Deep Dive: Technical Details of the ENERGY STAR MFNC Program

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Agenda

- Brief Overview of MFNC
- Rater Design & Field Checklists
  - New for MFNC
- Multifamily Workbook Walkthrough
- HVAC Design Report Walkthrough
- HVAC Functional Testing Checklist
- Policy Issues Under Review / Feedback
- Learn More

ENERGY STAR Residential New Construction Programs: Present




Certified Homes


MFHR



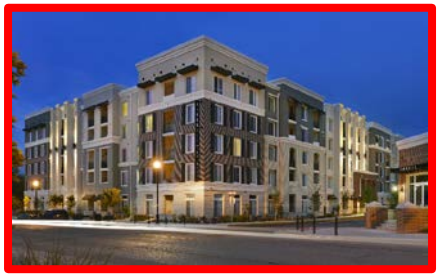

MFNC

ENERGY STAR Residential New Construction Programs: Present




Certified Homes

(permit before 1/1/2021)




MFHR

(permit + MFHR application before 1/1/2021)




MFNC

ENERGY STAR Residential New Construction Programs: Future*



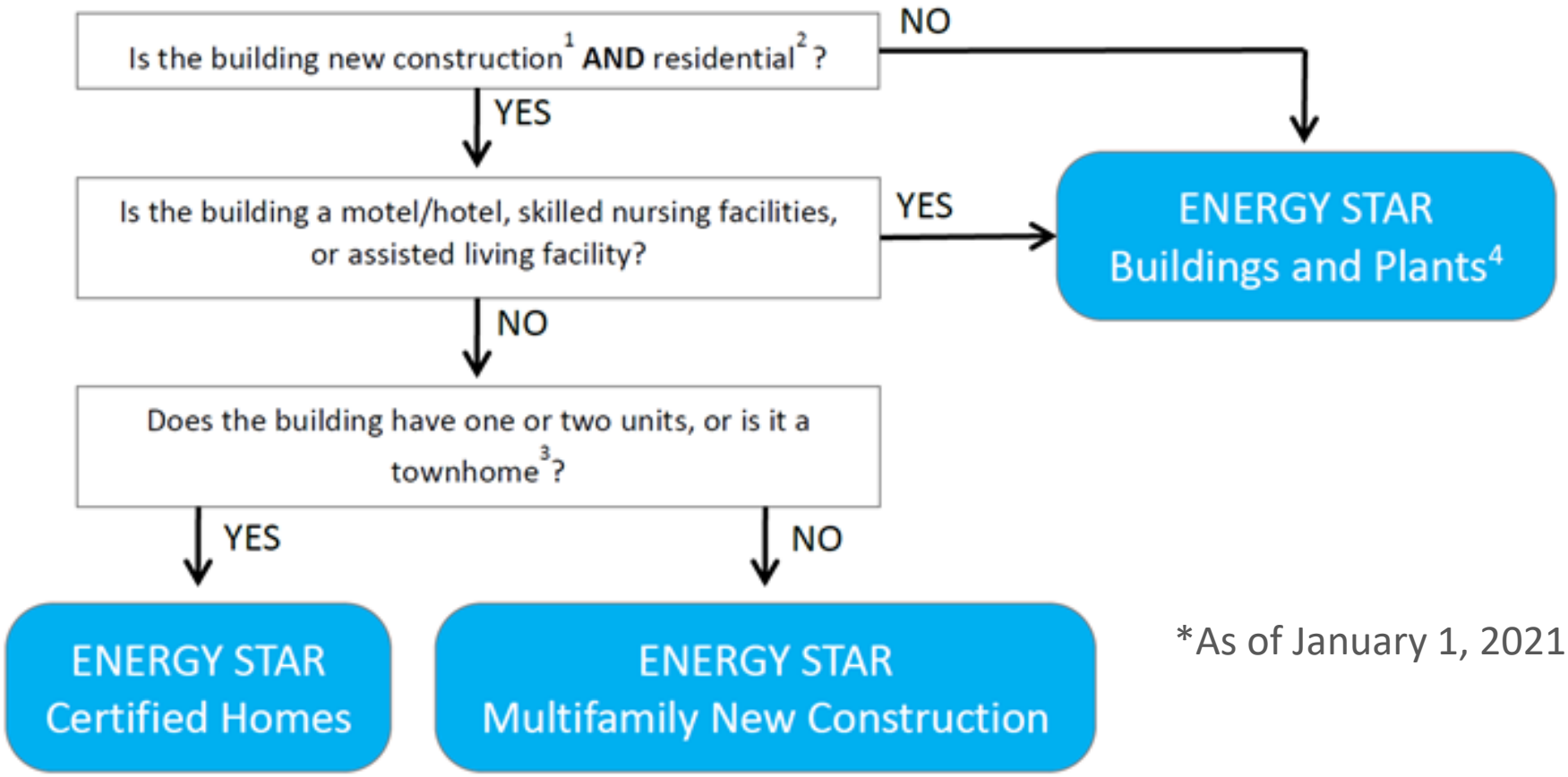
Certified Homes

*As of January 1, 2021



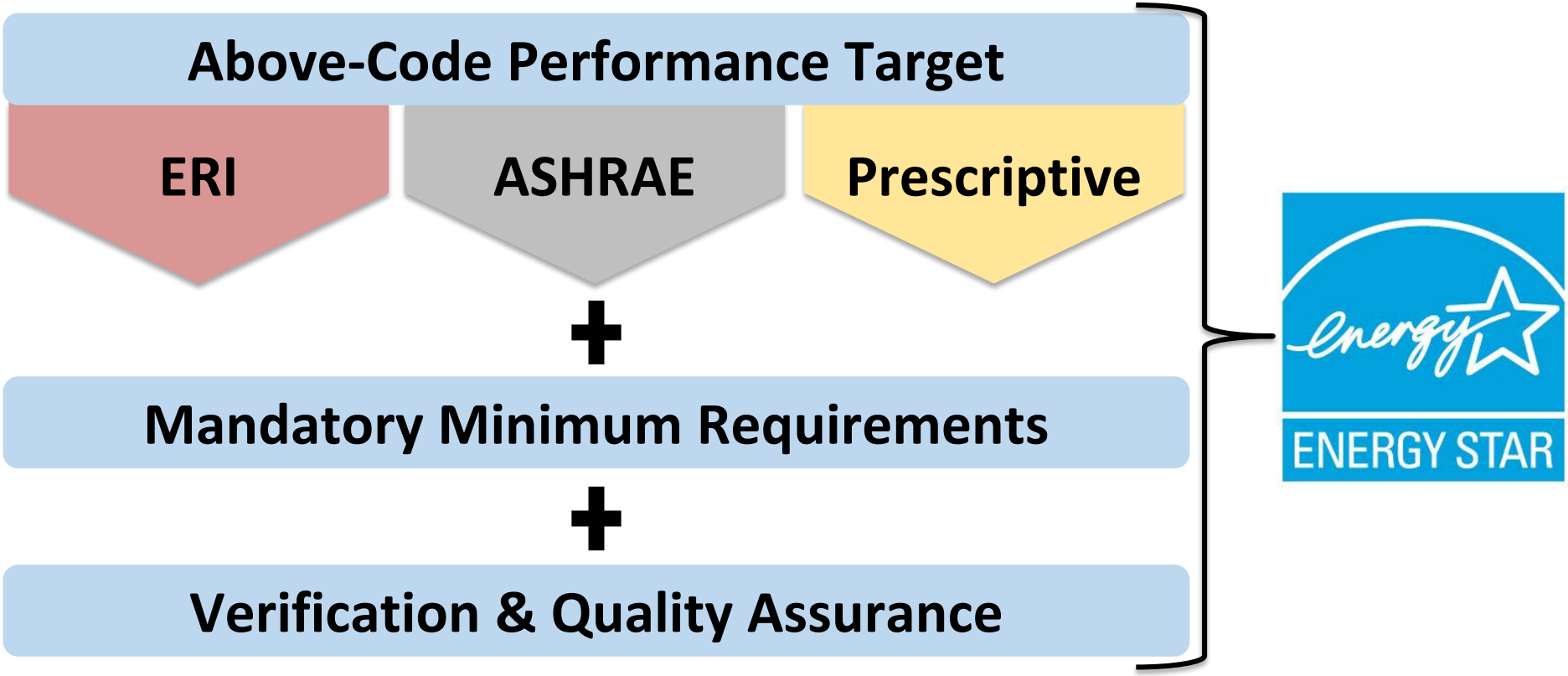

MFNC

ENERGY STAR Residential New Construction Programs: Future



*As of January 1, 2021

Key Components of ENERGY STAR MFNC



Certification Process

ERI

JOIN

All **participants** met participation requirements **prior to** certifying multifamily buildings.

✓ Builders ✓ Raters ✓ Functional Testing Agents ✓ Developers

DESIGN

Complete **Design Verification Documents.**

✓ Rater Design Review Checklist ✓ HVAC Design Report

Optional: Multifamily Workbook; Reference: Rater Field Checklist, Water Mgmt System Requirements

ERI → Conduct energy modeling to ensure that project design meets or exceeds the ERI Target.

BUILD

Complete **Construction Verification Documents.**

✓ Rater Field Checklist ✓ HVAC Functional Testing Checklist ✓ Photo Documentation

Optional: Multifamily Workbook; Reference: Water Mgmt System Requirements

CERTIFY

Rater submits all documentation to an oversight organization.

ERI → Update energy rating based on conditions. Register each unit in the project with an EPA-approved VOO.

MARKET

ENERGY STAR certification label and ENERGY STAR certificate.
ENERGY STAR plaques available for purchase.

Rater Checklists – New for MFNC

- Fenestration and Insulation Levels
- Thermal Bridging Details
- Non-ducted Returns
- Common Spaces and Garages
- Central Systems

Fenestration

2. High-Performance Fenestration		
2.1 Dwelling units:		
2.1.1 Prescriptive: Specified fenestration meets or exceeds ENERGY STAR MF Reference Design requirements. [5]	☐	☐
2.1.2 ERI and ASHRAE only: Specified fenestration meets or exceeds 2009 IECC residential requirements. [5]	☐	☐
2.2 Common space: [2]		
2.2.1 ERI and Prescriptive: Specified fenestration meets or exceeds ENERGY STAR MF Reference Design requirements. [5]	☐	☐
2.2.2 ASHRAE only: Specified fenestration meets or exceeds 2009 IECC commercial requirements. [5]	☐	☐

Fenestration

Footnote 5: All windows, doors and skylights must meet or exceed the U-factor and SHGC requirements specified in the table below.

Res. Windows in Unit

	Dwelling unit doors and windows that are not classified "Class AW"*	Dwelling unit windows and doors that are classified as "Class AW"*	Common Space†
ERI	2009 IECC Table 402.1.1	2009 IECC Table 502.3	ENERGY STAR MF Reference Design – for Class AW
ASHRAE	2009 IECC Table 402.1.1	2009 IECC Table 502.3	2009 IECC Table 502.3
Prescriptive	ENERGY STAR MF Reference Design	ENERGY STAR MF Reference Design – for Class AW	ENERGY STAR MF Reference Design – for Class AW

Windows and doors modeled, as illustrated below:

Version 1.0

Window U-Factor:	0.60 in CZs 1,2	0.35 in CZ 3	0.32 in CZ 4	0.30 in CZs 4 C,5,6,7,8
Window SHGC:	0.27 in CZs 1,2	0.30 in CZ 3	0.40 in CZ 4	Any in CZs 4 C,5,6,7,8
Door U-Factor:	Opaque: 0.21	≤½ lite: 0.27		>½ lite: 0.32
Door SHGC:	Opaque: Any	≤½ lite: 0.30		>½ lite: 0.30

Fenestration

All windows, doors and skylights must meet or exceed the U-factor and SHGC requirements specified in the table below.

	Dwelling unit doors and windows that are not classified "Class AW"*	Dwelling unit windows and doors that are classified as "Class AW"*	Common Space†
		All Other Windows	
ERI	2009 IECC Table 402.1.1	2009 IECC Table 502.3	ENERGY STAR MF Reference Design – for Class AW
ASHRAE	2009 IECC Table 402.1.1	2009 IECC Table 502.3	2009 IECC Table 502.3
Prescriptive	ENERGY STAR MF Reference Design	ENERGY STAR MF Reference Design – for Class AW	ENERGY STAR MF Reference Design – for Class AW

* Classified as "Class AW" under the North American Fenestration Standard (AAMA / WDMA / CSA 101 / I.S.2 / A440).

† Opaque doors in common spaces in CZ 1-6 shall not exceed U-0.70, and in CZ 7-8, shall not exceed U-0.5.

Exception: Class AW fenestration modeled to 2012 IECC levels (Commercial fenestration U-Factor requirements).

