Chapter 5: Dissemination and Partnering

The RESAVE program devoted a significant amount of effort to making sure its research is relevant to end users and the results achieved find their way into codes and standards, and to industrial partners.

5.1 Partners

RESAVE had two industrial partners who participated in project planning, the work of various tasks, and output review. In addition, these partners could make use of RESAVE results directly as they sought to improve their building products.

5.1.1 DuPont

DuPont Building Innovations participated as an industry partner with LBNL on the RESAVE program. As a producer of air barrier, water-resistive barrier, and flashing products, DuPont Building Innovations was primarily interested in aspects of the program concerning the air-tightness of the building envelope.

DuPont partnered with the RESAVE program in two areas:

- understanding the complexity of energy retrofit air sealing in existing homes, and
- working within ASTM to initiate new test standards or test standard revisions.

The most common ways of increasing the air-tightness of existing homes is either by using sealants at cracks, such as those around windows, or to install an air barrier as part of a cladding replacement. The prevalence of stucco construction in California limits the number of re-cladding opportunities. With this in mind, DuPont supported the work of the RESAVE program to identify the air-tightening potential from sealing of leakage between the living space and buffer zones such as an attached garage, attic, or crawlspace. The interface between the living space and these buffer zones is often ignored during the installation of traditional air barriers. DuPont continues to develop air barrier installation details for both new and retrofit construction.

Theresa Weston, the DuPont Building Innovations representative on the RESAVE team, is the chair of the ASTM Sub-Committee (E06.41) on the Performance of Buildings – Air Leakage and Ventilation. As such she was able to initiate ASTM work items to use the results of the RESAVE program to upgrade existing standards and to develop new standards:

1. Upgrades to ASTM *E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization,* incorporating the results described in Chapter 2 of this report, including the revision of multizone leakage measurement section and updating precision and bias of single and multi-point methods.

2. New standard *Test Method for Measuring the Capture Efficiency of Residential Kitchen Range Hoods* initiated. The task group developing this potential new standard will use the information discussed earlier in this report and thus build on RESAVE results.

This standards work continues beyond the completion of the RESAVE program.

5.1.2 Panasonic

Don Stevens has represented Panasonic Home and Environment Company (PHEC) as an industry partner with LBNL since the first discussions of this program in 2007. PHEC became Panasonic Eco Solutions North America (PESNA) in April 2012. Don is the National Research and Development Manager of PESNA responsible for ventilation and IAQ product and code development in North America. Figure 5.1.1 shows some example products.

PHEC/PESNA has used information from the RESAVE program to help in the design of several products for the North American market and California in particular. Data from the range hood study by Brett Singer has gone into Panasonic's range hood designs. Data from the filtration studies has influenced the development of a family of through-the-wall supply fans with Minimum Efficiency Reporting Value (MERV) 8 filters specifically targeted to California weatherization programs and to other products. Research projects have provided feedback on several products related to installation, sizing, and operation, including a recessed light/fan combination unit and small ERV that can be installed in the ceiling or exterior wall. All of these products can be used in new construction and existing homes and apartments.

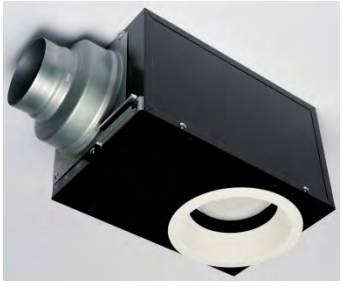
(a) (b)  (c)

Figure 5.1.1: Examples of a (a) Through-the-Wall Supply Fan, (b) Recessed Light/Fan Combo, and (c) Ceiling- or Wall-Mount ERV

The RESAVE program has also helped in the development of controls for ventilation devices, ranging from switches and timers to the development and commercialization of a condensation-potential controller that measures the relative humidity and temperature of the room and then calculates if there is a potential for condensation using the psychrometric chart from the ASHRAE Handbook of Fundamentals. Panasonic is using lessons learned from RESAVE to transition between lighted fans from compact fluorescent lamps to light-emitting diode technology.

5.2 Existing Homes Ventilation Guide

The Existing Homes Ventilation Guide sprang from an idea to help homeowners achieve proper ventilation in existing homes as they were weatherized or had major energy upgrades. It began as a written guide booklet, but it became obvious that the building community would be better served if it were moved to the RESAVE and/or Energy Commission websites so it was accessible and simple to update. Because it was targeted to contractors but accessible to owners and occupants, a Guide Advisory Panel (GAP) was established to provide input and review drafts for clarity. The GAP included industry, weatherization programs, and Energy Commission staff, to ensure the broadest review. The final product is currently located at http://resaveguide.lbl.gov/ under the title "Ventilate Right." Figure 5.2.1 shows the landing page. Don Stevens of PESNA (and Chair of ASHRAE SSPC 62.2) was the primary author of the Existing Homes Ventilation Guide, and Karol Stevens of Stevens and Associates was the technical editor.

