



# Quality Install Tool

October 17, 2024

**Energy Trust of Oregon Trade Ally Forum**  
Breakout Session



PNNL is operated by Battelle for the U.S. Department of Energy





## Quality Install Tool

A free, easy-to-use, tool with workflows to document all commonly done residential retrofits.

Tool developed by Pacific Northwest National Laboratory, funded by the U.S. Department of Energy.

A screenshot of the "Quality Install Tool" interface on a tablet. The interface has a green header with a back arrow and the title "Quality Install Tool". Below the header, the main content area is titled "Heat Pump Water Heater Installation" and "Demo HPWH". There are four tabs: "Project", "Assessment", "Installation" (which is active), and "Report". The "HPWH Installation" section contains several input fields: "Installation Date" with a date picker (mm/dd/yyyy), "HPWH Installation - Instructions" with a dropdown arrow, "Completed Installation - Photo" with a dropdown arrow and an "Add Photo" button, "Nameplate - Photo" with a dropdown arrow and an "Add Photo" button, and "HPWH Screen with Mode - Photo" with a dropdown arrow and an "Add Photo" button.

## Problem

Residential energy efficiency measures are frequently installed incorrectly, leaving energy and money savings that are not realized.

- 90+% of attic retrofits are “blow and go” jobs without first doing air sealing.
- In walls, insulating panels lose more than 36% of their performance if gaps represent only 0.5% of the insulation volume.
- A typical installation process rarely includes performance-related verifications or optimization of airflow, refrigerant charge, and control settings.
- The two most common faults in heat pumps are low indoor airflow rate and incorrect refrigerant charge level, a 9% increase over baseline (no-fault) usage, costing homeowners ~\$2.5 billion annually on utility bills.

These problems have the greatest impact on low-income households, who are counting most on the anticipated savings.



## Quality Installations Needed to Achieve Decarbonization Goals

- By 2035, 3% annual efficient envelope retrofit rate for existing residential is achieved and maintained or exceeded thereafter. Reduce the market barriers of envelope retrofits.
- Heat pumps for residential and small-to-medium commercial applications reach 75% of space heating sales by 2035 and >90% sales by 2050.
- By 2050, All primary electric resistance space and water heating is replaced by heat pumps.

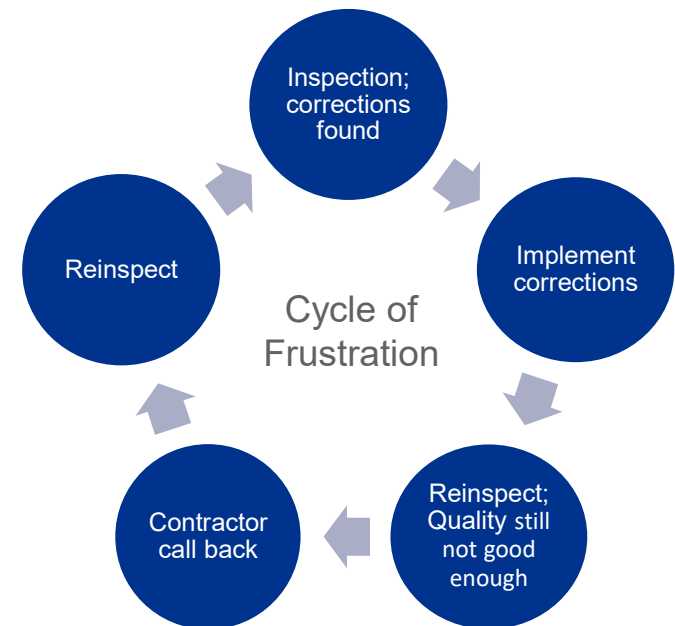
Quality installation is assumed and required to reach these goals.





## Prevailing Quality Verification Approach

- Typically only completed for 5% of projects.
- On-site inspection results in tons of wasted emissions from travel.
- 3rd party onsite validation is expensive—as such, all projects cannot be validated.
- Some programs opt for installing contractor checklists in-lieu of on-site inspections.
  - This provides no proof of proper installation.
- Many elements are impossible or difficult to inspect/check afterwards.

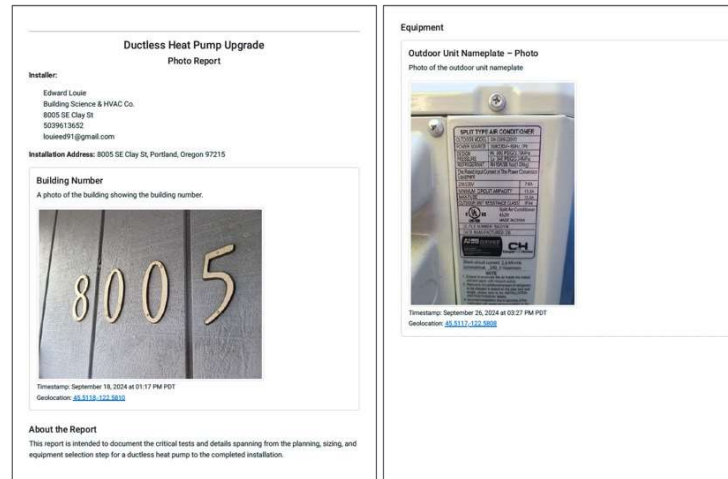


# Modern Approach

The Quality Install Tool (QIT) works seamlessly to provide best-practice guidance to installers while documenting the quality installation for a wide range of stakeholders.

## Typical Process Flow Using the QIT:

- 1) Contractor takes prompted pictures throughout the installation process
- 2) Tool converts picture series into PDF for sharing purposes (similar to a home inspection process)
- 3) PDF can be shared with many stakeholders for documentation of quality installation



Designed by FreePik

## Who Benefits?



Customer

Documents quality of the retrofit they have invested in



Contractor

Documents work completed and its quality at the time of completion; also serves as installation guide for trainees



3rd Party Verifiers

Supports review of work done without travel or logistical inconvenience



Utilities

Helps utilities have evidence that their program's incentives will realize full savings potential



Insurance

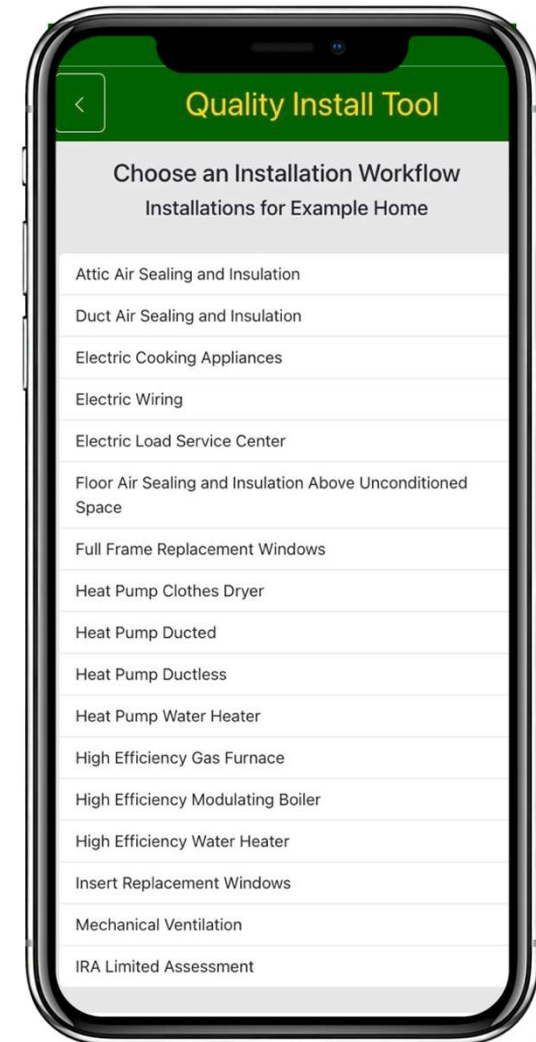
Photo documentation of assets for accurate risk assessment