Version 1.0

Climate Zone:	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4 C & 5	CZ 6	CZ 7	CZ 8
Fixed Window U-Factor:	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable Window U-Factor:	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Glazed Entrance Door U-Factor:	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC	0.27	0.27	0.30	0.40	0.40	0.40	any	any

Minimum Insulation Levels

3. High-Performance Insulation
3.1 Dwelling unit:
3.1.1: Prescriptive: Specified ceiling[6], wall[7], floor, and slab-on-grade insulation levels meet or exceed ENERGY STAR MF Reference Design requirements for "Group R"[8, 9, 10]
3.1.2: HERS and ASHRAE only: Specified ceiling[6], wall[7], floor, and slab-on-grade insulation levels meet or exceed values from the "Group R" column in the 2009 IECC Commercial chapter[8, 9, 10]
3.2 Common space:
3.2.1 HERS and Prescriptive: Specified ceiling[6], wall[7], floor, and slab-on-grade insulation levels meet or exceed ENERGY STAR MF Reference Design requirements for 'All other'[8, 9, 10]
3.2.2 ASHRAE only: Specified ceiling[6], wall[7], floor, and slab-on-grade insulation levels meet or exceed the values from the 2009 IECC Commercial chapter'[8, 9, 10]

Rater Design Checklist

	ASHRAE	ERI	Prescriptive
In-Unit	Minimum: 2009 IECC Comm. Group R	Minimum: 2009 IECC Comm. Group R	Ref Design: (Wood-frame) 1.0: 2009 IECC Comm. Group R 1.1: 2012 IECC Comm. Group R
Common Space	Minimum: 2009 IECC 'All Other'	Ref Design: 1.0: 2009 IECC 'All Other' 1.1: 2012 IECC 'All Other'	Ref Design: 1.0: 2009 IECC 'All Other' 1.1: 2012 IECC 'All Other'

a. ERI Path: register each unit in the building / project with the same EPA-recognized VCO.

b. ASHRAE and Prescriptive Path: specific documentation must be submitted based on as-built conditions to an MRO for their review and approval. These documents include the Multifamily Workbook; the Rater Field Checklist, unless included in the Multifamily Workbook; the HVAC Functional Testing Checklists; construction documents; photo documentation; and for ASHRAE projects, the ASHRAE Path Calculator and either the modeling file or input and output files.

National Program Requirements

ENERGY STAR Multifamily New Construction, Version 1 / 1.1 / OR-WA 1.2 (Rev. 01)

Exhibit 1: ENERGY STAR Multifamily Reference Design [10]

The ENERGY STAR Multifamily Reference Design is the set of efficiency features modeled to determine the ENERGY STAR ERI Target for each unit pursuing certification. Therefore, while the features below are not mandatory in the units for projects pursuing the ERI Path, if they are not used then other measures will be needed to achieve the ENERGY STAR ERI Target. In addition, note that the Mandatory Requirements for All Certified Multifamily Projects, Exhibit 2, contain additional requirements such as total duct leakage limits, minimum allowed insulation levels, and minimum allowed fenestration performance. Therefore, EPA recommends that partners review the documents in Exhibit 2 prior to selecting measures.

For projects pursuing the Prescriptive Path, the following features are mandatory within the units and, as specified in the National Rater and Field Checklists, in the common spaces. For projects pursuing the ERI Path, the following features are mandatory within the common spaces as specified in the National Rater Design Review and Field Checklists.

This Exhibit is not applicable for projects pursuing the ASHRAE Path.

Common Space Applicability Notes:

When using the Reference Design for common space measures as specified in the National Rater Design Review and Rater Field Checklist, the following notes apply.

1) Heating and Cooling efficiencies for additional equipment are available in the Exhibit X of the National Rater Field Checklist.
2) Insulation levels for common spaces in Version 1 and Version 1.1 are not the values shown in the Reference Design. They must instead meet or exceed the levels in the 2009 and 2012 IECC Commercial chapter, respectively. The required values should come from the "All Other" column and the row that corresponds to the building assembly (e.g., a building with steel-frame walls would use the value in the 'Metal framed' row).
3) Windows and glazed entrance doors are to meet or exceed the requirements specified for "Class AW" fenestration in the Reference Design.
4) All exterior and common space lighting fixtures are still subject to the efficiency requirements, even though they are not in 'ANSI / RESNET / ICC Standard 301-defined Qualifying Light Fixture Locations'. Therefore, 90% of all exterior and common space fixtures must be ENERGY STAR certified or meet the alternatives defined in the National Rater Field Checklist. This requirement applies to exterior lighting fixtures that are attached to the building, but does not apply to landscape or parking lot lighting fixtures.
5) Where an appliance type is not eligible for ENERGY STAR certification, (e.g., commercial dryers) the appliance is exempt from this requirement. Where a bathroom faucet or aerator is not eligible for WaterSense certification, (e.g., public use lavatory faucets) the fixture is exempt from this requirement.

	ASHRAE
In-Unit	Minimum: 2009 IECC Group R
Common Space	Minimum: 2009 IECC 'All Other'

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a, b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R- 38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
Walls, Above Grade																
Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci[c]	R-11.4ci	R-11.4ci	R-13.3 ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13+ 7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + 7.5	R-13 + R-7.5ci	R-13 + R-7.5 ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5 ci	R-13 + R-18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13+ R-3.8ci	R-13 + R-3.8ci	R-13 + 3.8	R-13 + 7.5	R-13 + R-7.5	R-13+ R-7.5ci	R-13 +7.5ci	R-13 + R-15.6ci	R-13 + 15.6ci
Walls, Below Grade																
Below grade wall[d]	NR	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	NR R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-7.5ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing Steel/(wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U –0.50	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(2).
c. R-5.7 ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with

	ASHRAE
In-Unit	Minimum: 2009 IECC Group R
Common Space	Minimum: 2009 IECC 'All Other'

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
CLIMATE ZONE	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
							Roofs									
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a, b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R- 38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
							Walls, Above Grade									
Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci[c]	R-11.4ci	R-11.4ci	R-13.3 ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13+ 7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + 7.5	R-13 + R-7.5ci	R-13 + R-7.5 ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5 ci	R-13 + R-18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13+ R-3.8ci	R-13 + R-3.8ci	R-13 + 3.8	R-13 + 7.5	R-13 + R-7.5	R-13+ R-7.5ci	R-13 +7.5ci	R-13 + R-15.6ci	R-13 + 15.6ci
							Walls, Below Grade									
Below grade wall[d]	NR	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	NR R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-7.5ci	R-12.5ci
							Floors									
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing Steel/(wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
							Slab-on-Grade Floors									
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U –0.50	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(2).
c. R-5.7 ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with

	ERI
In-Unit	Minimum: 2009 IECC Group R
Common Space	Ref Design: 1.0: 2009 IECC 'All Other' 1.1: 2012 IECC 'All Other'

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a, b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R- 38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
Walls, Above Grade																
Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci[c]	R-11.4ci	R-11.4ci	R-13.3 ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13+ 7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + 7.5	R-13 + R-7.5ci	R-13 + R-7.5 ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5 ci	R-13 + R-18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13+ R-3.8ci	R-13 + R-3.8ci	R-13 + 3.8	R-13 + 7.5	R-13 + R-7.5	R-13+ R-7.5ci	R-13 +7.5ci	R-13 + R-15.6ci	R-13 + 15.6ci
Walls, Below Grade																
Below grade wall[d]	NR	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	NR R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-7.5ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing Steel/(wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U –0.50	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(2).
c. R-5.7 ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with

	ERI
In-Unit	Minimum: 2009 IECC Group R
Common Space	Ref Design: **1.0: 2009 IECC 'All Other'** 1.1: 2012 IECC 'All Other'

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
CLIMATE ZONE	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
							Roofs									
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a, b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R- 38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
							Walls, Above Grade									
Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci[c]	R-11.4ci	R-11.4ci	R-13.3 ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13+ 7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + 7.5	R-13 + R-7.5ci	R-13 + R-7.5 ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5 ci	R-13 + R-18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13+ R-3.8ci	R-13 + R-3.8ci	R-13 + 3.8	R-13 + 7.5	R-13 + R-7.5	R-13+ R-7.5ci	R-13 +7.5ci	R-13 + R-15.6ci	R-13 + 15.6ci
							Walls, Below Grade									
Below grade wall[d]	NR	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	NR R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-7.5ci	R-12.5ci
							Floors									
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing Steel/(wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
							Slab-on-Grade Floors									
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U –0.50	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(2).
c. R-5.7 ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with

	ERI
In-Unit	Minimum: 2009 IECC Group R
Common Space	Ref Design: 1.0: 2009 IECC 'All Other' **1.1: 2012 IECC 'All Other'**

TABLE C402.2
OPAQUE THERMAL ENVELOPE REQUIREMENTS[a]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R
Roofs																
Insulation entirely above deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks)[b,c]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49
Walls, Above Grade																
Mass	R-5.7ci	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13+ R-19.5ci	R-13 + R-13ci	R-13+ R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5ci	R-13+ R17.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-15.6ci or R-20 + R-10ci	R-13 + R-15.6ci or R-20 + R-10ci
Walls, Below Grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-10ci	R-10ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30[f]	R-30[f]	R-30[f]	R-30[f]	R-30[f]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below
Heated slabs[d]	R-7.5 for 12" below	R-7.5 for 12" below	R-7.5 for 12" below	R-7.5 for 12" below	R-10 for 24" below	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 36" below	R-15 for 36" below	R-15 for 36" below	R-20 for 48" below	R-20 for 24" below	R-20 for 48" below	R-20 for 48" below	R-20 for 48" below
Opaque Doors																
Swinging	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Roll-up or sliding	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

For SI: 1 inch = 25.4 mm. ci = Continuous insulation. NR = No requirement.

LS = Liner System—A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins.

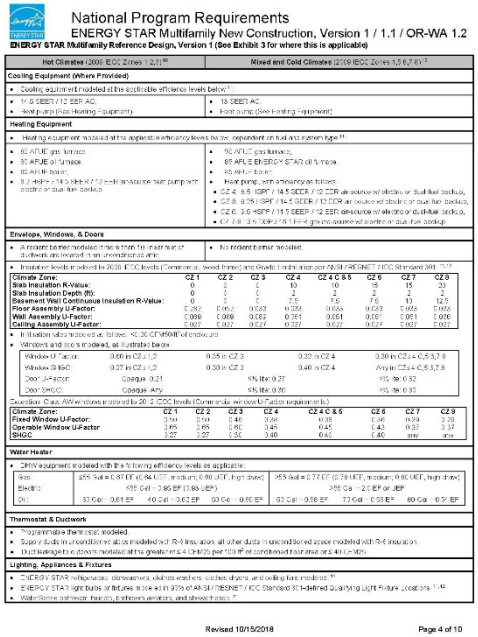
a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.2.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

	Prescriptive
In-Unit	Ref Design: (Wood-frame) **1.0: 2009 IECC Group R** 1.1: 2012 IECC Group R
Common Space	Ref Design: 1.0: 2009 IECC 'All Other' 1.1: 2012 IECC 'All Other'



National Program Requirements
ENERGY STAR Multifamily New Construction, Version 1 / 1.1 / OR-WA 1.2
ENERGY STAR Multifamily Reference Design, Version 1 (See Exhibit 3 for where this is applicable)

Hot Climates (2009 IECC Zones 1,2,3)	Mixed and Cold Climates (2009 IECC Zones 4,5,6,7,8)
Cooling Equipment (Where Provided)	
• Cooling equipment modeled at the applicable efficiency levels below:	
• 14.5 SEER / 12 EER AC • Heat pump (See Heating Equipment)	• 13 SEER AC • Heat pump (See Heating Equipment)
Heating Equipment	
• Heating equipment modeled at the applicable efficiency levels below, dependent on fuel and system type:	

• 80 AFUE gas furnace
• 80 AFUE oil furnace
• 82 AFUE boiler
• 8.2 HSPF / 14.5 SEER / 12 EER (assume heat pump with electric or dual-fuel backup)
	• 90 AFUE gas furnace
	• 85 AFUE ENERGY STAR oil furnace
	• 85 AFUE boiler
	• Heat pump, with efficiency as follows:
	  • CZ 4: 8.5 HSPF / 14.5 SEER / 12 EER (assume w/ electric or dual-fuel backup)
	  • CZ 5: 8.75 HSPF / 14.5 SEER / 13 EER (assume w/ electric or dual-fuel backup)
	  • CZ 6: 9.0 HSPF / 15.0 SEER / 12 EER (assume w/ electric or dual-fuel backup)
	  • CZ 7 & 8: 9.5 HSPF / 15.5 EER (assume w/ electric or dual-fuel backup)

Envelope, Windows, & Doors	
• A radiant barrier installed in the attic floor of buildings developed in an unconditioned attic	• No radiant barrier required.
• Insulation levels modeled to 2009 IECC levels (Commercial, wood-frame) and Grade I installation per ANSI / RESNET / ICC Standard 301. [11,12]	

