

Aerosol Sealing of Existing Residences

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ABSTRACT

Retrofit air sealing of homes provides a significant opportunity for reducing residential energy use. According to results published on national weatherization efforts, major air sealing in single-family homes resulted in an average leakage reduction of 35% resulting in an average natural gas savings of 7.2%. Achieving envelope leakage reduction greater than 35% requires more intrusive and expensive sealing methods that are either cost prohibitive or can only be applied during renovations. This paper describes the air leakage reductions achieved in an ongoing U.S. Department of Energy Building America project that integrates an aerosol-based sealing technology used primarily for new residential construction into existing home retrofits.

This project has documented the application protocols for applying aerosol sealing in existing homes, and demonstrated the envelope air sealing performance in 34 installations. The demonstrations were conducted in both single-family and multifamily residences in Minnesota and California. The application process was most easily completed at tenant change or during a renovation project when interior contents are removed from the home. The time and materials needed to prepare the homes for sealing were documented and evaluated based on different interior conditions and construction types.

The results show the aerosol sealing application achieved an average leakage reduction of more than 50% across all demonstrations. This is higher than the reductions seen using typical, non-aerosol sealing methods. The project also showed that unwanted sealant deposition on interior surfaces can be mitigated with detailed preparation of the home.

Introduction

The existing residential building stock was responsible for 21% of primary energy use in the United States in 2021 (EIA 2022), and it is estimated that about 51% of site energy is due to heating and cooling (EIA 2018). A significant fraction of heating and cooling loads is a result of infiltration with prior estimates showing infiltration accounting for 29% of residential conditioning loads, or 2.24 quads annually (DOE 2014). Of this infiltration-related energy use, heating accounted for the majority with 79% compared to cooling which accounted for the remaining 21% (DOE 2014). Assuming natural gas is the fuel used for space heating and electricity is the fuel used for cooling, the U.S. Environmental Protection Agency estimates (EPA 2022) infiltration-related energy use contributes 153 million metric tons in greenhouse gas emissions annually.

Existing homes in the U.S. are known to be much leakier than many current code requirements. For example, the 135,000 single-family U.S. homes in the ResDB database had a geometric mean leakage of 11 air changes per hour at a pressure difference of 50 Pascals (ACH_{50}) (Chan et al. 2013) compared to the International Energy Conservation Code requirement of 3-5 ACH_{50} depending on climate zone. Thus, air sealing the existing housing stock in the U.S. has been a major priority for weatherization programs (Blasnik et al. 2015). The national Weatherization Assistant Program (WAP) is funded by the Department of Energy to

provide grants to local agencies to administer efficiency upgrades to homes. A review of the impact of those programs conducted by Oak Ridge National Laboratory showed that envelope sealing measures were able to reduce leakage by 800-1,100 CFM at 50 Pa (CFM50), or 25-30% over pre-retrofit leakage (Blasnik et al. 2015).

Current state-of-the-art methods for air sealing retrofits are all manual, relying on contractors to visually identify and manually seal leaks. The achieved air-tightness levels are highly variable, and are based on the experience of the individual contractor that performs the work. Aerosol envelope sealing is being applied to new construction, but there are only limited demonstrations and no commercialization for existing residences. Widespread application of this process to existing residences will allow this new technology to improve the energy performance of the current housing stock. In addition to energy savings, air sealing can reduce moisture issues from uncontrolled movement of air through the building's exterior envelope (Lstiburek 2015).

This paper describes the results from applying the aerosol sealing process to 34 existing homes in Minnesota and California. The primary target was unoccupied homes either at time of sale or between tenants, when the homes were empty, to reduce the preparation required to protect contents in the home. However, some occupied residences were also included using an alternative installation protocol that applied the aerosol in the attic space only. Application protocols were developed, including preparation of the homes and manual pre-sealing activities, and the air sealing performance was documented for all test sites. Costs were not included in the analysis since this was a new application of the aerosol sealing technology and additional time was required on-site to develop application protocols. The cost for applying the technology to new construction is typically based on the floor area, number of units to be sealed, and an impact cost for achieving specific leakage reduction targets. A similar formula would be used for existing homes with a 25% to 50% higher cost per unit of floor area due to the increased time and materials for preparation of the home. Future work is recommended to determine the cost-effectiveness of the approach based on established installation procedures.

Background

Aerosol sealing has been used successfully for residential duct sealing for over 20 years, where it has been shown to seal duct leaks with a width of up to 5/8 inch (Modera et al. 1996). This technology was adapted by the UC Davis Western Cooling Efficiency Center (WCEC) for sealing leaks in the building envelope. The process involves pressurizing the building while dispersing an aerosol sealant "fog" to the building interior (see Figure 1). As air escapes the building through leaks in the envelope, the sealant particles are carried to the leaks where they make contact and stick, sealing the leaks. The sealant particles require a high velocity impact to adhere to a surface so sealant material generally does not deposit on walls or ceilings except for at leak sites; however, sealant will settle on the tops of horizontal surfaces due to gravity, so to avoid unwanted deposition, these surfaces should be covered. Initial proof-of-concept testing of the aerosol sealing process showed excellent results, sealing 40 square inches of leakage in a small-scale enclosure in less than 10 minutes (Harrington and Modera 2012).