## Quality Install Tool

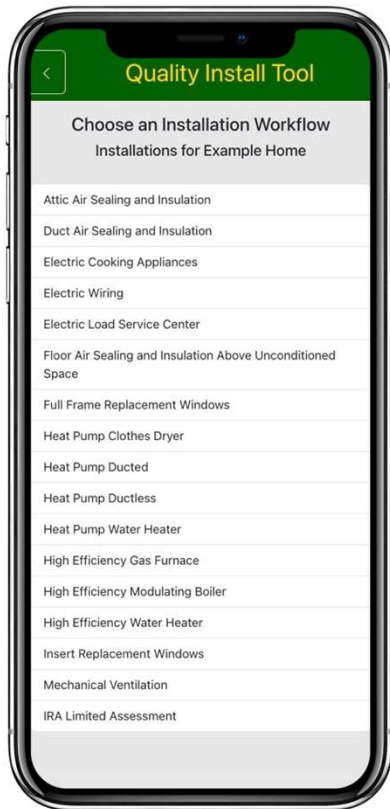
### Features to support wide-scale adoption and market transformation

- No other tool easily and systematically documents critical details and test results:
  - Streamlines quality install workflow for contractors
  - Points to other standards and tools where possible
  - Built-in geotagged and timestamped photos for proof of install at particular location
  - Automated PDF report generation – easy to share via email
- Free to use
- No download needed, “Web-app” works offline, saves offline, send PDF when back online
- Open-source code/adaptable – programs can use the code and change the requirements if desired (DOE version is best practice)



# Workflows

Currently available workflows:



## HVAC Workflows

- Heat Pump Ducted
- Heat Pump Ductless
- High Efficiency Gas Furnace
- Duct Air Sealing and Insulation
- Mechanical Ventilation
- IRA Limited Assessment

## Plumbing Workflows

- Heat Pump Water Heater
- High Efficiency (Gas/Oil) Water Heater
- High Efficiency (Gas/Oil) Modulating Boiler

## Safety Workflows

- Combustion Safety Testing

## Envelope Workflows

- Attic Air Sealing and Insulation
- Wall Air Sealing and Insulation
- Floor Air Sealing and Insulation Above Unconditioned Space
- Foundation Wall Air Sealing and Insulation
- Slab Foundation Air Sealing and Insulation
- Full Frame Replacement Windows
- Insert Replacement Windows

## Electrical & Appliance Workflows

- Electric Wiring
- Electric Load Service Center
- Heat Pump Clothes Dryer
- Electric Cooking Appliances



## Workforce Training Needed

- Blower door directed air sealing was developed in the 1980s by weatherization specialists supported by the Weatherization Assistance Program (WAP), however the skill is still not ubiquitous among the workforce.
- Air Conditioning Contractors of America (ACCA) released the first version of Quality Installation Specification in 2007; however, the skill to do a proper vacuum decay and pressure decay test is not ubiquitous among the workforce.
- QIT can also be used as part of training.

Vacuum Decay Test Setup – Photo

 Add Photo

Vacuum Decay Test Results – Photo

Take a photo of the vacuum decay test results. Use a digital micron gauge. The system must be isolated from the vacuum pump. The vacuum must not rise above 500 microns in 15 minutes.

 Add Photo





# Quality Install Tool - Introduction

Each workflow "Installation" can be done more than once (e.g., DHP #1, DHP #2, DHP #3)

First Time Use

Subsequent uses will start here

## Quality Install Tool

## Quality Install Tool

## Quality Install Tool

## Quality Install Tool

### New Project Information

Project Name

### Installer Information

The Installer information is optional, but we recommend filling in at least one field for reference in the final report.

Technician Name

Installation Company

Company Address

Company Phone

State

Zip Code

Building Number - Photo

Add Photo

Cancel

Save Project

Add a New Project

**Example House**  
935 SE Test St,  
Portland, Oregon 97215

**GreenHome Institute**  
1451 Lake Drive SE,  
Grand Rapids, Michigan 49516

**Test**  
123 Test St,  
Portland, Oregon 97215

Click here to learn more about the [Quality Install Tool](#)

### Choose an Installation Workflow

#### Installations for Example House

935 SE Test St, Portland, Oregon 97215

- Attic Air Sealing and Insulation (1)
- Duct Air Sealing and Insulation
- Electric Cooking Appliances
- Electric Wiring
- Electric Load Service Center
- Floor Air Sealing and Insulation Above Unconditioned Space (1)
- Full Frame Replacement Windows
- Heat Pump Clothes Dryer
- Heat Pump Ducted (1)
- Heat Pump Ductless (3)
- Heat Pump Water Heater (1)
- High Efficiency Gas Furnace
- High Efficiency Modulating Boiler
- High Efficiency Water Heater
- Insert Replacement Windows

## Welcome to the Quality Install Tool

With this tool you will be able to easily take photos and document your entire installation project.

For your records  
For your clients  
For quality assurance reporting

Add a New Project

Click here to learn more about the [Quality Install Tool](#)

# Attic Air Sealing & Insulation Workflow

## Pre-Installation

Pre-Installation   Installation   Post-Installation   Report

Existing Conditions


Existing Conditions

What is the starting air leakage rate for the home before modification?

Not Measured  
 CFM at 50Pa

CFM at 50Pa  
**2523**

Starting blower door manometer showing the CFM50 value – Photo



What is the existing insulation in the ceiling?  
Blown-in insulation

What is the existing insulation R-value in the ceiling?



# Attic Air Sealing & Insulation Workflow

## Pre-Installation

### General Safety

General Safety



Roof condition



What is the roof condition?

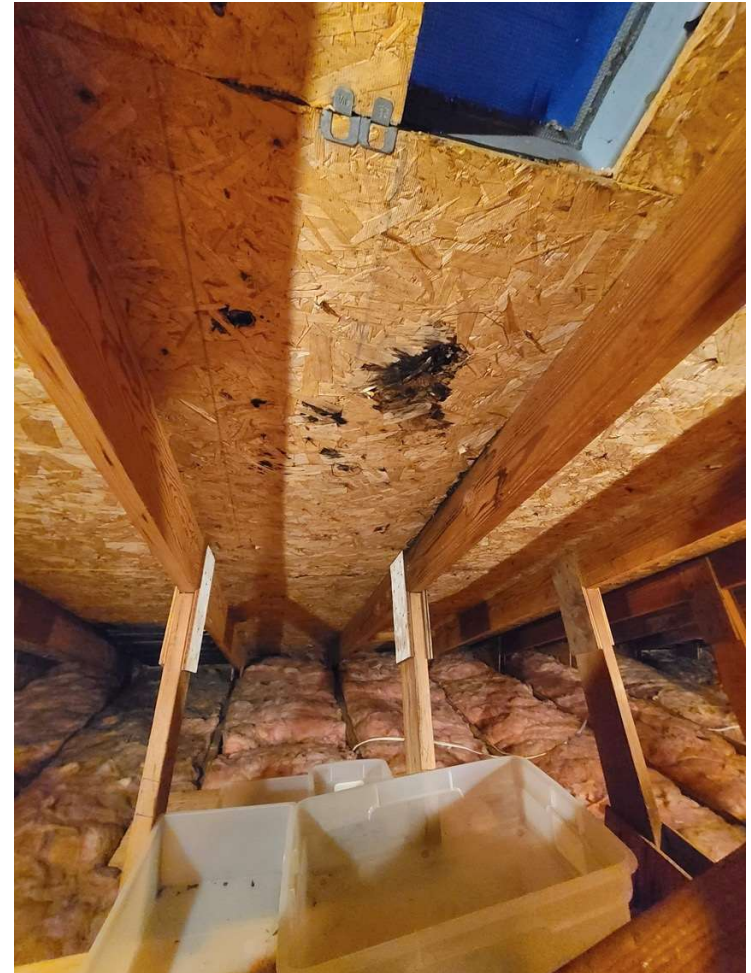
- Good
- Potential Issue

Mold or Moisture problems in the Attic



Are there signs of mold or moisture problems in the attic?

