

Residential Mechanical Rough-In

This Tip Sheet reflects code requirements of the 2021 International Residential Code (IRC), 2021 Uniform Plumbing Code (UPC), 2023 National Electric Code (NEC) and the 2021 Washington State Energy Code (WSEC) with Washington State Amendments.

(References to the IRC are indicated by: R = Residential; M = Mechanical; G = Gas)

Please verify the following before calling for mechanical rough-in inspection.

Permits and Plans

- Job address shall be posted in a visible location. (R319.1)
- Permit and approved plans are on the site. (R105.7, R106.1.1, R106.3.1)
- Permit information is correct (address, permit number, description of work, etc.) (R106.1.1)
- Duct rough-in test affidavit to be on site and available to the inspector. Maximum 4 cubic feet per minute (CFM) per 100 square feet (SF) of conditioned floor area with air handler installed or 3 CFM per 100 SF of conditioned floor area without air handler installed. (WSEC R403.3.6)

Forced-Air Furnace

General

It is important to note that there are exceptions to these general code references, if you question a specific application of the code the best way to resolve it is to first research the code at the local library then contact the jurisdiction that will issue the permit and do the inspections.

- Fuel burning appliances cannot be installed in sleeping rooms, bathrooms, toilet rooms, storage closets, or in a space that opens into such rooms or spaces unless they are direct vent or listed for use within living space. (G2406.2).
- Heat producing equipment installed shall maintain clearances to combustibles as required by the listing of the appliance, and the manufacturers' installation instructions (MII). (M1402.2, M1306.1)
- Furnace room passageway is minimum 24 inches wide. (M1305.1.1)
- M1305 has specific requirements for installation of mechanical equipment in attics and crawl spaces, consult the IRC for general requirements and the installation instructions for the appliance.
- A level working space is not less than 30 inches deep and 30 inches wide shall be provided in front of the control side to service appliance. (M1305.1).
- Electrical receptacle is required at or near the appliance. (Within 25 feet per NEC 210.63) (M1305.1.3.3)

- Means of disconnect are required within sight of appliance or the breaker is to be capable of being locked in the open position. (NEC 422.31(B))
- Switch controlled lighting (light protected or away from access) and receptacle outlet are provided at the required passageway for servicing of equipment. (M1305.1.3.3)
- Refer to the listing and manufacture installation instructions along with section M1409 for the installation of a wall furnace.

Underfloor and Attics

- When a furnace is installed in an underfloor area, it is suspended a minimum of 6 inches above grade or installed on a slab extending above adjoining grade. (M1305.1.3.1)
- When equipment is installed on wood platforms the framing and sheathing is preservative treated when installed within 18 inches of soil to bottom of framing. (R317)
- Excavations or pits for equipment have specific requirements; check the installation instructions and M1305.1.3.2 for minimum requirements.

Garage

- Equipment which has a flame, generates a spark or uses a glowing ignition source is open to the space in which it is installed and is elevated such that the source of ignition is at least 18 inches above the floor, unless the appliance is flammable vapor ignition resistant. (M1307.3)
- Ducts which penetrate a wall or ceiling separating the garage from the dwelling are 26 gauge with no openings to the garage. (R302.5.2)
- Appliances shall not be installed in a location subject to vehicle damage except where protected by approved barriers. (M1307.3.1)

Condensing Furnace (High Efficiency)

- Condensate drain required to drain by gravity to an approved place of disposal or install a UL 508-approved condensate pump or see code for other options. (M1411.3)
- Condensate pumps located in uninhabitable spaces shall prevent the connected appliance from operating if the pump fails. (M1411.4)
- Approved drainpipe material that leads from the drain pan is to be minimum 3/4 inch with 1/8-inch per foot slope. (M1411.3.2, M1411.2)
- Evaporative Cooling Equipment connected to potable water must have a backflow assembly. (M1413.1, as amended by Washington State; UPC 603)