Climate Zone:	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4 C & 5	CZ 6	CZ 7	CZ 8
Slab Insulation R-Value:	0	0	0	10	10	15	15	20
Slab Insulation Depth (ft):	0	0	0	2	2	2	2	2
Basement Wall Continuous Insulation R-Value:	0	0	0	7.5	7.5	7.5	10	12.5
Floor Assembly U-Factor:	0.282	0.052	0.033	0.033	0.033	0.033	0.033	0.033
Wall Assembly U-Factor:	0.089	0.089	0.089	0.064	0.051	0.051	0.051	0.036
Ceiling Assembly U-Factor:	0.027	0.027	0.027	0.027	0.027	0.027	0.027	0.027

• Infiltration rates modeled as follows: <0.30 CFM50/ft² of enclosure

• Windows and doors modeled, as illustrated below:								
Window U-Factor:	0.66 in CZ 1,2		0.35 in CZ 3		0.32 in CZ 4		0.30 in CZ 4 C,5,6,7,8	
Window SHGC:	0.27 in CZ 1,2		0.30 in CZ 3		0.40 in CZ 4		Any in CZ 4 C,5,6,7,8	
Door U-Factor:	Opaque: 0.21			5% Max: 0.27			5% Max: 0.32	
Door SHGC:	Opaque: Any			5% Max: 0.20			5% Max: 0.32	
Exception: Case AWWs may be approved to 2012 IECC levels (Commercial, wood-frame) U-Factor requirement is:								
Climate Zone:	CZ 1	CZ 2	CZ 3	CZ 4	CZ 4 C & 5	CZ 6	CZ 7	CZ 8
Fixed Window U-Factor:	0.50	0.50	0.46	0.36	0.36	0.36	0.29	0.29
Operable Window U-Factor	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
SHGC	0.27	0.27	0.30	0.40	0.40	0.40	any	any

Water Heater			
• DHW equipment modeled with the following efficiency levels as applicable:			
Gas:	≤55 Gal: 0.67 EF (0.64 UEF, medium; 0.80 UEF, high draw)		>55 Gal: 0.72 EF (0.78 UEF, medium; 0.80 UEF, high draw)
Electric:	≤55 Gal: 0.95 EF (0.93 UEF)		>55 Gal: 2.0 EF or UEF
Oil:	30 Gal: 0.61 EF	40 Gal: 0.62 EF	50 Gal: 0.65 EF	60 Gal: 0.58 EF	70 Gal: 0.59 EF	80 Gal: 0.59 EF

Thermostat & Ductwork
- Programmable thermostat modeled.
- Supply ducts in unconditioned attics modeled with R-8 insulation; all other ducts in unconditioned space modeled with R-6 insulation.
- Duct leakage to outside modeled at the greater of 4 CFM25 per 100 ft² of conditioned floor area or 4 cfm (+/-10%).

Lighting, Appliances & Fixtures
- ENERGY STAR refrigerator, dishwasher, clothes washer, ceiling fans modeled. [9]
- ENERGY STAR light bulbs or fixtures installed in 90% of ANSI / RESNET / ICC Standard 301-defined Qualifying Light Fixture Locations. [11,12]
- Water Sense bathroom faucets, bathroom aerators, and showerheads. [7]

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	Prescriptive
In-Unit	Ref Design: (Wood-frame) 1.0: 2009 IECC Group R 1.1: 2012 IECC Group R
Common Space	Ref Design: **1.0: 2009 IECC 'All Other'** 1.1: 2012 IECC 'All Other'

TABLE 502.2(1)
DING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

	3				4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
					All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs														
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a, b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R- 38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
Walls, Above Grade														
Mass	NR	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci[c]	R-11.4ci	R-11.4ci	R-13.3 ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13+ 7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + 7.5	R-13 + R-7.5ci	R-13 + R-7.5 ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5 ci	R-13 + R-18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13+ R-3.8ci	R-13 + R-3.8ci	R-13 + 3.8	R-13 + 7.5	R-13 + R-7.5	R-13+ R-7.5ci	R-13 +7.5ci	R-13 + R-15.6ci	R-13 + 15.6ci
Walls, Below Grade														
Below grade wall[d]	NR	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	NR R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-7.5ci	R-12.5ci
Floors														
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing Steel/(wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors														
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U –0.50	U – 0.50	U –0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(2).
c. R-5.7 ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with

Insulation: Heated Plenums and Garages

Plenums and Garages:

- Insulate top - 'ceiling' or floor above
- Insulate walls

ASHRAE projects can choose to not insulate, but regardless, heating energy must be modeled in both baseline and proposed (Rater Field, Footnote 9)

Plenums:

- Plenum 'wall' must be an air barrier
- Insulate bottom of plenum to R-13
  - Bottom of plenum can be suspended ceiling tiles (or other non-air barrier) (Rater Field, Footnote 10)
  - If using fiberglass batts, must be paper-faced (RF, Footnote 10)

Heated Plenums

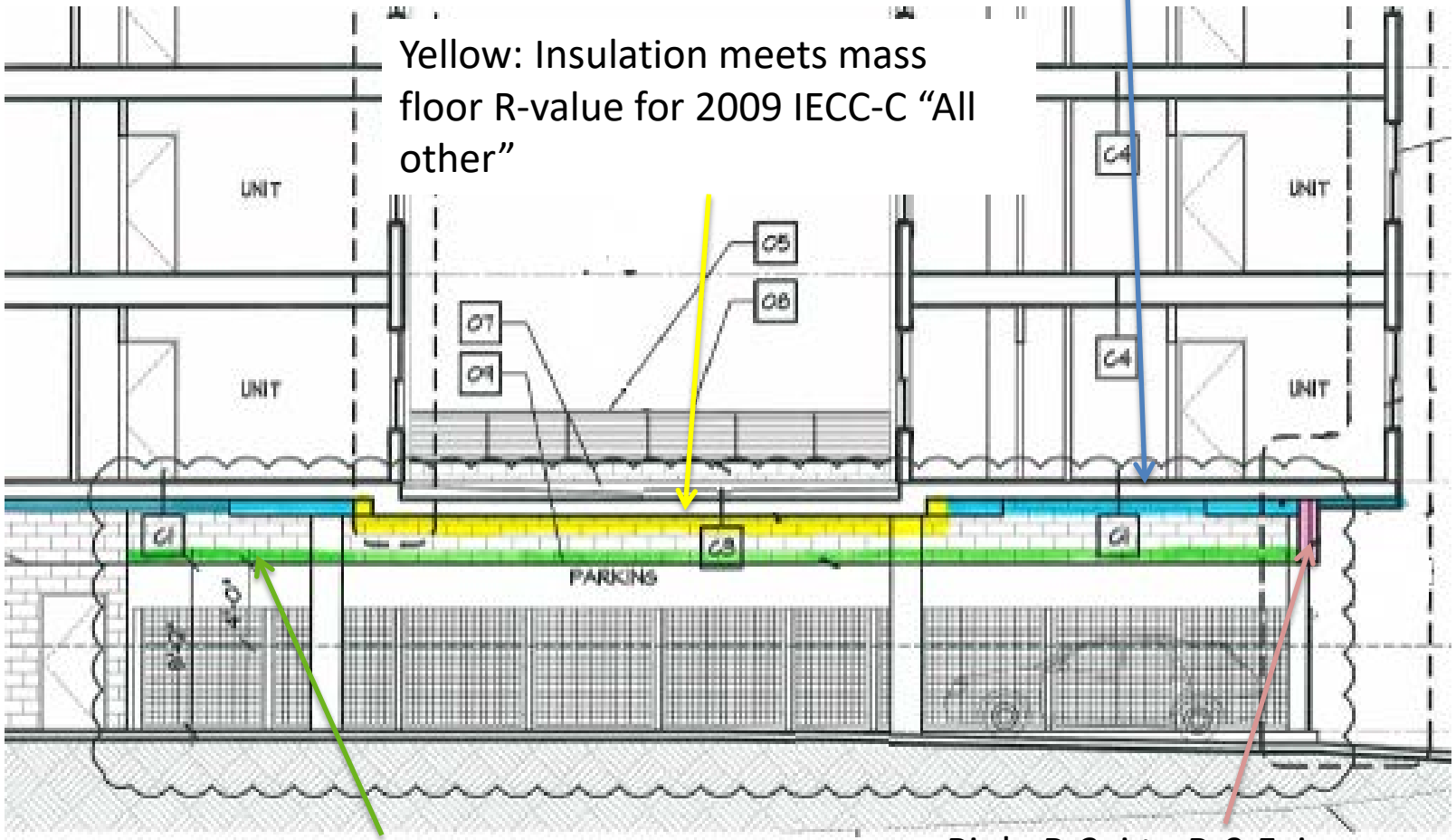
1.5 Heated plenums in unconditioned space or ambient conditions must meet the following requirements: [9]
1.5.1 Sides of plenum are an air barrier and insulated to ≥ R-3ci in CZ 1-4; ≥ R-5ci in CZ 5-6; ≥ R-7.5ci in CZ 7; ≥ R-9.5ci in CZ 8, **AND;**
1.5.2 Insulation at top of plenum meets or exceeds the R-value for mass floors from the "All Other" column of Table 502.2(1) of 2009 IECC, **AND;**
1.5.3 Bottom of plenum must have at least R-13 insulation. [10]
1.6 Garages with space heating must meet the following requirements: [9]
1.6.1 Insulation on above grade w … grade ≥ R-5ci in CZ 5-6; ≥ R-7.5ci in CZ 7; ≥ R-9.5ci in CZ 8,
1.6.2 Garage ceiling insulation meets or exceeds the R-value for mass floors from the "All Other" column of Table 502.2(1) of 2009 IECC.

Rater Field Checklist

Note: 1.5.2 already required unless ceiling is not attached to apartment or common areas

Heated Plenum Example

Blue: Insulation meets mass floor level for space above



Green: R-13 insulation; air barrier not required

Pink: R-3ci to R-9.5ci, depending on CZ

Heated Garages

1.5 Heated plenums in unconditioned space or ambient conditions must meet the following requirements: [9]
1.5.1 Sides of plenum are an air barrier and insulated to ≥ R-3ci in CZ 1-4; ≥ R-5ci in CZ 5-6; ≥ R-7.5ci in CZ 7; ≥ R-9.5ci in CZ 8, **AND;**
1.5.2 Insulation at top of plen … ass floors from the "All Other" column of Table 502.2(1) of 2009 IECC, **AND;**
1.5.3 Bottom of plenum must have at least R-13 insulation. [10]
1.6 Garages with space heating must meet the following requirements: [9]
1.6.1 Insulation on above grade walls and walls on the first story below grade ≥ R-5ci in CZ 5-6; ≥ R-7.5ci in CZ 7; ≥ R-9.5ci in CZ 8, **AND;**
1.6.2 Garage ceiling insulation meets or exceeds the R-value for mass floors from the "All Other" column of Table 502.2(1) of 2009 IECC.

Rater Field Checklist

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
							Floors									
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci

Note: 1.6.2 already required unless ceiling is not attached to apartment or common areas

Reduced Thermal Bridging (Item 3.7)

At apartment and common area above-grade walls separating conditioned from unconditioned space, use one of the following options:

1. Continuous insulation, insulated siding, or combination of the two is ≥ R-3 for CZ 1-4 and ≥ R-5 for CZ 5-8 *[this is the only option for metal-framing]*

OR

2. Select an advanced assembly option: Structural Insulated Panels; Insulated Concrete Forms; Double-wall framing

OR

For **wood**-framed projects ≤ 3 stories (any CZ) OR in CZ 1-3 (any height)

3. Complete the following 'advanced framing' details:

- Corners insulated ≥ R-6 to edge, AND
- Headers above windows & doors insulated ≥ R-3 for 2x4 framing and ≥ R-5 for all other, AND
- Interior/exterior wall intersections insulated to same R-value as rest of exterior wall

Reduced Thermal Bridging

3.7 At above-grade walls and rim / band joists separating conditioned from unconditioned space, one of the following options used: [23,26]			
3.7.1 Continuous rigid insulation, insulated siding, or combination of the two is: ≥ R-3 in CZ 1-4; ≥ R-5 in CZ 5-8 [24, 25, 26, 27], **OR**;	☐	☐	☐
3.7.2 Structural Insulated Panels **OR**; Insulated Concrete Forms **OR**; Double-wall framing **OR**; [24, 26, 28]	☐	☐	☐
3.7.3 Option only for wood-framed walls either in CZ 1-3 OR ≤ 3 stories: 'advanced framing' details including all of the Items below: [26,29]			
3.7.3a Corners insulated ≥ R-6 to edge [30], **AND**;	☐	☐	☐
3.7.3b Headers above windows & doors insulated ≥ R-3 for 2x4 framing or equivalent cavity width, and ≥ R-5 for all other assemblies (e.g., with 2x6 framing) [31], **AND**;	☐	☐	☐
3.7.3c Interior / exterior wall intersections insulated to same R-value as rest of exterior wall. [32]	☐	☐	☐