- Yes
- No





# Attic Air Sealing & Insulation Workflow

## Pre-Installation

Use your judgement.

A home with a very high starting air leakage rate is probably not going to get tight enough to where mechanical ventilation will be warranted.

But for homes that are decently tight to begin with but don't have MV, this is the time to calculate MV needs and pick an appropriate MV device.

Pre-retrofit mechanical ventilation calculation ^

- The pre-retrofit ventilation calculation can help estimate whether mechanical ventilation will be needed post air sealing and insulation work.
- Consider using RED Calc ASHRAE 62.2 tools to do the mechanical ventilation calculation. <https://basc.pnnl.gov/redcalc>
  - Consider infiltration credits. A very leaky home may still be leaky enough after the scoped air sealing and insulation work is completed.
- The ASHRAE 62.2 standard does not require the installation of a system smaller than 15 CFM (7 L/s)

Has mechanical ventilation calculation been performed pre-retrofit?


Yes

No

Have the answers to these safety questions been disclosed to the homeowner?

Yes

No



**ASHRAE 62.2-2016 Ventilation**

New or existing construction

Dwelling unit is

Use infiltration credit

Closest weather station

Weather and shielding factor [1/hr] = 0.52

Floor area [] 1500

Number of occupants []

Dwelling height [] 8

Measured leakage @ 50Pa [] 2523

Use Advanced Blower Door Inputs

Use Local Ventilation Alternative Compliance

**Dwelling-Unit Ventilation Results**

Effective annual avg infiltration rate [] = 68

Total required ventilation rate,  $Q_{tot}$  [] = 67.5

Infiltration credit,  $Q_{inf}$  [] = 68

Required mechanical ventilation rate,  $Q_{fan}$  [] = 0

NOTE: The ASHRAE 62.2-2016 standard does not require the installation of a system smaller than 15 CFM (7 L/s)

**Dwelling-Unit Ventilation Run-Time Solver**

Fan capacity [] =

Fan run-time per hour [] =

**Dwelling-Unit Leakage Rate Solver**

Target mechanical ventilation rate [] =

Corresponding measured leakage @ 50Pa [] =

Version 2016-07-06\_01:30





# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

[Pre-Installation](#) **Installation** [Post-Installation](#) [Report](#)

Provide a photo of each detail, skip if the feature is not present the home's attic.