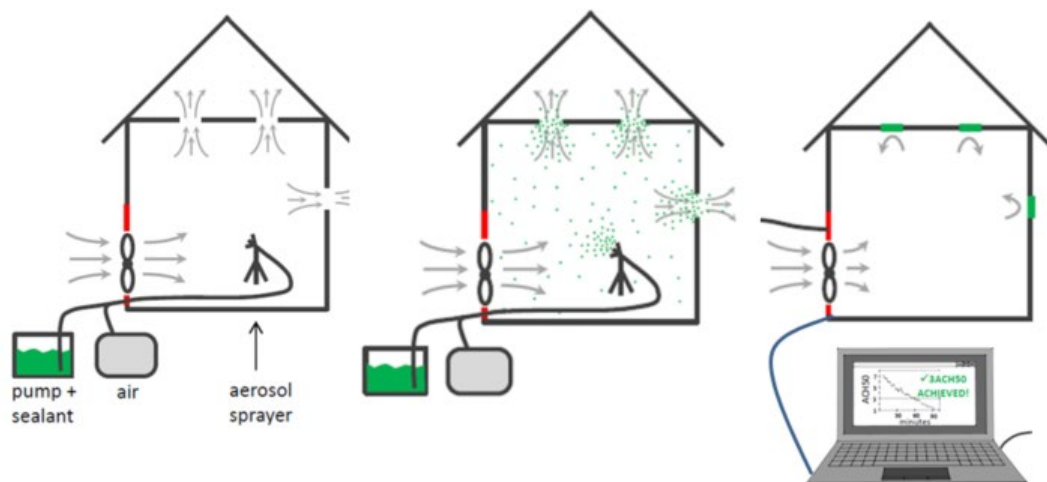


Figure 1. The images in this schematic diagram show the progression of the sealing process from the start (left) to the end (right).

Another project evaluated production-scale envelope sealing of new single-family homes (Harrington and Springer 2015). The envelope leakage of six houses in a large development was reduced by 62% to 85% with an average of 74%. The average pre-aerosol sealing leakage was 11.4 ACH₅₀ and the average post-aerosol sealing was 2.5 ACH₅₀. Since the process was applied at a rough-in stage of new construction, it would be expected that a significant amount of the leakage present before aerosol sealing would be sealed manually in later stages of construction (i.e. installation of electrical wall plates and plumbing flanges), the exception being duct leakage. To determine the overall impact, a comparison of homes sealed with aerosols versus those not sealed with aerosols at the end of construction would be needed.

More recently, a project was completed to identify the best stages for incorporating aerosol sealing into new home construction, from the perspectives of cost, performance, and seamless integration into the construction process (Bohac and Harrington 2020). The team sealed 11 new houses for two California builders, 15 houses for six Minnesota builders, and a triplex for an Illinois builder. This project found that the aerosol sealing process was successful at reducing envelope leakage at various stages of construction including before and after sheetrock relative to control homes that were not sealed with aerosols. The average final leakage of these homes was 1.6 air changes per hour at 50 Pa (ACH₅₀) with 11 homes measuring below 1.0 ACH₅₀ which is well below International Energy Conservation Code recommendations in those states. This paper also outlines air sealing efforts that can be avoided to reduce labor time when applying aerosol sealing.

Methodology

Initial outreach to recruit demonstration sites started with a focus on unoccupied homes. The project team worked with public housing providers and local utilities to identify apartments or houses that would be renovated or have a change in occupancy. An initial air leakage test was conducted on the demonstration sites to determine the air sealing opportunity. Eligibility criteria was broad, and primarily focused on potential safety issues. Information was also collected to identify any potential safety concerns related to combustion appliances or ventilation.

After a home was selected for the project, a second visit was scheduled for applying the aerosol envelope sealing. The sealing work was typically scheduled for a two-day period to

account for any delays in preparation activities. The first step was to identify any manual sealing and surface protection that would be required. The manual sealing was aimed at leaks larger than ½” in order to reduce the overall aerosol injection time required, and therefore reduce the potential for unwanted sealant deposition on building materials. Significant preparation and attention to detail were required to install the appropriate protection of finished surfaces.

A baseline air leakage test was performed by the project team prior to surface preparation and manual sealing. A local AeroBarrier dealer was contracted to provide the aerosol sealing service and they documented the leakage value after preparation activities before air sealing began. The aerosol sealing was performed and a post-sealing leakage test was completed by the AeroBarrier contractor. The temporary coverings in the home were then removed and the home was cleaned. Lastly, the project team performed a final leakage test to determine the overall impact of the sealing effort.

This methodology was consistent for the majority of homes with the exception of homes where the attic sealing approach was performed. In these installations, no surface preparation activities were performed inside the home and the sealing process was conducted by WCEC. The existing attic insulation was removed prior to the aerosol sealing, and new insulation was installed after the sealing process.

One of the limitations of the aerosol sealing method is that the poly sheets, tape, mask, and other materials used to protect surfaces from aerosol sealant deposition on finished surfaces can limit the sealant fog from reaching envelope leaks. In addition, removing the materials after the sealing can disturb the aerosol seals. In order to evaluate this issue, house leakage measurements were made before and after the materials were put in place. Air leakage testing was performed before sealing activities started to determine the baseline condition (existing), as well as after all work was completed (unmasked). Additional leakage data was collected at the start of aerosol sealing after all preparation of the home was complete (masked) and at the end of sealing before preparation was removed (post-aero). Since the aerosol-sealing process records air leakage data in real-time, this data was used to calculate the sealing rate at different points during the sealing process and record the total sealant injection time. The majority of existing and post-aero tests conducted were multipoint measurements with uncertainties between 1-3%.

Sealing Preparation

The surface protection activities performed (also referred to as “masking”) attempt to balance the time required for preparation time and clean up, while also avoiding covering potential leak sites. For example, attempts should be made to avoid blocking leaks under baseboards when applying floor protection; this level of detail adds to preparation time when placing that covering. The surface protection activities were successful with only one instance of property damage due to inadequate covering of a hot water heater. The issue with the water heater was caused by not sealing off the combustion air intake on the bottom of the unit causing the aerosol to find its way into the burner section. This was an oversight and compensation for the water heater was provided to the owner due to this error. All noticeable unwanted deposition was cleanable from surfaces including minor overspray on carpets and sealant build-up around large leaks on other surfaces. The general preparation process included the following steps:

- Covering of all flooring that will not be replaced (Figure 2)

- Cover with plastic and tape down at the edge up to the baseboard. For homes on raised foundations, ensure that tape is applied continuously to prevent aerosol from migrating under the plastic.
- For carpets, duct tape around perimeter at baseboard and use painter's tape to attach plastic to top of duct tape.