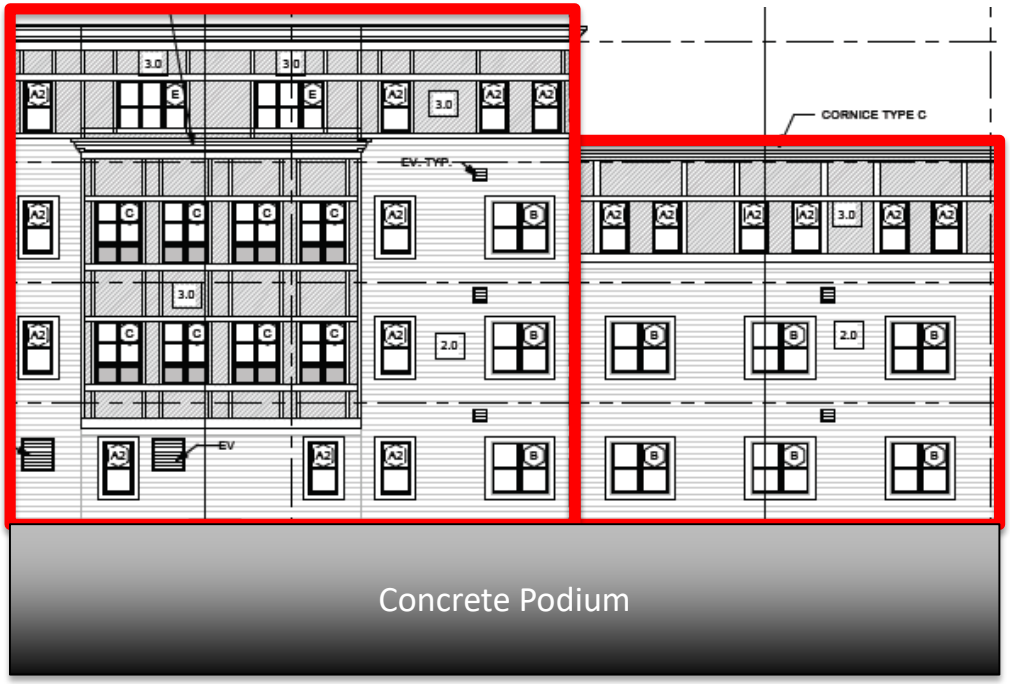
Rater Field Checklist

Reduced Thermal Bridging (Rev.01)

3.7.3 Option only for wood-framed walls either in CZ 1-3 OR ≤ 3 stories: 'advanced framing' details including all of the Items below:

Footnote: …For the purpose of this requirement, "≤ 3 stories" refers to any portion of the building elevation where the wood-framed walls do not exceed 3 stories in height. Partial floors that meet the definition of a mezzanine or loft, as defined by the 2012 IRC, do not count as a story…

Reduced Thermal Bridging (Rev.01)



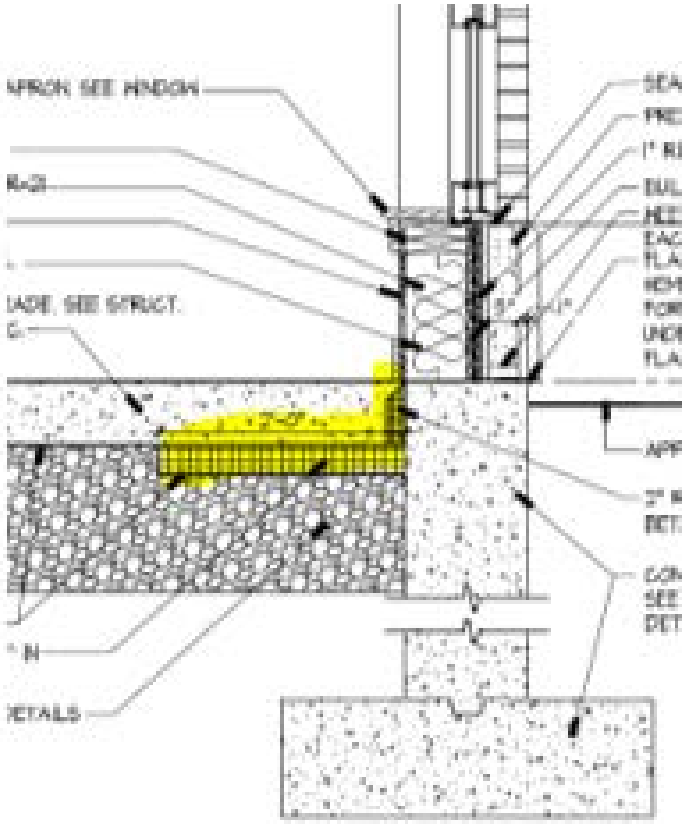
Slab-on-Grade Insulation (Rater Field, 3.4)

3. Reduced Thermal Bridging	
3.1	For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below and is ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8. [17]
3.2	For insulated ceilings with attic space above, attic access panels and drop-down stairs insulated ≥ R-10 or equipped with durable ≥ R-10 cover. [18]
3.3	Insulation beneath attic platforms (e.g., HVAC platforms, walkways) ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8.
3.4	For slabs on grade in CZ 4-8, 100% of slab edge insulated to ≥ R-5 at the depth specified by Table 502.2(1) of the 2009 IECC and aligned with the thermal boundary of the walls. [19, 20]
3.5	For elevated concrete slabs in CZ 4-8 (i.e., podiums and projected balconies, but not intermediate slab floor edges) 100% of the slab edge insulated to ≥ R-5. For podiums, insulation must be installed for the full height of the podium wall. Alternatives in Footnote 21. [21]
3.6	For elevated concrete slabs in CZ 4-8 (i.e., podiums, but not intermediate floor slabs), floor insulation meets the U-factor specified in Table 502.1.2 of the 2009 IECC for Group R when dwelling units are above the slab, and for 'All Other' when common space is above the slab. [22]

Slab-on-Grade Insulation (Rater Field, 3.4)

For slabs on grade in CZ 4-8, 100% of slab edge insulated to ≥ R-5 at the depth specified by the 2009 IECC and aligned with the thermal boundary of the walls

- Required for apartments & <u>common areas</u>
- Required when floor surface less than 24" below grade; and must extend to top of slab
- Required where slab-on-grade transitions from conditioned to unconditioned space (ie. patio)



Elevated Slab Edge Insulation (Rater F-3.5 & 3.6)

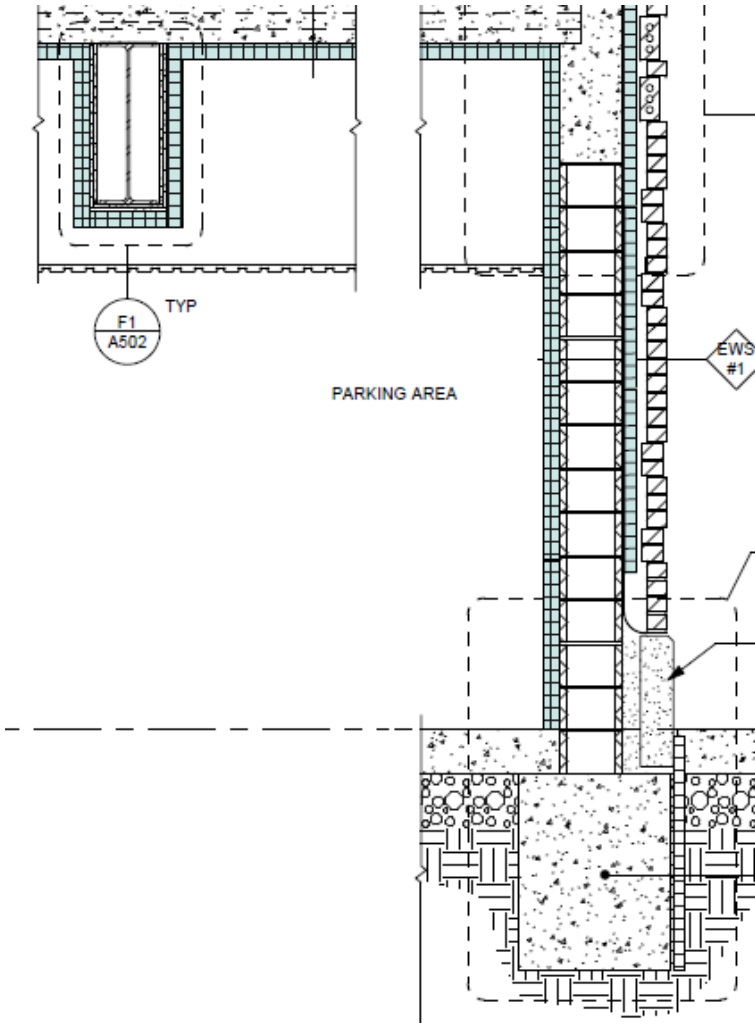
3. Reduced Thermal Bridging	
3.1	For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below and is ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8. [17]
3.2	For insulated ceilings with attic space above, attic access panels and drop-down stairs insulated ≥ R-10 or equipped with durable ≥ R-10 cover. [18]
3.3	Insulation beneath attic platforms (e.g., HVAC platforms, walkways) ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8.
3.4	For slabs on grade in CZ 4-8, 100% of slab edge insulated to ≥ R-5 at the depth specified by Table 502.2(1) of the 2009 IECC and aligned with the thermal boundary of the walls. [19, 20]
3.5	For elevated concrete slabs in CZ 4-8 (i.e., podiums and projected balconies, but not intermediate slab floor edges) 100% of the slab edge insulated to ≥ R-5. For podiums, insulation must be installed for the full height of the podium wall. Alternatives in Footnote 21. [21]
3.6	For elevated concrete slabs in CZ 4-8 (i.e., podiums, but not intermediate floor slabs), floor insulation meets the U-factor specified in Table 502.1.2 of the 2009 IECC for Group R when dwelling units are above the slab, and for 'All Other' when common space is above the slab. [22]

Footnotes 21 and 22

Elevated Slab Edge Insulation (Rater Field, 3.5)

For elevated slabs in CZ4 - 8 (such as balconies or **garage podiums** with apartments or common areas above),

- The elevated slab edge must be insulated **to R-5** (for podium, this means the full height of the wall);
  - **Issue Under Review**: what about multiple story garages? What about columns?



Elevated Slab Edge Insulation (Rater Field, 3.5)

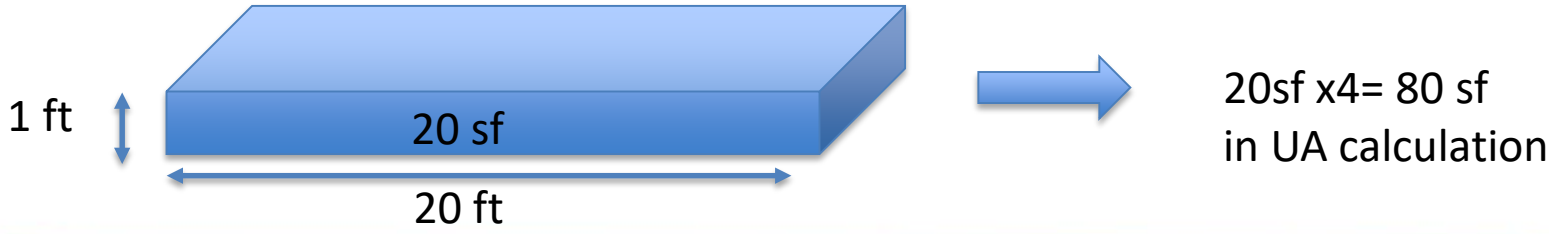
For elevated slabs in CZ4 - 8 (such as **balconies** or garage podiums with apartments or common areas above),

- The elevated slab edge must be insulated **to R-5** (for balcony, there is an alternative);

Modified UA Calculation (Balcony) Footnote 21

If you don't install an R-5 thermal break, you can account for the uninsulated slab edge thermal impact, by increasing its area in the UA calculation (using a multiplier of 4)

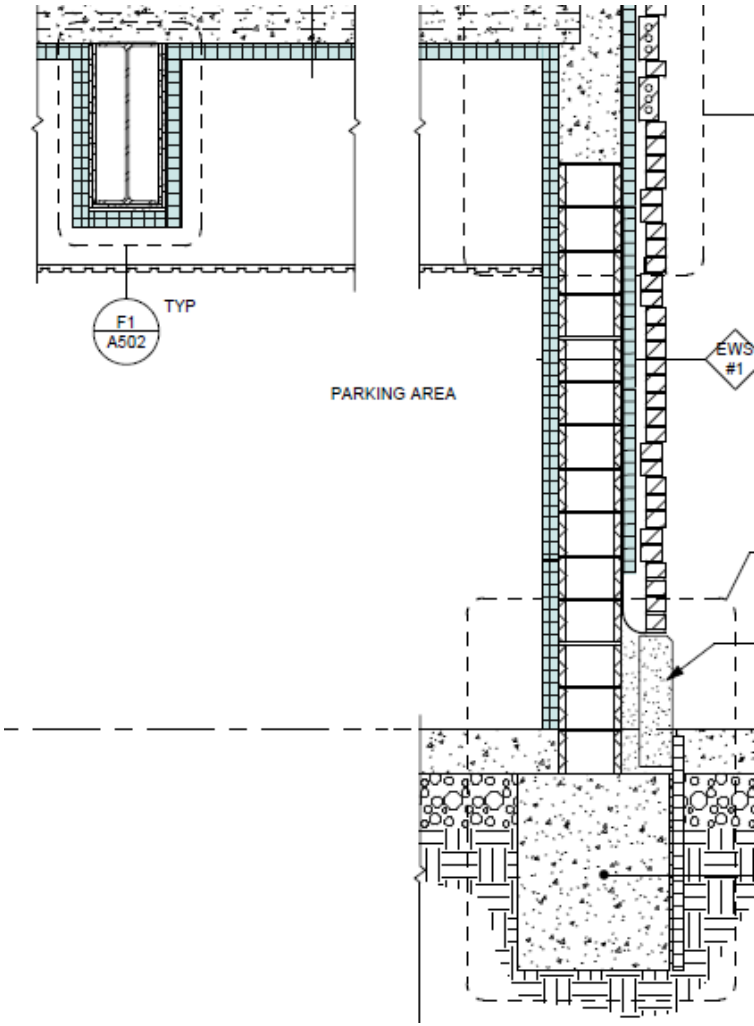
- For example, for a balcony that is 20 feet wide, and has a thickness (height) of 1 foot, the area is 20 ft^2. The area to be used in the UA calculation is instead increased to 80 ft^2. The resulting UA must be used for compliance with the wall insulation requirements.
- The horizontal distance the balcony projects from the building is not used in this calculation.