**Installation - Air Sealing** [Installation - Insulation](#)

Drywall to Top Plate – Photo



Add Photo



Soffit Air Baffles – Photo



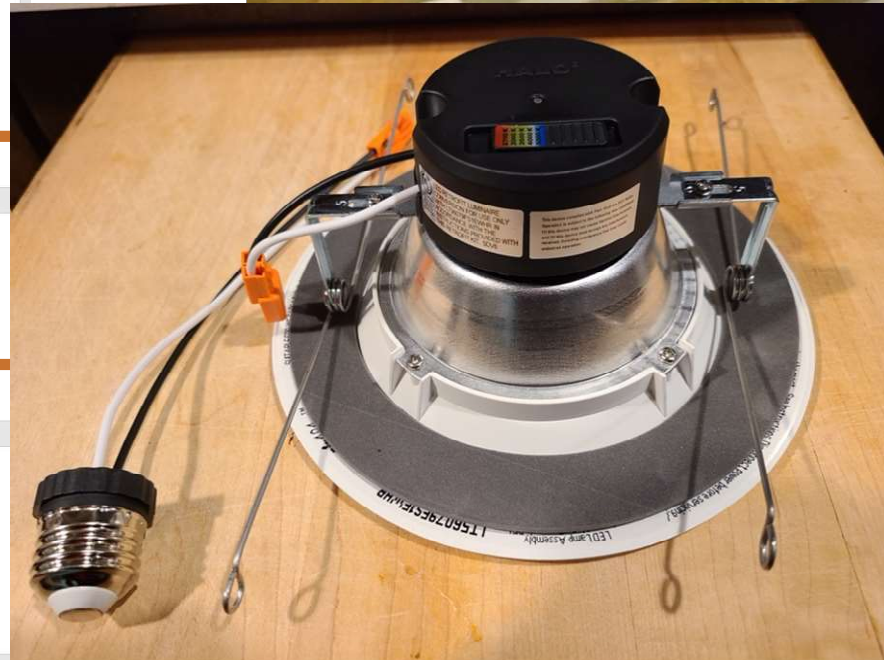
Add Photo



Leaky Recessed Light – Photo



Add Photo





# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

Chimney Dam – Photo ▼

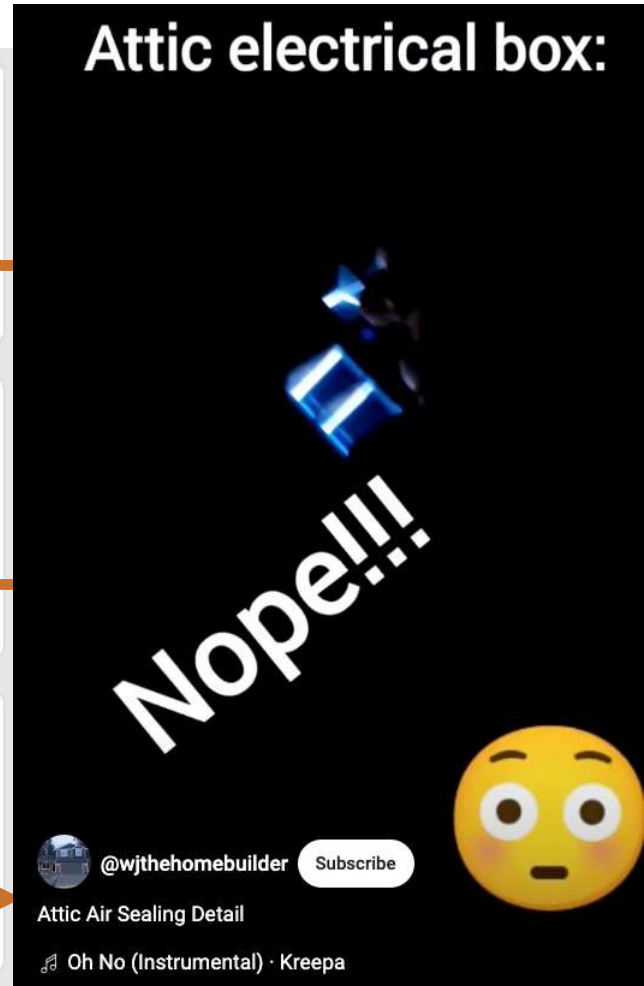
Add Photo

Hot Flue Pipe Dam – Photo ▼

Add Photo

Wire and Pipe Penetrations – Photo ▼

Add Photo



# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

Large Opening Sealed – Photo



 Add Photo

Duct Boot to Drywall – Photo



 Add Photo

Exhaust Fan Sealed to Drywall – Photo



 Add Photo





# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

Knee Walls Sealed – Photo



 Add Photo

Knee Walls Enclosed – Photo

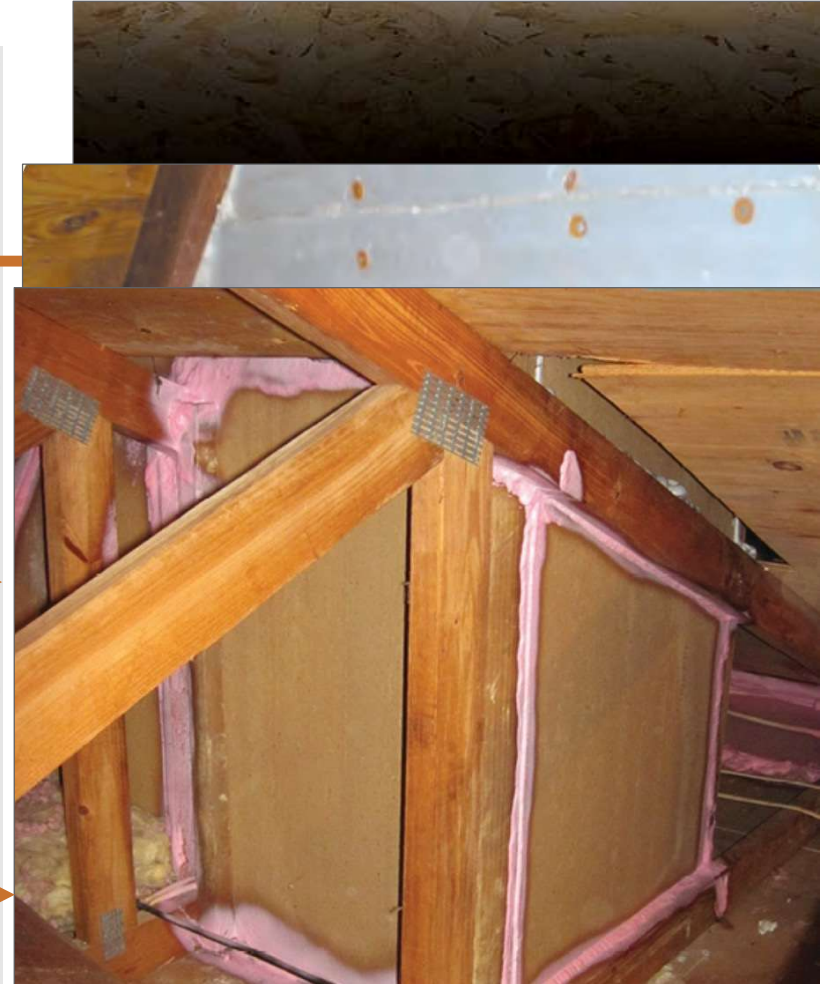


 Add Photo

Skylight Walls Sealed – Photo



 Add Photo





# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

Skylight Walls Enclosed – Photo



 Add Photo

Balloon Walls Sealed – Photo



 Add Photo

Stairwell Wall Sealed – Photo



 Add Photo







# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

T&G Ceiling Sealed – Photo



 Add Photo

Storage Platform Preparation – Photo



 Add Photo

Overview of Air Sealed Attic – Photo



 Add Photo



# Attic Air Sealing & Insulation Workflow

## Installation – Air Sealing

Attic Access Dam – Photo



 Add Photo



Attic Access Weatherstrip – Photo



 Add Photo



# Attic Air Sealing & Insulation Workflow

## Installation – Insulation

Installation - Air Sealing    Installation - Insulation

Insulation Measuring Rulers – Photo ▼

Add Photo

R-value Per Inch – Photo ▼

Add Photo

Skylight Shaft – Photo ▼

Add Photo







# Attic Air Sealing & Insulation Workflow

## Installation – Insulation

Knee Wall – Photo



 Add Photo

Stairwell Wall – Photo



 Add Photo

Storage Platform – Photo



 Add Photo





# Attic Air Sealing & Insulation Workflow

## Installation – Insulation

Wide Angle – Photo



 Add Photo

Attic Access - Photo



 Add Photo







# Attic Air Sealing & Insulation Workflow

## Post-Installation


### Final Conditions

What is the air sealing level you have achieved?

- Not Measured
- CFM at 50Pa

CFM at 50Pa

1756

Final blower door manometer showing the CFM50 value –   
Photo

 Add Photo









# Attic Air Sealing & Insulation Workflow Report – Print Report

The tool automatically generates a PDF report that can be saved to a phone. One can then use the phone's sharing capabilities to email a copy of the PDF and/or save it to a cloud storage location.

The report has the photos rotated and sized to fit into pages and places them into text that describes the photo. If the photo is of a test, the text describes to the reader what numbers represents good results.

<p>10/3/24, 4:22 PM</p> <p>DOE - Quality Installation Report</p> <p><b>Attic Air Sealing and Insulation Upgrade</b> Photo Report</p> <p><b>Installer:</b> Greatest Tech Ever Best Home Performance Company Ever 1234 Excellence Ave 503-123-4567 BestHPCC@gmail.com</p> <p><b>Installation Address:</b> 935 SE Test St, Portland, Oregon 97215</p> <p><b>Building Number</b> A photo of the building showing the building number:</p>  <p>Timestamp: September 16, 2024 at 01:11 PM PDT Geolocation: <a href="#">45.5118, -122.5812</a></p> <p><b>Existing Conditions</b> What part of the home are you air sealing? <b>Attic</b> What is the starting air leakage rate for the home before modification? <b>2523 CFM at 50Pa</b></p> <p><b>Starting blower door manometer showing the CFM50 value – Photo</b> Photo of the manometer showing CFM50 of air leakage before air sealing and insulation work was performed</p>  <p>Timestamp: October 3, 2024 at 04:20 PM PDT Geolocation: <a href="#">45.5118, -122.5812</a></p> <p><a href="https://quality-install-tool.pnl.gov/app/dae453f6-389d-4a89-a423-73b87a32eb5b/dae_workflow_attic_air_sealing_and_insulation/31485fa-e75c-41ac-ad5c-a364ca9...">https://quality-install-tool.pnl.gov/app/dae453f6-389d-4a89-a423-73b87a32eb5b/dae_workflow_attic_air_sealing_and_insulation/31485fa-e75c-41ac-ad5c-a364ca9...</a></p>	<p>10/3/24, 4:22 PM</p> <p>DOE - Quality Installation Report</p> <p>What is the existing insulation in the ceiling? <b>Blown-in insulation</b> What is the existing insulation R-value in the ceiling? <b>13</b></p> <p><b>General Safety</b> What is the roof condition? <b>Potential Issue</b> Are there signs of mold or moisture in the attic? <b>Yes</b> Has an mechanical ventilation calculation been performed pre-retrofit? <b>No</b> Have the answers to these safety questions been disclosed to the homeowner? <b>Yes</b></p> <p><b>Installation - Air Sealing Details</b></p> <p><b>Drywall to Top Plate – Photo</b> Photo of drywall to top plate seam sealed</p>  <p>Timestamp: October 3, 2024 at 04:21 PM PDT Geolocation: <a href="#">45.5118, -122.5812</a></p> <p><b>Soffit Air Baffles – Photo</b> Photo of soffit air baffles installed blocked with batt insulation and/or air sealed with spray foam</p>  <p>Timestamp: October 3, 2024 at 04:22 PM PDT Geolocation: <a href="#">45.5118, -122.5812</a></p> <p><a href="https://quality-install-tool.pnl.gov/app/dae453f6-389d-4a89-a423-73b87a32eb5b/dae_workflow_attic_air_sealing_and_insulation/31485fa-e75c-41ac-ad5c-a364ca9...">https://quality-install-tool.pnl.gov/app/dae453f6-389d-4a89-a423-73b87a32eb5b/dae_workflow_attic_air_sealing_and_insulation/31485fa-e75c-41ac-ad5c-a364ca9...</a></p>
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# Heat Pump Ducted Workflow Assessment

Assessment [Planning](#) [Installation](#) [Post-Installation](#)

[Report](#)

## Visual Assessment of the Ductwork

If the ducts will be entirely replaced or the visual inspection found significant duct upgrades and repairs are needed:

- Make notes and skip performing a duct leakage test at the initial phase
- Perform the duct leakage test post upgrades and repairs to verify the ducts are sufficiently airtight

Ductwork – Photo



Add Photo

Ductwork Comments



# Heat Pump Ducted Workflow Assessment

## Static Pressure Test

Total external static pressure measurement

Pre-upgrade Static Pressure Test – Photo



 Add Photo

Comment on remediation plans

*If total external static pressure is above 0.5 i.w.c, assess whether the static pressure is in the supply or return. If it is in the return, consider recommending upsizing the return filter to accommodate a larger size and a deeper filter.*