Figure 5.2.1: The First Page of the RESAVE Ventilation Guide

This page allows users to get as little or as much information as they want or need to design and install a proper ventilation system. It includes both spot ventilation in baths and kitchens as well as whole-building ventilation for IAQ for the entire house or apartment. The material is organized based on the eight-step process on the landing page.

The designs and recommendations are all compliant with ASHRAE Standard 62.2. Guidance is provided for the current requirements found in the 2007 edition of 62.2, (as required by the 2008 Title 24 for new construction) that apply to current new construction and energy upgrade projects. In addition, it addresses the requirements of the 2010 edition of 62.2 with the 2012

published addenda as adopted by the Energy Commission for the 2013 Title 24. "Best Practice" recommendations are provided for users who want to go beyond code requirements. Because ASHRAE 62.2 is a "high profile" standard, it is constantly being revised. These differences are called out through-out the 100-plus pages of information. Many terms are linked, to allow users to access other sections when more information or clarity is needed. Energy Upgrade California program could also use this guide.

The guide includes various informative tables and charts, including one that compares 16 different ventilation strategies with a relative ranking of first cost range, an energy use range (expressed in kWh/year), a range of ventilation fan efficacy, and maintenance. Figure 5.2.2 shows a subset of the guide for exhaust-only systems.

Exhaust-Only Systems				
Name / Description	Cost	Energy (kWh/year)	Fan (cfm/watt)	Maintenance
E1: Single Point Exhaust-Only System One fan exhausts stale air from one location. Wall vents or air leakage through the building envelope provide make-up air.	$ – $$	35 – 438	1 to 15	Clean 1 fan grille
E2: Two Point Exhaust-Only System Two fans (or one inline fan with two pickups) exhaust stale air. Wall vents or air leakage through the building envelope provide make-up air.	$ – $$$	70 – 701	1 to 15	Clean 2 fan grilles
E3: Multiple Point Exhaust-Only System Multiple fans (or a multi-port fan ducted to several rooms) exhaust stale air. Wall vents or air leakage through the building envelope provide make-up air.	$$ – $$$$	70 – 876	1 to 15	Clean 3 or more exhaust grilles

Figure 5.2.2: Example Guide Section for Exhaust Systems

As shown in Figure 5.2.3, each ventilation system features a graphic showing a generic system installed in a house, as well as common points of outdoor air entry or indoor air exit based on that system.

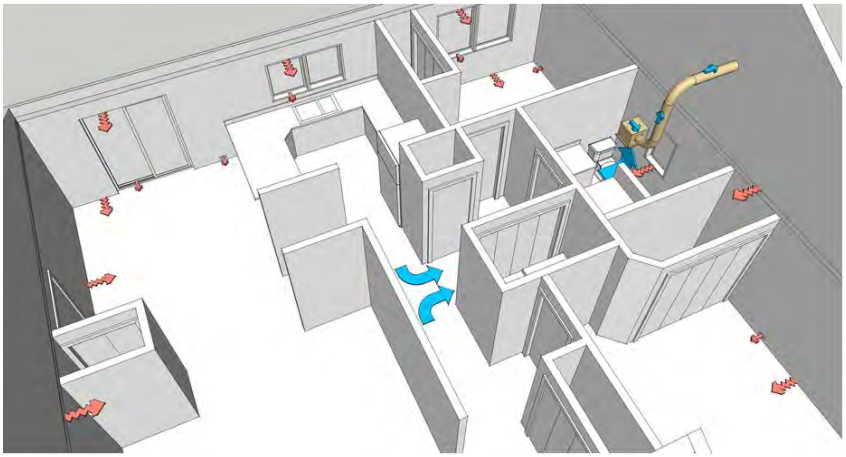


Figure 5.2.3: Example Illustration of Air Flow Paths

5.3 National Standards

5.3.1 Air Leakage Standards

5.3.1.1 Summary of Current Ventilation Standards and How They Relate to California Standards

The two important ASTM ventilation standards are E779 for measuring air leakage of homes and E1554 for measuring duct leakage. Neither have changed substantially in recent years; however, it is likely that E779 will be rewritten in 2013 or 2014 to remove some of the superfluous test elements that are impractical and to add single-point testing and a wider range of test result metrics such as ACH_{50}, Q50, normalized leakage area (NLA), and specific leakage area (SLA). The specific addition of SLA would be of interest, as this is the metric used in Title 24.

