WASHINGTON STATE UNIVERSITY
Energy Program

Hello, and welcome to WSU-EP monthly trainings.

This event is being recorded. We ask kindly that you remain muted throughout the presentation. We will answer questions in the Q&A tab. We will attempt to keep up with the chat. We will offer live Q&A with the remaining time at the end of this presentation. We are limited to 500 attendees.

Thank you for your understand and we will begin our presentation at 1pm.

Washington State University
Energy Program

WASHINGTON STATE UNIVERSITY
Energy Program

Ventilation
&
WSEC-R 2021 2nd Edition

Washington State University
Energy Program

Thank you to our sponsor!

neea

About NEEA
Our Purpose - *The Northwest Energy Efficiency Alliance (NEEA) is an alliance of utilities and energy efficiency organizations that pools resources and shares risks to transform the market for energy efficiency to the benefit of consumers in the Northwest.*

(https://neea.org/about-neea)

Table of Contents

This presentation's purpose is to guide the perspective viewer through a summary review of the Washington Amended Codes as they pertain to WA State Amended Codes-Residential. This education is an estimated two hour class.

Washington State Energy Code Support?

WASHINGTON STATE UNIVERSITY
Energy Program

WASHINGTON STATE ENERGY CODE
LOGIN
Create Account

Residential

WSU Energy Program

energycode@energy.wsu.edu

360-956-2042

Commercial

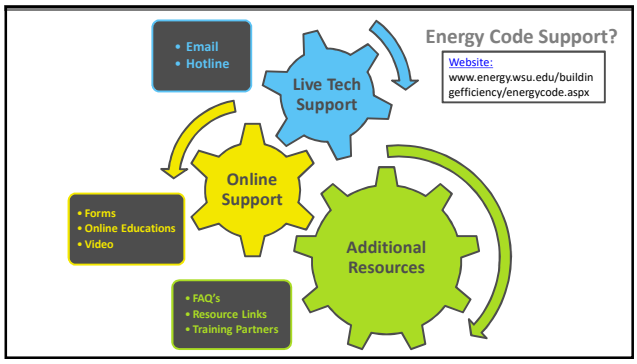
Evergreen Technology Consulting

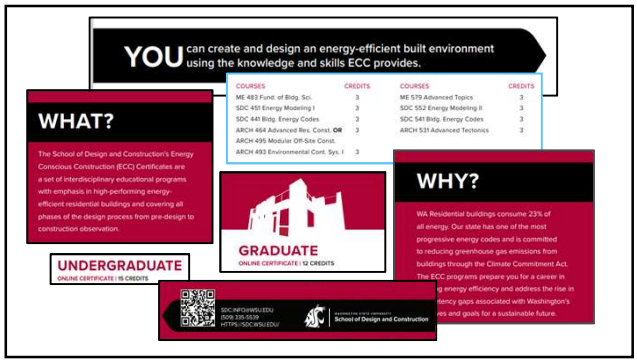
com.techsupport@waenergycodes.com

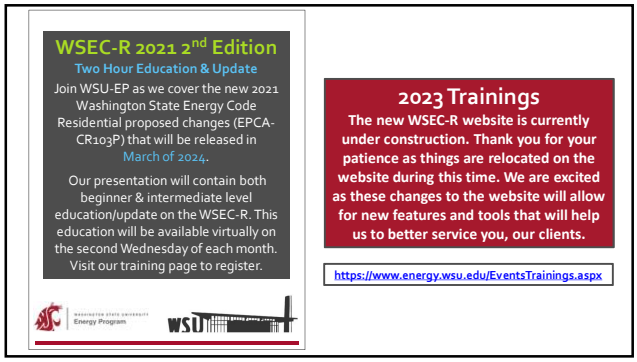
360-539-5202

The WSU (Washington State University) Energy Program has a long history of working towards energy efficiency, renewable energy, and sustainable practices. Here is an overview of its history:

Establishment: The WSU Energy Program was established in 1996 as part of the Washington State University Extension. It was initially known as the Washington Energy Extension Service.
Early Focus: In its early years, the program primarily focused on energy conservation and efficiency. It aimed to educate and provide technical assistance to individuals, businesses, and communities in Washington State to promote energy conservation practices.
Growth and Diversification: Over time, the program expanded its scope and initiatives. It began to work on a broader range of energy-related issues, including renewable energy, clean technologies, and sustainable practices. The program became involved in research, development, and deployment of new energy technologies.
Federal Programs and Partnerships: The WSU Energy Program has actively collaborated with federal agencies, including the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA). These partnerships allowed the program to access resources, funding, and expertise to further its mission.
Energy Codes and Standards: The WSU Energy Program played a significant role in the development and implementation of energy codes and standards in Washington State. It worked closely with government agencies, utility companies, and industry stakeholders to establish energy efficiency requirements for buildings and appliances.
Renewable Energy Initiatives: The program has been involved in various renewable energy initiatives, such as solar power, wind energy, bioenergy, and energy storage. It has supported research, demonstration projects, and educational efforts to promote the adoption of renewable energy technologies.
Education and Training: The WSU Energy Program has been actively engaged in providing education and training to professionals, students, and the general public. It offers workshops, seminars, and certification programs on energy efficiency, renewable energy, and sustainable practices.
Focus on Communities: The program has a strong focus on serving communities throughout Washington State. It provides technical assistance, funding support, and resources to help communities develop sustainable energy plans, implement energy projects, and reduce energy consumption.
Continued Innovation: The WSU Energy Program continues to evolve and adapt to changing energy landscapes and emerging technologies. It stays at the forefront of energy research, policy development, and industry trends to address current and future energy challenges.
Overall, the WSU Energy Program has a rich history of promoting energy efficiency, renewable energy, and sustainable practices. Its work has contributed to the advancement of clean energy technologies and the reduction of energy consumption in Washington State and beyond.


• Email
• Hotline
Live Tech Support
Energy Code Support?
Website:
www.energy.wsu.edu/buildingefficiency/energycode.aspx
Online Support
• Forms
• Online Educations
• Video
Additional Resources
• FAQ's
• Resource Links
• Training Partners


YOU can create and design an energy-efficient built environment using the knowledge and skills ECC provides.
WHAT?
The School of Design and Construction's Energy Conscious Construction (ECC) Certificates are a set of interdisciplinary educational programs with emphasis in high-performing energy-efficient residential buildings and covering all phases of the design process from pre-design to construction observation.
COURSES
CREDITS
ME 483 Fund. of Bldg. Sci. 3
SDC 451 Energy Modeling I 3
SDC 441 Bldg. Energy Codes 3
ARCH 464 Advanced Res. Const. OR 3
ARCH 495 Modular Off-Site Const.
ARCH 493 Environmental Cont. Sys. I 3
COURSES
CREDITS
ME 579 Advanced Topics 3
SDC 552 Energy Modeling II 3
SDC 541 Bldg. Energy Codes 3
ARCH 531 Advanced Tectonics 3
GRADUATE
ONLINE CERTIFICATE | 12 CREDITS
WHY?
WA Residential buildings consume 23% of all energy. Our state has one of the most progressive energy codes and is committed to reducing greenhouse gas emissions from buildings through the Climate Commitment Act. The ECC programs prepare you for a career in
UNDERGRADUATE
ONLINE CERTIFICATE | 15 CREDITS
SDC.INFO@WSU.EDU
(509) 335-9539
HTTPS://SDC.WSU.EDU/
School of Design and Construction


WSEC-R 2021 2nd Edition
Two Hour Education & Update
Join WSU-EP as we cover the new 2021 Washington State Energy Code Residential proposed changes (EPCA-CR103P) that will be released in March of 2024.
Our presentation will contain both beginner & intermediate level education/update on the WSEC-R. This education will be available virtually on the second Wednesday of each month. Visit our training page to register.
Energy Program
WSU
2023 Trainings
The new WSEC-R website is currently under construction. Thank you for your patience as things are relocated on the website during this time. We are excited as these changes to the website will allow for new features and tools that will help us to better service you, our clients.
https://www.energy.wsu.edu/EventsTrainings.aspx

State Building Code Council (SBCC)

What is the SBCC & what do they do?

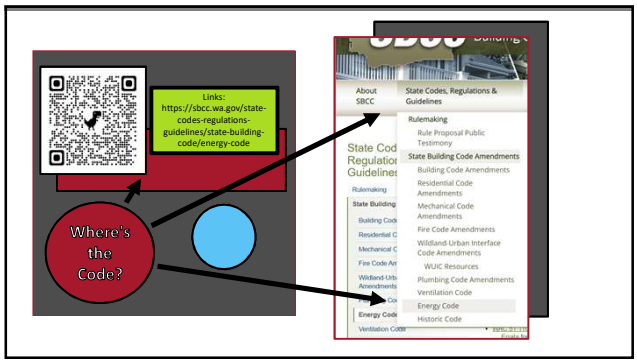
The State Building Code Council (SBCC) was created to provide independent analysis and objective advice to the legislature and the Governor's Office on state building code issues. The SBCC establishes the minimum building, mechanical, fire, plumbing and energy code requirements necessary to promote the health, safety and welfare of the people of the state of Washington by reviewing, developing and adopting the state building code.

REVISED EFFECTIVE DATE FOR 2021 CODES MARCH 15, 2024

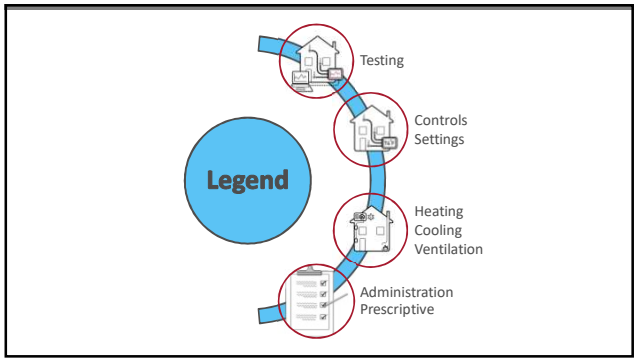
The State Building Code Council voted on May 24, 2023, to delay the effective date of the 2021 codes for 120 days, which changed the effective date from July 1, 2023 to October 29, 2023. On September 15, 2023, the State Building Code Council agreed on another delay. The new effective date for all building codes is March 15, 2024.

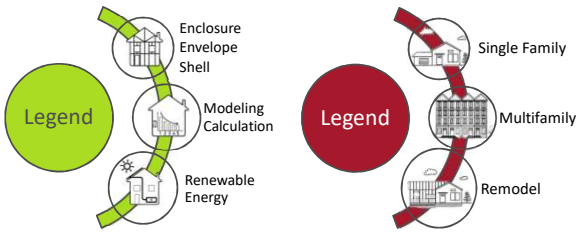
The Council is also entering rulemaking to modify sections in the commercial and residential energy codes to address legal uncertainty stemming from the decision in California Restaurant Association v. City of Berkeley recently issued by the Ninth Circuit Court of Appeals.

Information on SBCC and related documents are courtesy of:
The State Building Code Council


Links:
https://sbcc.wa.gov/state-codes-regulations-guidelines/state-building-code/energy-code
Where's the Code?
About SBCC
State Codes, Regulations & Guidelines
Rulemaking
Rule Proposal Public Testimony
State Building Code Amendments
Building Code Amendments
Residential Code Amendments
Mechanical Code Amendments
Fire Code Amendments
Wildland-Urban Interface Code Amendments
WUIC Resources
Plumbing Code Amendments
Ventilation Code
Energy Code
Historic Code


2021 Code Adoption Cycle
Information on the CR-103P and related documents are courtesy of SBCC:
https://www.sbcc.wa.gov/news/adopted-changes-energy-code-epca-concerns
Where's the WAC?
Group 2 - 2021 Washington State Energy Code - Residential
(see Group 3, below, for EPCA changes adopted to the 2021 code)
Group 3 - Addressing EPCA Concerns in the 2021 Washington State Energy Code - Residential


Testing
Controls
Settings
Legend
Heating
Cooling
Ventilation
Administration
Prescriptive



Why Ventilate?

WSEC Ventilation Class
Based on WAC 2021 Codes

Indoor Air Quality (IAQ)? What is that really?

- Lead
- Cadmium
- Gypsum
- Formaldehyde
- Carpet Fibers
- Soot
- Dust mite feces
- Molds
- Fire retardants
- Asbestos
- Chemicals
- Tire fragments
- Water Vapor
- Building material off gassing
- Dander
- Charred wood
- Insect parts
- Paint spheres
- Plant particles
- Pollens
- Paper
- Pesticides
- Herbicides
- Fly ash
- Radon
- ***And other stuff…***

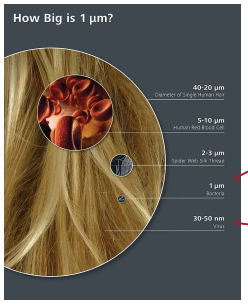
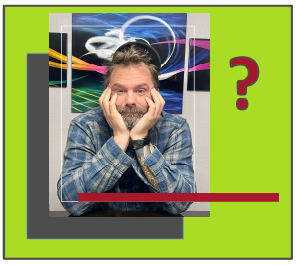


Photo source: Wikipedia.org

MERV Rating	Average Particle Size Efficiency in Microns
8	1.0-3.0 greater than or equal to 20% 3.0-10.0 greater than or equal to 70%
9	1.0-3.0 greater than or equal to 35% 3.0-10.0 greater than or equal to 75%
10	1.0-3.0 greater than or equal to 50% 3.0-10.0 greater than or equal to 80%
11	0.30-1.0 greater than or equal to 20% 1.0-3.0 greater than or equal to 65% 3.0-10.0 greater than or equal to 85%
12	0.30-1.0 greater than or equal to 35% 1.0-3.0 greater than or equal to 80% 3.0-10.0 greater than or equal to 90%
13	0.30-1.0 greater than or equal to 50% 1.0-3.0 greater than or equal to 85% 3.0-10.0 greater than or equal to 90%

Photo source: EPA

WSU Ventilation Video Series
Why Ventilate?



Wait . . . what did that guy in the video say?

- **Control the flow of fresh air, moisture, and pollutants**
- Poor ventilation can result in…mold & mildew growth, increased levels of airborne chemicals, combustion safety problems, i.e. carbon monoxide poisoning & high utility bills.
- **Ventilation systems protect people and preserve buildings by…**
- Diluting airborne pollutants, supplying fresh air, eliminating odors, reducing drafts, preserving structures by controlling airborne moisture.
- **Two styles of ventilation: Passive & Active**
- Passive venting relies on non-mechanical air movement such as open windows, open vents in attics, and vented crawl spaces. This relies on pressure and temperature differences between outside and inside of structure.
- Active or mechanical ventilation moves air through the home using fans and ducts.