Figure 2: Duct tape used at the perimeter of carpeted rooms as a base for attaching the plastic covering (left). Plastic covering on carpeted floor (right).

- Drape plastic over kitchen and bathroom counters and appliances (Figure 3)
 - Leave cabinets with plumbing or electrical penetrations open to allow sealant to reach those leaks.
 - Consider applying a cleaning solution to tops of countertops to make it less likely that sealant will adhere and allow for easier cleanup



Figure 3: Kitchen appliances and cabinets covered for sealing. Photo on right shows cabinets opened to allow aerosol to seal plumbing penetrations and outlets below the sink.

- Bag chandeliers and ceiling fans (Figure 4)
- Remove electric outlet and switch plates. Tape over outlet plugs allowing sealant to flow into electrical box.
- Tape sliding components of operable windows (Figure 4)

- Tape over weep holes from exterior if possible (if second floor could reach out and block weep hole)



Figure 4: Windows prepped (left) and ceiling fan covered to protect from sealant deposition

- Tape exterior door seams
- Cover tops of horizontal surfaces (alternatively, could apply cleaning solution to these surfaces prior to sealing that will prevent sealant from adhering and allows easy cleanup after sealing).
 - Door knobs
 - Switches
 - Window sills
 - Door hinges
- Cover HVAC including supply and return grilles, bathroom/kitchen exhaust grilles, and dryer exhaust
- Protect water heater or other vented combustion equipment if in living space
 - Block intake and exhaust from sealant deposition
- Fill p-traps and toilets with water

Table 1 shows the average time recorded to complete major steps in the sealing process. The sealing preparation for existing homes took a team of three approximately 8 hours to protect a 1,500-2,500 sq. ft. home. The majority of time and materials was for covering floors, and while a significant amount of disposable plastic is used, according to the Inventory of Carbon and Energy database (Hammond and Jones 2011) the embodied carbon in 3.5 mil plastic to cover 1,000 sq. ft. is less than 16 kg CO₂e. This carbon could be offset by saving 41 kWh of electricity or less than 3 therms of natural gas. This time will vary widely depending on the type of flooring, number of windows and mounted fixtures, and building geometry. Also, as teams develop preparation strategies and experience this time could be reduced. The time required to seal the multifamily apartments undergoing major renovation was significantly lower since many surfaces including the flooring was scheduled to be replaced, and therefore not required to be protected. For the attic sealing applications, no surface protection was required, but insulation would need to be removed and replaced as part of the retrofit.

Table 1. Summary of person-hours required to complete each task in the sealing process for the first eight homes and attic sealing demonstrations

Construction Type	Average Person-Hours			
	Preparation	Equipment setup	Sealing	Cleanup
Single Family	23	2	1.7	7
Multifamily Renovation	6	1	1.25	1
Multifamily from Attic	TBD*	1	1	0.5

*Attic preparation was not evaluated during this study.

Manual pre-sealing of larger leaks should also be performed prior to aerosol sealing. This allows the manual process to be performed faster and with less precision since the aerosol can fill in any small errors. The preparation time reflected in Table 1 includes any pre-sealing that was performed. Manual sealing of larger leakage can also be performed during the process if an installer notices the sealing not progressing as expected. This sealing can involve can foam, caulk, or other dense foam products that can be lodged in holes to block the bulk airflow path. Temporarily covering large holes is also acceptable but does not address the leakage caused by the hole. If the size of leaks behind a large hole cannot be determined it is best to cover the hole and determine how the larger hole can best be sealed at a later time. For example, data cable access points may not have any housing within the wall cavity; in this case, leaving this opening to the wall cavity can create significant sealant deposition around the opening of the hole without impacting the air leakage due to the size of the opening. This would also lead to more sealant product being used.

Results

California

A total of 14 existing homes were sealed in California including five single-family homes and nine multifamily units. The five single-family homes were unoccupied at the time of sealing with one partially furnished. Six of the multifamily homes sealed for this project were undergoing major renovation which included replacing the heating and cooling system, toilets, and flooring. The three other multifamily homes were sealed from the attic space and were occupied at the time of sealing.

Single-Family

Three of the single-family homes sealed in California were built before 1950 and two were built in the 1980s. The homes ranged in size from 1,160-2,140 ft². They were all constructed on raised foundations requiring that the floor coverings be taped completely around the perimeter to prevent aerosol from migrating under the plastic to a leak in the middle of the floor. The floor covering process accounted for most of the time needed for building preparation. Figure 5 shows the pre- and post-seal leakage results for the homes. The average leakage reduction was 53% going from an average initial leakage of 12.0 ACH50 to an average final leakage of 5.5 ACH50.