Elevated Slab Edge Insulation (Rater Field, 3.6)

For elevated slabs in CZ4 - 8 (such as balconies or **garage podiums** with apartments or common areas above),

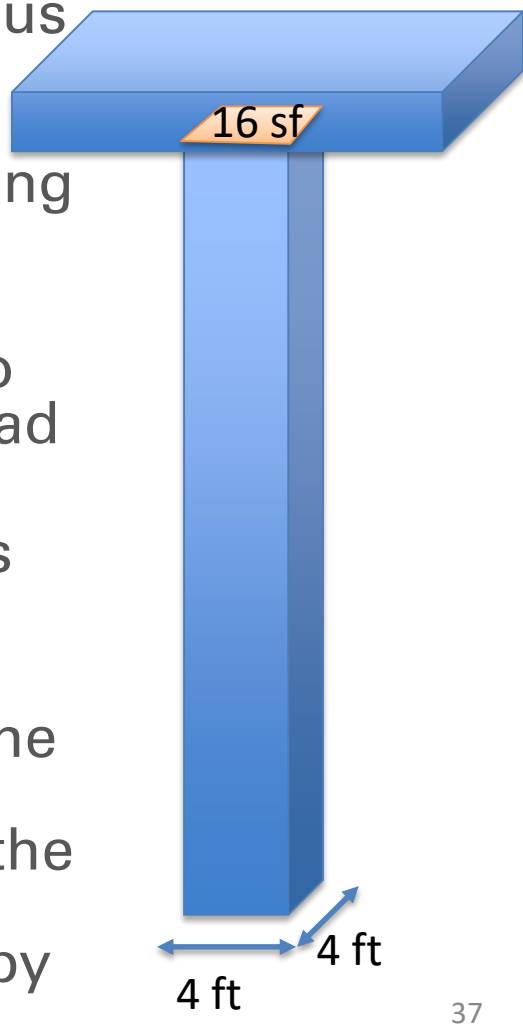
- Floor insulation installed on top or below the podium slab. If installed below the slab:
  - Where insulation below the slab is interrupted by walls or columns, insulation must be installed vertically to maintain a continuous thermal boundary **or those uninsulated areas are part of a modified UA calculation (Footnote 22)**



Modified UA Calculation (Podium)

Where installed floor insulation isn't continuous (e.g., at columns), the UA calculation for the floor assembly must account for the thermal impact of the uninsulated column, by increasing its 'area' in the UA calculation (using a multiplier of 4).

- For example, for a 4'x4' column, the area to be used in the UA calculation is 64 ft^2 instead of 16 ft^2.
- The height of the column is not used in this calculation.
- Alternatively, if the structural column is insulated vertically for a minimum of 4 ft, the modification to the area used in the UA calculation is not required. The U-value of the column insulation shall be associated with the uninsulated area of the floor occupied by the column.



Total Duct Leakage Testing

MFNC Rater Field Checklist Item 6.4

6.4 Rater-measured total duct leakage in dwelling units meets one of the following two options: [48, 49]
6.4.1 Rough-in: Tested per allowances below, with air handler & all ducts, building cavities used as ducts, & duct boots installed. In addition, all duct boots sealed to finished surface, Rater-verified at final. [50] No ducted returns [36]: The greater of ≤ 3 CFM25 per 100 sq. ft. of CFA or ≤ 30 CFM. Additionally, the Rater-measured pressure difference between the space containing the air handler and the conditioned space, with the air handler running at high speed, is ≤ 5 Pa. For systems > 1 ton, increase by 1 Pa per half ton. One or two ducted returns [36]: The greater of ≤ 4 CFM25 per 100 sq. ft. of CFA or ≤ 40 CFM. Three or more ducted returns [36]: The greater of ≤ 6 CFM25 per 100 sq. ft. of CFA or ≤ 60 CFM.
6.4.2 Final: Tested per allowances below, with the air handler & all ducts, building cavities used as ducts, duct boots, & register grilles atop the finished surface (e.g., drywall, floor) installed. [51] No ducted returns [36]: The greater of ≤ 6 CFM25 per 100 sq. ft. of CFA or ≤ 60 CFM. Additionally, the Rater-measured pressure difference between the space containing the air handler and the conditioned space, with the air handler running at high speed, is ≤ 5 Pa. For systems > 1 ton, increase by 1 Pa per half ton. One or two ducted returns [36]: The greater of ≤ 8 CFM25 per 100 sq. ft. of CFA or ≤ 80 CFM. Three or more ducted returns [36]: The greater of ≤ 12 CFM25 per 100 sq. ft. of CFA or ≤ 120 CFM.

Testing Limits – Rough-In

Total Duct Leakage Limit When Tested at Rough-In

(CFM @ 25 Pa)

CFA	# Returns in Duct System	
	<3	≥ 3
500	40	60
1,000	40	60
1,500	60	90
2,000	60	120
2,500	100	150
3,000	120	180
3,500	140	210
4,000	160	240

(Certified Homes)

No ducted returns

Total Duct Leakage Limit When Tested at Rough-In (CFM @ 25 Pa)

CFA	# Returns in Duct System
	0
500	30
1,000	30
1,500	45
2,000	60
2,500	75
3,000	90
3,500	105
4,000	120

Testing Limits – Rough-In

Total Duct Leakage Limit When Tested at Rough-In

(CFM @ 25 Pa)

CFA	# Returns in Duct System		
	0	1- 2	≥ 3
500	30	40	60
1,000	30	40	60
1,500	45	60	90
2,000	60	80	120
2,500	75	100	150
3,000	90	120	180
3,500	105	140	210
4,000	120	160	240

Testing Limits – Final

Total Duct Leakage Limit When Tested at Final

(CFM @ 25 Pa)

CFA	# Returns in Duct System		
	0	1- 2	≥ 3
500	60	80	120
1,000	60	80	120
1,500	90	120	180
2,000	120	160	240
2,500	150	200	300
3,000	180	240	360
3,500	210	280	420
4,000	240	320	480

Common Spaces and Garages

Rater Inspections

- Same inspections as unit
- Stair and elevator shaft vent motorized dampers (5.9)
- Freeze protection system controls (5.10)
- Garage exhaust controls that sense CO and NO_2 (8.4)
- Lighting power density and controls (Section 12)

Rater Testing

- Ventilation tests (supply & exhaust airflows)
- Functional Testing
  - Section 5 can be completed by Rater

Central Systems

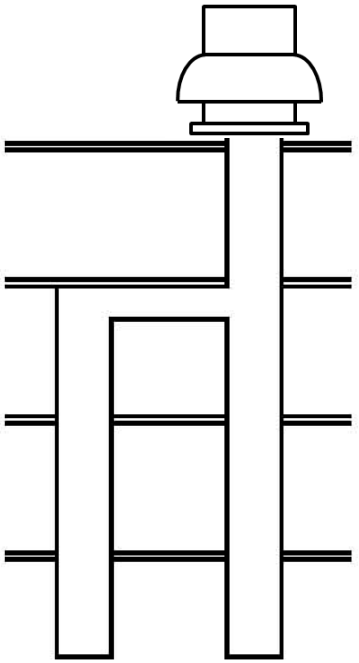
- Still identify equipment model and efficiency
- Ventilation fan efficiency
- Central exhaust duct leakage test

Central Exhaust Duct Leakage Test (RF, 6.7)

Prior to drywall, 25% of exhaust fan CFM

At final, 30% of exhaust fan CFM

Footnote 53 limits over-sizing of fan



Central Exhaust Duct Leakage Test, Rev. 01

Question: We usually test at 50 Pa, but what if my system pressure is 100 Pa? Does the allowance or test pressure change?

Option 1: Test at 50 Pa, but convert CFM50 to CFM at design Pa

Option 2: Test at design or operating pressure

Footnote 53:

Where testing at the design or average operating pressure is not feasible, testing at 50 Pa is permitted, however the following flow equation must be used to determine the leakage allowance at 50 Pa

$$CFM_{50} = CFM_{design} / [P_{design}^{(0.65)} / 50^{(0.65)}]$$

Multifamily Workbook

Multifamily Workbook (Excel-based) offers:

- Spreadsheet versions of the two Rater Checklists
- Dwelling unit testing results spreadsheet
- Common area testing results spreadsheet
- Spreadsheets to help demonstrate compliance with envelope, DHW, lighting, and HVAC requirements
- Version online shows example

Used by MRO's in ASHRAE & Prescriptive Paths;

Optional for ERI Path

HVAC Design Report

HVAC Designer to provide one report that documents HVAC design, that includes **ALL** HVAC systems in the building:

- Cooling & Heating Loads & Equipment Selection for all
  - over-sizing limits apply to in-unit ducted systems only
  - room-by-room loads only required for Townhouses
- Dwelling Unit Duct Design (Manual D not required)
- All Ventilation Systems covered (in-unit, local, common)
- Items from Rater Field are on HVAC Design Report
  - Equipment Controls & Hydronic Distribution
  - Duct Quality Installation
    - Dwelling Unit (leakage test, insulation, etc)
    - Common Area & Central Exhaust Duct Leakage Test

2a. Dwelling & Common Area OA Ventilation

National HVAC Design Report [1]

ENERGY STAR Multifamily New Construction, Version 1 / 1.1 / 1.2 (Rev. 01)

HVAC Designer Responsibilities:

- Complete one National HVAC Design Report for each building / project, which includes system design for all unique unit plans and common spaces. [1]
- Obtain efficiency features (e.g., window performance, insulation levels, and infiltration rate) from the builder, architect, or Rater. [2]
- Provide the completed National HVAC Design Report to the Rater and the person / company completing the National HVAC Functional Testing Checklist. [2]

1. Design Overview

1.1 Designer name: John Doe Designer company: ABC HVAC Services, Inc. Date: 01/01/2019

1.2 Select which party you are providing these design services to: ■ Builder / Developer ☐ FT Agent ☐ MEP / Credentialed HVAC contractor

1.3 Name of company you are providing these design services to (if different than Item 1.1): ABC Construction

1.4 Project address: 123 Street City: Fairfax State: VA Zip code: 22031

2a. Dwelling Unit & Common Space Mechanical Ventilation Design [3, 4]						**Designer Verified**
Airflow:						
2.1 Dwelling unit ventilation airflow design rate & run-time meet the requirements of Section 4 of ASHRAE 62.2. [5] ☐ 2010 ■ 2013						■
2.2 Common space outdoor airflow design rate meet the requirements of Section 6 of ASHRAE 62.1 [6] ☐ 2010 ■ 2013, without exceeding 2013 rates by more than 50%.						■
2.3 Access points to measure airflow rate are provided and accessible by the Rater. [2]						■
List unique unit plan for which 62.2 ventilation rates were calculated in the spaces to the right: [7]	1 Bed	2 Bed	3 Bed			
2.4 # of bedrooms:	1	2	3			
2.5 Square footage:	800	1200	1800			
2.6 Ventilation airflow rate required by ASHRAE 62.2:	39	59	69			
2.7 Ventilation airflow rate designed:	39	59	69			
2.7.1 If applicable, run-time per cycle (minutes):	NA	NA	NA			
2.7.2 If applicable, cycle time (minutes):	NA	NA	NA			
List common space for which 62.1 ventilation rates were calculated in the spaces to the right: [7]	Lobby	Corridor	Community Room			
2.8 Ventilation airflow rate required by ASHRAE 62.1:	200	150	500			
2.9 Ventilation airflow rate designed:	200	150	500			

2a. Dwelling & Common Area OA Ventilation

National HVAC Design Report [1]

ENERGY STAR Multifamily New Construction, Version 1 / 1.1 / 1.2 (Rev. 01)

