dirty
19	58	305%	Good

The condition of the fan did not clearly correlate with current measured fan flow; however, very dirty fans tended to have lower flow rates. Not all customers are cleaning the fans.



TDWG members reported that the ducting installed for the fans to vent to the outdoors was observed to be durable and still highly functional.



Concerning the durability of installed ventilation, fans installed in early years were performing as well currently as at the time of installation. No correlation was observed to document the decrease in flow rates of older fans over time. Table 10 illustrates the current measured flow rate for fans as compared the installation date.

**Table 10 – Installation Dates and Change in Measured Flow Rates**

Date of Install	% of install flow	Date of Install	% of install flow
6/15/2007	79%	5/5/2011	65%
5/12/2008	133%	8/16/2011	90%
5/30/2008	189%	8/31/2011	97%
3/27/2009	78%	9/27/2011	90%
4/28/2009	71%	10/3/2011	65%
6/8/2009	98%	10/5/2011	82%
11/30/2009	153%	10/18/2011	113%
3/5/2010	113%	10/26/2011	109%
5/13/2010	96%	3/26/2012	100%
5/26/2010	108%	3/27/2012	121%
6/30/2010	91%	6/6/2012	62%
8/6/2010	0%	6/6/2012	100%
10/20/2010	91%	10/26/2012	100%
10/21/2010	305%	1/24/2013	31%
1/3/2011	53%	3/25/2013	84%
1/11/2011	67%	4/23/2013	81%
3/22/2011	100%	5/17/2013	97%
		6/27/2013	117%

## **FIELD ASSESSMENT CONCLUSIONS**

A common observation of installed fans is equipment can and will get dirty. As the fan gets dirtier, flow rates tend to decrease. Customers may need more information and instructions on how to clean the fans. No degradation of fan flow was attributable to the age of ventilation equipment. The evidence shows that the equipment installed is of high quality and will last for a long period of time.



## APPENDIX A – SURVEY QUESTIONS

1 - Hi, I'm {your name} calling from {WX Agency Name}. We're conducting a short follow-up survey regarding weatherization services that our records show you received in {month/year}. This should take only a few minutes of your time. Do you have a few minutes now to answer my questions?

>>>If yes, continue with the survey. If no, schedule a time to call back and close survey.

2. Ok, I have just a few questions about the services you received from our agency. Do you recall receiving weatherization services from {WX Agency Name} in {month/year}?

- Yes
- No
- Not sure

>>> If yes, go to #4

3. Is there someone else I could speak with who might be familiar with those services?

- Yes
- No
- Not sure

>>>If no or not sure, go to #22

>>>If yes Ask to speak to the person and then reintroduce the survey: Hi, I'm {your name} calling from {WX Agency Name}. We're conducting a short follow-up survey regarding weatherization services that our records show you received in {month/year}. This should take only a few minutes of your time. Do you have a few minutes now to answer my questions? If yes, continue with the survey. If no, schedule a time to call back and close survey.

4. I'd like to start off by just getting a sense of your overall level of satisfaction with the weatherization services that you received. How would you rate your satisfaction with the services you received? Were you...

- Very dissatisfied
- Dissatisfied
- Neither dissatisfied nor satisfied
- Satisfied
- Very satisfied
- Don't know
- Refused

>>> if not Dissatisfied nor Very dissatisfied go to 6

5. Can you tell me a bit more about why you feel that way?

...will need to type in their response

6. Now I have some questions about ventilation equipment that may have been installed in your home as part of the weatherization services. This would have been an exhaust fan or ventilator that was set to run continuously or on a regular daily schedule. Do you recall having something like this installed in your home when you received weatherization services?

- Yes
- No
- Not sure

>>>If Yes go to #8

7. Our records show that we installed ventilation equipment in {location} in {month/year}. Do you remember that?

- Yes
- No
- Still not sure

>>>If Yes go to #9

>>>If No or not sure got to #22

8. Where is the ventilation equipment located?

- Location \_\_\_\_\_ (record to see if it matches file records)
- Don't know
- Refused

9. As far as you know, is the ventilation equipment still operating?

- Yes
- No
- Not sure

>>> If yes, go to #11

>>>If not sure, got to #22

10. Can you tell me why it is no longer operating?

>>>Record their answer and then go to #22

11. How does the ventilation equipment operate? Does it run...

- Continuously
- Part of each hour
- Part of each day
- Only when you turn it on
- Something else \_\_\_\_\_
- Don't know
- Refused

12. Does the ventilation equipment have controls that you can use to adjust it?

- Yes
- No
- Not sure

>>>If no or not sure go to #14

13. Please describe the controls.

>>>> Record answer

14. Now I'd like to know how you think the fan that you received has affected your indoor comfort compared to before it was installed. I'm going to read some qualities, and for each one I'd like you to tell me if the ventilation equipment made that quality a lot worse, a little worse, a little better, a lot better, or has made no difference in terms of that quality.

	a lot worse	a little worse	no difference	a little better	a lot better	not sure	refused
Overall comfort of your home in winter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall comfort of your home in summer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Humidity in your home in winter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Humidity in your home in summer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall air quality in your home, like stale air and odors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Noise levels in your home	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. In general, how satisfied would you say you are you with the ventilation equipment you received. Were you...

- Very dissatisfied
- Dissatisfied
- Neither satisfied nor dissatisfied
- Satisfied
- Very satisfied

>>> if not Dissatisfied nor Very dissatisfied go to 17

16. Can you tell me a bit more about why you feel that way?

>>>Record their answer

17. Now I'd like to know about air conditioning in your home. Do you have:

- One or more room air conditioners
- Central air conditioning
- No air conditioning

18. Do you use a dehumidifier in your home?

- Yes
- No

19. Do you use a humidifier in your home?

- Yes
- No

20. How many people currently live in your home full time?

21. Finally, we are doing a research project on the endurance of residential fans like the one you had installed. Someone from {WX Agency} may call you with a request to visit your home and complete some measurements on your fan. Would you be willing to participate in this study?

- Yes
- No

22. Thank you for your time. Those are all the questions I have for you today.

23. Customer identification -- to be completed by interviewer before submitting the survey.

- WX Agency \_\_\_\_\_
- Customer Name \_\_\_\_\_
- Work Order Number \_\_\_\_\_