Ducting

General

- Duct to ground has a minimum 4-inch clearance. (M1601.4.8)
- Metal ducts underground shall be encased by concrete a minimum of 2 inches thick. (M1601.1.2)
- Crimp joints for round and oval ducts shall be lapped in the direction of airflow a minimum 1 inch and fastened with (3) sheet-metal screws or rivets equally spaced around the joint. (M1601.4.2)
- Joints, seams, and fittings of ducts are sealed with mastic or other approved means. (M1601.4.1)
- Flex duct is supported per manufacturer's specifications. (M1601.4.4)
- Metal duct is supported every 10 feet minimum. (M1601.4.4; SMACNA HVAC Standard)
- Ducts shall not displace required insulation of walls, floors, ceilings, exterior walls and building cavities. (WSEC R403.3.7)
- Venting systems shall not extend into or pass through any fabricated air duct or furnace plenum. (G2427.3.4)
- Wall and joist cavities shall not be used as a supply or return air duct. (M1601.1.1 #7)

Return Air

- Return air taken from a room or space is not greater than flow rate of supply air delivered to a room or space. (M1602.2, Item 2)
- Return air cannot be taken from a closet, bathroom, toilet room, kitchen, garage, boiler room, furnace room, unconditioned attic or other dwelling unit. See applicable exceptions. Dedicated systems serving only a garage may obtain return from the garage served. Return air shall not discharge from one dwelling unit to another dwelling unit. (M1602.2, Item 4)
- Return air inlets cannot be located within 10 feet of any fuel burning appliance fire box or draft hood located in the same space. (M1602.2, Item 1)
- Minimum return, air transfer openings, and duct shall be sized in accordance with: appliance or equipment manufacturers' installation instructions; Manual "D"; or by a Registered Design Professional. (M1602.2, Item 3; G2442.1) (Forced air furnaces minimum outside, return air, openings 2 square inches/ kBtu/ hr. (Electric Heat pumps per UL 1995)).
- Ducts shall not displace required insulation of walls, floors, ceilings, exterior walls and building cavities.(WSEC R403.3.7)
- Venting systems shall not extend into or pass through any fabricated air duct or furnace plenum. (G2427.3.4)

Insulation

- Ducts, boots and connectors used for heating or cooling insulated to R-8 in unconditioned spaces. (WSEC R403.3.1) Ducts shall not displace required insulation of walls, floors, ceilings, exterior walls and building cavities.(WSEC R403.3.7)

Combustion Air

- The minimum cross section dimension for combustion air ducting is 3 inches. (G2407.6)
- Ducts shall not displace required insulation of walls, floors, ceilings, exterior walls and building cavities. (WSEC R403.3.7)
- Venting systems shall not extend into or pass through any fabricated air duct or furnace plenum. (G2427.3.4)
- Combustion air ducts cannot be screened when terminating in an attic space. (G2407.11, Item 5)
- When combustion air is obtained from the attic or crawl space, they must be sufficiently vented. (G2407.6, Figure G2407.6.1(1))
- For indoor combustion air openings, each opening shall be 1 square inch per 1,000 Btu/h input of all appliances, but not less than minimum of 100 square inches. Provide one opening at the top and one at the bottom. (G2407.5.3.1)
- Outdoor combustion air openings (attic and crawl) shall communicate directly or freely with the outdoors. (G2407.6.1)
- Where vertical ducts are used to provide combustion air from the outdoors, each opening requires 1 square inch of opening per 4,000 Btu/h of total input rating of all appliances in the space. (M1701.1 / G2407.6.1 – Two Opening Method).
- Where horizontal ducts are used each opening requires 1 square inch of opening per 2,000 Btu/h of total input rating of all appliances in the space. (G2407.6.1)
- When the one opening method is used the opening requires 1 square inch of opening per 3,000 Btu/h of total input rating of all appliances in the space and be within the top 12 inches of the space. The openings shall communicate directly or freely with the outdoors. (G2407.6.2)
- Outside combustion air openings are to be screened with corrosion-resistant mesh material not smaller than 1/4 inch. (G2407.10)
- Combustion air may be drawn from inside the building if of ordinary tightness and the conditioned space is at least 50 cubic feet per 1,000 Btu/h input for all fuel burning appliances combined. (M1701.1; G2407.5.1)

Vents and Connectors

- Venting systems shall be installed per the manufacturer's instructions. (M1801.1; G2427.6.2)