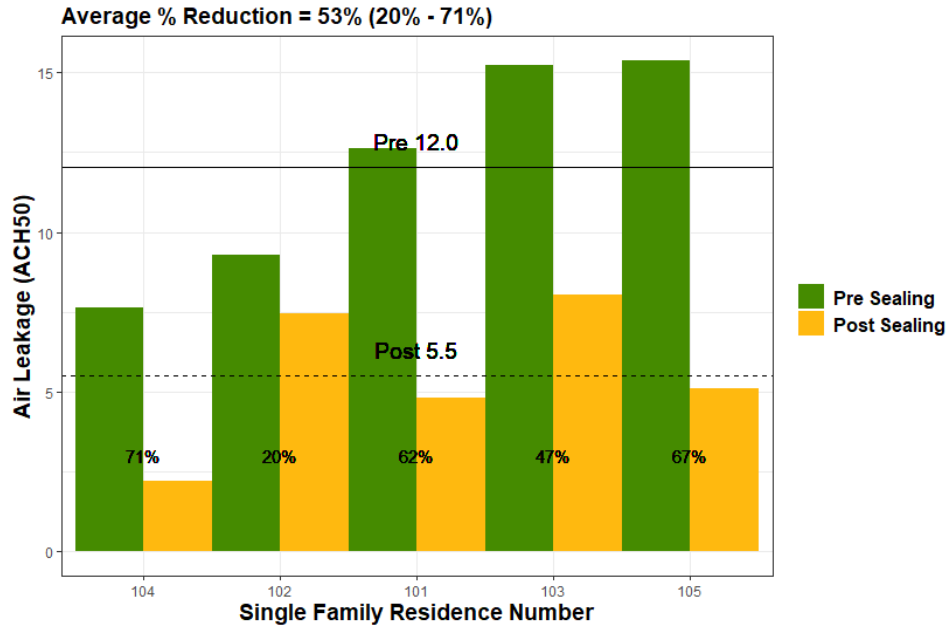


Figure 5. Air sealing results for single-family homes sealed in California

Figure 6 shows the sealing profile and air leakage test results for Residence Number 101. In this case, the sealing time was relatively short, requiring only 41 minutes of injection compared to the average of 1.7 hours. The sealing rate started around 95 CFM50 of leakage sealed every minute down to 5 CFM50 per minute at the end of the process. The air leakage test results show the amount of leakage covered by surface protection (4.10 ACH50) and the amount uncovered at the end of sealing (3.91 ACH50), suggesting the tightest the building could be sealed through the aerosol process was around 4 ACH50. The majority of air leakage covered by surface protection appeared to be from the floor which was built on a raised foundation. The aerosol sealing process dropped the leakage down to 0.9 ACH50 before removing the surface preparation, and after removing the protection the final building leakage ended up at 4.8 ACH50. This example shows the covered and uncovered air leakage was in general agreement; in some cases, the amount of leakage covered differed from the amount measured when uncovering which is discussed in more detail in a later section.

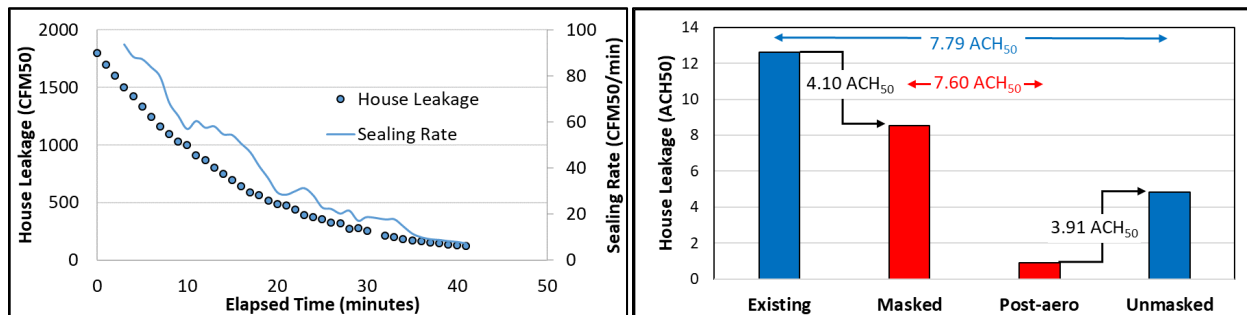


Figure 6. Sealing profile (left) and leakage results summary (right) for California Residence Number 101

Multifamily

The six multifamily homes presented here were part of a major renovation project meaning there was significantly less surface preparation required. The duct systems for heating and cooling were disconnected in some apartments, and therefore excluded from the pre and post-air leakage measurements. Due to the minimum surface protection, the overall envelope leakage reductions were greater than the single-family homes. The average leakage reduction was 60% from an average initial leakage of 8.3 ACH50 to a final average leakage of 3.3 ACH50.

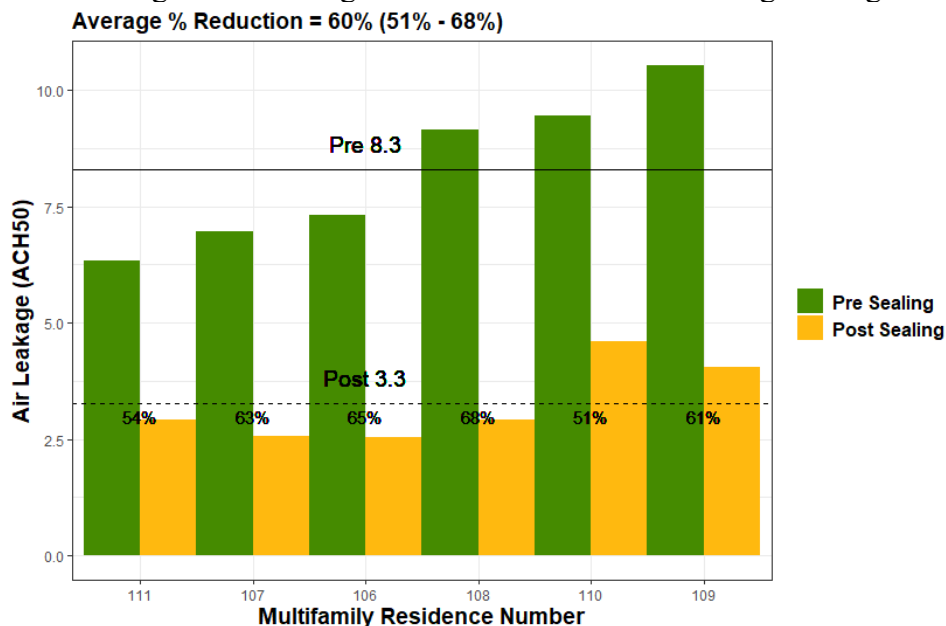


Figure 7. Air sealing results for multifamily homes sealed in California

The preparation for aerosol sealing in the multifamily installations in California were similar to new construction due to the types of renovation activities being performed. The floors were not covered, kitchen appliances were removed, and only minimal finished surfaces needed to be protected. The biggest challenge was working with the building owner and other trades to coordinate the sealing effort into the overall retrofit. For example, the aerosol application occurred with the existing carpet in place. It would have been preferable to seal the home after the carpet was removed to avoid potentially disturbing seals at the baseboard at removal. There were also new cabinets installed before sealing that required additional prep work.