Only Two Choices

Uncontrolled Infiltration

- No control of where air enters or exits
- Escaped heat is unrecoverable
- Rate & duration is controlled by outside force such as ΔT & pressure.
- Questionable indoor air quality
- Greater risk of water intrusion,
  - bacterial growth, rot, structural damage
- Health risks

Controlled Ventilation

- Can direct fresh air in and stale air out
- Recover between 70% and 90% of latent heat
- Mange the rate & duration of ventilation
- Filter out pollutants
- Regulate moisture & humidity
- Minimize or eliminate health risks

NIH National Library of Medicine
National Center for Biotechnology Information

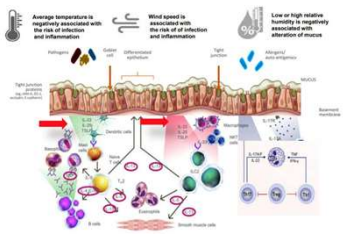
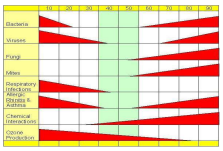


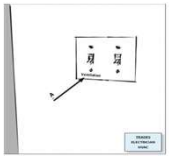
Photo Source: NIH National Library of Medicine.

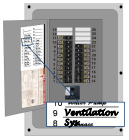


Percent Relative Humidity

Ventilation Distribution

WSEC Ventilation Class
Based on WAC 2021 Codes

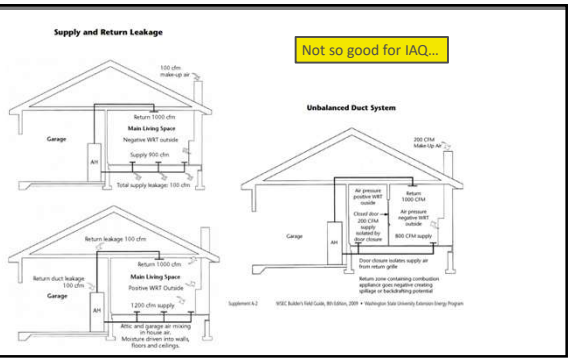


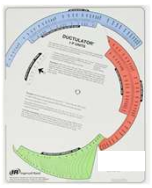



- Must have automatic controls with manual overrides, (automatic timer)
- Must be readily accessible
- Must provide operating instructions
- Must have label "whole house ventilation, see operating instructions"
- Operable air inlets may be used – required in each occupiable space
- Sone rating of 1.0 or less
- One dedicated fan may be used for whole house

Leaky Duct Systems Contribute to Poor IAQ

- Leaks in **return** ductwork draw air into the house from crawlspaces, garages and attics bringing with it dust, mold spores, insulation fibers and other contaminants.
- **Return** leaks pull outside air (hot in summer, cold in winter) into the duct system reducing both efficiency and capacity.
- Leaks in the **supply** ductwork cause expensive conditioned air to be dumped into the attic, crawlspace or garage instead of into the house.
- Leaky ductwork has been found to greatly increase the use of electric strip heaters in heat pumps during the heating season.
- Household depressurization from duct leaks and imbalanced duct systems can cause spillage of combustion products (from furnaces, water heaters, and fireplaces) into the house.





ASHRAE Std. 62.2 Table 5.3 Prescriptive Duct Sizing Chart

Duct Diameter (inches)	Maximum Length in Feet Fan Rating in cfm Certified @ 0.25 in. w.c.							
	Flex Duct (cfm)				Smooth Duct (cfm)			
	50	80	100	125	50	80	100	125
3	n/a	n/a	n/a	n/a	5	n/a	n/a	n/a
4	70	3	n/a	n/a	105	35	5	n/a
5	no limit	70	35	20	no limit	135	85	55
6	no limit	no limit	135	95	no limit	no limit	no limit	145
7 and above	no limit	no limit	no limit	no limit	no limit	no limit	no limit	no limit

ard f2.2 requirements.
ength for each elbow.

Every Elbow Adds 15 Lineal Feet

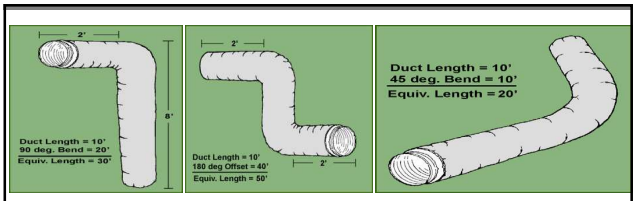
https://ductulator.com/

Ductulator Duct Sizing
The Simple Duct Sizing App

App store. This was Apple

As an unconditioned basement, what's wrong with this installation ?

If the basement is conditioned, do you need to seal the ducts ?

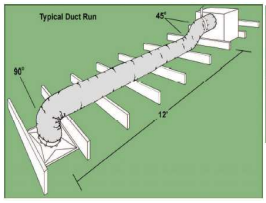


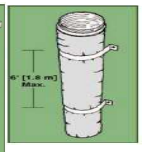
In Duct Length Equivalents,

Elbows Matter!

ADC Flexible Duct Performance & Installation Standards, 6th Edition
Air Duct Council, 1300 Sumner Ave. Cleveland, OH 44115
Tel: (216) 241-7333 info@flexibleduct.org

Flex Duct Length, Bends, and Vertical Application



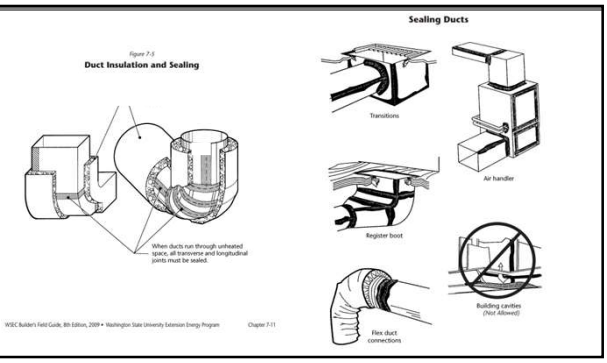


Entrance Fitting	35ft
Total Duct Length	14ft
2 x 45° Bends (2x10')	20ft
1 x 90° Bend (1x20')	20ft
Exit Fitting	35ft
Total Effective Length	124ft

ADC Flexible Duct Performance & Installation Standards, 6th Edition
Air Duct Council, 1300 Sumner Ave. Cleveland, OH 44115
Tel: (216) 241-7333
info@flexibleduct.org

Although the distance from the plenum to the terminal end in this example is approximates 12ft…
the total equivalent is … 124ft.

The equivalent length values for bends & fittings represented above are default values from the ACCA Manual D and based on 900fpm at 0.08 IWC/100ft for supply ducts and 700fpm at the 0.08 IWC/100ft of return ducts.



Use Water Based Mastic
common referred to in the PNW as:
"Pookie".

Turns out we should stop calling it Pookie…

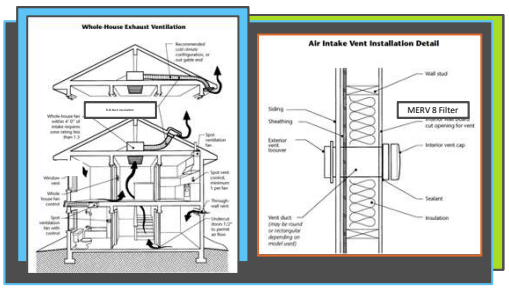
Flex Duct Length, Bends, and Vertical Application

Flex Duct Length, Bends, and Vertical Application

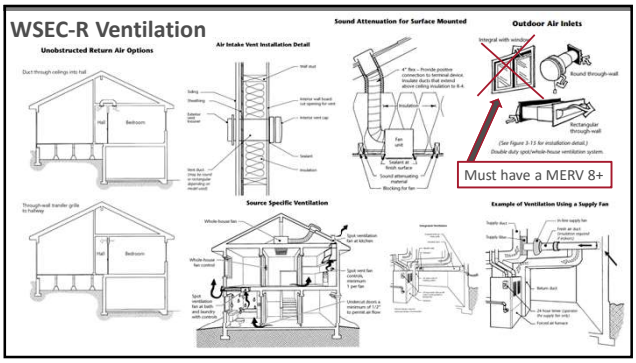
Three ways to ventilate:

- **Exhaust Only**
  - **Typically known as spot ventilation**
- **Supply Only**
  - **Usually integrated stand-alone systems**
  - **Can be combined with exhaust only to create a balanced system**
- **Balanced Ventilation**
  - **Typically done with HRV/ERV equipment**
    - **Also known as balanced ventilation with recovery**
  - **A balanced and commissioned supply and exhaust fan**
    - **Typically known as balanced without recovery**

WSEC-R Ventilation



WSEC-R Ventilation



WSEC-R

The Energy Codes & Ventilation

WSEC Ventilation Class
Based on WAC 2021 Codes

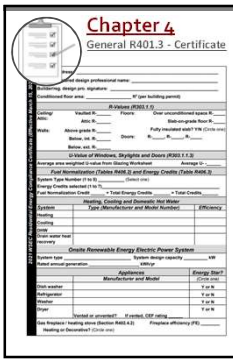
WSEC-R Ducts

R403.3 Ducts

- Ductwork & their location
- Ductwork & their insulation
- Duct work & their leakage/sealing/testing
- No building cavities as plenums

R403.4 Mechanical System Pipe Insulation

- Mech. system piping capable of carrying fluids above 105 degrees or below 55% degrees shall be insulated to a min. of R-6
- Protection of piping insulation (removable)



Chapter 4

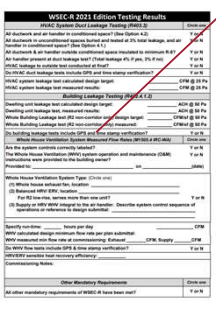
General R401.3 - Certificate

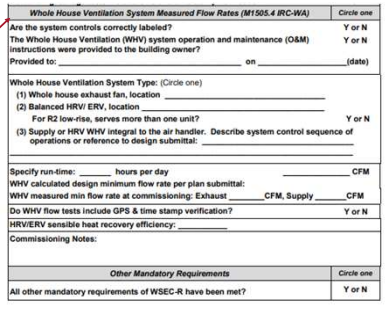
WSEC-R Ducts

A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located, a utility room, or an approved location inside the building. When located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label, or other required labels. The certificate shall indicate the following:

1. The predominant R-values of insulation installed in or on ceiling/roof, walls, foundation (slab, belowgrade wall, and/or floor) and ducts outside conditioned spaces.
2. U-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall indicate the area weighted average value.
3. The results from any required duct system and building envelope air leakage testing done on the building.
4. The results from the whole-house mechanical ventilation system flow rate test.
5. The types, sizes and efficiencies of heating, cooling, whole-house mechanical ventilation, and service water heating appliances. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be listed for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters..
6. Where on-site photovoltaic panel systems have been installed, the array capacity, inverter efficiency, panel tilt, orientation and estimated annual electrical generation shall be noted on the certificate.
7. The code edition under which the structure was permitted, and the compliance path used.

The code official may require that documentation for any required test results include an electronic record of the time, date and location of the test. A date-stamped smart phone photo or air leakage testing software may be used to satisfy this requirement.





Whole House Ventilation System Measured Flow Rates (M1505.4 IRC-WA)	Circle one
Are the system controls correctly labeled?	Y or N
The Whole House Ventilation (WHV) system operation and maintenance (O&M) instructions were provided to the building owner?	Y or N
Provided to: _____ on _____(date)	
Whole House Ventilation System Type: (Circle one)	
(1) Whole house exhaust fan, location _____	
(2) Balanced HRV/ ERV, location _____	
For R2 low-rise, serves more than one unit?	Y or N
(3) Supply or HRV WHV integral to the air handler. Describe system control sequence of operations or reference to design submittal: _____	
Specify run-time: _____ hours per day	_____ CFM
WHV calculated design minimum flow rate per plan submittal:	
WHV measured min flow rate at commissioning: Exhaust _____CFM, Supply _____CFM	
Do WHV flow tests include GPS & time stamp verification?	Y or N
HRV/ERV sensible heat recovery efficiency: _____	
Commissioning Notes:	
Other Mandatory Requirements	**Circle one**
All other mandatory requirements of WSEC-R have been met?	Y or N

WSEC-R Ducts

Yes.
You are required to test your ventilation systems.

Maybe not this one…

WSEC-R Ducts

Inspector C… support request topic R-403.3.2, ducts located in…

R403.3.2.4 Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

4.1. A continuous air barrier installed between unconditioned space and the duct.
4.2. Insulation installed in accordance with Section R402.2.7.
4.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

R403.3.2.5 Ductwork located within exterior walls of the building thermal envelope shall comply with the following:

5.1. A continuous air barrier installed between unconditioned space and the duct.
5.2. A minimum R-10 insulation installed in the cavity width separating the duct from unconditioned space.
5.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

R403.3.7 Building cavities. Building framing cavities shall not be used as ducts or plenums. Installation of ducts in exterior walls, floors or ceilings shall not displace required envelope insulation.

R402.2.7 Floors. Floor cavity insulation shall comply with one of the following:

1. Insulation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required R-value or readily fill the available cavity space. Insulation supports shall be installed so spacing is no more than 24- inches on center. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.
2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed. 2021 Washington State Energy Code RE-25
3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The combined R-value of the cavity and continuous insulation shall equal the required R-value for floors. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

WSEC-R Ducts

…ter 51-11R WAC
…ON AND AMENDMENT OF THE ~~2018~~ 2021
…AL ENERGY CONSERVATION CODE, RESIDENTIAL
…TING CODE
…THE STATE

R403.3.7 Building cavities. Building framing cavities shall not be used as ducts or plenums. Installation of ducts in exterior walls, floors or ceilings shall not displace required envelope insulation. [Statutory Authority: RCW 19.27A.020, 19.27A.045, 19.27A.160, and chapter 19.27A RCW. WSR 13-02-066, 13-01-102, and 10-20-022, § 51-11R-40320, filed 1/3/23, 6/7/13, and 9/25/27, effective 1/15/24. Statutory Authority: RCW 19.27A.020, 19.27A.045, 19.27A.160 and chapter 19.27 RCW. WSR 10-01-079, § 51-11R-40320, filed 12/9/15, effective 7/1/20. Statutory Authority: RCW 19.27A.025, 19.27A.045, 19.27A.160, and 19.27.074. WSR 17-10-043, § 51-11R-40320, filed 5/3/17, effective 6/2/17. Statutory Authority: RCW 19.27A.020, 19.27A.045, 19.27A.160, and 19.27.074. WSR 16-07-127, § 51-11R-40320, filed 1/8/16, effective 7/1/16. Statutory Authority: RCW 19.27A.020, 19.27A.045 and chapters 19.27 and 34.05 RCW. WSR 13-04-055, § 51-11R-40320, filed 2/1/13, effective 7/1/13.)