HVAC Designer Responsibilities:

- Complete one National HVAC Design Report for each building / project, which includes system design for all unique unit plans and common spaces. [1]
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1.4 Project address: 123 Street City: Fairfax State: VA Zip code: 22031

2a. Dwelling Unit & Common Space Mechanical Ventilation Design [3, 4]	**Designer Verified**
Airflow:	
2.1 Dwelling unit ventilation airflow design rate & run-time meet the requirements of Section 4 of ASHRAE 62.2. [5]-☐ 2010 ■ 2013	■
2.2 Common space outdoor airflow design rate meet the requirements of Section 6 of ASHRAE 62.1 [6]-☐ 2010 ■ 2013, without exceeding 2013 rates by more than 50%.	■
2.3 Access points to measure airflow rate are provided and accessible by the Rater. [2]	■

List unique unit plan for which 62.2 ventilation rates were calculated in the spaces to the right: [7]	1 Bed	2 Bed	3 Bed			
2.4 # of bedrooms:	1	2	3			
2.5 Square footage:	800	1200	1800			
2.6 Ventilation airflow rate required by ASHRAE 62.2:	39	59	69			
2.7 Ventilation airflow rate designed:	39	59	69			
2.7.1 If applicable, run-time per cycle (minutes):	NA	NA	NA			
2.7.2 If applicable, cycle time (minutes):	NA	NA	NA			
List common space for which 62.1 ventilation rates were calculated in the spaces to the right: [7]	Lobby	Corridor	Community Room			
2.8 Ventilation airflow rate required by ASHRAE 62.1:	200	150	500			
2.9 Ventilation airflow rate designed:	200	150	500			

2a. Dwelling & Common Area OA Ventilation

National HVAC Design Report [1]

ENERGY STAR Multifamily New Construction, Version 1 / 1.1 / 1.2 (Rev. 01)

HVAC Designer Responsibilities:

- Complete one National HVAC Design Report for each building / project, which includes system design for all unique unit plans and common spaces. [1]
- Obtain efficiency features (e.g., window performance, insulation levels, and infiltration rate) from the builder, architect, or Rater. [2]
- Provide the completed National HVAC Design Report to the Rater and the person / company completing the National HVAC Functional Testing Checklist. [2]

1. Design Overview

1.1 Designer name: John Doe Designer company: ABC HVAC Services, Inc. Date: 01/01/2019

1.2 Select which party you are providing these design services to: ■ Builder / Developer ☐ FT Agent ☐ MEP / Credentialed HVAC contractor

1.3 Name of company you are providing these design services to (if different than Item 1.1): ABC Construction

1.4 Project address: 123 Street City: Fairfax State: VA Zip code: 22031

2a. Dwelling Unit & Common Space Mechanical Ventilation Design [3, 4]						**Designer Verified**
Airflow:						
2.1 Dwelling unit ventilation airflow design rate & run-time meet the requirements of Section 4 of ASHRAE 62.2. [5] ☐ 2010 ■ 2013						■
2.2 Common space outdoor airflow design rate meet the requirements of Section 6 of ASHRAE 62.1 [6] ☐ 2010 ■ 2013, without exceeding 2013 rates by more than 50%.						■
2.3 Access points to measure airflow rate are provided and accessible by the Rater. [2]						■
List unique unit plan for which 62.2 ventilation rates were calculated in the spaces to the right: [7]	1 Bed	2 Bed	3 Bed			
2.4 # of bedrooms:	1	2	3			
2.5 Square footage:	800	1200	1800			
2.6 Ventilation airflow rate required by ASHRAE 62.2:	39	59	69			
2.7 Ventilation airflow rate designed:	39	59	69			
2.7.1 If applicable, run-time per cycle (minutes):	NA	NA	NA			
2.7.2 If applicable, cycle time (minutes):	NA	NA	NA			
List common space for which 62.1 ventilation rates were calculated in the spaces to the right: [7]	Lobby	Corridor	Community Room			
2.8 Ventilation airflow rate required by ASHRAE 62.1:	200	150	500			
2.9 Ventilation airflow rate designed:	200	150	500			

2b. Dwelling Unit Local Exhaust

2b. Dwelling Unit Local Mechanical Exhaust Design – System(s) are designed that mechanically exhaust air from each dwelling uni kitchen and bathroom directly to the outdoors or to ventilation risers and meet the continuous and/or intermittent rates. [12] ▣

Location		Continuous Rate	Intermittent Rate[13]	Exhaust Fan Type
Kitchen	Airflow	≥ 5 ACH, based on kitchen volume[14, 15, 16]	≥ 100 CFM and, if not integrated with range, also ≥ 5 ACH based on kitchen volume [14, 15, 16, 17]	☐ Continuous ▣ Intermittent
	Sound	Recommended if in-unit: ≤ 1 sone	Recommended if in-unit: ≤ 3 sones	▣ In-unit fan ☐ Central / shared fan
Bathroom	Airflow	≥ 20 CFM	≥ 50 CFM	☐ Continuous ▣ Intermittent
	Sound	Required if in-unit: ≤ 2 sones	Recommended if in-unit: ≤ 3 sones	▣ In-unit fan ☐ Central / shared fan

2c. Common Space and Garage Minimum Exhaust Rates – System(s) are designed that mechanically exhaust air from each common space, as required by ASHRAE 62.1-2010 or 2013 ▣

Location	ASHRAE 62.1 Rate	Design Rate	Location	ASHRAE 62.1 Rate	Design Rate
Janitor Room	1 cfm/ft²	50	Common space kitchen [18]	50 cfm / 100 cfm	100
Trash / Recycling Room	1 cfm/ft²	200	Common space bathroom [19]	50 cfm per toilet / urinal	50
Parking Garage	0.05 cfm/ft², standby 0.75 cfm/ft², full-on	500, 7500	▣ Garage exhaust fan controls include CO and NO2 sensors.		

2c. Common Area Local Exhaust

2b. Dwelling Unit Local Mechanical Exhaust Design – System(s) are designed that mechanically exhaust air from each dwelling unit kitchen and bathroom directly to the outdoors or to ventilation risers and meet the continuous and/or intermittent rates. [12]			▣
Location		**Continuous Rate**	**Intermittent Rate**[13]	**Exhaust Fan Type**
Kitchen	Airflow	≥ 5 ACH, based on kitchen volume[14, 15, 16]	≥ 100 CFM and, if not integrated with range, also ≥ 5 ACH based on kitchen volume [14, 15, 16, 17]	☐ Continuous ▣ Intermittent
	Sound	Recommended if in-unit: ≤ 1 sone	Recommended if in-unit: ≤ 3 sones	▣ In-unit fan ☐ Central / shared fan
Bathroom	Airflow	≥ 20 CFM	≥ 50 CFM	☐ Continuous ▣ Intermittent
	Sound	Required if in-unit: ≤ 2 sones	Recommended if in-unit: ≤ 3 sones	▣ In-unit fan ☐ Central / shared fan

2c. Common Space and Garage Minimum Exhaust Rates – System(s) are designed that mechanically exhaust air from each common space, as required by ASHRAE 62.1-2010 or 2013					▣
Location	**ASHRAE 62.1 Rate**	**Design Rate**	**Location**	**ASHRAE 62.1 Rate**	**Design Rate**
Janitor Room	1 cfm/ft²	50	Common space kitchen [18]	50 cfm / 100 cfm	100
Trash / Recycling Room	1 cfm/ft²	200	Common space bathroom [19]	50 cfm per toilet / urinal	50
Parking Garage	0.05 cfm/ft², standby 0.75 cfm/ft², full-on	500, 7500	▣ Garage exhaust fan controls include CO and NO2 sensors.		

3. Dwelling & Common Area Design Loads

3. Heating & Cooling Loads

Dwelling Unit Heating & Cooling Loads (only required for ducted split AC, unitary AC, ASHP, WSHP, GSHP, and furnaces.)[20] ☐ N/A

3.1 Loads calculated using: ☐ Unabridged ACCA Manual J v8 ■ 2013 / 2017 ASHRAE Fundamentals ☐ Other per AHJ[21]
Townhouses only: Loads must be calculated room-by-room.

3.2 Check one box only to indicate whether the Dwelling Unit Loads is unit-specific or represents the design of more than one unit: [22]
☐ Unit-specific design ■ Group design[23] 3 total groups for this project, representing 30 units.
☐ Worst-case design (If the top floor unit with the greatest CFA and window area results in total heat gain <18 kBtuh, it may represent all other units if cooling system selected for all is single-speed & <20 kBtuh or two-speed / variable-speed & <25 kBtuh.

3.3 Indoor design temperatures used in loads are 70°F for heating and 75°F for cooling. ■

3.4 Outdoor design temperatures used in loads: (See Footnote 23 and www.energystar.gov/hvacdesigntemps.)[24]
County & State selected: Fairfax County, Virginia Cooling season: 94 °F Heating season: 18 °F

List the unit plan for which Loads were calculated:[7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads: [22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh): [22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads: [22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads: [22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads: [22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads: [29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads: [22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh): [22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW): [23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh): [22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh): [22]	12	14	16	22	24	26		

3. Dwelling Unit Design Loads

3. Heating & Cooling Loads								
Dwelling Unit Heating & Cooling Loads (only required for ducted split AC, unitary AC, ASHP, WSHP, GSHP, and furnaces.)[20] ☐ N/A								
3.1 Loads calculated using: ☐ Unabridged ACCA Manual J v8 ■ 2013 / 2017 ASHRAE Fundamentals ☐ Other per AHJ [21] Townhouses only: Loads must be calculated room-by-room.								
3.2 Check one box only to indicate whether the Dwelling Unit Loads is unit-specific or represents the design of more than one unit: [22] ☐ Unit-specific design ■ Group design [23] 3 total groups for this project, representing 30 units. ☐ Worst-case design (If the top floor unit with the greatest CFA and window area results in total heat gain <18 kBtuh, it may represent all other units if cooling system selected for all is single-speed & <20 kBtuh or two-speed / variable-speed & <25 kBtuh.								
3.3 Indoor design temperatures used in loads are 70°F for heating and 75°F for cooling.								■
3.4 Outdoor design temperatures used in loads: (See Footnote 23 and www.energystar.gov/hvacdesigntemps.) [24] County & State selected: Fairfax County, Virginia Cooling season: 94 °F Heating season: 18 °F								
List the unit plan for which Loads were calculated: [7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads: [22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh): [22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads: [22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads: [22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads: [22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads: [29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads: [22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh): [22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW): [23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh): [22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh): [22]	12	14	16	22	24	26		

3. Dwelling Unit Design Loads: Worst-Case

3. Heating & Cooling Loads								
Dwelling Unit Heating & Cooling Loads (only required for ducted split AC, unitary AC, ASHP, WSHP, GSHP, and furnaces.)[20] ☐ N/A								
3.1 Loads calculated using: ☐ Unabridged ACCA Manual J v8 ■ 2013 / 2017 ASHRAE Fundamentals ☐ Other per AHJ[21] Townhouses only: Loads must be calculated room-by-room.								
3.2 Check one box only to indicate whether the Dwelling Unit Loads is unit-specific or represents the design of more than one unit:[22] ☐ Unit-specific design ■ Group design[23] 3 total groups for this project representing 30 units.								
☐ Worst-case design (If the top floor unit with the greatest CFA and window area results in total heat gain <18 kBtuh, it may represent all other units if cooling system selected for all is single-speed & <20 kBtuh or two-speed / variable-speed & <25 kBtuh.								
3.3 Indoor design temperatures used in loads are 70°F for heating and 75°F for cooling.								■
3.4 Outdoor design temperatures used in loads: (See Footnote 23 and www.energystar.gov/hvacdesigntemps.)[24] County & State selected: Fairfax County, Virginia Cooling season: 94 °F Heating season: 18 °F								
List the unit plan for which Loads were calculated:[7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads:[22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh):[22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads:[22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads:[22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads:[22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads:[29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads:[22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh):[22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW):[23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh):[22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh):[22]	12	14	16	22	24	26		

3. Dwelling Unit Design Loads: Input/Outputs

3. Heating & Cooling Loads

Dwelling Unit Heating & Cooling Loads (only required for ducted split AC, unitary AC, ASHP, WSHP, GSHP, and furnaces.)[20] ☐ N/A

3.1 Loads calculated using: ☐ Unabridged ACCA Manual J v8 ■ 2013 / 2017 ASHRAE Fundamentals ☐ Other per AHJ [21]
Townhouses only: Loads must be calculated room-by-room.

3.2 Check one box only to indicate whether the Dwelling Unit Loads is unit-specific or represents the design of more than one unit: [22]
☐ Unit-specific design ■ Group design [23] 3 total groups for this project, representing 30 units.
☐ Worst-case design (If the top floor unit with the greatest CFA and window area results in total heat gain <18 kBtuh, it may represent all other units if cooling system selected for all is single-speed & <20 kBtuh or two-speed / variable-speed & <25 kBtuh.