Attic sealing for Occupied Homes

One new strategy investigated to address occupied homes was to install the aerosol envelope sealing from the attic space. The goal was to focus on the ceiling-attic surface, which was demonstrated in a study of new California homes to contribute 51% of the total air leakage of the homes (Proctor et al. 2011). The aerosol sealing process was modified for this application by depressurizing the house to 100 Pa while applying the aerosol “fog” of sealant material in the ventilated attic space. The sealant particles deposited on leaks as the particles were drawn into the home. The attic insulation was removed prior to the installation to allow the sealant a path to the leaks on the attic floor. The attics tested were well ventilated and attic pressures monitored during the process showed very little attic depressurization relative to outside. This led to some loss of sealant material through attic vent openings but did not have a noticeable impact on

sealant material usage relative to other applications. Sealant loss could be reduced by temporarily blocking some attic ventilation openings or using a secondary fan system to reduce attic pressures.

This method for aerosol sealing required no preparation of interior surfaces in the home which greatly reduced the setup time. There were some sealant particles that blew through larger leaks and ended up in the home, but were quickly removed by the blower door fan. Sealant particles entering the living space can be mitigated further by running a room air filter, or making small intentional openings in windows to allow the blower door to run at higher speed and create more room air changes at the same operating pressure.

The test site used included 938 ft² and 764 ft² single story apartments built on a slab with a ventilated attic. The aerosol sealing process was applied to three apartments, while the remaining 37 apartments received conventional foam sealing of the attic by the insulation service contractor. The foam sealing focused on electrical penetrations, HVAC connection boots, and construction seams. Two conventionally sealed apartments were tested and compared to the three sealed with aerosols. All baseline and post sealing leakage tests were performed with the attic insulation removed. Figure 8 shows the sealing results for the attic sealed with the aerosol process and those sealed with manual foam application. The aerosol sealed homes reduced total envelope leakage of the homes by an average of 55% from an average initial leakage of 8.0 ACH50 to a final leakage of 3.6 ACH50. By contrast, the conventionally sealed attics reduced the leakage of the home by an average of only 14% from an initial leakage of 7.2 ACH50 to a final leakage of 6.2 ACH50.

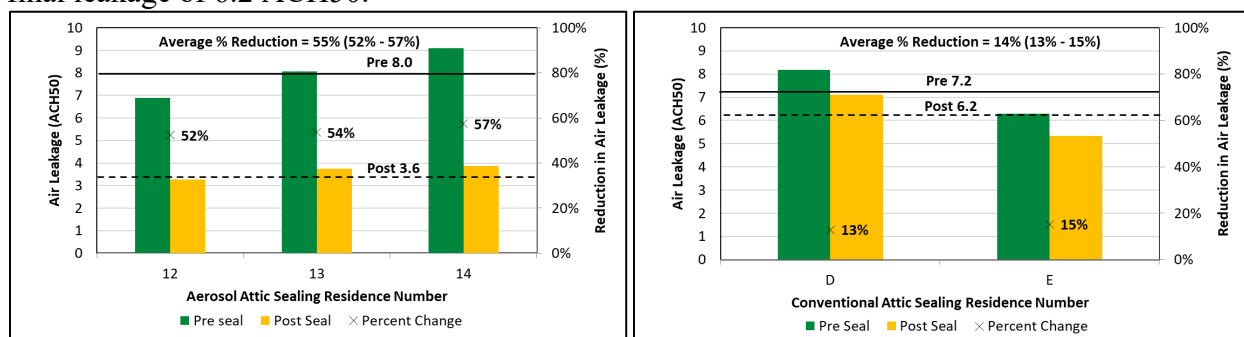


Figure 8. Attic sealing results for aerosol application (left) and conventional foam application (right)

The aerosol sealing process was effective at achieving reduction in overall air leakage, particularly considering the limited opportunity based on application only from the attic. With slab-on-grade construction it is understandable that a significant portion of the leakage in a home would flow through a ventilated attic where wire penetrations in the top plates and ceiling mounted fixtures provide paths for air to leak. This project also highlighted the challenges of manual sealing. Leaks can be challenging to reach near the exterior walls, and it is not always obvious where leakage occurs so contractors tend to apply sealant products along entire seams which may not be a source of leaks (Figure 9). Contractor experience is a key factor when evaluating the performance of manual sealing methods, which is one reason that having an automated approach is expected to provide more consistent results. This project presents results for one particular contractor, and further evaluation is needed to understand the broader benefits of the approach relative to current conventional methods.

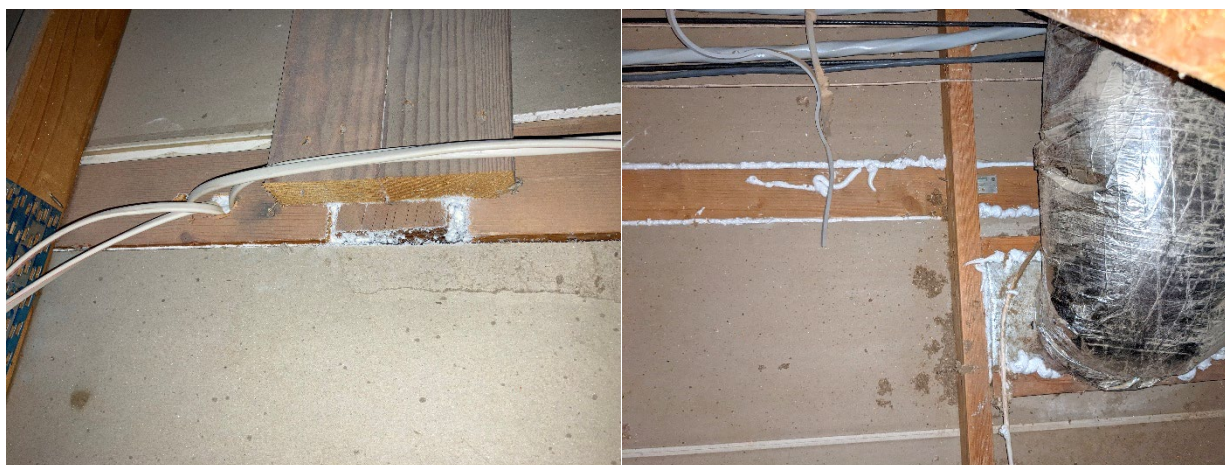


Figure 9. Photos of aerosol seals targeting specific leaks (left) vs. manual foam sealing applied liberally along seams (right)