# Heat Pump Ducted Workflow Assessment

## Airflow Test

Use flow plate test OR the pressure matching technique

Pre-Upgrade Airflow Test Setup – Photo

Add Photo

Pre-Upgrade Airflow Results – Photo

Add Photo

Comments on Pre-Upgrade Airflow Test

*Comment on remediation plan if flow is much lower than 400 CFM per ton*

## Air Flow & Static Pressure Test - Cooling

! Problems detected

DETAILS

Air Flow

TESP



376 SCFM/ton  
(1128 SCFM, 3 ton)

1.003 inH<sub>2</sub>O



Return Plenum Pressure

0.556 inH<sub>2</sub>O



Filter Pressure Drop



# Heat Pump Ducted Workflow Assessment

## Duct Leakage Testing

If the ducts will be entirely replaced or the visual inspection found significant duct upgrades and repairs are needed:

- Make notes and skip performing a duct leakage test at the initial phase
- Perform the duct leakage test post upgrades and repairs to verify the ducts are sufficiently airtight

Select the test method used:  
Duct leakage tester

Duct Test Setup – Photo

Add Photo

Duct Leakage CFM – Photo

Add Photo

### CFM25 per 100 ft<sup>2</sup> Calculator

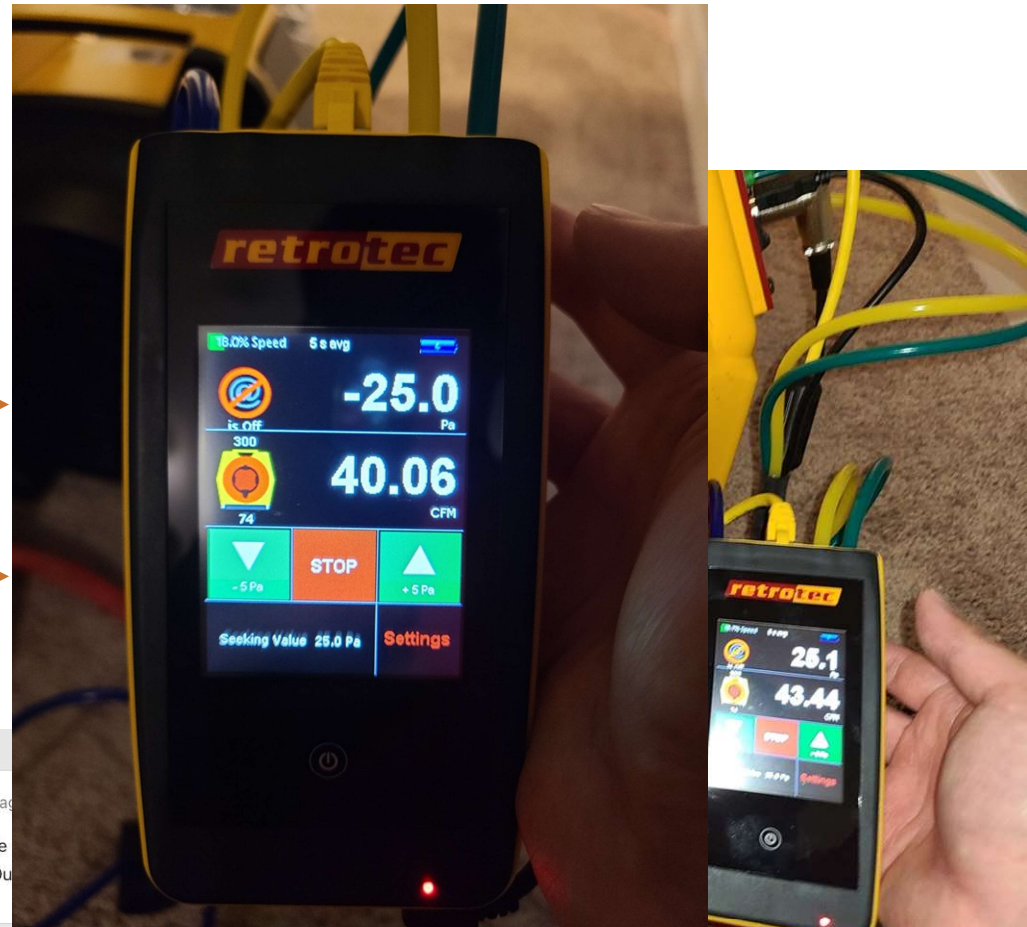
CFM25  
40

Conditioned Floor Area (ft<sup>2</sup>)  
1320

CFM25 per 100 ft<sup>2</sup> = 3

### Type Of Test

- Type of duct leakage
- Total Leakage
  - Leakage to Outside







# Heat Pump Ducted Workflow Planning

Assessment **Planning** Installation Post-Installation Report

### Planned Install Location

Proposed ODU Install Location – Photo ▼

 Add Photo 

ODU Mounting Style

- Pad
- Ground Stand
- Wall Mount
- Roof Mount

ODU Inches Above The Ground (elevated above the snow)

14

Overhead Snow & Ice Protection

- Awning/Cover
- None





# Heat Pump Ducted Workflow Planning

## Manual J Calculation

Manual J Calculation Details

PDF of Manual J - File

File Types Accepted: PDF

Add File

Manual J Notes or Comments

## Acceptable Manual J Load Calculation

4/5/24, 8:50 AM HVAC Sizing Tool: Results

**Full Residential Load Calculation**  
(Supports Block Load™, Room-by-Room Load™, Zone-by-Zone™ and Adequate Exposure Diversity™ or AED™ Calculations)

[Wrightsoft Right-J8](#)  
[Elite RHVAC](#)  
[Adtek Acculoads](#)  
[Florida Solar Energy Center's EnergyGauge](#)  
[Carmelsoft HVAC ResLoad-J](#)  
[Avenir MJ8 Editions of HeatCAD and LoopCAD](#)  
[Cool Calc Manual J](#)  
[Conduit Tech](#)  
[Amplify Energy](#)

	Suggested Ducts	Actual Ducts	Duct Size CFM/Duct	Actual CFM Measured	Floor Area	Ext. Length	Height Override	Uncond Ceiling	Uncond Floor	Heating Load	Cooling Load
Laundry Room	2	3	112	500	30.0			100 %	100 %	5,294	4,706
Bathroom 1	1	3	50	150	10.0			100 %	100 %	1,347	1,905
Bathroom 1	1	3	50	150	10.0			100 %	100 %	1,347	1,905
<b>Total</b>				1,500						15,300	12,682

Kwik Model uses Florida Solar Energy Center's EnergyGauge for Manual J

Other Manual J software or sizing method approved by your state/utility's program



# Heat Pump Ducted Workflow Planning

## Equipment Performance Tables

You are encouraged to use the [Cold Climate Heat Pump Decision Tool](#) which can help assist in selecting the right heat pump for this home. The Cold Climate Heat Pump Decision Tool will make use of the Manual J load values and the duct air flow capability test result data.

Equipment Selection Details

Mfr's Heating Performance Table – Photo

Add Photo

Aux Heat Lockout Above This Temperature (°F)

Compressor Lockout Below This Temperature (°F)

Dual Fuel Switch Over Temperature (°F)

Mfr's cooling performance table – Photo

Add Photo

Some manufacturers provide extended performance data for heating and cooling which is ideal for selecting equipment with adequate performance at the design temperatures.

## Cooling Capacity Table for LV181HHV4 (LUU180HHV + LVN181HV4)

Table 30: Cooling Capacity Table for LUU180HHV + LVN181HV4.