- Where two gas appliances are vented through a common vent connector, it is equal to the largest connector plus 50% of the smaller flue outlet and not less than the combined area of the flue outlets for which it acts as a common connector. (G2427.10.3.4)
- Vent connector clearances to combustibles are per the manufacturer's listing or performance standards. (M1803.3.4, M1306.1, G2427.7.8)
- Single wall vents cannot penetrate a wall, floor or ceiling without a listed pass-through assembly, except for gas vents. Exterior combustible walls only with a "ventilated metal thimble". (M1803.3.1; G2427.7.7, Requirements 1-3)
- Vent terminations are installed per the manufacturer's listing. (M1804.1; G2427)
- Exhaust vent terminations for mechanical draft and direct venting shall not be less than 4 feet below or 4 feet horizontally from, and not less than 1 foot above a door, an operable window or a gravity air inlet into a building, nor less than 3 feet above any forced air intake within 10 feet, nor within 12 inches of grade. (M1804.2.6, Items 1-7; G2427.8; IRC appendix C)
- Gas vent terminations for listed caps, for roof or wall size and clearances see Table G2427.6.4. Gas vents less than 12 inches, and not less than 8 feet from vertical wall or obstruction, shall terminate above roof per table (pitch of roof). Gas vents more than 12 inches shall terminate 2 feet above, and 10 feet away from any portion of a building. (G2427.6.3)
- Vent terminal (except direct vent) not mounted directly above or within 3 feet horizontally of a gas meter or oil tank vent. (M1804.2.6 (5))
- Vent terminal no closer than 3 feet to an interior corner formed by two perpendicular walls. (M1804.2.6)
- Power exhaust terminals not located within 10 feet of property line and adjacent buildings, and 7 feet above any finished ground level public walkway. (M1804.2.6; G2427.3.3)
- Venting systems shall not extend into or pass through any fabricated air duct or furnace plenum. (G2427.3.4)
- A chimney or vent connector shall not pass through any floor or wall ceiling and shall not pass through a wall or partition unless the connector is listed and labeled for wall pass-through and installed per the listing. (M1803.3.1; G2427.7.6)
- Where vents extending into an attic pass through insulated assemblies, an insulation shield of 26 gage sleeve not less than 2 inches above the insulation, secured in place and shall be installed to provide clearance between the vent and the combustible insulation materials, specified by the vent manufacturer. (G2426.4)
- Venting supported per manufacturer's listing. (M1801.1; M1801.7)

Appliances

Clothes Dryer

- Exhausted per manufacturer's instructions. (M1502.1 & G2439.1)
- Clothes dryer exhaust ducts of metal with smooth interior surfaces, with joints running in the direction of air flow. (M1502.4.2; G2439.7.1)
- Protective shield steel plates of 0.062 thickness, where nails or screws are likely to penetrate clothes dryer exhaust duct, including at framing members less than 1-1/4 inches between duct and finished face of framing member and extend not less than 2 inches above the sole plate and beyond the top plate. (M1502.5; G2439.6)
- Screws allowed as fasteners. No more than 1/8-inch protrusion. (M1502.4.2; G2439.7.2)
- Duct connector 4 inches minimum or appliance outlet size. (M1502.4.1; G2439.7.1)
- 2 Methods for determining dryer duct length:
 - Exhaust duct doesn't exceed 35 feet. (M1502.4.6)
 - Deduct 2-1/2 feet for each 45-degree elbow and 5 feet for each 90-degree bend.
 - Maximum length determined by the manufacturer's installation instructions when make and model of dryer are provided to the Code Official at rough-in. (M1502.4.6, Exception; G2439.7.4.2)
- Clothes dryer ducting run independently of other ducted systems and shall convey moisture to the outdoors (except listed and labeled condensing ductless clothes dryers). (M1502.2; G2439.1)
- Exterior termination is backdraft dampered with no screens, and 3 feet minimum away from any openings into building. Clothes dryer exhaust ducts shall not connect to vent connectors, vent, or chimney. (M1502.3; G2439.3)
- Clothes dryer ducting concealed in construction exceeding 35 feet must be labeled with the equivalent length. Label shall be located within 6 feet of the exhaust connection. (M1502.4.7; G2439.7.5)
- Dryer exhaust duct required at time of occupancy. If dryer is not installed, exhaust duct shall be capped at the location of the future dryer (except listed and labeled condensing ductless clothes dryers) (M1502.4.8; G2439.7.6).
- Dryer transition duct shall be single length, listed and labeled to UL 2158A, and maximum length 8 feet long. Transition ducts shall not be concealed within construction. (M1502.4.3; G2439.7.3)
- Gas dryer gas connectors maximum 6 feet long, measured along centerline of the connector; one connector only. (G2422.1.2.1)
- Gas shutoff valve installed immediately ahead of connector. (G2422.1.2.4)