Minnesota

A total of 20 existing homes were sealed in Minnesota including 11 single-family homes and nine multifamily units. Of the 11 single-family homes, six were undergoing significant remodeling, and five were changing occupancy. Seven of the nine multifamily homes were part of a rehabilitation project and two were sealed at time of occupancy change.

Single-Family

The single-family homes sealed in Minnesota all had basements and the majority were multi-story. Nine of the homes were built before 1961 with four built before 1916. The homes ranged in size from 1,092-3,398 ft². Since these homes were built with basements, the floor covering process did not require continuous sealing around the perimeter, saving some time on preparation. Figure 10 shows the pre- and post-seal leakage results for each home. The average leakage reduction was 41% going from an average initial leakage of 7.3 ACH50 to an average final leakage of 4.3 ACH50.

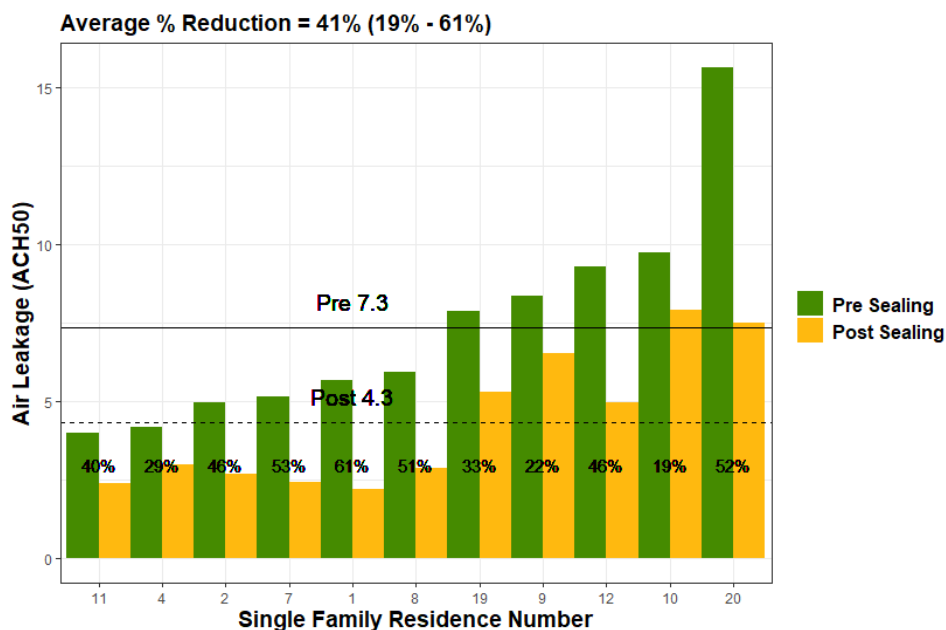


Figure 10. Air sealing results for single-family homes sealed in Minnesota

The homes in Minnesota were significantly tighter before sealing than the homes in California. While the percent leakage reduction was lower than the single-family homes sealed in California, the homes ended up tighter overall. Figure 11 shows the sealing profile and measured leakage for Residence Number 7. The sealing rate started between 10 to 15 CFM50/min and decreased gradually. After 95 minutes the sealing was still above 5 CFM50/min so the system was paused for 15 minutes to refill some of the sealant containers. The measurements showed that only 0.54 ACH₅₀ of leakage was covered by surface protection which was significantly less than that for Residence 101 in California due to the minimal leakage through the floor. This allows the sealing process to address more leakage in the building and results in a tighter home.

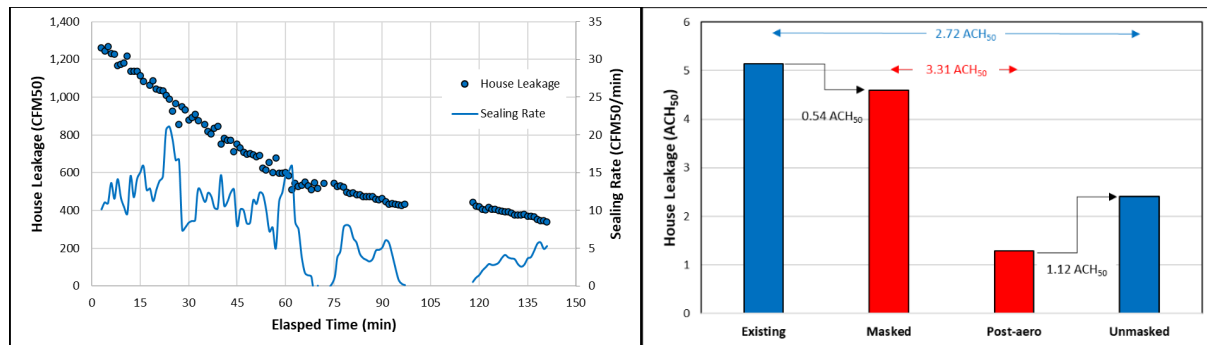


Figure 11. Air leakage results summary for Minnesota Residence Number 7

Multifamily

Six of the multifamily homes sealed for this project were in the same complex undergoing a major renovation (Minnesota Residence 13 – 18). The flooring and cabinets were being replaced and sections of drywall cut out as need for electrical upgrades. These were mostly small studio apartments of only 280 ft² with one single bedroom apartment that was 452 ft². The other three multifamily homes (Minnesota Residence #3, 5, and 6) were townhouse apartments (1,294-2,319 ft²) and the tightest of the group. Two of the townhouses were sealed during a change of occupancy and the third (#6) was undergoing major renovation to sections of the unit. Figure 12 shows the pre and post-seal leakage results for the nine multifamily test sites in Minnesota. The average starting leakage was slightly higher than the multifamily homes in California at 9.5 ACH₅₀, and the average leakage reduction was 39% resulting in an average final leakage of 5.8 ACH₅₀.