(IRC 2021 WSEC)

- Stud wall cavities in the outside walls of building envelope assemblies shall not be utilized as air plenums.
- 7.3. Stud wall cavities shall not convey air from more than one floor level.

R402.2.7 Floors. Floor cavity insulation shall comply with one of the following:

1. Insulation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required R-value or readily fill the available cavity space. Insulation supports shall be installed so spacing is no more than 24- inches on center. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.
2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed. 2021 Washington State Energy Code RE-25
3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The combined R-value of the cavity and continuous insulation shall equal the required R-value for floors. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

WSEC-R Ducts & Testing

R403.3.5 Duct Testing

- Ducts shall be leak tested in accordance with WSU RS-33, using the maximum duct leakage rates specified.
- EXCEPTION: A duct air leakage test shall not be required for ducts serving ventilation systems that are not integrated with the ducts serving heating or cooling systems.
- A written report of the results shall be signed by the party conducting the test and provided to the code official.

R403.3.6 Duct leakage.

The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:

- Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m2) of conditioned floor area. For forced air ducts, a maximum of 10 linear feet of return ducts and 5 linear feet of supply ducts may be located outside the conditioned space. All metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic. If flex ducts are used, they cannot contain splices. Flex duct connections must be made with nylon straps and installed using a plastic strapping tensioning tool. Ducts located in crawl spaces do not qualify for this exception.

WSEC-R HVAC design

Ventilation will have an effect on comfort and the homes energy use!

ACCA Manual Types J, S, D, & T:

- As you can see there is a lot to the design and implementation of and HVAC system. All homes are required to provide a Manual J and provide the equipment selected to meet the Manual J.
- This is the bare bones minimum the code requires. As you can see by the chart on my right that there is a lot more to good system HVAC design, installation and commissioning.

Image courtesy of ACCA

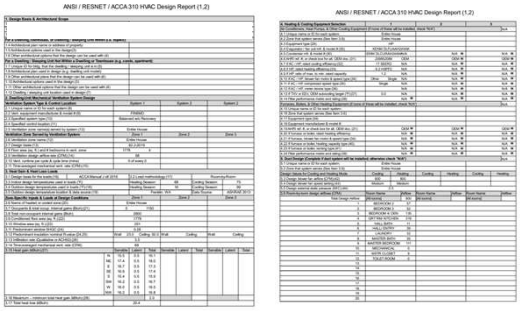
ACCA Manual and Sizing Capable Software

The WSU-EP Simple heat calculator does not performing cooling calculations for AC's or heat pump units! R403.3 requires the use of proper ACCA Manuals or approved alternative calculation. If software is needed, BetterBuiltNW.com offers HVAC ST.

Heating, Ventilation, & Air-Conditioning Sizing Tool

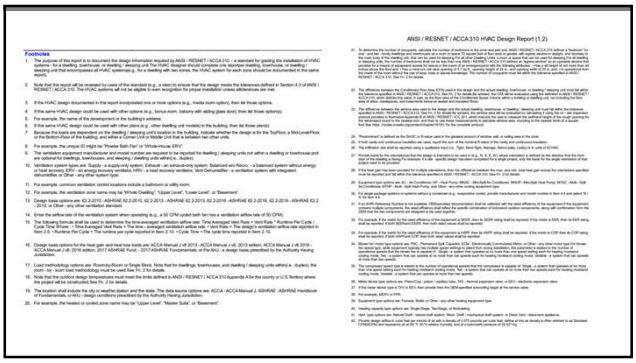
Photo courtesy of: BetterBuiltnw.org

WSEC-R Heating & Cooling



ANSI / RESNET / ACCA 310 HVAC Design Report (1,2)

ANSI / RESNET / ACCA 310 HVAC Design Report (1,2)



ANSI / RESNET / ACCA 310 HVAC Design Report (1,2)

WSEC-R Ventilation

R403.6 Mechanical Ventilation.

- **The buildings complying with Section R402.4.1 shall be provided with mechanical ventilation that meets the requirements of Section M1505 in the International Residential Code (WAC edition) or Section 403 in the WA Mechanical Code (WAC edition), as applicable, or with other approved means of ventilation.**
- **Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.**

WSEC-R Ventilation

R403.6.1 Whole-House Mechanical Ventilation System Fan Efficacy.

- Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1 at one or more rating points. Fans shall be tested in accordance with HVI 916 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing on the label.
- Fan efficacy for fully ducted HRV, ERV, balanced, and in-line fans shall be determined at a static pressure of not less than 0.2 inch w.c. (49.85 Pa).
- Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch w.c. (24.91 Pa).

WSEC-R Ventilation

R403.6.2 Testing.

Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

EXCEPTION:

Kitchen range hoods that are ducted to the outside with 6-inch (152 mm) or larger duct and not more than one 90-degree (1.57 rad) elbow or equivalent in the duct run.

WSEC-R Ventilation

Photo courtesy of: usatoday.com article, Best of 2022.

WSEC-R Ventilation

TABLE R403.6.1
WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

SYSTEM TYPE	AIR FLOW RATE (CFM)	MINIMUM EFFICACY (CFM/WATT)
HRV, ERV or balanced	Any	1.2 cfm/watt
Range hoods	Any	2.8 cfm/watt
In-line supply or exhaust fan	Any	3.8 cfm/watt
Other exhaust fan	<90	2.8 cfm/watt
	≥90	3.5 cfm/watt

For SI: 1 cfm = 28.3 L/min.

a. Design outdoor or exhaust airflow rate/watts of fan used.

WSEC-R Ventilation

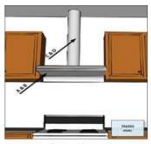
Scope:

A. In each full bathroom, verify that an exhaust fan is installed that vents directly to the outdoors, not into an attic or crawlspace.

B. Measure the airflow and verify that it is ≥ 50 CFM for intermittent fans and ≥ 20 CFM for continuous fans.

For a continuous fan, also verify that the rated sound is ≤ 1 sone. For an intermittent fan, it is also recommended, but not required, that the rated sound be ≤ 3 sones.

Verify that bath fan exhausts to the outdoors and meets airflow and sound requirements



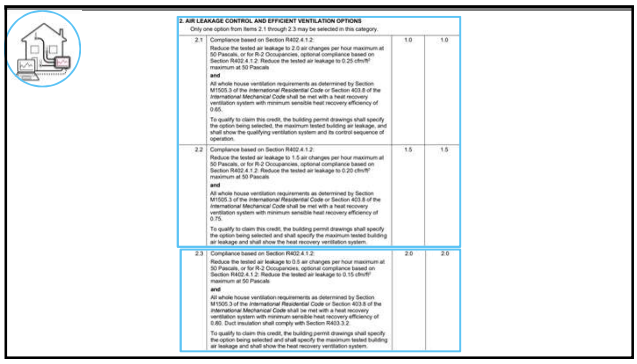
Verify that kitchen fan exhausts to the outdoors and meets airflow and sound requirements

C. For an intermittent fan that's not a range hood or appliance-range hood combination (e.g., a fan through the kitchen wall), measure the airflow and verify that it is ≥ 100 CFM and also ≥ 5 ACH based on kitchen volume. It is also recommended, but not required, that the sound rating be ≤ 3 sones.

Building America Solution Center

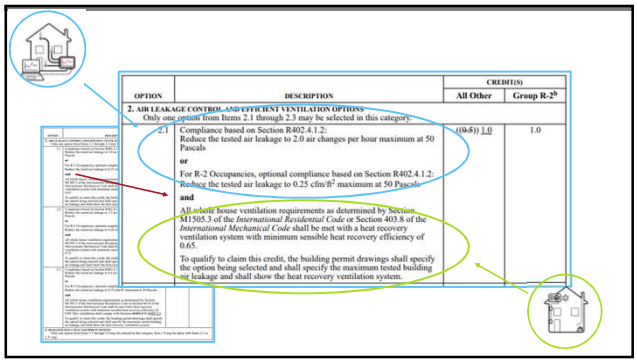
HVAC WSEC-R

WSEC Ventilation Class
Based on WAC 2021 Codes



2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS
Only one option from Items 2.1 through 2.3 may be selected in this category.

2.1	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft² maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1505.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65. To qualify to claim this credit, the building permit drawings shall specify the option being selected, the maximum tested building air leakage, and shall show the qualifying ventilation system and its control sequence of operation.	1.0	1.0
2.2	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 1.5 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.20 cfm/ft² maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1505.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.75. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	1.5	1.5
2.3	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.6 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.15 cfm/ft² maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1505.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.80. Duct insulation shall comply with Section R403.3.2. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	2.0	2.0



OPTION	DESCRIPTION	CREDIT(S) All Other	CREDIT(S) Group R-2[b]
2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS Only one option from Items 2.1 through 2.3 may be selected in this category.			
2.1	Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals **or** For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft² maximum at 50 Pascals **and** All whole house ventilation requirements as determined by Section M1505.3 of the *International Residential Code* or Section 403.8 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.	~~(0.5)~~ 1.0	1.0

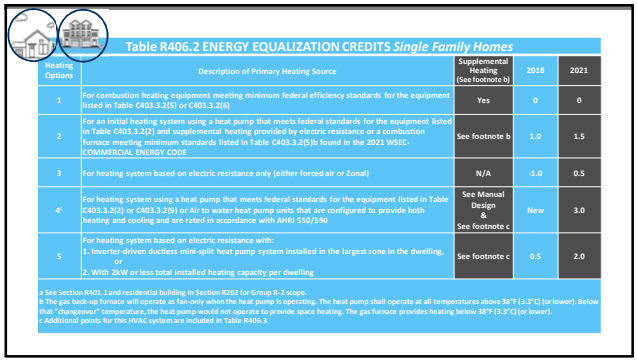


Table R406.2 ENERGY EQUALIZATION CREDITS *Single Family Homes*

Heating Options	Description of Primary Heating Source	Supplemental Heating (See footnote b)	2018	2021
1	For combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(5) or C403.3.2(6)	Yes	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) and supplemental heating provided by electric resistance or a combustion furnace meeting minimum standards listed in Table C403.3.2(5)b found in the 2021 WSEC-COMMERCIAL ENERGY CODE	See footnote b	1.0	1.5
3	For heating system based on electric resistance only (either forced air or Zonal)	N/A	-1.0	0.5
4[c]	For heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) or C403.3.2(9) or Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	See Manual Design & See footnote c	New	3.0
5	For heating system based on electric resistance with: 1. Inverter-driven ductless mini-split heat pump system installed in the largest zone in the dwelling, or 2. With 2kW or less total installed heating capacity per dwelling	See footnote c	0.5	2.0

a See Section R401.1 and residential building in Section R202 for Group R-2 scope.
b The gas back-up furnace will operate as fan-only when the heat pump is operating. The heat pump shall operate at all temperatures above 38°F (3.3°C) (or lower). Below that "changeover" temperature, the heat pump would not operate to provide space heating. The gas furnace provides heating below 38°F (3.3°C) (or lower).
c Additional points for this HVAC system are included in Table R406.3

Table R406.2 ENERGY EQUALIZATION CREDITS *Multifamily Homes*

Options	Description of Primary Heating Source	Supplemental Heating	2018	2021
1	For combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(5) or C403.3.2(6)	Yes	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) and supplemental heating provided by electric resistance or a combustion furnace meeting minimum standards listed in Table C403.3.2(5)b found in the 2021 WSEC- COMMERCIAL ENERGY CODE	See footnote b	1.0	0
3	For heating system based on electric resistance only (either forced air or Zonal)	N/A	-1.0	-0.5
4c	For heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) or C403.3.2(9) or Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	See Manual Design & See footnote c	New	2.0
5	For heating system based on electric resistance with: 1. Inverter-driven ductless mini-split heat pump system installed in the largest zone in the dwelling, or 2. With 2kW or less total installed heating capacity per dwelling	See footnote c	0	0

a See Section R401.1 and residential building in Section R202 for Group R-2 scope.
b The gas back-up furnace will operate as fan-only when the heat pump is operating. The heat pump shall operate at all temperatures above 38°F (3.3°C) (or lower). Below that "changeover" temperature, the heat pump would not operate to provide space heating. The gas furnace provides heating below 38°F (3.3°C) (or lower).
c Additional points for this HVAC system are included in Table R406.3

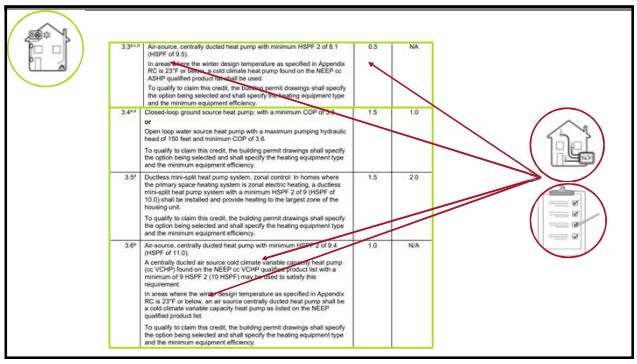
R406.3 Additional Energy Efficiency Requirements

- Each dwelling unit in a residential building shall comply with sufficient options from Tables R406.2 and R406.3 so as to achieve the following minimum number of credits:
- 1. Small Dwelling Unit: ..... ~~(3.0)~~ 5.0 credits
  Dwelling units less than 1500 square feet in conditioned floor area with less than 300 square feet of fenestration area. Additions to existing building greater than 500 square feet of heated floor area but less than 1500 square feet.
- 2. Medium Dwelling Unit: ..... ~~(6.0)~~ 8.0 credits
  All dwelling units that are not included in #1, #3 or #4.
- 3. Large Dwelling Unit: ..... ~~(7.0)~~ 9.0 credits
  Dwelling units exceeding 5000 square feet of conditioned floor area.
- 4. Dwelling units serving Group R-2 occupancies: ..... ~~(4.5)~~ 6.5 credits
  See Section R401.1 and residential building in Section R202 for Group R-2 scope.
- 5. Additions 150 square feet to 500 square feet: ..... ~~(1.5)~~ 2.0 credits
- The drawings included with the building permit application shall identify which options have been selected and the point value of each option, regardless of whether separate mechanical, plumbing, electrical, or other permits are utilized for the project.