Outdoor Air Temp. (°F DB)	Indoor Air Temp. °F DB / °F WB																	
	68 / 57			72 / 61			77 / 64			80 / 67			86 / 72			90 / 75		
	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI
-4	17.70	13.35	0.80	18.80	14.10	0.83	19.89	13.66	0.86	20.69	13.94	0.87	22.09	14.06	0.88	23.19	14.33	0.90
-0.4	17.69	13.43	0.81	18.79	14.19	0.84	19.88	13.74	0.87	20.68	14.03	0.88	22.08	14.14	0.89	23.18	14.41	0.91
5	17.67	13.55	0.82	18.77	14.31	0.85	19.87	13.86	0.88	20.66	14.15	0.89	22.06	14.27	0.91	23.16	14.54	0.93
10	17.66	13.65	0.83	18.76	14.42	0.86	19.85	13.97	0.89	20.64	14.26	0.90	22.05	14.38	0.92	23.14	14.65	0.94
15	17.65	13.76	0.84	18.74	14.54	0.88	19.84	14.08	0.91	20.63	14.37	0.92	22.03	14.49	0.94	23.12	14.77	0.95
20	17.63	13.87	0.86	18.73	14.65	0.89	19.82	14.19	0.92	20.61	14.49	0.93	22.01	14.61	0.95	23.11	14.88	0.97
25	17.62	13.98	0.87	18.71	14.77	0.90	19.81	14.30	0.93	20.60	14.60	0.94	22.00	14.72	0.96	23.09	15.00	0.98
30	17.60	14.08	0.88	18.70	14.88	0.91	19.79	14.41	0.95	20.58	14.71	0.96	21.98	14.83	0.98	23.07	15.11	1.00
35	17.59	14.19	0.89	18.68	14.99	0.93	19.78	14.52	0.96	20.57	14.82	0.97	21.96	14.95	0.99	23.05	15.23	1.01
40	17.58	14.30	0.91	18.67	15.10	0.94	19.76	14.63	0.97	20.55	14.93	0.98	21.94	15.06	1.00	23.04	15.34	1.02
45	17.56	14.41	0.92	18.66	15.22	0.95	19.75	14.73	0.99	20.53	15.04	1.00	21.93	15.17	1.02	23.02	15.46	1.04
50	17.55	14.51	0.93	18.64	15.33	0.96	19.73	14.84	1.00	20.52	15.16	1.01	21.91	15.28	1.03	23.00	15.57	1.05
55	17.54	14.62	0.94	18.63	15.44	0.98	19.72	14.95	1.01	20.50	15.27	1.02	21.89	15.40	1.04	22.98	15.69	1.06
60	17.52	14.72	0.95	18.61	15.55	0.99	19.70	15.06	1.03	20.49	15.38	1.04	21.88	15.51	1.06	22.97	15.80	1.08
65	17.51	14.83	0.97	18.60	15.67	1.00	19.69	15.17	1.04	20.47	15.49	1.05	21.86	15.62	1.07	22.95	15.91	1.09
70	17.50	14.94	0.98	18.58	15.78	1.01	19.67	15.28	1.05	20.46	15.60	1.06	21.84	15.73	1.08	22.93	16.03	1.10
75	17.08	14.69	1.03	18.16	15.54	1.07	19.24	15.06	1.11	20.03	15.39	1.12	21.41	15.54	1.14	22.50	15.85	1.16
80	16.66	14.44	1.08	17.74	15.29	1.12	18.82	14.84	1.16	19.60	15.18	1.18	20.98	15.34	1.20	22.06	15.66	1.22
85	16.24	14.18	1.14	17.32	15.04	1.18	18.40	14.61	1.22	19.17	14.95	1.24	20.55	15.14	1.26	21.63	15.46	1.28
90	15.82	13.91	1.19	16.90	14.77	1.23	17.97	14.37	1.28	18.75	14.72	1.29	20.12	14.92	1.32	21.20	15.26	1.34
95	15.37	13.76	1.24	16.44	14.64	1.29	17.51	14.27	1.33	18.00	14.40	1.35	19.65	14.84	1.38	20.72	15.19	1.40
100	14.99	13.39	1.30	16.06	14.27	1.34	17.13	13.92	1.39	17.77	14.18	1.41	19.28	14.52	1.43	20.35	14.88	1.46
105	14.62	13.02	1.35	15.69	13.90	1.40	16.76	13.59	1.45	17.53	13.95	1.46	18.90	14.21	1.49	19.97	14.57	1.52
110	14.24	12.58	1.40	15.32	13.45	1.45	16.39	13.17	1.50	17.16	13.54	1.52	18.53	13.80	1.55	19.60	14.17	1.58
115	13.87	12.20	1.45	14.94	13.07	1.51	16.01	12.82	1.56	16.79	13.19	1.58	18.15	13.47	1.61	19.22	13.85	1.64
118	13.65	12.11	1.49	14.72	12.99	1.54	15.79	12.75	1.60	16.56	13.13	1.61	17.93	13.43	1.64	19.00	13.81	1.68
122	13.57	12.08	1.53	14.64	12.97	1.58	15.71	12.73	1.64	16.49	13.11	1.66	17.85	13.41	1.69	18.92	13.80	1.72





# Heat Pump Ducted Workflow Installation

Assessment   Planning   **Installation**   Post-Installation   Report

Installation Date  
mm/dd/yyyy

**Refrigerant Recovery**

Is this heat pump installation replacing an old AC or heat pump?

Yes  
 No

Old AC or Heat Pump Nameplate – Photo

Add Photo

Recovery Setup – Photo

Add Photo

Recovery Scale – Photo

Add Photo





# Heat Pump Ducted Workflow Installation

**Equipment**

ODU nameplate – Photo

IDU nameplate – Photo

**Electrical**

ODU circuit breaker – Photo

IDU circuit breaker – Photo

Circuit Breaker Notes  
**IDU powered by ODU at the disconnect**  
*E.g., wire size modifications, or shared or repurposed circuits.*





# Heat Pump Ducted Workflow Installation

## Installation Tests

Nitrogen Pressure Test Setup – Photo

Add Photo

Nitrogen Pressure Decay Test Results – Photo

Add Photo

Vacuum Decay Test Setup – Photo

Add Photo

Vacuum Decay Test Results – Photo

Add Photo





# Heat Pump Ducted Workflow Installation

## Refrigerant Adjustments

Refrigerant Adjustments (if applicable) – Photo ▼

## Additional Refrigerant Calculator

Feet of line set beyond factory charge  
**0**

Ounce of refrigerant per foot of line set  
**0.69**

*Please write the ounces of additional refrigerant added beyond the factory charge behind the service cover.*

Ounces of additional refrigerant = **0**

Notes about refrigerant quantity adjustments or weigh in

## REFRIGERANT PIPE DATA

	Indoor unit	EEV for cooling
Throttle type	Outdoor unit	EEV for heating
Design pressure	(PSIG)	550/340
Refrigerant type		R410A
Refrigerant charge	oz	102.32
Refrigerant precharge	(ft)	25.0
	(m)	7.5
Additional charge for each ft	(oz/ft)	0.69
Additional charge for each m	(g/m)	65.0
Liquid side/ Gas side(indoor)	(inch)	3/8" / 3/4"
	(mm)	9.52/19
Liquid side/ Gas side(outdoor)	(inch)	3/8" / 3/4"
	(mm)	9.52/19
Max. pipe length	(ft)	164.0
	(m)	50.0
Max. difference in level	(ft)	82.0
	(m)	25.0
Connection method		Flared