3.3 Indoor design temperatures used in loads are 70°F for heating and 75°F for cooling. ■

3.4 Outdoor design temperatures used in loads: (See Footnote 23 and www.energystar.gov/hvacdesigntemps.) [24]
County & State selected: Fairfax County, Virginia Cooling season: 94 °F Heating season: 18 °F

List the unit plan for which Loads were calculated: [7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads: [22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh): [22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads: [22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads: [22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads: [22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads: [29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads: [22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh): [22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW): [23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh): [22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh): [22]	12	14	16	22	24	26		

3. Dwelling Unit Design Loads: Input/Outputs

3. Heating & Cooling Loads

Dwelling Unit Heating & Cooling Loads (only required for ducted split AC, unitary AC, ASHP, WSHP, GSHP, and furnaces.)[20] ☐ N/A

3.1 Loads calculated using: ☐ Unabridged ACCA Manual J v8 ■ 2013 / 2017 ASHRAE Fundamentals ☐ Other per AHJ [21]
Townhouses only: Loads must be calculated room-by-room.

3.2 Check one box only to indicate whether the Dwelling Unit Loads is unit-specific or represents the design of more than one unit: [22]
☐ Unit-specific design ■ Group design [23] 3 total groups for this project, representing 30 units.
☐ Worst-case design (If the top floor unit with the greatest CFA and window area results in total heat gain <18 kBtuh, it may represent all other units if cooling system selected for all is single-speed & <20 kBtuh or two-speed / variable-speed & <25 kBtuh.

3.3 Indoor design temperatures used in loads are 70°F for heating and 75°F for cooling. ■

3.4 Outdoor design temperatures used in loads: (See Footnote 23 and www.energystar.gov/hvacdesigntemps.) [24]
County & State selected: Fairfax County, Virginia Cooling season: 94 °F Heating season: 18 °F

List the unit plan for which Loads were calculated: [7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads: [22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh): [22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads: [22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads: [22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads: [22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads: [29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads: [22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh): [22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW): [23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh): [22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh): [22]	12	14	16	22	24	26		

3. Common Area & Building Design Loads

List the unit plan for which Loads were calculated: [7]	1.1	1.2	1.3	2.1	2.2	2.3		
3.5 Location of Unit: top, mid, bottom, corner, interior	Bottom Interior	Bottom Corner	Bottom Corner	Top Interior	Top Corner	Top Corner		
3.6 Number of occupants used in loads: [22, 25]	2	3	4	2	3	4		
3.7 Total occupant gains (Btuh): [22]	860	1290	1720	860	1290	1720		
3.8 Conditioned floor area used in loads: [22, 26]	800	1200	1800	800	1200	1800		
3.9 Window area used in loads: [22, 27]	120	180	270	120	180	270		
3.10 Predominant window SHGC used in loads: [22, 25]	0.30	0.30	0.30	0.30	0.30	0.30		
3.11 Infiltration (ACH / ACH50 / CFM) used in loads: [29]	4.0 ACH60	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50	4.0 ACH50		
3.12 Mechanical ventilation (CFM) used in loads: [22]	39	59	69	39	59	69		
3.13 Non-occupant Internal gains (appliance, equipment and lighting) used in loads (Btuh): [22]	1200	1200	1200	1200	1200	1200		
3.14 Orientation (N, NE, E, SE, S, SW, W, NW): [23]	NE	N	E	NE	N	E		
3.15 Sensible Heat Gain At Design Conditions (kBtuh): [22]	10	11	13	19	20	22		
3.16 Latent Heat Gain At Design Conditions (kBtuh):	2	3	3	3	4	4		
3.17 Total Heat Gain at Design Conditions (kBtuh): [22]	12	14	16	22	24	26		
3.18 Total Heat Loss at Design Conditions (kBtuh):	10	12	14	17	19	21		

3.19 Common Space Heating & Cooling Loads [7]

Common Space Name: Lobby	Design Conditions: Total Heat Gain: 18	(kBtuh)	Total Heat Loss: 16	(kBtuh)	
Common Space Name: Corridor	Design Conditions: Total Heat Gain: 12	(kBtuh)	Total Heat Loss: 10	(kBtuh)	
Common Space Name: Community Room	Design Conditions: Total Heat Gain: 32	(kBtuh)	Total Heat Loss: 29	(kBtuh)	

3.20 Building Heating & Cooling Loads [7] (only required when shared systems such as central boilers or chillers are specified.)

Designer Verified: ☒ N/A

System Name:	Design Conditions: Total Heat Gain:	(kBtuh)	Total Heat Loss:	(kBtuh)
System Name:	Design Conditions: Total Heat Gain:	(kBtuh)	Total Heat Loss:	(kBtuh)

4. Cooling Equipment & Sizing Limit

Cooling Equipment [7] (Complete all applicable items; otherwise check "N/A".)				
List Cooling Equipment ID in the spaces to the right:	HP1	HP2	HP3	HP4
4.4 Equipment type: (e.g., PTAC / AC, Chiller / CT, PTHP / WLHP / GSHP / ASHP / VRF)	ASHP	ASHP	ASHP	ASHP
4.5 Area / Space(s) that system serves:	1 BR	2 BR	3 BR	Common Spaces
4.6 Chiller / condenser / outdoor unit manufacturer:	HP Manufac.	HP Manufac.	HP Manufac.	HP Manufac.
4.7 Chiller / condenser / outdoor unit model #:	XP111	XP1818	XP2222	XP2525
4.8 Evaporator / indoor unit manufacturer:	HP Manufac.	HP Manufac.	HP Manufac.	HP Manufac.
4.9 Evaporator / indoor unit model #:	XPHGR1111	XPHGR1818	XPHGR2222	XPHGR2525
4.10 AHRI reference #: [31]	5678910	5678911	5678912	5678913
4.11 AHRI listed efficiency:	14.5 SEER	14.5 SEER	14.5 SEER	14.5 SEER
4.12 Evaporator fan type: PSC, ECM / ICM Other:	ECM	ECM	ECM	ECM
4.13 Compressor speed: Single, Two, Variable	Single	2-speed	Single	Single
4.14 Turn down ratio (for variable speed equipment):	NA	NA	NA	NA
4.15 Latent capacity at design conditions (kBtuh): [32]	5	7	9	10
4.16 Sensible capacity at design conditions (kBtuh): [32]	13	17	21	26
4.17 Total capacity at design conditions (kBtuh): [32]	18	24	30	36

Equipment Type & Climate Condition	Compressor Type (Per Item 4.13)		
	Single-Speed	Two-Speed	Variable-Speed
A: For Cooling-Only Equipment or For Cooling Mode of Heat Pump in Condition A Climate [33]	Recommended: 90 – 115% Allowed: 90 – 130%	Recommended: 90 – 120% Allowed: 90 – 140%	Recommended: 90 – 130% Allowed: 90 – 160%
B: For Cooling Mode of Heat Pump in Condition B Climate [33]	90% - 100%, plus 15 kBtuh	90% - 100%, plus 15 kBtuh	90% - 100%, plus 15 kBtuh
C: For low-load spaces (≤15 kBtuh) [34]	≤ 20 kBtuh		
D: For low-load spaces (≤18 kBtuh) [34]		≤ 25 kBtuh	≤ 25 kBtuh

4. Heating Equipment & Furnace Sizing Limit

Heating Equipment [7] (Complete all applicable items; otherwise check "N/A".)							**Designer Verified** ☐ N/A
List Heating Equipment ID in the spaces to the right:	HP1	HP2	HP3	HP4			
4.22 Electric equipment type: PTHP, WLHP, GSHP, ASHP, VRF, Boiler, Furnace, Electric Resistance	ASHP	ASHP	ASHP	ASHP			
4.23 Gas Equipment type: HW PTAC / fan coil, Gas-Fired PTAC, Boiler, Furnace	NA	NA	NA	NA			
4.24 Area / Space(s) that system serves:	Bedrooms	Bedrooms	Bedrooms	Common Spaces			
4.25 Manufacturer:	HP Manufac.	HP Manufac.	HP Manufac.	HP Manufac.			
4.26 Model Number:	XPY7236	XPY7246	XPT8446	XPT8456			
4.27 Listed efficiency:	8.5 HSPF	8.5 HSPF	8.5 HSPF	8.5 HSPF			
4.28 Equipment output capacity (kBtuh):	18	24	30	36			
4.29 Air-source heat pump output capacity (17°F) (kBtuh):	11	15	18	22			
4.30 Type of Venting: Natural Draft, Mechanically Drafted, Direct Vent [35]	NA	NA	NA	NA			
4.31 Furnace heating sizing % = Total capacity (Item 4.28) divided by Total Heat Loss of space(s) in Item 4.24:	NA	NA	NA	NA			
4.32 Meets furnace sizing limit: (see below for A, B, C, or N/A) [20]	NA	NA	NA	NA			
A: For low-load spaces (≤ 10 kBtuh), furnace output capacity is ≤ 40 kBtuh							
B: When Used for Heating Only	C: When Paired With Cooling						
100 – 400%	Recommended: 100 – 140% Allowed: 100 – 400%						

4. Equipment Controls & Hydronic Req'ts

Equipment Controls	
4.33 All equipment controls below have been included where applicable in the HVAC Design.	▣
4.34 All heating and cooling systems serving a dwelling unit shall have thermostatic controls within the dwelling unit which are not located on exterior walls.	
4.34.1 Prescriptive Path: Dwelling unit thermostats are programmable.	
4.35 Stair and elevator shaft vents shall be equipped with motorized dampers that are capable of being automatically closed during normal building operation and are interlocked to open as required by fire and smoke detection systems.	
4.36 Freeze protection systems, such as heat tracing of piping and heat exchangers, including self-regulating heat tracing, and garage / plenum heaters shall include automatic controls capable of shutting off the systems when pipe wall or garage / plenum temperatures are above 40°F. Where heat tracing is specified for freeze protection, controls must be based on pipe wall temperature and a minimum of R-3 pipe insulation is also required.	
4.37 Snow- and ice-melting systems shall include automatic controls capable of shutting off the systems when the pavement temperature is above 50°F and no precipitation is falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F so that the potential for snow or ice accumulation is negligible.	

5. Dwelling Unit Duct Design

5. Dwelling Unit Duct Design (Complete if heating or cooling equipment will be installed with ducts; otherwise check "N/A".)	**Designer Verified**
	☐ N/A
5.1 Duct system designed for the equipment selected in Section 4, per ☒ ACCA Manual D ☐ Other:	☒
5.2 Room-by-room design airflows documented below (which should sum to the mode with the higher Design HVAC fan airflow). [7, 36, 37]	

Name of the unit plan: 1.1	Name of the unit plan: 1.2
Design HVAC fan airflow: [38] Cooling mode 600 CFM Heating mode 600 CFM	Design HVAC fan airflow: [38] Cooling mode 800 CFM Heating mode 800 CFM
Design HVAC fan speed setting (e.g., low, medium, high): [39] Cooling mode medium Heating mode medium	Design HVAC fan speed setting (e.g., low, medium, high): [39] Cooling mode high Heating mode high
Design total external static pressure (corresponding to the mode with the higher airflow above): [40] 0.5 IWC	Design total external static pressure (corresponding to the mode with the higher airflow above): [40] 0.7 IWC

	Room Name	Design Airflow (CFM)
1	Bedroom	200
2	Bathroom	75
3	Kitchen	165
4	Living	160
5		
6		
7		
8		
9		
10		
	Total for all rooms	600

	Room Name	Design Airflow (CFM)
1	Bedroom	200
2	Bedroom	150
3	Bathroom	75
4	Kitchen	200
5	Living	175
6		
7		
8		
9		
10		
	Total for all rooms	800

6. Duct Quality Installation

6. Duct Quality Installation - *Applies to Heating, Cooling, Ventilation, Exhaust, & Pressure Balancing Ducts, Unless Noted in Footnote*	
6.1 All duct quality installation requirements below have been included where applicable in the HVAC Design.	■
6.2 Ductwork specified without kinks, sharp bends, compressions, or excessive coiled flexible ductwork. [41]	
6.3 All supply and return ducts not in conditioned space, including connections to trunk ducts, are insulated to ≥ R-6. [42]	
6.3.1 Prescriptive Path: Dwelling unit ductwork meets the location and insulation requirements specified in the ENERGY STAR MF Reference Design.	
Dwelling Unit	
6.4 MERV 6+ filter(s) specified for each ducted mech. system serving an individual dwelling unit and located to facilitate access & regular service by the occupant or building owner. Filter access panel specified with a gasket or comparable sealing mechanism. All return air and mechanically supplied outdoor air designed to pass through filter prior to conditioning.	
6.5 Ductwork air-sealing specified such that Rater-measured total duct leakage is ≤ 4 CFM25 per 100 ft² of CFA at rough-in or ≤ 8 CFM25 per 100 ft² at final, or if there are no ducted returns, ≤ 3 CFM25 per 100 ft² of CFA at rough-in or ≤ 6 CFM25 per 100 ft² at final. [43] Additionally, for Townhouses only, Rater-measured duct leakage to the outside is ≤ 4 CFM25 per 100 ft² of CFA or ≤ 40 CFM25. [44]	
6.6 Bedrooms with a design supply airflow ≥ 150 CFM (as reported in Item 5.2) are specified with any combination of transfer grilles, jump ducts, dedicated return ducts, and/or undercut doors to achieve a Rater-measured pressure differential ≥ - 5 Pa and ≤ 5 Pa with respect to the main body of the dwelling unit when all air handlers are operating.	
Common Space	
6.7 Duct design specifies that all supply, return, and exhaust ductwork and all plenums shall be sealed at all transverse joints, longitudinal seams, and duct wall penetrations.	
6.8 Central exhaust systems (that serve four or more dwelling units): Ductwork air-sealing specified such that measured duct leakage does not exceed 25% of exhaust fan flow at rough-in (e.g., including trunks, branches, and take-offs) or 30% of exhaust fan flow at final (e.g., inclusive of all ductwork between the fan and the grilles). [45]	