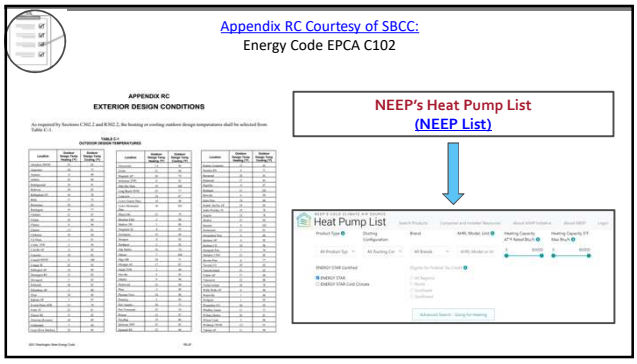
3. HIGH EFFICIENCY HVAC EQUIPMENT OPTIONS

Only one option from Items 3.1 through 3.10 may be selected in this category. Item 3.11 may be taken with Items 3.1 or 3.3[c] only.

3.1[a]	For a System Type 1 in Table R406.2: Energy Star rated (U.S. North) Gas or propane furnace with minimum AFUE of 95% **or** Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.0	1.0
3.2[a]	For secondary heating system serving System Type 2 in Table R406.2: Air-source centrally ducted heat pump with minimum HSPF of 9.5 **or** Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	0.5	0.5
3.3[a,b,d]	Air-source, centrally ducted heat pump with minimum HSPF 2 of 8.1 (HSPF of 9.5). In areas where the winter design temperature as specified in Appendix RC is 23°F or below, a cold climate heat pump found on the NEEP cc ASHP qualified product list shall be used. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	0.5	NA



3.3[a,c,d]	Air-source, centrally ducted heat pump with minimum HSPF 2 of 8.1 (HSPF of 9.3). In areas where the winter design temperature as specified in Appendix RC is 23°F or below, a cold climate heat pump found on the NEEP cc ASHP qualified product list shall be used. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	0.5	NA
3.4[c,d]	Closed-loop ground source heat pump; with a minimum COP of 3.6 **or** Open loop water source heat pump with a maximum pumping hydraulic head of 150 feet and minimum COP of 3.6. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.5	1.0
3.5[f]	Ductless mini-split heat pump system, zonal control: In homes where the primary space heating system is zonal electric heating, a ductless mini-split heat pump system with a minimum HSPF 2 of 9 (HSPF of 10.0) shall be installed and provide heating to the largest zone of the housing unit. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.5	2.0
3.6[e]	Air-source, centrally ducted heat pump with minimum HSPF 2 of 9.4 (HSPF of 11.0). A centrally ducted air source cold climate variable capacity heat pump (cc VCHP) found on the NEEP cc VCHP qualified product list with a minimum of 9 HSPF 2 (10 HSPF) may be used to satisfy this requirement. In areas where the winter design temperature as specified in Appendix RC is 23°F or below, an air source centrally ducted heat pump shall be a cold climate variable capacity heat pump as listed on the NEEP qualified product list. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.0	N/A



[Appendix RC Courtesy of SBCC:](#)
Energy Code EPCA C102

APPENDIX RC
EXTERIOR DESIGN CONDITIONS

As required by Sections C302.2 and R302.2, the heating or cooling outdoor design temperatures shall be selected from Table C-1.

TABLE C-1
OUTDOOR DESIGN TEMPERATURES

NEEP's Heat Pump List
(NEEP List)

Energy credit option	New HSPF 2 value	Old HSPF value
3.2 & 3.3 ducted central heat pump	8.1	9.5
3.5 ductless heat pump in main living area + electric resistance in other rooms	9	10
3.6 ducted central heat pump	9.4	11
3.6 ducted central heat pump – NEEP cc VCHP list	8.5	10
3.7 ductless heat pump with no electric resistance (except footnote A)	9	10
3.7 ductless heat pump with no electric resistance ≤ 24,000 Btu (except footnote A)	8.1	9

3.3[a,c,d]	Air-source, centrally ducted heat pump with minimum HSPF 2 of 8.1 (HSPF of 9.5). In areas where the winter design temperature as specified in Appendix RC is 23°F or below, a cold climate heat pump found on the NEEP cc ASHP qualified product list shall be used. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	0.5	NA
3.4[c,d]	Closed-loop ground source heat pump; with a minimum COP of 3.3 **or** Open loop water source heat pump with a maximum pumping hydraulic head of 150 feet and minimum COP of 3.6. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.5	1.0
3.5[c]	Ductless mini-split heat pump system, zonal control: In homes where the primary space heating system is zonal electric heating, a ductless mini-split heat pump system with a minimum HSPF 2 of 9 (HSPF of 10.0) shall be installed and provide heating to the largest zone of the housing unit. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.5	2.0
3.6[c]	Air-source, centrally ducted heat pump with minimum HSPF 2 of 9.4 (HSPF of 11.0). A centrally ducted air source cold climate variable capacity heat pump (cc VCHP) found on the NEEP cc VCHP qualified product list with a minimum of 9 HSPF 2 (10 HSPF) may be used to satisfy this requirement. In areas where the winter design temperature as specified in Appendix RC is 23°F or below, an air source centrally ducted heat pump shall be a cold climate variable capacity heat pump as listed on the NEEP qualified product list. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.0	N/A

3.7[a,d,e]	Ductless split system heat pumps with no electric resistance heating in the primary living areas. A ductless heat pump system with a minimum HSPF 2 of 9 (HSPF of 10) shall be sized and installed to provide heat to entire dwelling unit at the design outdoor air temperature. **Exception:** In homes with total heating loads of 24,000 or less using multi-zone mini-split systems with nominal ratings of 24,000 or less, the minimum HSPF 8 to claim this credit shall be 8.19 HSPF 2 (or 9 HSPF). To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type).	2.0	3.0
3.8[a,d]	Air-to-water heat pump with minimum COP of 3.2 at 47°F, rated in accordance with AHRI 550/590 by an accredited or certified testing lab. To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type).	1.0	NA
3.9	Gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15. For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units.	1.5	1.5

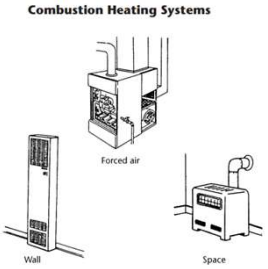
Couples with Option 1

1	For combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(5) or C403.3.2(6)

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2[b]
3.10[c]	Combination water heating and space heating system shall include one of the following: Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0. **or** For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0., shall serve all units. **or** For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.	2.5	2.5
3.11[c]	Connected thermostat meeting ENERGY STAR Certified Smart Thermostats/EPA ENERGY STAR specifications. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the thermostat model.	0.5	0.5

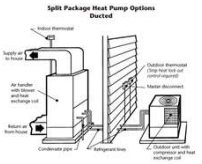
Energy Equalization Option 1
HVAC Selection Available

- 3.1
- 3.9
- 3.10
- Possible 3.11



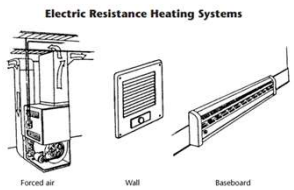
Energy Equalization Option 2
HVAC Selection Available

- 3.2
- Possibly 3.11 Need Clarification on Errata.



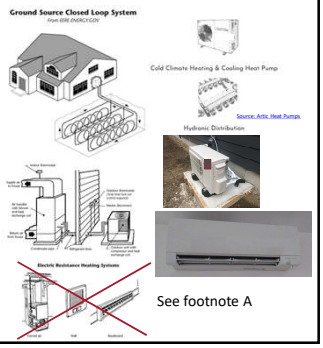
Energy Equalization Option 3
HVAC Selection Available

- N/A



Energy Equalization Option 4
HVAC Selection Available

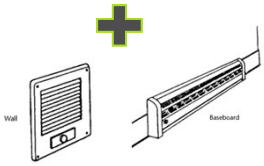
- 3.3
- 3.4
- 3.6
- 3.7
- 3.8

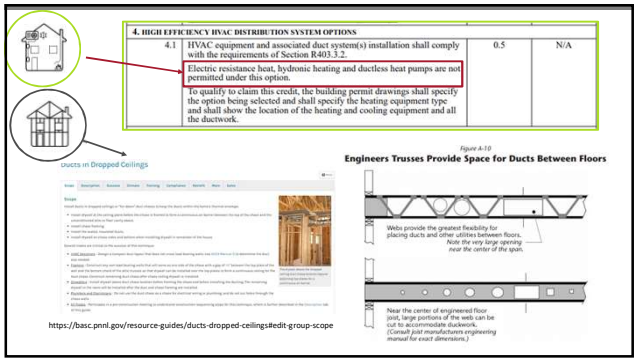


See footnote A

Energy Equalization Option 5
HVAC Selection Available

- 3.5





4. HIGH EFFICIENCY HVAC DISTRIBUTION SYSTEM OPTIONS			
4.1	HVAC equipment and associated duct system(s) installation shall comply with the requirements of Section R403.3.2. Electric resistance heat, hydronic heating and ductless heat pumps are not permitted under this option. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and shall show the location of the heating and cooling equipment and all the ductwork.	0.5	N/A

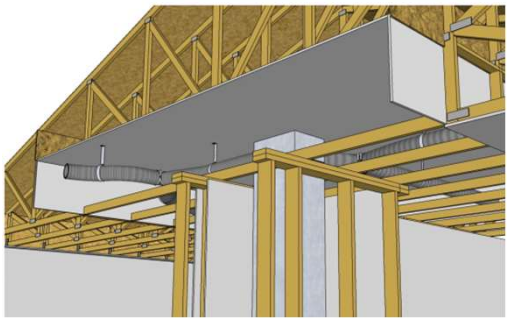
Ducts in Dropped Ceilings

https://basc.pnnl.gov/resource-guides/ducts-dropped-ceilings#edit-group-scope

Figure A-10
Engineers Trusses Provide Space for Ducts Between Floors

Webs provide the greatest flexibility for placing ducts and other utilities between floors. *Note the very large opening near the center of the span.*

Near the center of engineered floor joist, large portions of the web can be cut to accommodate duckwork. *(Consult joist manufacturers engineering manual for exact dimensions.)*



Mechanical Code
Ventilation Requirements
WSEC Ventilation Class
Based on WAC 2021 Codes

CHAPTER 1 SCOPE AND ADMINISTRATION [A] 101.2 Scope.
This code shall regulate the design, installation, maintenance, alteration and inspection of mechanical systems that are permanently installed and utilized to provide control of environmental conditions and related processes within buildings……

References in this code to Group R shall include Group I-1, Condition 2 assisted living facilities licensed by Washington state under Chapter 388-78A WAC and Group I-1, Condition 2 residential treatment facilities licensed by Washington state under Chapter 246-337 WAC.

Exceptions:
1. Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories high with separate means of egress and their accessory structures **shall comply with the International Residential Code.**

2. The standards for liquefied petroleum gas installations shall be the 2020 edition of NFPA 58 (Liquefied Petroleum Gas Code) and the 2021 edition of ANSI Z223.1/NFPA 54 (National Fuel Gas Code).

Scope of work, Compliance & Certification.

Chapter 4, of the 2021 WA State Mechanical Code.

R401 covers the beginning of the journey by defining the administrative process

R-401.1 Scope of Work

- This chapter shall govern the ventilation of spaces within a building intended to be occupied. Mechanical exhaust systems, including exhaust systems serving clothes dryers and cooking *appliances*; hazardous exhaust systems; dust, stock and refuse conveyor systems; subslab soil exhaust systems; smoke control systems; energy recovery ventilation systems and other systems specified in Section 502 shall comply with Chapter 5.

401.2.1 Group R occupancies.

- Ventilation in Group R occupancies shall be provided in accordance with Section 403.4.

401.2.3 All other occupancies

- Ventilation in all other occupancies shall be provided by natural means in accordance with Section 402 or by mechanical means in accordance with Sections 403.1 through 403.7.

401.3 When required.

- Group R occupancies shall be vented continuously or intermittently in accordance with Section 403.4. Ventilation in all other occupancies shall be provided during the periods that the room or space is occupied.

401.4 Intake opening location.

Air intake openings shall comply with all of the following:

1. Intake openings shall be located not less than 10 feet (3048 mm) from lot lines or buildings on the same lot. Lot lines shall not be defined as a separation from a street or public way.
2. Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) horizontally from any hazardous or noxious contaminant source, such as vents, streets, alleys, parking lots and loading docks, except as specified in Item 3 or Section 501.3.1. Outdoor air intake openings shall be permitted to be located less than 10 feet (3048 mm) horizontally from streets, alleys, parking garage entries, parking lots and loading docks provided that the openings are located not less than 25 feet (7620 mm) vertically above such locations. Where openings front on a street or public way, the distance shall be measured from the closest edge of the street or public way.

Exceptions:

1. Intake air openings providing **less than 500 cfm** of outdoor air to Group R occupancies are permitted to be located less than 10 feet (3048 mm) horizontally from parking lots provided that the openings are not less than 15 feet (4572 mm) vertically above the parking lot.
2. Intake air openings providing **less than 500 cfm** of outdoor air to Group R occupancies are permitted to be located less than 10 feet (3048 mm) horizontally from parking lots provided that the openings are not less than 15 feet (4572 mm) vertically above the clear height for vehicles in the parking garage.

3. Intake openings shall be located not less than 3 feet (914 mm) below contaminant sources where such sources are located within 10 feet (3048 mm) of the opening. Separation is not required between intake air openings, operable openings, and living space *exhaust air* openings of an individual *dwelling unit* or *sleeping unit* where an approved factory-built intake/exhaust combination termination fitting is used to separate the air streams in accordance with the manufacturer's instructions. For these combined terminations, the exhaust air concentration within the intake airflow shall not exceed 10 percent as established by the manufacturer, in accordance with ASHRAE 62.2 Section 6.8, Exception 4. A minimum of 3 feet (914 mm) separation shall be maintained between other environmental air exhaust outlets and other dwelling or sleeping unit factory-built intake/exhaust combination termination fittings.
4. Intake openings on structures in flood hazard areas shall be at or above the elevation required by Section 1612 of the *International Building Code* for utilities and attendant equipment.

Exception: Enclosed parking garage and repair garage ventilation air intakes are permitted to be located less than 10 feet (3048 mm) horizontally from or 25 feet (7620 mm) vertically above a street, alley, parking lot and loading dock.