The most important ASHRAE standard is the one that has already been discussed— ASHRAE 62.2, for residential indoor air quality. However, other ventilation- and infiltration-related standards, such as ASHRAE 119 and ASHRAE 136, also pertain. Over the past couple of years these standards have been incorporated in ASHRAE 62.2, so that all the calculation procedures required for natural infiltration contributions to ventilation are in one place—in Standard 62.2. Therefore, adoption of more recent versions of 62.2 will incorporate the key parts of standards 119 and 136.

EPA's current ENERGY STAR program has the following prescriptive requirements for envelope leakage:

- 5 ACH_{50} in Climate Zones (CZs) 1 and 2
- 5 ACH_{50} in CZs 3 and 4
- 4 ACH_{50} in CZs 5, 6, and 7
- 3 ACH_{50} in CZ 8

California has CZs 2, 3, 4, 5, and 6—indicating a wide range of requirements for the state to match ENERGY STAR. This wide variation is justified because of California's wide range of

climates—in the same way that Title 24 prescriptive requirements currently have climate variation.

The current Title 24 does not set limits for air leakage—but it does give credit for homes tighter than the defaults of SLA of 4.3 for homes with ducted unsealed HVAC systems, 3.8 for homes with ducted and sealed HVAC systems, and 3.2 for homes without ducted HVAC systems (approximately corresponding to 8.6, 7.6, and 3 ACH_{50}, respectively). There is also the requirement in Title 24 for balanced ventilation (or additional added leakage) if a home has an SLA below 1.5.

The 2012 IECC has prescriptive requirements for envelope leakage that would require homes in California to be 3 ACH_{50} or less. This seems a reasonable requirement to add to future Title 24 requirements.

The Canadian R2000 standard limits envelope leakage to 1.5 ACH_{50} or less. In extreme Canadian climates this might be reasonable, but in the majority of California, our moderate climates make this level of leakage unnecessary in a minimum performance code such as Title 24.

Passive House requirements are even tighter, at 0.6 ACH_{50} for new homes and 1 ACH_{50} for retrofits. As with the Canadian R2000 standard, these low levels of leakage produce diminishing returns in mild California climates, and it is not necessary to go this low as a baseline for a minimum performance code in California.

The U.S. Green Building Council's LEED Residential requirements give both an upper limit and credit for limiting air leakage. The upper limits are:

- 7 ACH50 for IECC Climate Zones 1 and 2
- 6 ACH50 for Climate Zones 3 and 4
- 5 ACH50 for Climate Zones 5, 6, and 7
- 4 ACH50 for Climate Zone 8

The maximum LEED points for air leakage reduction are awarded at the level of:

- 3 ACH_{50} for IECC Climate Zones 1 and 2
- 2.5 ACH_{50} for Climate Zones 3 and 4
- 2 ACH_{50} for Climate Zones 5, 6, and 7
- 1.5 ACH_{50} for Climate Zone 8

California contains IECC Climate Zones 3, 4, 5, and 6.

5.3.2 RESNET and BPI

5.3.2.1 Summary of Ventilation-Related Changes in RESNET and BPI Standards

During the course of this project both the Residential Energy Services Network (RESNET) and the Building Performance Institute (BPI) changed their requirements to match those of California by requiring compliance with ASHRAE Standard 62.2. However, they refer to the

2010 version of the standard and not the 2007 version referenced in Title 24. It is recommended that California update its requirements to the 2010 version of Standard 62.2.

5.3.2.2 Summary of Future Ventilation Issues at RESNET and BPI, Including Whole-House/Local Ventilation and Combustion Safety

The process of training contractors and agencies to use ASHRAE 62.2 is ongoing, and it is not clear that all contractors are yet following the new standard. Within RESNET there is the feeling that we should stick with the ASHRAE 62.2-2010 standards for the next few years so that contractors get used to using them before changing to the 2013 version. In January 2013 BPI decided to only refer to the 2010 version of 62.2 for a very brief transitional period and to refer to 62.2-2013 as soon as it is published. There is a major change between 2010 and 2013 in that contractors will need to use substantially larger fans and flow rates, unless they measure the house leakage with a blower door in order to get credit for natural infiltration. RESNET and BPI might find the changeover from 2010 to 2013 easier than other institutions, as they already require blower door testing for envelope leakage.