Range

- Vertical clearance to combustibles is 30 inches minimum or per manufacturer's listing. Minimum clearance reduced to 24 inches (gas cooking appliance) with one of three exceptions. (M1901.1; G2447.5 (1-3)).
- Gas connector maximum 6 feet long maximum. (G2422.1.2.1)
- Shutoff valve installed immediately ahead of connector. (G2422.1.2.4)

Range Hood

- Terminates outside, it is air-tight, it is equipped with a backdraft damper, and it shall be independent of all other exhaust systems. (M1503.3)
- Hoods with an exhaust rate over 400 CFM shall be mechanically or passively provided with makeup air at a rate approximately equal to the exhaust air rate unless all fuel-burning appliances are direct-vent or uses a mechanical draft venting system with at least one damper. (M1503.6)
- Ducting is galvanized steel, stainless steel, or copper, with a smooth interior. Exception: Ducts for domestic cooking appliances equipped with downdraft exhaust system can be schedule 40 PVC and comply with all five exception requirements. (M1503.2.1-5)
- Domestic open-top broiler units shall have a metal exhaust hood, having a minimum thickness of 0.0157 inch with (M1503.2.1, WA State Amendment):
 - 1/4-inch clearance between the hood and the underside of combustible materials or cabinets, and
 - A clearance of minimum 24 inches between cooking surface to combustible materials or cabinets, unless listed and labeled for broiler units with integral exhaust system.
- The hood shall be not less than the width of the broiler unit, extend over the entire unit, and when located inside the building envelope, shall discharge to the outdoors and be equipped with a backdraft damper or other means to control infiltration/exfiltration when not in operation. (M1503.2.1, WA State Amendment)
- Broiler units incorporating an integral exhaust system and listed and labeled for use without an exhaust hood, or broiler units permanently installed outside the building envelope and having the cooking surface at least 5 feet below a 1-hour fire resistance rated ceiling, need not have an exhaust hood. (M1503.2.1, WA State Amendment)

Fireplace

- Factory built fireplaces are certified, listed, and labeled in accordance with ASTM E2558. Testing shall be performed by Washington State DOE and a US EPA-accredited laboratory. (R1004.1.1)

- Certified Masonry and Concrete fireplaces and heaters are tested and certified to Washington State Building Code Standard 31-2. Testing is performed by Washington State DOE and a US EPA-accredited laboratory. (R1001.1, R1004.1; M1415.1)
- Solid fuel burning appliances and fireplaces have tight-fitting metal/ceramic doors and are certified to test No. 11-Negative pressure test, Section 12.3, of ULCS627-M1984 for outside combustion air; duct 4 inches minimum and 20 feet maximum length. (R1006.6, as amended by Washington State)
- Hearth extensions are to be readily distinguishable from the surrounding floor and in accordance with the fireplace listing. (R1004.2)
- Installed per manufacturer's installation instructions when installed in a solid fuel burning fireplace. (Decorative Gas Fireplace) (G2432.1)
- Appliance shutoff valves shall be located in the same room, and within 6 feet of the appliance.
- Appliance shutoff valves located in fireplace firebox shall be installed per the appliance manufacturer's instructions.
- Shutoff valves for vented decorative appliances and room heaters shall be permitted to be installed in a remote area from the appliance where such valves are provided with ready access, permanent identification, and serve no other appliance. Shutoff valve installed at a manifold within 50 feet of appliance, but other requirements apply, as above.(G2420.5.1-3)
- Decorative shrouds used at chimney terminations are to be listed and labeled for use with specific chimney systems. (R1004.3; R1005.2)