401.5 Intake opening protection.

- Air intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles. Openings in louvers, grilles and screens shall be sized in accordance with Table 401.5, and shall be protected against local weather conditions. Louvers that protect air intake openings in structures located in hurricane-prone regions, as defined in the *International Building Code*, shall comply with AMCA 550. Outdoor air intake openings located in exterior walls shall meet the provisions for exterior wall opening protectives in accordance with the *International Building Code*.

CHAPTER 4 VENTILATION

TABLE 401.5

OPENING SIZES IN LOUVERS, GRILLES AND SCREENS PROTECTING AIR INTAKE OPENINGS

OUTDOOR OPENING TYPE	MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS[a]
Intake openings in residential occupancies	Not < 1/4 inch and not > 1/2 inch
Intake openings in other than residential occupancies	> 3/4 inch and not > 1 inch

For SI: 1 inch = 25.4 mm.

a. For rectangular openings, the table requirements apply to the shortest side. For round openings, the table requirements apply to the diameter. For square openings, the table requirements apply to any side.

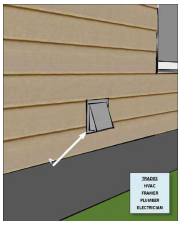
403.4 Group R
Mechanical Code

401.6 Contaminant sources.

- **Stationary local sources producing airborne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 5** or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an *approved* location at the exterior of the building.

401.7 Testing and balancing.

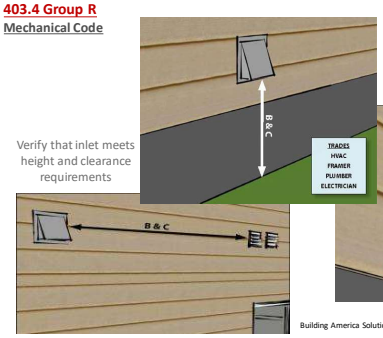
- At the discretion of the building official, flow testing may be required to verify that the mechanical system(s) satisfies the requirements of this chapter.
- Flow testing may be performed using flow hood measuring at the intake or exhaust points of the system, in-line pitot tube, or pitot-traverse-type measurement systems in the duct, short-term tracer gas measurements, or other means *approved* by the code official.



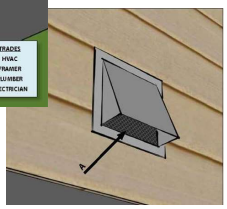
Building America Solution Center

403.4 Group R
Mechanical Code

Verify that inlet meets height and clearance requirements



Verify that all inlets are covered by a mesh screen with hole size at most 0.5 inches.



Building America Solution Center

403.4 Group R
Mechanical Code

This means balanced

This is calculated ventilation in residential spaces

403.4 Group R whole house mechanical ventilation system. Each dwelling unit or sleeping unit shall be equipped with a whole house mechanical ventilation system that complies with Sections 403.4.1 through 403.4.6. Each dwelling unit or sleeping unit shall be equipped with local exhaust complying with Section 403.4.7. All occupied spaces, including public corridors, other than the Group R dwelling units and/or sleeping units, that support the Group R occupancy shall meet the natural ventilation of Section 402 or the mechanical ventilation requirements of Sections 403.1 through 403.3.

Exception: Alternate balanced whole house ventilation systems and local exhaust systems subject to the Washington State Energy Code, Residential Provisions serving Group R dwelling units designed and commissioned in accordance with ASHRAE Standard 62.2 are permitted.

403.4.1 System design. The whole house ventilation system shall consist of one or more supply fans, one or more exhaust fans, or an ERV/HRV with integral fans; and the associated ducts and controls. Local exhaust fans shall be permitted to serve as part of the whole house ventilation system when provided with the proper controls in accordance with Section 403.4.5. The systems shall be designed and installed to supply and exhaust the minimum outdoor airflow rates in accordance with Section 403.4.2 as corrected by the balanced and/or distributed whole house ventilation system coefficients in accordance with Section 403.4.3 where applicable.

403.4.2 Whole house mechanical ventilation rates. The sleeping unit whole house mechanical ventilation minimum outdoor airflow rate shall be determined in accordance with the breathing zone ventilation rates minimum outdoor airflow rate shall be determined in accordance with the breathing zone ventilation rates requirements of Section 403.3.1.1.1.2 using Equation 4-2. The dwelling unit whole house mechanical ventilation minimum outdoor airflow rate shall be determined in accordance with Equation 4-10 or Table 403.4.2.

$$Q_f = 0.01 * A_{floor} + 7.5 * (N_{br} + 1) \quad \textbf{(Equation 4-10)}$$

where:

Q_f = Ventilation airflow rate, cubic feet per minute (cfm) but not less than 30 cfm for each dwelling unit.
A_{floor} = Conditioned floor area, square feet (ft^2)
N_{br} = Number of bedrooms, not less than one.

403.4 Group R
Mechanical Code

Quality Adjustment

403.4.3 Ventilation quality adjustment. The minimum whole house ventilation rate from Section 403.4.2 shall be adjusted by the system coefficient in Table 403.4.3 based on the system type not meeting the definition of a *balanced whole house ventilation system* and/or not meeting the definition of a *distributed whole house ventilation system*.

$$Q_v = Q_r * C_{system} \quad \text{(Equation 4-11)}$$

where:

Q_v = Quality-adjusted ventilation airflow rate in cubic feet per minute (cfm)
Q_r = Ventilation airflow rate, cubic feet per minute (cfm) from Equation 4-10 or Table 403.4.2
C_{system} = System coefficient from Table 403.4.3

403.4.6.5 Intermittent off operation. Whole house mechanical ventilation systems shall be provided with advanced controls that are configured to operate the system with intermittent off operation and shall operate for at least two hours in each four-hour segment. The whole house ventilation airflow rate determined in accordance with Section 403.4.2 as corrected by Section 403.4.3 shall be multiplied by the factor determined in accordance with Table 403.4.6.5.

403.4 Group R
Mechanical Code

Quality Adjustment

TABLE 403.4.2
WHOLE HOUSE MECHANICAL VENTILATION AIRFOW RATE
(CONTINUOUSLY OPERATING SYSTEM)

Floor area (ft²)	Bedrooms[1]				
	1	2	3	4	≥5
<500	30	30	35	45	50
500 – 1000	30	35	40	50	55
1001 - 1500	30	40	45	55	60
1501 – 2000	35	45	50	60	65
2001 – 2500	40	50	55	65	70
2501 – 3000	45	55	60	70	75
3001 – 3500	50	60	65	75	80
3501 – 4000	55	65	70	80	85
4001 – 4500	60	70	75	85	90
4501 – 5000	65	75	80	90	95

1. Minimum airflow (Qr) is set at not less than 30 cfm for each dwelling unit.

TABLE 403.4.6.5
INTERMITTENT WHOLE HOUSE MECHANICAL VENTILATION RATE FACTORS[a,b]

Run-time Percentage in Each 4-hour Segment	50%	66%	75%	100%
Factor[a]	2	1.5	1.3	1.0

a. For ventilation system run-time values between those given, the factors are permitted to be determined by interpolation.
b. Extrapolation beyond the table is prohibited.

Table 403.4.3
SYSTEM COEFFICIENT (C_{system})

System Type	Distributed	Not Distributed
Balanced	1.0	1.25
Not Balanced	1.25	1.5

403.4.4.1 Whole house ventilation in Group R-2 occupancies. Residential dwelling and sleeping units in Group R-2 occupancies system shall include supply and exhaust fans and be a *balanced whole house ventilation system* in accordance with Section 403.4.6.3. The system shall include a heat or energy recovery ventilator with a sensible heat recovery effectiveness as prescribed in Section C403.3.6 or when selected as an option of R406 of the *Washington State Energy Code*. The whole house ventilation system shall operate continuously at the minimum ventilation rate determined in accordance with Section 403.4. The whole house supply fan shall provide ducted outdoor ventilation air to each habitable space within the residential unit.

Exceptions:

1. *Interior adjoining spaces* that are ventilated from another habitable space are not required to have outdoor air ducted directly to the adjoining space. These systems are considered *not distributed whole house ventilation systems* and shall use the "not distributed" quality adjustment system coefficient in accordance with Section 403.4.3.
2. *Interior adjacent rooms* that are ventilated from another habitable space are not required to have outdoor air ducted directly to the *interior adjacent room*. These systems are considered *not distributed whole house ventilation systems* and shall use the "not distributed" quality adjustment system coefficient in accordance with Section 403.4.3. The *interior adjacent room* shall be provided with a transfer fan with a minimum airflow rate of 30 cfm or with relief air inlet with a minimum airflow of 20 cfm that is connected to the exhaust/relief air inlet of an ERV/HRV whole house ventilation system. Transfer fans that ventilate *interior adjacent rooms* shall meet the sone rating in Section 403.4.6 and shall have whole house ventilation controls in accordance with Section 403.4.5.

403.4.4.2 Whole house ventilation for other than Group R-2 occupancies. Residential dwelling and sleeping units in other than Group R-2 occupancies, including I-1 condition 2 occupancies, shall have a whole house mechanical ventilation system with supply and exhaust fans in accordance with Section 403.4.6.1, 403.4.6.2, 403.4.6.3, or 403.4.6.4. The whole house ventilation system shall operate continuously at the minimum ventilation rate determined in accordance with Section 403.4.2 unless configured with intermittent off controls in accordance with Section 403.4.6.5. The whole house supply fan shall provide ducted outdoor ventilation air to each habitable space within the residential unit.

Commercial code reference for ventilation

C403.3.6 Ventilation for Group R-2 occupancy.

For all Group R-2 dwelling and sleeping units, a balanced ventilation system with a heat recovery system shall provide outdoor air directly to all habitable space. The heat recovery system shall have a 60 percent minimum sensible recovery effectiveness as calculated in accordance with Section C403.3.5.1. The ventilation system shall allow for the design flow rates to be tested and verified at each habitable space as part of the commissioning process in accordance with Section C408.2.2.

Exception: Heat recovery and energy recovery ventilators (H/ERV) that are rated and listed in accordance with HVI 920 can demonstrate compliance with the sensible recovery effectiveness requirements using the adjusted sensible recovery effectiveness (ASRE) rating of the equipment at 32°F test conditions. Applied flow rate for ASRE rating shall be no less than the design flow rate or the closest value interpolated between two listed flow rates

WA State 2021 Mechanical Code Ventilation Summary

	Neither Balanced or Distributed 1.5x cfm	Distributed 1.25 cfm	Balanced 1.25 cfm
Exhaust Only	No Can Do	Must balance first in order to use as whole house ventilation	Passive or active supply with MERV 8 required May add distribution
Supply Only	MERV 8 required	1.25	1.25

Balanced & Distributed
All conditioned spaces including adjoining Rooms, 1x cfm
Exemption allows jumpers & transfer fans, 1.25x cfm

ERV/HRV of 60%+ HVI
or
WSEC-R R406.3 selection requirements
May add distribution

All other in Group R (no single family)
Must Start Here!
Can adjust backwards to 1.5x cfm

Multifamily
Must Start Here!

403.4 Group R
Mechanical Code

403.4.7 Local exhaust. Bathrooms, toilet rooms and kitchens shall include a local exhaust system. Such local exhaust systems shall have the capacity to exhaust the minimum airflow rate in accordance with Table 403.4.7 and Table 403.3.1.1, including notes. Fans required by this section shall be provided with controls that enable manual override or automatic occupancy sensor, humidity sensor, timer controls, or pollutant sensor controls. An "on/off" switch shall meet this requirement for manual controls. Manual fan controls shall be provided with ready access in the room served by the fan.

TABLE 403.4.7
MINIMUM EXHAUST RATES

Area to be exhausted	Exhaust Rate: Intermittent	Exhaust Rate: Continuous
Open Kitchens	In accordance with Section 403.4.7.3	Not permitted
Enclosed Kitchens	In accordance with Section 403.4.7.3	5 ACH based on kitchen volume
Bathrooms – Toilet rooms	50 cfm	20 cfm

403.4.7.1 Whole house exhaust controls. If the local exhaust fan is included in a whole house ventilation system in accordance with Section 403.4.6, the exhaust fan shall be controlled to operate as specified in Section 403.4.5.

403.4.7.2 Local exhaust fans. Exhaust fans shall meet the following criteria.

1. Exhaust fans shall be tested and rated in accordance with HVI 915, HVI 916, and HVI 920 or equivalent.
2. Fan airflow rating and duct system shall be designed and installed to deliver at least the exhaust airflow required by Table 403.4.7. The airflows required refer to the delivered airflow of the system as installed and tested using a flow hood, flow grid, or other airflow measurement device. Local exhaust systems shall be tested, balanced and verified to provide a flow rate not less than the minimum required by this section.
3. Design and installation of the system or equipment shall be carried out in accordance with manufacturers' installation instructions.
4. Intermittent local exhaust system serving kitchens shall be rated for sound at a maximum of 3 sones at one or more airflow settings not less than 100 cfm at a static pressure not less than that determined at working speed as specified in HVI 916 Section 7.2.
5. Continuous local exhaust system serving kitchens shall be rated for sound at a maximum of 1 sone at one or more airflow settings not less than 100 cfm at a static pressure not less than that determined at working speed as specified in HVI 916 Section 7.2..

Exceptions:

1. The installed airflow is not required to be field-verified where an exhaust airflow rating at a pressure of 0.25 in. w.g. may be used, provided the duct sizing meets the prescriptive requirements of Table 403.4.7.2.
2. Remote mounted fans need not meet sound requirements. To be considered for this exception, a remote mounted fan shall be mounted outside the kitchen, and there shall be at least 4 feet (1 m) of ductwork between the fan and the intake grille.

TABLE 403.4.7.2
PRESCRIPTIVE EXHAUST DUCT SIZING

Fan Tested cfm at 0.25 inches w.g.	Minimum Flex Diameter	Maximum Length in Feet	Minimum Round Diameter	Maximum Length in Feet	Maximum Elbows[a]
50	4 inches	25	4 inches	70	3
50	5 inches	90	5 inches	100	3
50	6 inches	No Limit	6 inches	No Limit	3
80	4 inches[b]	NA	4 inches	20	3
80	5 inches	15	5 inches	100	3
80	6 inches	90	6 inches	No Limit	3
100	5 inches[b]	NA	5 inches	90	3
100	6 inches	45	6 inches	No Limit	3
125	6 inches	15	6 inches	No Limit	3
125	7 inches	70	7 inches	No Limit	3

a. For each additional elbow, subtract 10 feet from length.
b. Flex ducts of this diameter are not permitted with fans of this size.