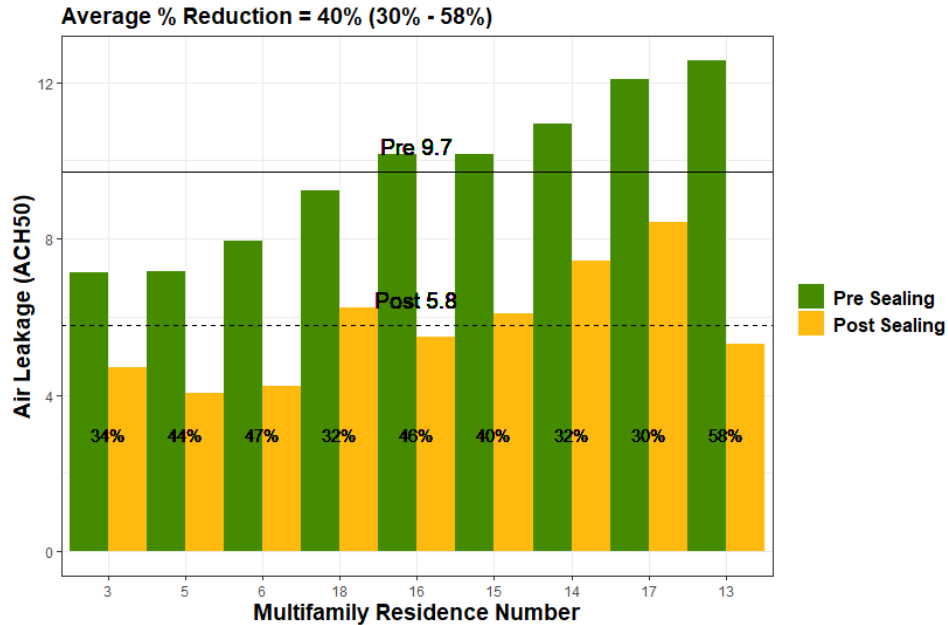


Figure 12. Air sealing results for multifamily homes sealed in Minnesota

Discussion

For all 34 residences, the average leakage reduction was 47%, with somewhat higher reductions for the California residences. The California homes were 19% leakier than Minnesota residences (Figure 13) which could be due to construction differences between the regions or differences in preparation of the home by the contractors. It was thought that higher leakage reductions could be the result of higher initial leakage; However, as shown by Figure 14 there is almost no correlation between the existing air leakage and the percent leakage reduction with an R^2 of 0.05 for both the multifamily and single-family residences.

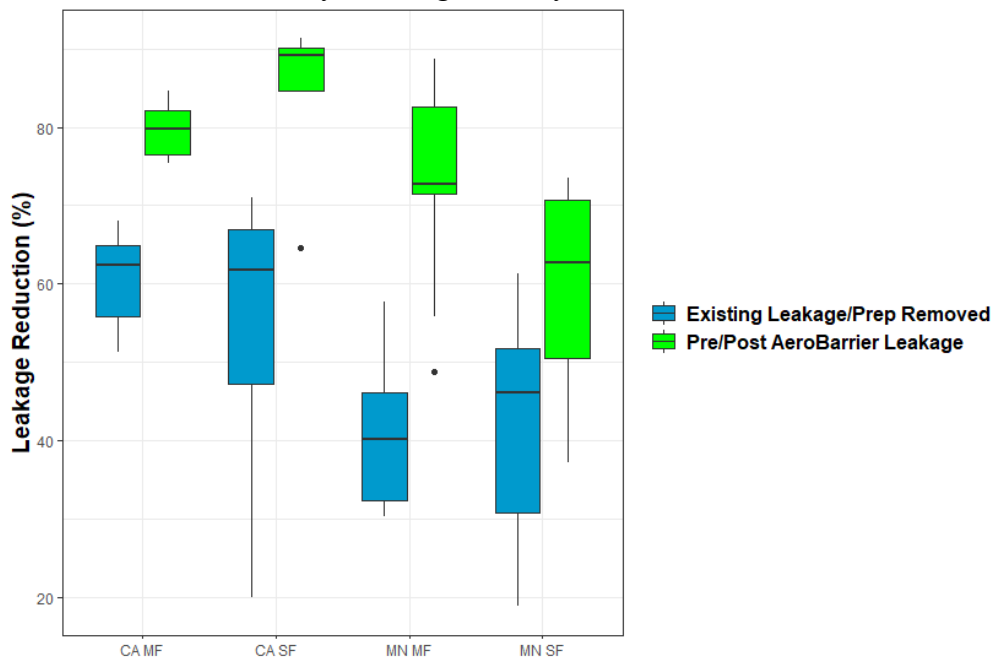


Figure 13. Air leakage results summary for all residences

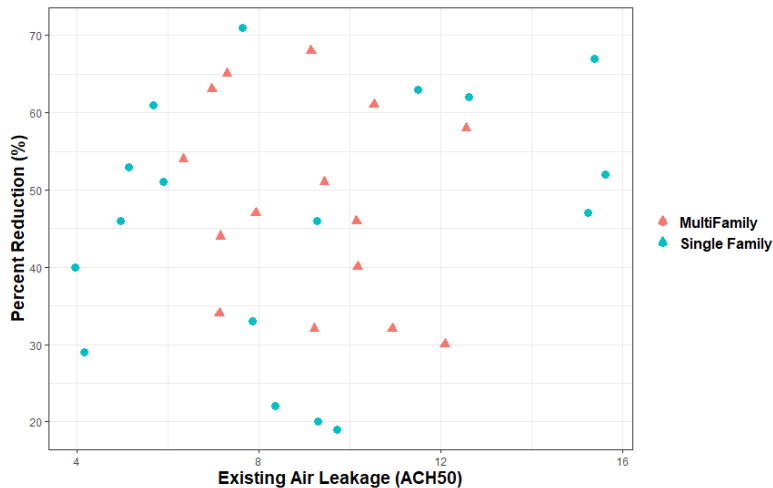


Figure 14. Air leakage reductions vs. existing air leakage showing no correlation to existing leakage levels