The other related issue for RESNET and BPI is combustion safety testing. Both organizations are currently rewriting their combustion safety testing procedures, and LBNL is participating with both organizations to ensure that a good technical approach is used and that the two organization's procedures are as similar as possible. In addition to this harmonization, both organizations are examining the combustion appliance depressurization limit testing, due to the time it can take to do the testing and the lack of reliability associated with the results noted by LBNL and others. Representatives of the gas industry are strong advocates for simply referring to national gas codes. However these codes (primarily NFPA 54) give little or no guidance on how to carry out testing. RESNET and BPI are both reaching out to the National Fire Protection Association (NFPA) so that whatever procedures they adopt might also be transferred into the NFPA document to improve its utility to contractors.

5.3.2.3 RESNET, BPI, and ANSI Certification

Both RESNET and BPI are pursuing ANSI certification for their standards. This is leading to some conflicts between the two organizations and other organizations, such as Air Conditioning Contractors of America (ACCA) who are also publishing a suite of ANSI standards related to residential HVAC and home performance. It is likely that there are sufficient differences between the approaches and specific test procedures that all groups will have their own ANSI approved documents within the next 12 months. Some of which may be useful references for Title 24.

5.3.3 ASHRAE Standard 62.2

5.3.3.1 Summary of Changes to ASHRAE 62.2 Since Adoption in Title 24

There have been substantial changes since the 2007 version of ASHRAE 62.2 that was adopted by the Title 24. The following changes were made for the 2010 version of 62.2.

1. Removed the climate zone 3B and 3C exceptions to whole-house ventilation requirements (providing allowed to do so by the authority having jurisdiction)
2. Required measurement of whole-house and local exhaust airflow
3. Changed the effective ventilation for intermittent fans
4. Replaced the "transfer air" requirements with air sealing for adjacent spaces and an added section on multifamily buildings
5. Added more requirements for air sealing of attached garages, and the measurement of HVAC system air leakage was revised to refer to Method D of ASTM E1554 as well as California Title 24
6. Added the new U.S. DOE climate zone map
7. Added a normative annex for existing buildings that allows additional whole-house ventilation to compensate for lack of kitchen and bathroom exhaust

The following additional changes have more recently been made for 2013. They are from currently approved addenda:

1. Added an option for minimum filtration referring to Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 680 as well as ASHRAE MERV ratings.
2. Clarification of test pressure requirements for sound ratings.
3. Added a requirement that system designs include the pressure drop from the filters.
4. Removed limits on net exhaust flows that depended on climate and the associated climate map.
5. Clarified the existing buildings appendix.
6. Expanded and revised the section for intermittent fans that introduced the concept of equivalent dose (as used in the RIVEC controller studied in this project).
7. Added a requirement for carbon monoxide alarms.
8. Added a new section for multifamily buildings.
9. Changed the core of the standard to incorporate the default infiltration rate of 2 cfm/100 ft^2 directly into the fan sizing equation and uses tables that have many more entries in the range of houses sizes that are normally built (increments of 500 ft^2) and has better resolution for smaller homes. The required relationships and data from ASHRAE

standards 119 and 136 were incorporated directly into 62.2 for the infiltration calculations. New weather factors were calculated for all the current Typical Meteorological Year (TMY)2 data sites that included better assumptions about wind shelter that led to slightly reduced infiltration rates. Unlike the 2007 version, the full credit for infiltration is now allowed. Unless a blower door test is performed to estimate infiltration and take credit, the fan sizing will be approximately doubled compared with the value from the 2007 version. There was an intermediate version of the standard that allowed the old relationships to be used for fan sizing only, with no infiltration credit allowed, but a new addendum removed this approach.

10. The standard will require that mechanical systems be operated in order to comply with the standard.

5.3.3.2 Current ASHRAE 62.2 Activities That May Affect Future Title 24

The most important current ASHRAE 62.2 activity is the investigation of filtration effects and consideration of the addition of minimum filtration levels: either for outside for mechanical supply systems and/or for air recirculation systems (either as part of the ventilation system or a central forced air heating or cooling system). The impact on Title 24 would be that there would be a requirement for a minimum filter level on forced air heating and cooling systems, and on supply sir systems. Houses without central forced air heating and cooling systems would require the addition of a central forced air filtration system to remove indoor-generated pollutants; in other words, it would not be sufficient to supply filtered outdoor air, as this does not remove indoor pollutants. This latter effect would be minor in terms of additional equipment in California because almost every home has a central forced air system, but it could add substantially to energy budgets if central forced air fans operate either continuously, or, at the very least, for many more hours of the year.

The operation of central forced air systems for filtration would require that:

- ducts not leak,
- ducts be in the conditioned space (or be very well insulated—much more so than current standards), and
- energy requirements for the forced air blowers be introduced (because there are substantial fan energy savings available for systems that use Brushless Permanent Magnet blowers, lower continuous air flows, and low air flow resistance duct systems).

These would all be issues for Title 24.