403.4 Group R
Mechanical Code

504.9.4.1 Specified length.
The maximum length of the exhaust duct shall be 35 feet (10 668 mm) from the connection to the transition duct from the dryer to the outlet terminal. Where fittings are used, the maximum length of the exhaust duct shall be reduced in accordance with Table 504.9.4.1.

CHAPTER 5 EXHAUST SYSTEMS

TABLE 504.9.4.1
DRYER EXHAUST DUCT FITTING EQUIVALENT LENGTH

DRYER EXHAUST DUCT FITTING TYPE	EQUIVALENT LENGTH
4˝ radius mitered 45-degree elbow	2 feet 6 inches
4˝ radius mitered 90-degree elbow	5 feet
6˝ radius smooth 45-degree elbow	1 foot
6˝ radius smooth 90-degree elbow	1 foot 9 inches
8˝ radius smooth 45-degree elbow	1 foot
8˝ radius smooth 90-degree elbow	1 foot 7 inches
10˝ radius smooth 45-degree elbow	9 inches
10˝ radius smooth 90-degree elbow	1 foot 6 inches

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

403.4 Group R
Mechanical Code

TABLE 403.4.7.3
KITCHEN RANGE HOOD AIRFLOW RATES (CFM)
AND ASTM E3087 CAPTURE EFFICIENCY (CE) RATINGS
ACCORDING TO KITCHEN RANGE FUEL TYPE

Hood Over Electric Range	Hood Over Combustion Range
65 percent CE or 160 cfm	80 percent CE or 250 cfm

505.3 Domestic exhaust ducts.

- Ducts serving **domestic cooking exhaust equipment** shall discharge to the outdoors through sheet metal ducts constructed of galvanized steel, stainless steel, aluminum or copper. Such ducts shall have smooth inner walls, shall be airtight, shall be equipped with a backdraft damper and **shall be independent of all other exhaust systems.**
- Domestic kitchen exhaust ducts may terminate with other domestic dryer exhaust and residential local exhaust ducts at a common location where each duct has an independent backdraft damper.
- ***Listed and labeled*** exhaust booster fans shall be permitted when installed in accordance with the manufacturer's installation instructions.

403.4 Group R
Mechanical Code

403.4.7.3 Local intermittent kitchen exhaust system. Kitchen range hoods for domestic cooking appliances shall meet or exceed either the minimum airflow or the minimum capture efficiency in accordance with Table 403.4.7.3. Capture efficiency ratings shall be determined in accordance with ASTM E3087.

Exception: Other intermittent kitchen exhaust fans, including downdraft, shall meet or exceed 300 cfm airflow.

2. The verification shall utilize certified rating data from *HVI Publication 911, AHAM-Certified Range Hood Directory*, or another directory of certified product performance ratings approved by the code official for determining compliance. The verification procedure shall consist of visual inspection of the local intermittent kitchen exhaust system to verify and record the following information:
   2.1. The manufacturer name and model number.
   2.2. The model is listed in the HVI, AHAM, or equivalent directory.
   2.3. The rated airflow value listed in the HVI, AHAM, or equivalent directory.
   2.4. The sound rating value listed in the HVI, AHAM, or equivalent directory.
   2.5. If the value for the rated airflow given in the directory is greater than or equal to the airflow requirements specified in Section 403.4.7.3 *and* if the value for the sone rating given in the directory is less than or equal to the sone rating requirements specified in Section 403.4.7.2, then the local intermittent kitchen exhaust system complies, otherwise the local intermittent kitchen exhaust system does not comply.

TABLE 403.4.7.3
KITCHEN RANGE HOOD AIRFLOW RATES (CFM)
AND ASTM E3087 CAPTURE EFFICIENCY (CE) RATINGS
ACCORDING TO KITCHEN RANGE FUEL TYPE

Hood Over Electric Range	Hood Over Combustion Range
65 percent CE or 160 cfm	80 percent CE or 250 cfm

403.4.7.3.1 Field verification and diagnostic testing for local intermittent kitchen exhaust system. The local exhaust system for kitchens shall be installed to comply with local mechanical exhaust requirements specified in Section 403.4.7.3 and shall be field verified in accordance with the procedures below to confirm the model is rated by HVI or AHAM to comply with the following requirements:

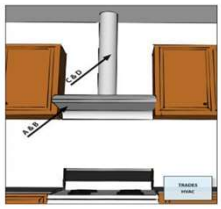
1. Local intermittent exhaust system for kitchens shall be tested and verified to provide a minimum airflow rate or capture efficiency required by Section 403.4.7.3. Testing shall include verification of the maximum sound rating as specified in Section 403.4.7.2. Testing for the intermittent kitchen exhaust systems shall occur with the whole house ventilation system operating and with all dwelling unit or sleeping unit entry doors closed. Testing for exhaust systems that require mechanical makeup air in accordance with Section 505.4 shall include verifying that the mechanical makeup air opening is open. Testing for exhaust systems that require mechanical makeup air in accordance with Section 505.4 shall include verifying that the mechanical makeup air system is controlled to automatically start. Testing for exhaust systems that do not require mechanical makeup air in accordance with Section 505.4 and that are exempt from pressurize equalization per Section 501.4 shall be tested with operable openings manually opened unless design exhaust airflow can be achieved with all operable openings closed. Where required by the building official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the building official.

Exception: The installed airflow is not required to be field-verified where an exhaust airflow rating at a pressure of 0.25 in. w.g. is used, provided the duct sizing meets the prescriptive requirements of Table 403.4.7.2.

Scope:

A. Verify that an exhaust fan is installed in the kitchen that vents directly outdoors.

B. The most common fan type is an intermittent range hood or appliance-range hood combination. If that's the type, measure the airflow and verify that it is ≥ 100 CFM. It is also recommended, but not required, that the sound rating be ≤ 3 sones.



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505.4 Makeup air required.

Exhaust hood systems capable of exhausting **in excess of 400 cfm** (0.19 m^3/s) shall be provided with *makeup air* at a rate approximately equal to the *exhaust air* rate. Such *makeup air* systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system.

IMC Kitchen & Dryer

Dryer Venting

- 35' in length
- No inline booster fans
- Must be labeled

Kitchen Exhaust

- 35 ' in Length/Per Manufacture
- Testing exemptions based on design and inspections

Sone

- 1 or less continuous
- 3 or less intermediate

Installation

- Do not vent into attics, soffits, ridge vents or crawlspaces
- 12.5 Sq.In. opening.
- Intake 3' from building openings

Distance & height vary. 401.4 WA Mech. Code

IRC Ventilation Requirements

WSEC Ventilation Class
Based on WAC 2021 Codes

CHAPTER 15 EXHAUST SYSTEMS

SECTION M1501 GENERAL
M1501.1 Outdoor discharge.
The air removed by every mechanical exhaust system shall be discharged to the outdoors in accordance with Section M1504.3. Air shall not be exhausted into an attic, soffit, ridge vent or crawl space.

Exception: Whole-house *ventilation*-type *attic* fans that discharge into the *attic* space of *dwelling units* having private *attics* shall be permitted.

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CHAPTER 15 EXHAUST SYSTEMS

SECTION M1502
CLOTHES DRYER EXHAUST

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M1502.1 General.
Clothes dryers shall be exhausted in accordance with the manufacturer's instructions.

M1502.2 Independent exhaust systems.
Dryer exhaust systems shall be independent of all other systems and shall convey the moisture to the outdoors.

Exception: This section shall not apply to *listed* and *labeled* condensing (ductless) clothes dryers.

M1502.3 Duct termination.
Exhaust ducts shall terminate on the outside of the building. Exhaust duct terminations shall be in accordance with the dryer manufacturer's installation instructions. If the manufacturer's instructions do not specify a termination location, the exhaust duct shall terminate not less than 3 feet (914 mm) in any direction from openings into buildings, including openings in ventilated soffits. Exhaust duct terminations shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination.

M1502.3.1 Exhaust termination outlet and passageway size.
The passageway of dryer exhaust duct terminals shall be undiminished in size and shall provide an open area of not less than 12.5 square inches (8065 mm^2).

M1502.4 Dryer exhaust ducts.
Dryer exhaust ducts shall conform to the requirements of Sections M1502.4.1 through M1502.4.8.

M1502.4.1 Material and size.
Exhaust ducts shall have a smooth interior finish and shall be constructed of metal not less than 0.0157 inch (0.3950 mm) in thickness (No. 28 gage). The duct shall be 4 inches (102 mm) nominal in diameter.

M1502.4.2 Duct installation.
Exhaust ducts shall be supported at intervals not to exceed 12 feet (3658 mm) and shall be secured in place. The insert end of the duct shall extend into the adjoining duct or fitting in the direction of airflow. Exhaust duct joints shall be sealed in accordance with Section M1601.4.1 and shall be mechanically fastened. Ducts shall not be joined with screws or similar fasteners that protrude more than $^1/_8$ inch (3.2 mm) into the inside of the duct. Where dryer exhaust ducts are enclosed in wall or ceiling cavities, such cavities shall allow the installation of the duct without deformation.

M1502.4.3 Transition duct.
Transition ducts used to connect the dryer to the exhaust *duct system* shall be a single length that is *listed* and *labeled* in accordance with UL 2158A. Transition ducts shall be not greater than 8 feet (2438 mm) in length. Transition ducts shall not be concealed within construction.

M1502.4.4 Dryer exhaust duct power ventilators.
Domestic dryer exhaust duct power ventilators shall conform to UL 705 for use in dryer exhaust duct systems. The dryer exhaust duct power ventilator shall be installed in accordance with the manufacturer's instructions.

M1502.4.5 Booster fans prohibited.
Domestic booster fans shall not be installed in dryer exhaust systems.

M1502.4.6 Duct length.
The maximum allowable exhaust duct length shall be determined by one of the methods specified in Sections M1502.4.6.1 through M1502.4.6.3.

M1502.4.6.1 Specified length.
The maximum length of the exhaust duct shall be 35 feet (10 668 mm) from the connection to the transition duct from the dryer to the outlet terminal. Where fittings are used, the maximum length of the exhaust duct shall be reduced in accordance with Table M1502.4.6.1. The maximum length of the exhaust duct does not include the transition duct.

TABLE M1502.4.6.1
DRYER EXHAUST DUCT FITTING EQUIVALENT LENGTH

DRYER EXHAUST DUCT FITTING TYPE	EQUIVALENT LENGTH
4-inch radius mitered 45-degree elbow	2 feet 6 inches
4-inch radius mitered 90-degree elbow	5 feet
6-inch radius smooth 45-degree elbow	1 foot
6-inch radius smooth 90-degree elbow	1 foot 9 inches
8-inch radius smooth 45-degree elbow	1 foot
8-inch radius smooth 90-degree elbow	1 foot 7 inches
10-inch radius smooth 45-degree elbow	9 inches
10-inch radius smooth 90-degree elbow	1 foot 6 inches

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

M1502.4.6.2 Manufacturer's instructions.

The size and maximum length of the exhaust duct shall be determined by the dryer manufacturer's installation instructions. The code official shall be provided with a copy of the installation instructions for the make and model of the dryer at the concealment inspection. In the absence of fitting equivalent length calculations from the clothes dryer manufacturer, Table M1502.4.6.1 shall be used.

M1502.4.6.3 Dryer exhaust duct power ventilator.

The maximum length of the exhaust duct shall be determined in accordance with the manufacturer's instructions for the dryer exhaust duct power ventilator.

M1502.4.7 Length identification.

Where the exhaust duct equivalent length exceeds 35 feet (10 668 mm), the equivalent length of the exhaust duct shall be identified on a permanent *label* or tag. The *label* or tag shall be located within 6 feet (1829 mm) of the exhaust duct connection.

M1502.4.8 Exhaust duct required.

Where space for a clothes dryer is provided, an exhaust *duct system* shall be installed. Where the clothes dryer is not installed at the time of occupancy the exhaust duct shall be capped or plugged in the space in which it originates and identified and marked "future use."

Exception: Where a *listed* condensing clothes dryer is installed prior to occupancy of the structure.

M1502.5 Protection required.

Protective shield plates shall be placed where nails or screws from finish or other work are likely to penetrate the clothes dryer exhaust duct. Shield plates shall be placed on the finished face of framing members where there is less than $1\frac{1}{4}$ inches (32 mm) between the duct and the finished face of the framing member. Protective shield plates shall be constructed of steel, shall have a minimum thickness of 0.062 inch (1.6 mm) and shall extend not less than 2 inches (51 mm) above sole plates and below top plates.

M1505.4 Whole-house mechanical ventilation system.

Each dwelling unit shall be equipped with a ventilation system. The whole-house mechanical ventilation systems shall be designed in accordance with Sections M1505.4.1 through M1505.4.4.

This means balanced

M1505.4.1 System design.

The *whole-house ventilation system* shall consist of one or more supply fans, one or more exhaust fans, or an ERV/HRV with integral fans, associated ducts and controls. Whole-house mechanical *ventilation* system supply and exhaust fans shall meet the requirements of Sections M1505.4.1.2, M1505.4.1.3, M1505.4.1.4, and M1505.4.1.5. Local exhaust fans are permitted to serve as part of the *whole-house ventilation system* when provided with the proper controls in accordance with Section M1505.4.2. The systems shall be designed and installed to exhaust and/or supply the minimum outdoor airflow rates required by Section M1505.4.3 as modified by *whole-house ventilation system* coefficients in Section M1505.4.3.1 where applicable. The *whole-house ventilation system* shall operate continuously at the minimum *ventilation* rate required by Section M1505.4.2 unless configured with intermittent off controls in accordance with Section M1505.4.3.2.

M1505.4.1.1 Whole-house system component requirements.

Whole-house ventilation supply and exhaust fans specified in this section shall have a minimum efficacy as prescribed in the *Washington State Energy Code*. Design and installation of the system or equipment shall be carried out in accordance with manufacturers' installation instructions. Whole-house ventilation fans shall be rated for sound at no less than the minimum airflow rate required by Section M1505.4.3.1. Ventilation fans shall be rated for sound at a maximum of 1.0 sone. This sound rating shall be at a minimum of 0.1 in. w.c. (25 Pa) static pressure in accordance with HVI procedures specified in Sections M1505.4.1.2 and M1505.4.1.3.

Exception: HVAC air handlers, ERV/HRV units, and remote mounted fans need not meet the sound requirements. To be considered for this exception, a remote mounted fan must be mounted outside the habitable spaces, bathrooms, toilets, and hallways, and there must be at least 4 feet (1.3 m) of ductwork between the fan and the intake grille.