# Heat Pump Ducted Workflow Installation

## Protection

Line Set Protection – Photo



Add Photo



Electrical Surge Protection Device – Photo



Add Photo



Service Caps Reinstalled and Tight – Photo



Add Photo

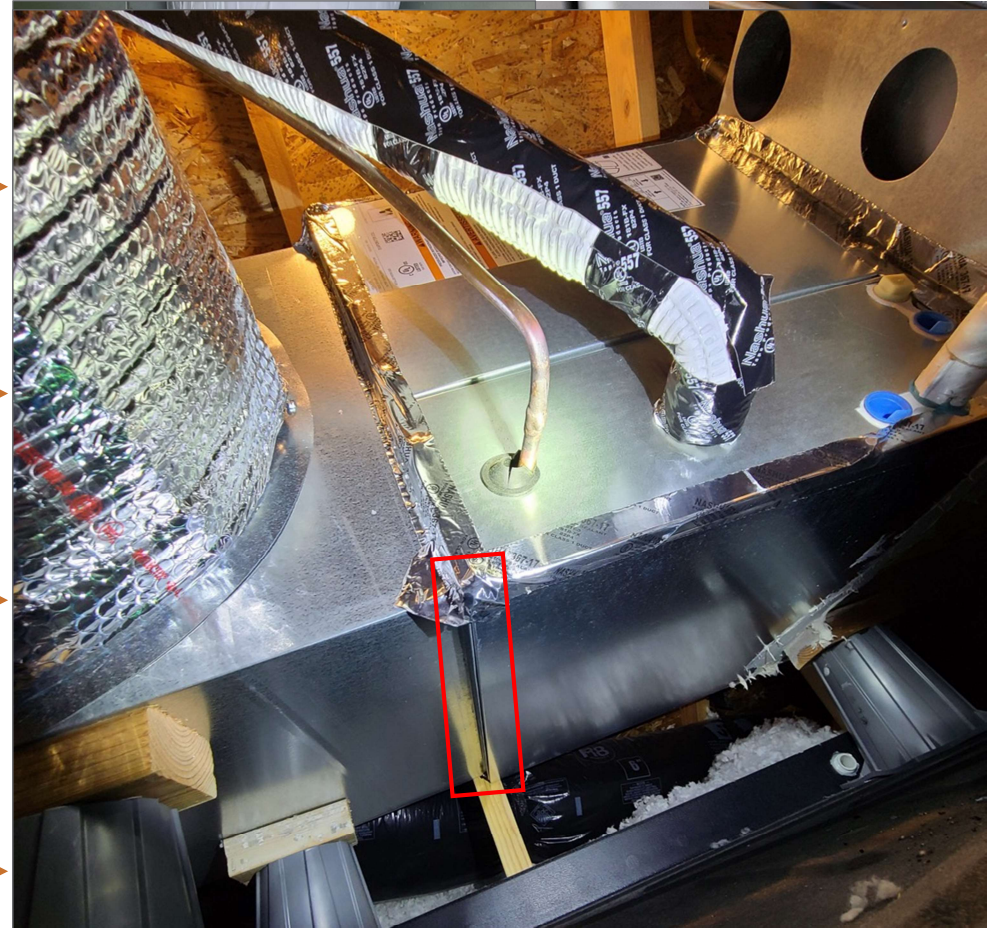


## Plenum connections

Plenum Connections – Photo



Add Photo






# Heat Pump Ducted Workflow

## Post-Installation


Assessment Planning Installation **Post-Installation** Report

### Post-install Airflow Test

Post-Install Airflow Test Setup – Photo


 Add Photo

Post-Install Airflow Test Results – Photo


 Add Photo

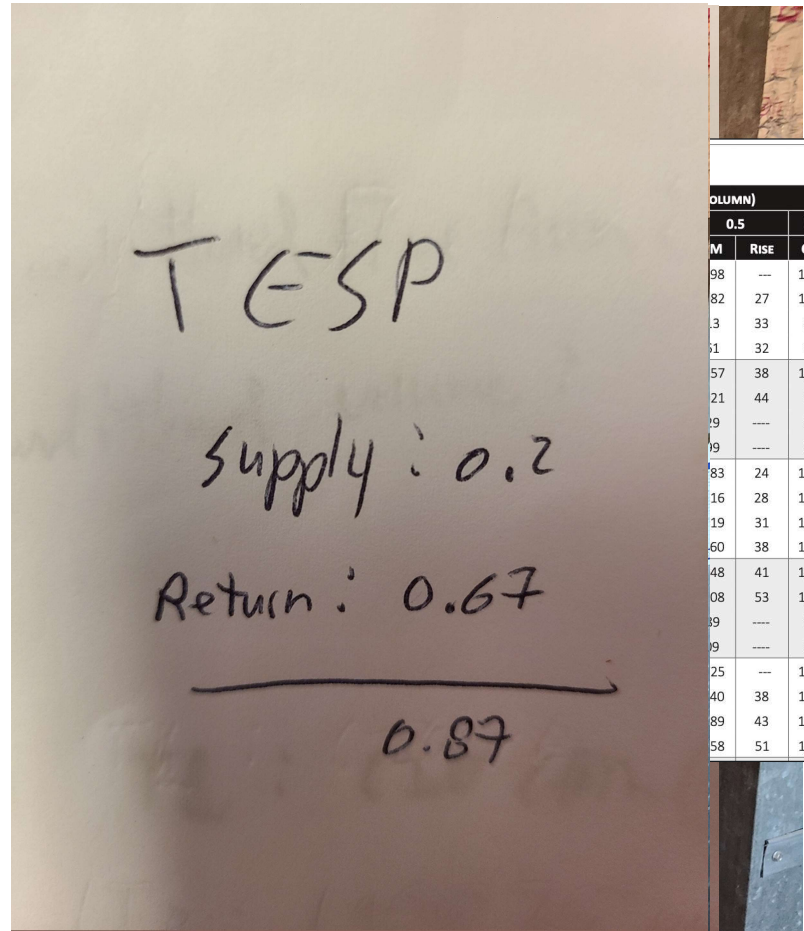
### Post-install Static Pressure Test

Post-Install Static Pressure Test Setup – Photo

 Add Photo

Post-Install Static Pressure Test Results – Photo

 Add Photo



		COLUMN)			
		0.5	0.6	0.7	0.8
M	RISE	CFM	CFM	CFM	CFM
98	---	1,243	1,164	1,075	
82	27	1,042	997	925	
3	33	882	821	803	
51	32	745	716	668	
57	38	1,092	1,075	983	
21	44	983	924	868	
9	---	818	792	728	
9	---	677	649	626	
83	24	1,786	1,700	1,601	
16	28	1,549	1,492	1,391	
19	31	1,378	1,328	1,261	
60	38	1,144	1,111	1,071	
48	41	1,390	1,302	1,222	
08	53	1,075	1,033	957	
9	---	865	829	785	
9	---	683	666	604	
25	---	1,627	1,530	1,439	
40	38	1,475	1,394	1,307	
89	43	1,339	1,274	1,204	
58	51	1,125	1,125	1,080	



# Heat Pump Ducted Workflow Post-Installation

## Thermostat Settings

Thermostat Setting – Photo

Add Photo



Notes about thermostat settings

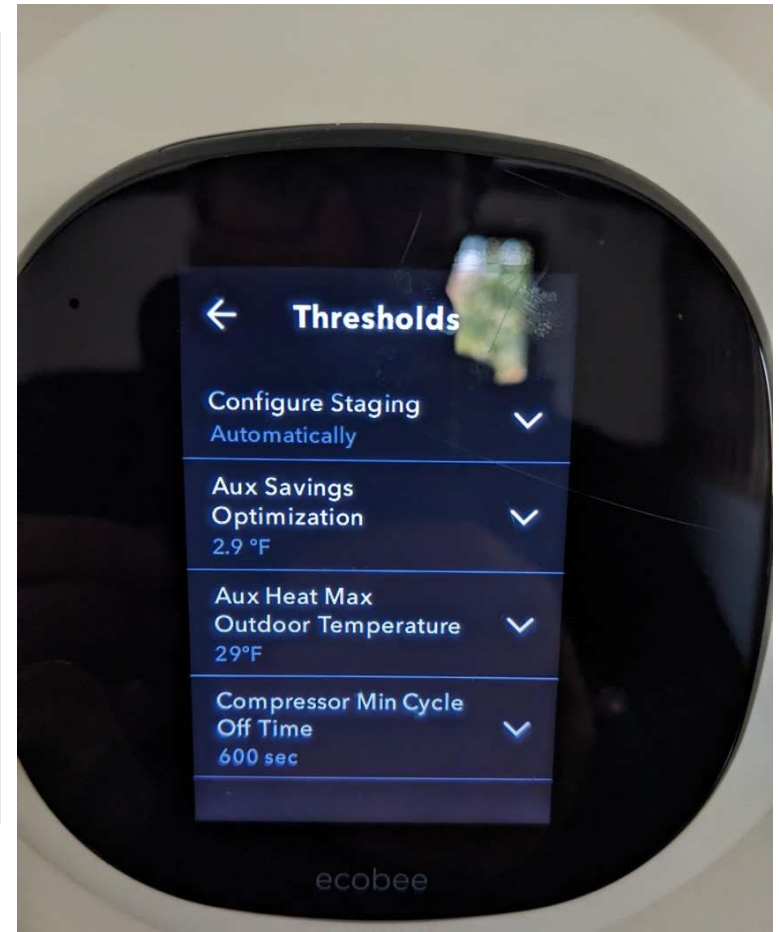
## Project Invoice

Project Invoice – Photo

Add Photo

## Mechanical Ventilation

If the addition of supply based mechanical ventilation is included in the heat pump upgrade. Use the mechanical ventilation quality installation workflow to document that installation.