Figure 13 shows the percent leakage reductions by comparing the pre-sealing leakage measured before masking was applied to the post-sealing leakage after the masking was removed (blue boxes). It also shows the percent reduction immediately before and after the aerosol sealing when the masking was in place (green boxes). With masking in place, the aerosol process reduced leakage by an average of 71%. This indicates that the aerosol process sealed almost three quarters of the leaks that were not covered by masking.

The 71% reduction is significantly greater than the average overall reduction of 47% from before the masking was applied and after it was removed. The lower reduction when the masking was not in place was due to the percentage of leaks that are covered by the masking process and the aerosol seals that are disturbed when the masking is removed. For the California single-family residences an average of 25% of the house leakage was covered by the masking and the average was 10% for the multifamily units (Figure 15). For the Minnesota residences, the averages were 6% and 8% for the single-family and multifamily residences respectively. The average for all of the residences was 10%. The amount of aerosol seals that were disturbed for each residence was estimated from the amount of leakage covered by masking subtracted from the increase in leakage when the masking was removed. The average was 9% for the California single-family residences and 12% for the multifamily units. The average was 15% for the Minnesota single-family residences and 24% for the multifamily units. The average for all of the residences was 16%. It appears that improved methods for applying the surface protection could increase leakage reduction by 10 or more percentage points.

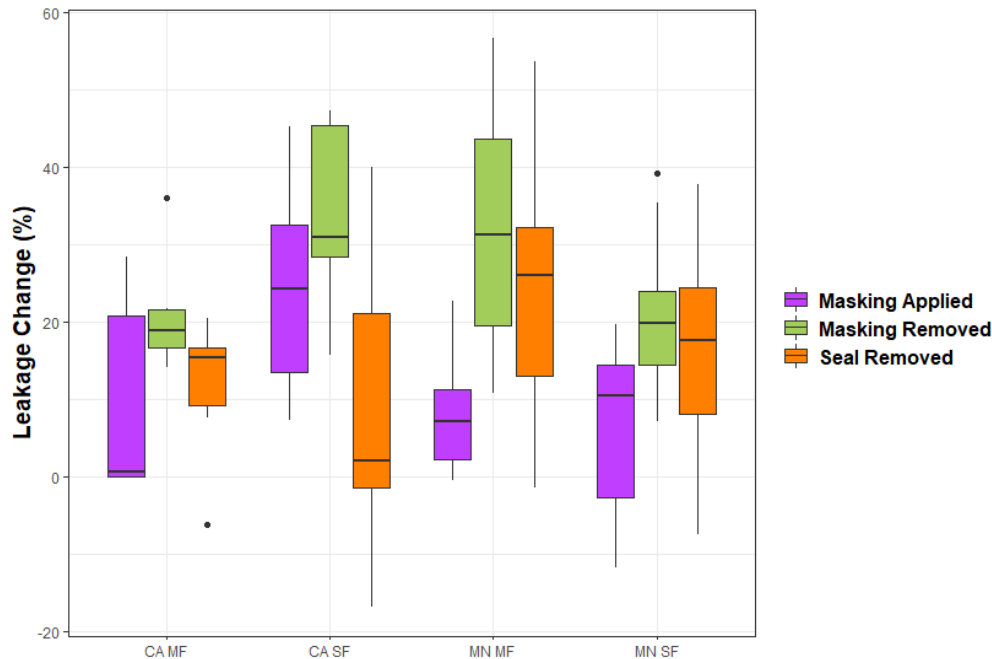


Figure 15: Air leakage covered when applying and removing masking, and re-introduced leakage from seal disturbance when removing masking

In order to achieve lower leakage for the California single-family residences on raised foundations where 25% of the leakage was covered, it may be necessary to use a different method for sealing the leakage through the lower-level floors. For example, the approach used to seal attics from the house could be used for crawl spaces. Other sources of leakage that cannot be addressed by the aerosol sealing process include intentional openings (e.g. combustion air ducts, combustion appliance vents, exhaust fan ducts, and clothes dryer vents) that must remain open or have damper leakage. The leakage through these openings effectively set a minimum for the achievable house air tightness using the aerosol process.

Conclusion

The aerosol-sealing performance in existing homes was effective with an average leakage reduction of 47% across all 34 sites. This is in comparison to 25-30% from a review of the national weatherization programs. The preparation of the homes undergoing occupancy change is fairly extensive requiring an average of 23 person-hours for a single-family home, but this work can be significantly reduced when aerosol sealing can be incorporated into a renovation project. The materials used for protecting surfaces in the home during the sealing process prevented the sealant from reaching some leaks. For homes on raised foundations, the leakage covered by protecting floors was significant and reduced the achievable air tightness. The sealing of occupied slab-on-grade apartments from the ventilated attic space showed very encouraging results, with these homes achieving a 52-57% leakage reduction with no required protection of the interior of the residence. In these cases, the attic insulation would need to be removed and the sealing could be included as part of an overall attic insulation and air sealing upgrade package. A similar approach could be evaluated for use from crawl spaces for homes on raised foundations to address floor leakage that would otherwise be covered by surface preparation when applying the aerosol from inside the home.

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