The whole-house supply fan shall provide ducted outdoor ventilation air to each habitable space within the residential unit. This means distributed

Exception: Interior joining spaces provided with a 30 cfm whole-house transfer fan or a permanent opening with an area of not less than 8 percent of the floor area of the interior adjoining space but not less than 25 square feet (2.3 m^2) do not require ducted outdoor ventilation air to be supplied directly to the space. Whole-house transfer fans shall meet the sone rating of Section M1505.4.1.1 and shall have whole-house ventilation controls that comply with Section M1505.4.2.

M1505.4.1.2 Exhaust fans.

Exhaust fans required shall be ducted directly to the outside. Exhaust air outlets shall be designed to limit the pressure difference to the outside and equipped with backdraft dampers or motorized dampers in accordance with the *Washington State Energy Code*. Exhaust fans shall be tested and rated in accordance with the airflow and sound rating procedures of the Home Ventilating Institute (HVI 915, *HVI Loudness Testing and Rating Procedure*, HVI 916, *HVI Airflow Test Procedure*, and HVI 920, *HVI Product Performance Certification Procedure*, as applicable). Exhaust fans required in this section may be used to provide local ventilation. Bathroom exhaust fans that are designed for intermittent exhaust airflow rates higher than the continuous exhaust airflow rates in Table M1505.4.3.2 shall be provided with occupancy sensors or humidity sensors to automatically override the fan to the high speed airflow rate. The exhaust fans shall be tested and the testing results shall be submitted and posted in accordance with Section M1505.4.1.6.

M1505.4.1.3 Supply fans.

Supply fans used in meeting the requirements of this section shall supply outdoor air from intake openings in accordance with *International Mechanical Code* Sections 401.4 and 401.5. When designed for intermittent off operation, supply systems shall be equipped with motorized dampers in accordance with the *Washington State Energy Code*. Supply fans shall be tested and rated in accordance with the airflow and sound rating procedures of the Home Ventilating Institute (HVI 915, *HVI Loudness Testing and Rating Procedure*, HVI 916, *HVI Airflow Test Procedure*, and HVI 920, *HVI Product Performance Certification Procedure*, as applicable). Where outdoor air is provided by supply fan systems the outdoor air shall be filtered. The filter shall be accessible for regular maintenance and replacement. The filter shall have a Minimum Efficiency Rating Value (MERV) of at least 8.

M1505.4.1.4 Balanced whole-house ventilation system.

A *balanced whole-house ventilation* system shall include both supply and exhaust fans. The supply and exhaust fans shall have airflow that is within 10 percent of each other. The tested and balanced total mechanical exhaust airflow rate is within 10 percent or 5 cfm, whichever is greater, of the total mechanical supply airflow rate. The flow rate test results shall be submitted and posted in accordance with Section M1505.4.1.7. The exhaust fan shall meet the requirements of Section M1505.4.1.2. The supply fan shall meet the requirements of Section M1505.4.1.3. Balanced *ventilation* systems with both supply and exhaust fans in a packaged product, such as an ERV/HRV shall meet the requirements of HVI 920, as applicable. Local exhaust systems that are not a component of the whole-house mechanical ventilation system are exempt from the balanced airflow calculation.

M1505.4.1.5 Furnace integrated supply.

Systems using space heating and/or cooling air handler fans for outdoor air supply distribution are not permitted.

Exception: Air handler fans shall have multi-speed or variable speed supply airflow control capability with a low speed operation not greater than 25 percent of the rated supply airflow capacity during *ventilation* only operation. Outdoor air intake openings must meet the provisions of Sections R303.5 and R303.6 and must include a motorized damper that is activated by the *whole-house ventilation system* controller. The motorized damper must be controlled to maintain the outdoor airflow intake airflow within 10 percent of the whole-house mechanical exhaust airflow rate. The flow rate for the outdoor air intake must be tested and verified at the minimum *ventilation* fan speed and the maximum heating or cooling fan speed. The results of the test shall be submitted and posted in accordance with Section M1505.4.1.7.

M1505.4.1.6 Testing.

Whole-house mechanical *ventilation* systems shall be tested, balanced and verified to provide a flow rate not less than the minimum required by Sections M1505.4.3 and M1505.4.4.1. Testing shall be performed according to the *ventilation* equipment manufacturer's instructions, or by using a flow hood, flow grid, or other airflow measuring device at the mechanical *ventilation* fan's inlet terminals, outlet terminals or grilles or in the connected *ventilation* ducts. Where required by the *building official*, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *building official* and be posted in the *dwelling unit* per Section M1505.4.1.7.

M1505.4.1.7 Certificate.

A permanent certificate shall be completed by the mechanical contractor, test and balance contractor or other approved party and posted on a wall in the space where the furnace is located, a utility room, or an approved location inside the building. When located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label, or other required labels. The certificate shall list the flow rate determined from the delivered airflow of the whole-house mechanical *ventilation* system as installed and the type of mechanical *whole-house ventilation system* used to comply with Section M1505.4.3.1.

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS			
0–1	2	3	4	5 or more
	Airflow in CFM			
< 500	30	30	35	45
501–1,000	30	35	40	50
1,001–1,500	30	40	45	55
1,501–2,000	35	45	50	60
2,001–2,500	40	50	55	65
2,501–3,000	45	55	60	70
3,001–3,500	50	60	65	75
3,501–4,000	55	65	70	80
4,001–4,500	60	70	75	85
4,501–5,000	65	75	80	90

AREA TO BE EXHAUSTED	EXHAUST RATES
Intermittent	Continuous
Open Kitchens	In accordance with Section M1505.4.4.3
Enclosed Kitchens	In accordance with Section M1505.4.4.3
Bathrooms - Toilet rooms	50 cfm

CHAPTER 15 EXHAUST SYSTEMS

M1505.4.3 Mechanical ventilation rate.

The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate as determined in accordance with Table M1505.4.3(1) or Equation 15-1.

"Ventilation rate in cubic feet per minute = 0.01 × total square feet area of [home] + [7.5 × (number of bedrooms + 1)]. For not less than 30 cfm for each dwelling unit

TABLE M1505.4.3(1)
WHOLE-HOUSE MECHANICAL VENTILATION AIRFLOW RATE

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0-1	2	3	4	5 or more
	Airflow in CFM				
< 500	30	30	35	45	50
501-1,000	30	35	40	50	55
1,001-1,500	30	40	45	55	60
1,501-2,000	35	45	50	60	65
2,001-2,500	40	50	55	65	70
2,501-3,000	45	55	60	70	75
3,001-3,500	50	60	65	75	80
3,501-4,000	55	65	70	80	85
4,001-4,500	60	70	75	85	90
4,501-5,000	65	75	80	90	95

TABLE M1505.4.3(2)
SYSTEM COEFFICIENT (CSYSTEM)

SYSTEM TYPE	DISTRIBUTED	NOT DISTRIBUTED
Balanced	1.0	1.25
Not Balanced	1.25	1.5

M1505.4.3.1 Ventilation quality adjustment.

The minimum whole-house ventilation rate from Section 1505.4.3 shall be adjusted by the system coefficient in Table M1505.4.3(2) based on the system type not meeting the definition of a balanced whole-house ventilation system and/or not meeting the definition of a distributed whole-house ventilation system.

$Q_F = Q_T \times C_{SYSTEM}$

Where: (Equation 15-2)

Q_F = Quality-adjusted ventilation airflow rate in cubic feet per minute (cfm) (m³/s).
Q_T = Ventilation airflow rate, cubic feet per minute (cfm) (m³/s) from 15-1 or Table M1505.4.3(1).
C_{SYSTEM} = System coefficient from Table 1505.4.3(2).

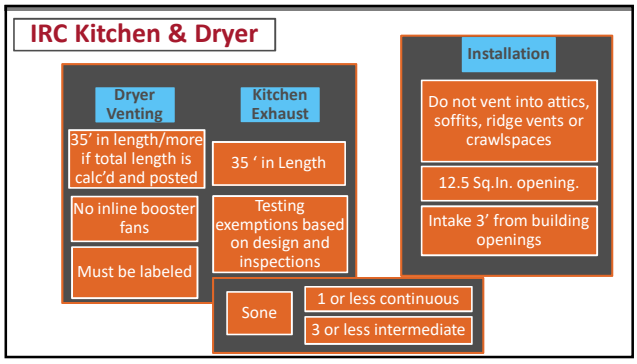
M1505.4.3.2 Intermittent off operation.

Wholehouse mechanical ventilation systems shall be provided with advanced controls that are configured to operate the system with intermittent off operation shall operate for a least two hours in each 4-hour segment. The whole-house ventilation airflow rate determined in accordance with Section M1505.4.3 as corrected by Section M1505.4.3.1 is multiplied by the factor determined in accordance with Table M1505.4.3.2.

TABLE M1505.4.3.2
INTERMITTENT OFF WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS[a, *]

Run-time % in Each 4-hour Segment	50%	66%	75%	100%
Factor*	2	1.5	1.3	1.0

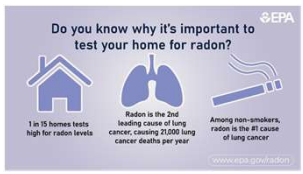
a. For ventilation system run-time values between those given, the factors are permitted to be determined by interpolation.



EPA's information about Radon.

- **Check out this guide** – A Citizen's Guide to Radon outlines important information on radon, useful for homebuilders and residents.
- **Learn about the lung cancer risks** – Read about the risks associated with radon exposure in homes to gain a better understanding of the importance of protecting homes.
- **Know radon hotlines and resources** – EPA provides support hotlines and connections to training programs for radon certifications.
- **Test your home** – EPA recommends that all homes in the U.S. be tested for radon. Testing is easy and inexpensive. Radon test kits can be obtained through the mail or at local hardware stores.
- **Build with radon-resistant features** – See EPA guidance for how to protect your homes from radon.
- **Learn about the EPA Map of Radon Zones,** and radon risks specific to your customers' EPA Regional Office, State, or Tribal program.

EPA & Radon Gas



EPA & Radon Gas

WHAT TO LOOK FOR IN A RADON REDUCTION SYSTEM

In selecting a radon reduction method for your home, you and your contractor should consider several things, including: how high your initial radon level is, the costs of installation and system operation, your home size, and your foundation type.

Installation and Operating Costs

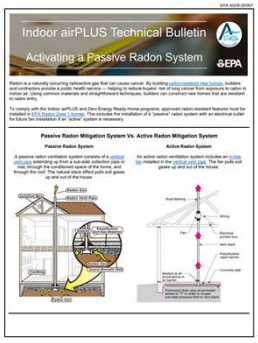
Most types of radon reduction systems cause some loss of heated or air conditioned air, which could increase your utility bills. How much your utility bills increase will depend on the climate you live in, what kind of reduction system you select, and how your home is built. Systems that use fans are more effective in reducing radon levels; however, they will slightly increase your electric bill.

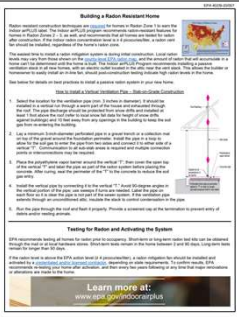
Radon!

Radon & Existing homes:

- EPA's guidance on radon & existing homes:
- 20 pages on existing homes
- Radon is still a silent killer!
- Working on additions or remodels and looking for guidance?

https://www.epa.gov/sites/default/files/2016-12/documents/2016_consumers_guide_to_radon_reduction.pdf





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2021 WA IRC Edition & Radon

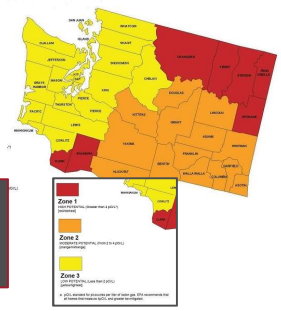
SECTION AF101 SCOPE

TABLE AF101(1)
HIGH RADON POTENTIAL (ZONE 1) COUNTIES.
The EPA recommends that this county listing be supplemented with other available state and local data to further understand the radon potential of a Zone 1 area.

FIGURE AF101
EPA MAP OF RADON ZONES

AF101.1 General.
This appendix contains requirements for new construction in *jurisdictions* where radon-resistant construction is required. Inclusion of this appendix by *jurisdictions* shall be required in high radon potential counties as determined in Figure AF101 and as listed in Table AF101(1). Unvented crawlspaces are not permitted in any high radon potential county. In other areas, requirements of this appendix apply to any structure constructed with unvented crawl spaces as specified in R408.3

Appendix AF IRC WAC 2021 Edition



AF102.1 General.

For the purpose of these requirements, the terms used shall be defined as follows:

DRAIN TILE LOOP. A continuous length of drain tile or perforated pipe extending around all or part of the internal or external perimeter of a *basement* or *crawl space* footing.

RADON GAS. A naturally occurring, chemically inert, radioactive gas that is not detectable by human senses. As a gas, it can move readily through particles of soil and rock, and can accumulate under the slabs and foundations of homes where it can easily enter into the living space through construction cracks and openings.

SOIL-GAS-RETARDER. A continuous membrane of 6-mil (0.15 mm) polyethylene or other equivalent material used to retard the flow of soil gases into a building.

SUBMEMBRANE DEPRESSURIZATION SYSTEM. A system designed to achieve lower sub-membrane air pressure relative to *crawl space* air pressure by use of a vent drawing air from beneath the soil-gas-retarder membrane.

SUBSLAB DEPRESSURIZATION SYSTEM (Active). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a fan-powered vent drawing air from beneath the slab.

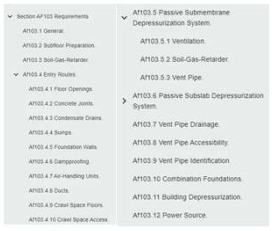
SUBSLAB DEPRESSURIZATION SYSTEM (Passive). A system designed to achieve lower sub-slab air pressure relative to indoor air pressure by use of a vent pipe routed through the *conditioned space* of a building and connecting the sub-slab area with outdoor air, thereby relying on the convective flow of air upward in the vent to draw air from beneath the slab

AF103.2 Subfloor preparation.

A layer of gas-permeable material shall be placed under all concrete slabs and other floor systems that directly contact the ground and are within the walls of the living spaces of the building, to facilitate future installation of a subslab depressurization system, if needed.