Air Conditioning

- Cooling coils installed downstream (return side) from heat exchanger. (M1411.2)
- Working space minimum 30 inches by 30 inches. (M1305.1)
- Condensate disposal line to an approved place of disposal, but not to public street, alley, or create a nuisance. (M1411.3)
- Auxiliary and secondary drain systems (including pan) in addition to condensate disposal, where damage to any building components will occur from overflow or stoppage of condensate drain piping (four methods, including UL 508 shutoff switch). (M1411.3.1.1-4)
- Condensate line minimum 3/4 inch and sloped to drain termination without sags; 1/8 unit in 12 units (1-percent slope). (M1411.3; UPC 814.1)
- Refrigerants shall conform to ANSI/ASHREA 34. (M1411)
- Refrigerant lines shall be insulated to R-3, and perm rating of maximum 0.05. (M1411.6)
- Refrigerant circuit access ports shall be fitted with the locking-type tamper-resistant caps. (M1411.9)

Exhaust Venting

- Source specific ventilation fans are required in kitchens, bathrooms, water closet rooms per Table M1505.4.4 (1), as amended by Washington State.
- Bathroom fans are 50 cubic feet per minute (CFM) minimum or 20 CFM continuous. Kitchen fans are 160 cfm for electric range and 250 cfm for combustion range.
- All exhaust ducts shall terminate outside the building and can not vent to attic, crawl space, soffit, or ridge vent. (M1501.1)

Whole House Ventilation Systems

Each dwelling unit shall be equipped with a ventilation system. Consult code section M1505 for the different ventilation options including whole house fan systems and exhaust type systems. Exhaust rates are listed in the tables. (M1505)

Energy Code Requirements

- Verify energy credits on approved plans including: water heater specs, insulation values, appliances, and specific types of heating and cooling equipment that is required.
- Duct rough-in test affidavit to be on site available to the inspector. Maximum 4 CFM per 100 square feet with air handler installed; 3 CFM per 100 square feet without an air handler installed. (WSEC R403.3.3-4)
- Building framing cavities shall not be used as duct or plenums. Installation of ducts in exterior walls, floors and ceilings shall not displace required envelope insulation. (WSEC 403.3.7)
- Ducts located in conditioned space. For ducts to be considered as inside a conditioned space, such ducts shall comply with one of the following: (WSEC 403.3.2)
 1. All duct systems shall be located completely within the continuous air barrier and within the building thermal envelope.
 2. All heating, cooling and ventilation system components shall be installed inside the conditioned space including, but not limited to, forced air ducts, hydronic piping, hydronic loops, convectors and radiators. Combustion equipment shall be direct vent or sealed combustion.
 3. For forced air ducts, a maximum of 10 linear feet of return ducts and 5 linear feet of supply ducts is permitted to be located outside the conditioned space, provided they are insulated to a minimum of R-8.
 4. Ductwork in floor cavities located over unconditioned space shall have a continuous air barrier between unconditioned space and the duct, insulation per R402.2.7 and minimum R19 separating duct from unconditioned space.

- Ducts outside the building thermal envelope shall be insulated to a minimum of R-8. Ducts within a concrete slab or in the ground shall be insulated to R-10 with insulation designed to be used below grade. (WSEC R403.3)
- HVAC supply and return register boots shall be sealed to the sub floor, wall covering, or ceiling penetrated by the boot. (WSEC Table R402.4.1.1)
- The entire area of a heated slab on grade floor shall be thermally isolated from the soil with a minimum of R-10 insulation. (WSEC R402.2.9.1)
- Additional Energy Efficiency Requirements (Energy Credits) Additional energy efficiency requirements for all new construction shall comply so as to achieve the following minimum number of credits:
 1. Small Dwelling Unit: 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: 8.0 credits
 - All dwelling units that are not included in Options 1, 3 or 4
 3. Large Dwelling Unit: 9.0 credits
 4. Dwelling units serving R-2 occupancies: 6.5 credits.
 5. Additions 150 square feet to 500 square feet: 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. (WSEC 406.3)
- For more information, go to <http://www.energy.wsu.edu/BuildingEfficiency/EnergyCode.aspx> for more information on the Washington State Energy Code requirements.