## Accurate Geolocation & Time Stamps



Instructions/guide to accurate geolocation and time stamps when using the QIT.

Enable location services on phone and allow the web browser and/or camera to use the device's location while using the App if/when prompted.

Accurate geolocation and time stamps to the job site:

- Photos taken using the QIT using a smartphone
- Photos transferred from phone to desktop/laptop using a USB cable and uploaded to the QIT I using a desktop/laptop

Not accurate geolocation and time stamps to the job site:

- Photos uploaded to the QIT from the phone's storage when off-site
  - ✓ Reason: iOS and Android security prevents the web browser from accessing a file's metadata. Thus, the QIT must instead record the geolocation and time of the phone's current location.
- Photos transferred from Android phones to desktop/laptop using email or Google Drive
  - ✓ Reason: Android security removes geolocation data when uploading files from the phone to email and cloud storage platforms.

# Checking the Geolocation

- In the report, click on the geolocation link below an image to see the location on Google Maps.
- In the QIT workflow, click on the geolocation link below an image to see the location on Google Maps.
- Check to see if this location matches the installation address in the report.

## Quality Installation Report PDF


10/3/24, 4:22 PM DOE - Quality Installation Report

Attic Air Sealing and Insulation Upgrade  
Photo Report

Installer:  
Crestless Tech Ever  
Best Home Performance Company Ever  
1234 Excellence Ave  
503-123-4567  
BestHPCE@gmail.com

Installation Address: 935 SE Test St, Portland, Oregon 97215


Building Number  
A photo of the building showing the building number.



Timestamp: September 18, 2024 at 01:11 PM PDT  
Geolocation: [45.5118, -122.5810](#)

Existing Conditions  
What part of the home are you air sealing? Attic  
What is the starting air leakage rate for the home before modification? 2523 CFM at 50Pa

Starting blower door manometer showing the CFM50 value – Photo  
Photo of the manometer showing CFM50 of air leakage before air sealing and insulation work was performed




Timestamp: October 3, 2024 at 04:20 PM PDT  
Geolocation: [45.5118, -122.5810](#)

[https://quality-install-tool.pnl.gov/app/doi4536c-3894-4a89-a423-73b87a32eb36/doi\\_workflow\\_attic\\_air\\_sealing\\_and\\_insulation/3148364a-e75c-41ac-ad5c-a364ca9...](https://quality-install-tool.pnl.gov/app/doi4536c-3894-4a89-a423-73b87a32eb36/doi_workflow_attic_air_sealing_and_insulation/3148364a-e75c-41ac-ad5c-a364ca9...) 1/4

## Quality Installation Tool Workflow

Starting blower door manometer showing the CFM50 value – Photo

Replace Photo



Timestamp: October 3, 2024 at 04:20 PM PDT  
Geolocation: [45.5118, -122.5810](#)





# Contact

Feel free to contact Edward Louie if you have further questions.

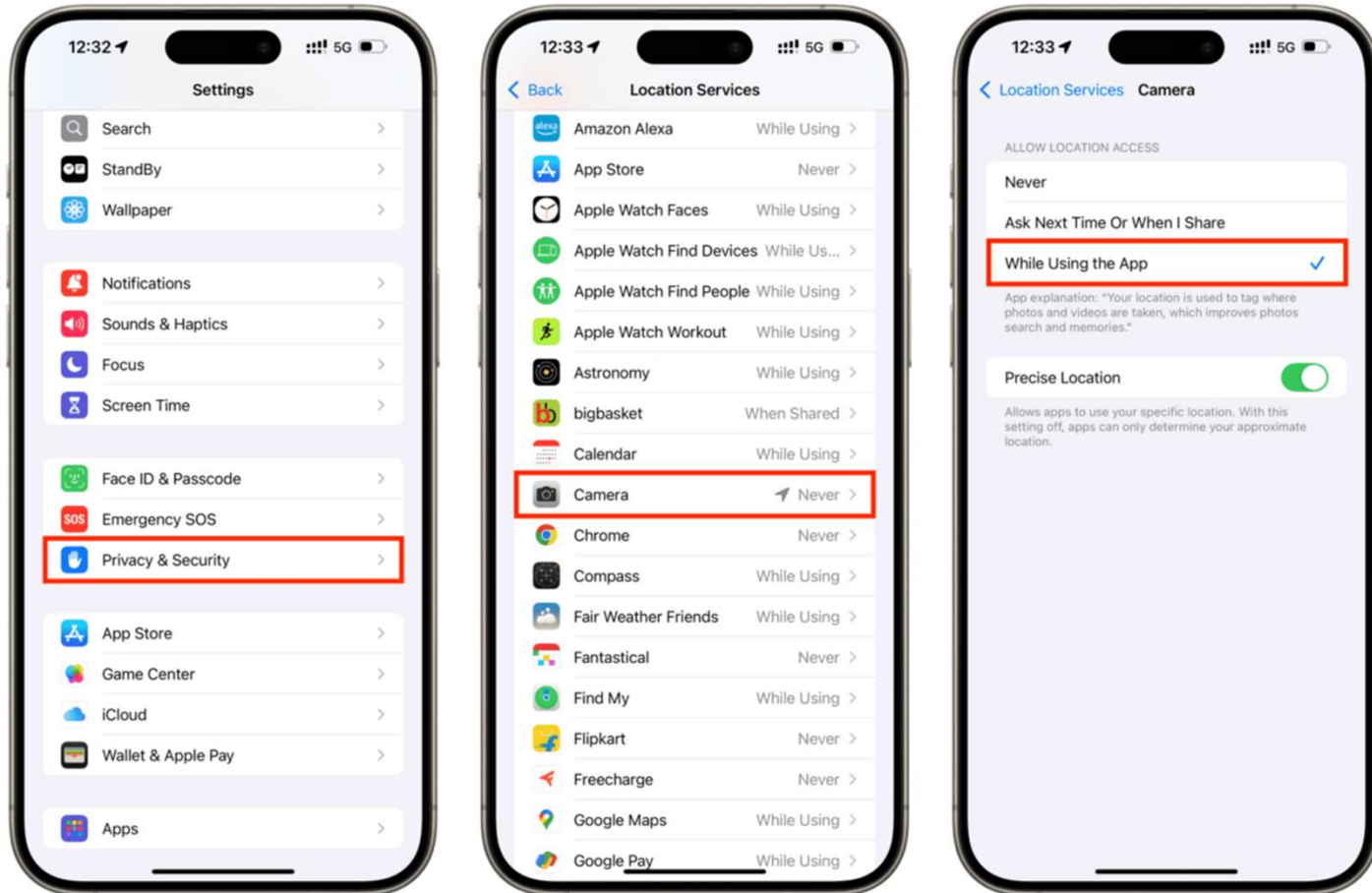
[edward.louie@pnnl.gov](mailto:edward.louie@pnnl.gov)

902 Battelle Boulevard  
P.O. Box 999  
Richland, WA 99352

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## Troubleshooting Location Permission Settings on iOS



## Troubleshooting Location Permission Settings on Android