The gas-permeable layer shall consist of one of the following:

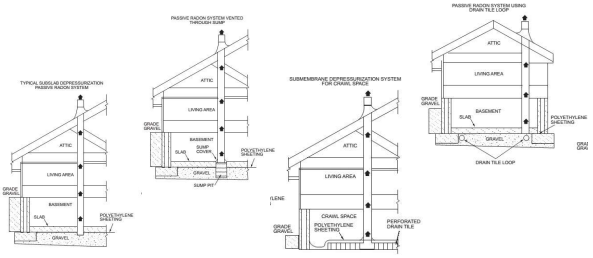
1. A uniform layer of clean aggregate, not less than 4 inches (102 mm) thick. The aggregate shall consist of material that will pass through a 2-inch (51 mm) sieve and be retained by a $^1/_4$-inch (6.4 mm) sieve.
2. A uniform layer of sand (native or fill), not less than 4 inches (102 mm) thick, overlain by a layer or strips of geotextile drainage matting designed to allow the lateral flow of soil gases.
3. Other materials, systems or floor designs with demonstrated capability to permit depressurization across the entire subfloor area.

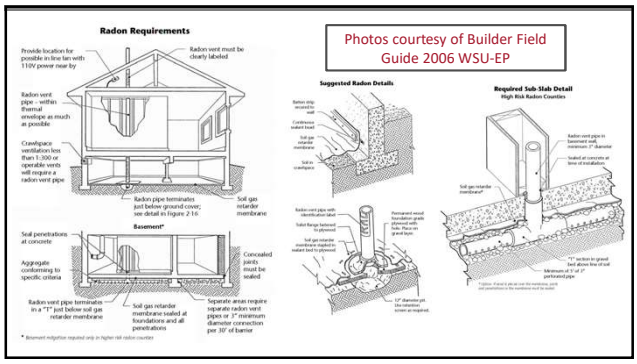


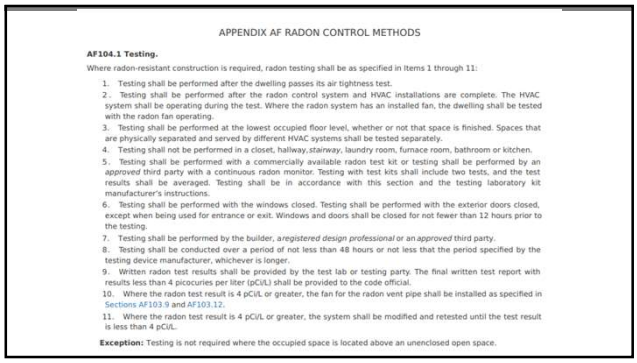
As you can see the radon section is larger than one would think.

AF103.1 General.

The following construction techniques are intended to resist radon entry and prepare the building for post-construction radon mitigation, if necessary (see Figure AF103.1). These techniques are required in high radon potential counties designated in Table AF101(1).







APPENDIX AF RADON CONTROL METHODS

AF104.1 Testing.

Where radon-resistant construction is required, radon testing shall be as specified in Items 1 through 11:

1. Testing shall be performed after the dwelling passes its air tightness test.
2. Testing shall be performed after the radon control system and HVAC installations are complete. The HVAC system shall be operating during the test. Where the radon system has an installed fan, the dwelling shall be tested with the radon fan operating.
3. Testing shall be performed at the lowest occupied floor level, whether or not that space is finished. Spaces that are physically separated and served by different HVAC systems shall be tested separately.
4. Testing shall not be performed in a closet, hallway, *stairway*, laundry room, furnace room, bathroom or kitchen.
5. Testing shall be performed with a commercially available radon test kit or testing shall be performed by an approved third party with a continuous radon monitor. Testing with test kits shall include two tests, and the test results shall be averaged. Testing shall be in accordance with this section and the testing laboratory kit manufacturer's instructions.
6. Testing shall be performed with the windows closed. Testing shall be performed with the exterior doors closed, except when being used for entrance or exit. Windows and doors shall be closed for not fewer than 12 hours prior to the testing.
7. Testing shall be performed by the builder, a *registered design professional* or an *approved* third party.
8. Testing shall be conducted over a period of not less than 48 hours or not less that the period specified by the testing device manufacturer, whichever is longer.
9. Written radon test results shall be provided by the test lab or testing party. The final written test report with results less than 4 picocuries per liter (pCi/L) shall be provided to the code official.
10. Where the radon test result is 4 pCi/L or greater, the fan for the radon vent pipe shall be installed as specified in Sections AF103.9 and AF103.12.
11. Where the radon test result is 4 pCi/L or greater, the system shall be modified and retested until the test result is less than 4 pCi/L.

Exception: Testing is not required where the occupied space is located above an unenclosed open space.

Thank you to our sponsor.

neea

Again!

About NEEA

Our Purpose - *The Northwest Energy Efficiency Alliance (NEEA) is an alliance of utilities and energy efficiency organizations that pools resources and shares risks to transform the market for energy efficiency to the benefit of consumers in the Northwest.*

(https://neea.org/about-neea)

Acknowledgments & Additional Credits

First we must give credit to ICC, whom many slides were gleaned from or copied as there are embodied code text language. We are not able to change the wording as that may have an effect on the out come of the intent of the original language.

It was gleaned for educational purposes only and copies of the full bodied text books from ICC will be necessary to follow along with the classes.

https://codes.iccsafe.org/

Link to digital Codes: https://play.google.com/store/apps/details?id=org.iccsafe.codes

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Our WSEC-Residential technical support team is not an affiliate of, nor do we speak for, the Washington State Building Code Council (SBCC). Official opinions of WSEC intent are made only by the SBCC in response to official inquiries submitted to the SBCC by authorities having jurisdiction. While we try to stay aligned with the SBCC, the technical support we provide is advisory only and non-binding on authorities having jurisdiction, builders, designers, and the building trades personnel involved with construction and remodeling of residential structures.

WASHINGTON STATE UNIVERSITY
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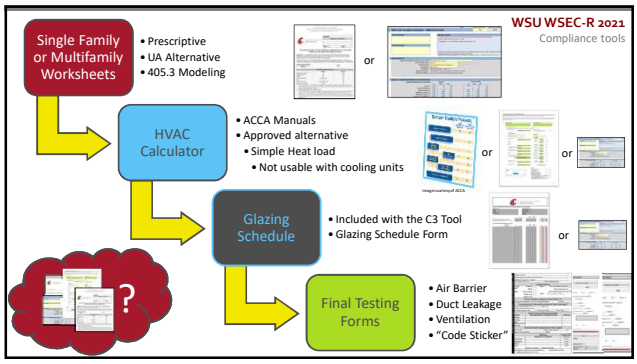
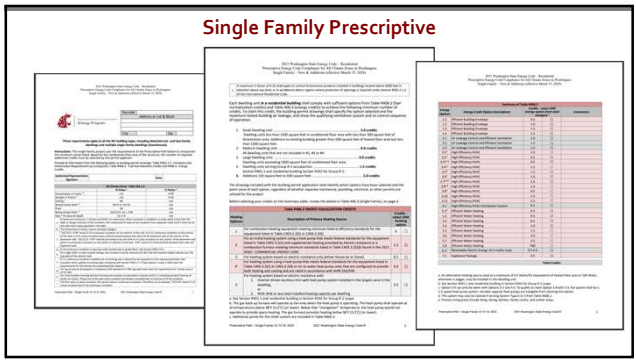
Questions?

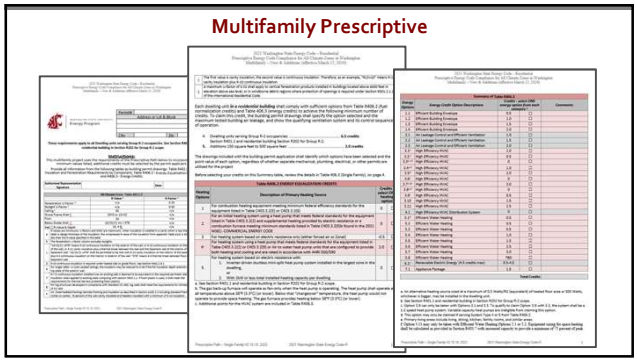
Thank You!

For additional information, visit our website at
www.energy.wsu.edu

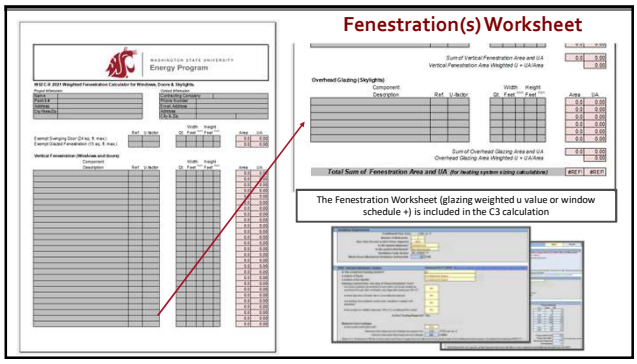
360-956-2042
EnergyCode@energy.wsu.edu


WSU WSEC-R 2021
Compliance tools
Single Family or Multifamily Worksheets
• Prescriptive
• UA Alternative
• 405.3 Modeling
or
HVAC Calculator
• ACCA Manuals
• Approved alternative
• Simple Heat load
• Not usable with cooling units
or
or
Glazing Schedule
• Included with the C3 Tool
• Glazing Schedule Form
or
?
Final Testing Forms
• Air Barrier
• Duct Leakage
• Ventilation
• "Code Sticker"


Single Family Prescriptive

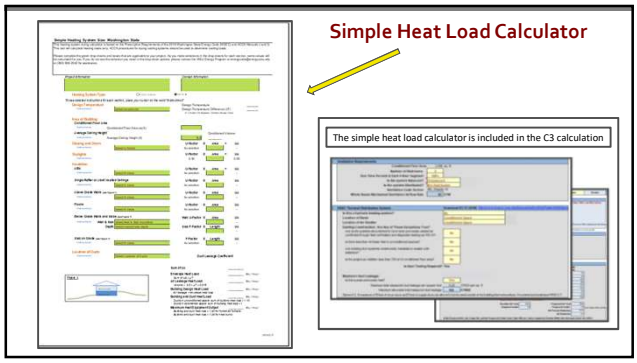

Multifamily Prescriptive

Fenestration(s) Worksheet



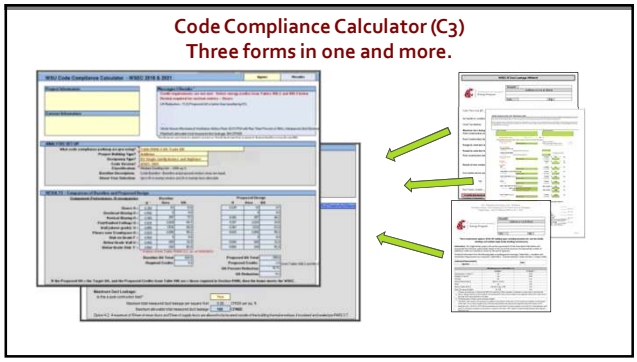
The Fenestration Worksheet (glazing weighted u value or window schedule +) is included in the C3 calculation

Simple Heat Load Calculator

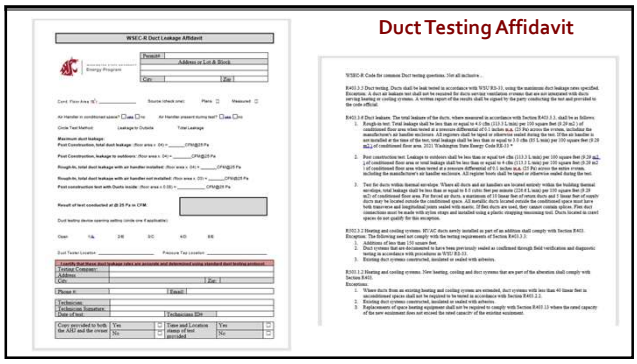


The simple heat load calculator is included in the C3 calculation

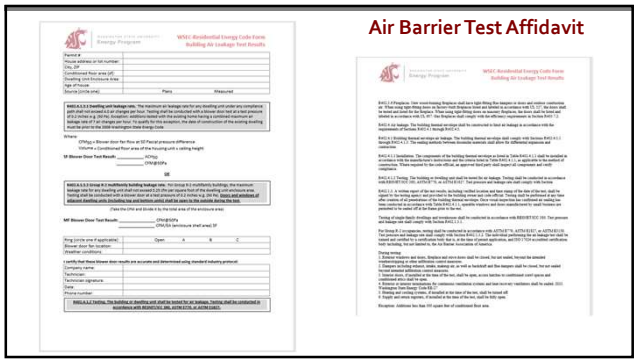
Code Compliance Calculator (C3)
Three forms in one and more.

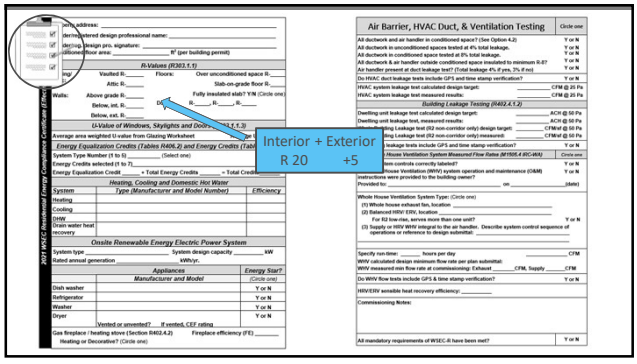


Duct Testing Affidavit



Air Barrier Test Affidavit





Remodel / Alteration Worksheet

Will you be exposing the walls?	Will the roof/ceiling framing cavities or attic be exposed?	Will the will the floor framing cavities be exposed?
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
If yes,	If yes,	If yes,
☐ 2 X 4 wall studs require R-15 insulation	Exposed roof or ceiling assemblies must be insulated -	☐ Exposed floor cavities must be insulated to R-30
☐ 2 X 6 wall studs require R-21 insulation	☐ Vaulted ceilings, Insulate to the full depth of the framing member	
☐ If siding is replaced C.I. equal to R-5 might need installed under the siding.	☐ Flat ceilings, install R-60 insulation or what the attic space can accommodate based on the roof pitch	

Are the windows and/or doors being replaced?	Will the heating or cooling system be replaced?	Will the hot water system be altered?	Are more than 10% of the light fixtures being changed?
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
If yes,	If yes,	If yes,	If yes,
☐ New windows and doors (+Frames) must have an area weighted average U-factor of ≤0.30	☐ New equipment must meet current requirements and the ducts need to be tested	☐ New water heating equipment must meet current code requirements	☐ 100% of all lamps must be high efficacy