HVAC Functional Testing Checklist

Verified by HVAC Credentialed Contractor, individual with commissioning credentials from AEE, BCCP, ASHRAE or NEBB, OEM representative

- Checklist must be collected if not an HVAC credentialed contractor
- Credentialed contractors can only complete Sections 1-5 (cannot complete Sections 6-9)
- If installing contractor wants to be FT Agent, they have to be a credentialed contractor*
- Issue under Review: can they do sampling?
- Rev. 01 Update: FT Agent can witness testing

HVAC Functional Testing Checklist

All systems (boilers, chillers, cooling towers, PTAC/PTHPs, furnaces, mini-split heat pumps, etc) will require some level of functional testing whether in-unit, common, or central, such as:

- Functional testing of systems, controls, sensors, thermostats
- Testing for proper refrigerant charge, fan flow & power, static pressure, like in Certified Homes
- Verifying temperatures on central hydronic systems

MFNC Functional Testing Checklist

Section 1: Functional Testing Overview

Section 2: Refrigerant Charge

Section 3: Indoor HVAC Fan Airflow

Section 4: Air Balancing of Supply/Return

[Recommended, not required]

Section 5: Indoor/Terminal Units

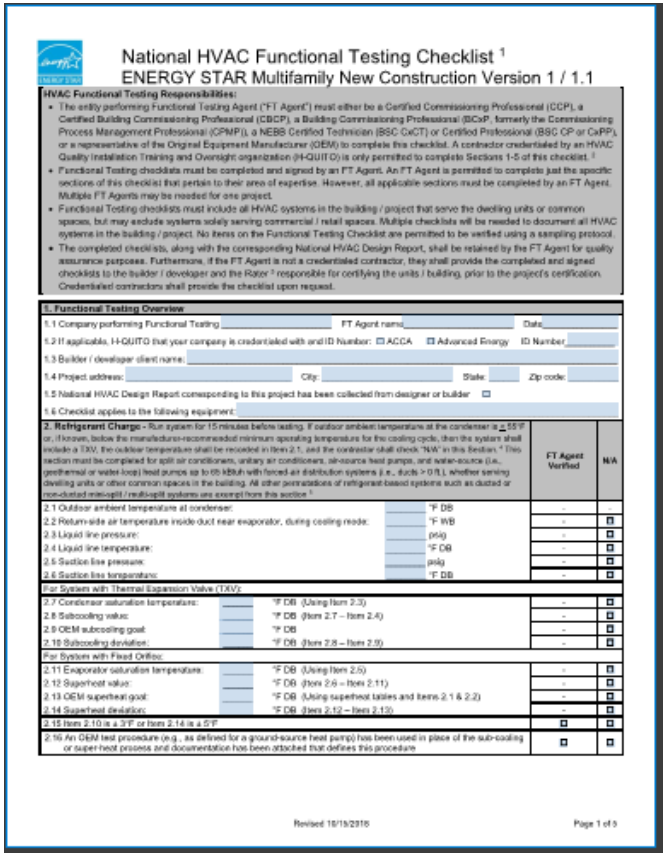
[Rater can complete]

Section 6: VRF Outdoor Unit

Section 7: Central Boilers

Section 8: Cooling Towers

Section 9: Chillers



National HVAC Functional Testing Checklist [1]
ENERGY STAR Multifamily New Construction Version 1 / 1.1

HVAC Functional Testing Responsibilities:

- The entity performing Functional Testing Agent ("FT Agent") must either be a Certified Commissioning Professional (CCP), a Certified Building Commissioning Professional (CBCP), a Building Commissioning Professional (BCxP, formerly the Commissioning Process Management Professional (CPMP)), a NEBB Certified Technician (BSC CxCT) or Certified Professional (BSC CP or CxPP), or a representative of the Original Equipment Manufacturer (OEM) to complete this checklist. A contractor credentialed by an HVAC Quality Installation Training and Oversight organization (H-QUITO) is only permitted to complete Sections 1-5 of this checklist. [2]
- Functional Testing checklists must be completed and signed by an FT Agent. An FT Agent is permitted to complete just the specific sections of this checklist that pertain to their area of expertise. However, all applicable sections must be completed by an FT Agent. Multiple FT Agents may be needed for one project.
- Functional Testing checklists must include all HVAC systems in the building / project that serve the dwelling units or common spaces, but may exclude systems solely serving commercial / retail spaces. Multiple checklists will be needed to document all HVAC systems in the building / project. No items on the Functional Testing Checklist are permitted to be verified using a sampling protocol.
- The completed checklists, along with the corresponding National HVAC Design Report, shall be retained by the FT Agent for quality assurance purposes. Furthermore, if the FT Agent is not a credentialed contractor, they shall provide the completed and signed checklists to the builder / developer and the Rater [3] responsible for certifying the units / building, prior to the project's certification. Credentialed contractors shall provide the checklist upon request.

1. Functional Testing Overview

1.1 Company performing Functional Testing: _____ FT Agent name: _____ Date: _____

1.2 If applicable, H-QUITO that your company is credentialed with and ID Number: ☐ ACCA ☐ Advanced Energy ID Number: _____

1.3 Builder / developer client name: _____

1.4 Project address: _____ City: _____ State: _____ Zip code: _____

1.5 National HVAC Design Report corresponding to this project has been collected from designer or builder ☐

1.6 Checklist applies to the following equipment: _____

2. Refrigerant Charge - Run system for 15 minutes before testing. If outdoor ambient temperature at the condenser is ≥ 65°F or, if known, below the manufacturer-recommended minimum operating temperature for the cooling cycle, then the system shall include a TXV, the outdoor temperature shall be recorded in Item 2.1, and the contractor shall check "N/A" in this Section. [4] This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps, and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft.), whether serving dwelling units or other common spaces in the building. All other permutations of refrigerant-based systems such as ducted or non-ducted mini-split / multi-split systems are exempt from this section. [5]			FT Agent Verified	N/A
2.1 Outdoor ambient temperature at condenser:		°F DB	-	
2.2 Return-side air temperature inside duct near evaporator, during cooling mode:		°F WB	-	☐
2.3 Liquid line pressure:		psig	-	☐
2.4 Liquid line temperature:		°F DB	-	☐
2.5 Suction line pressure:		psig	-	☐
2.6 Suction line temperature:		°F DB	-	☐
For System with Thermal Expansion Valve (TXV):				
2.7 Condenser saturation temperature:		°F DB (Using Item 2.3)	-	☐
2.8 Subcooling value:		°F DB (Item 2.7 – Item 2.4)	-	☐
2.9 OEM subcooling goal:		°F DB	-	☐
2.10 Subcooling deviation:		°F DB (Item 2.8 – Item 2.9)	-	☐
For System with Fixed Orifice:				
2.11 Evaporator saturation temperature:		°F DB (Using Item 2.5)	-	☐
2.12 Superheat value:		°F DB (Item 2.6 – Item 2.11)	-	☐
2.13 OEM superheat goal:		°F DB (Using superheat tables and Items 2.1 & 2.2)	-	☐
2.14 Superheat deviation:		°F DB (Item 2.12 – Item 2.13)	-	☐
2.15 Item 2.10 is a -3°F or Item 2.14 is a ±3°F			☐	☐
2.16 An OEM test procedure (e.g., as defined for a ground-source heat pump) has been used in place of the sub-cooling or superheat process and documentation has been attached that defines this procedure			☐	☐

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MFNC Functional Testing Checklist

Section 1: Functional Testing Overview

1. Functional Testing Overview
1.1 Company performing Functional Testing _____ FT Agent name _____ Date _____
1.2 If applicable, H-QUITO that your company is credentialed with and ID Number: ☐ ACCA ☐ Advanced Energy ID Number _____
1.3 Builder / developer client name: _____
1.4 Project address: _____ City: _____ State: _____ Zip code: _____
1.5 National HVAC Design Report corresponding to this project has been collected from designer or builder ☐
1.6 Checklist applies to the following equipment: _____

MFNC Functional Testing Checklist

Section 2: Refrigerant Charge

2. Refrigerant Charge - Run system for 15 minutes before testing. If outdoor ambient temperature at the condenser is ≤ 55°F or, if known, below the manufacturer-recommended minimum operating temperature for the cooling cycle, then the system shall include a TXV, the outdoor temperature shall be recorded in Item 2.1, and the contractor shall check "N/A" in this Section. [4] This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps, and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft.), whether serving dwelling units or other common spaces in the building. All other permutations of refrigerant-based systems such as ducted or non-ducted mini-split / multi-split systems are exempt from this section [5]

This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps, and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft.), whether serving dwelling units **or other common spaces** in the building.

All other permutations of refrigerant-based systems such as ducted or non-ducted mini-split / multi-split systems are exempt from this section. *[Multi-splits like central VRFs do this test under Section 6]*

MFNC Functional Testing Checklist

Footnote 5: The term “mini-split” refers to air conditioners and heat pumps that have variable refrigerant flow and distributed refrigerant technology with a single outdoor section serving a single indoor section. The indoor section is typically, but not exclusively, mounted on room walls and/or ceilings and designed to heat or cool air within the conditioned space either directly or through limited duct runs.

The term “multi-split” refers to air conditioners and heat pumps that have variable refrigerant flow and distributed refrigerant technology with the capability of serving multiple indoor sections with a single outdoor section. The indoor sections are typically, but not exclusively, mounted on room walls and/or ceilings and designed to heat or cool air within the conditioned space either directly or through a ducted system. A single outdoor section can serve one or more dwelling units.

The length of the duct system is not a determinant for meeting either of these definitions.

MFNC Functional Testing Checklist

Section 2: Refrigerant Charge

			FT Agent Verified	N/A
2.1 Outdoor ambient temperature at condenser:	_____	°F DB	-	-
2.2 Return-side air temperature inside duct near evaporator, during cooling mode:	_____	°F WB	-	☐
2.3 Liquid line pressure:	_____	psig	-	☐
2.4 Liquid line temperature:	_____	°F DB	-	☐
2.5 Suction line pressure:	_____	psig	-	☐
2.6 Suction line temperature:	_____	°F DB	-	☐
For System with Thermal Expansion Valve (TXV):				
2.7 Condenser saturation temperature:	_____	°F DB (Using Item 2.3)	-	☐
2.8 Subcooling value:	_____	°F DB (Item 2.7 – Item 2.4)	-	☐
2.9 OEM subcooling goal:	_____	°F DB	-	☐
2.10 Subcooling deviation:	_____	°F DB (Item 2.8 – Item 2.9)	-	☐
For System with Fixed Orifice:				
2.11 Evaporator saturation temperature:	_____	°F DB (Using Item 2.5)	-	☐
2.12 Superheat value:	_____	°F DB (Item 2.6 – Item 2.11)	-	☐
2.13 OEM superheat goal:	_____	°F DB (Using superheat tables and Items 2.1 & 2.2)	-	☐
2.14 Superheat deviation:	_____	°F DB (Item 2.12 – Item 2.13)	-	☐
2.15 Item 2.10 is ± 3°F or Item 2.14 is ± 5°F			☐	☐
2.16 An OEM test procedure (e.g., as defined for a ground-source heat pump) has been used in place of the sub-cooling or super-heat process and documentation has been attached that defines this procedure			☐	☐

MFNC Functional Testing Checklist

Section 3: Indoor HVAC Fan Airflow

3. Indoor HVAC Fan Airflow - This section must be completed for split air conditioners, unitary air conditioners, air-source heat pumps (including multi-splits), and water-source (i.e., geothermal or water-loop) heat pumps up to 65 kBtuh with forced-air distribution systems (i.e., ducts) and to furnaces up to 225 kBtuh with forced-air distribution systems (i.e., ducts > 0 ft.), whether serving dwelling units or other common spaces in the building. Mini-splits, ducted or non-ducted, are exempt, however multi-split systems such as central VRF systems, where indoor HVAC fans with forced-air distribution are connected to a shared outdoor unit that exceeds 65 kBtuh, are not exempt [5]

Mini-splits, ducted or non-ducted, are exempt, however multi-split systems such as central VRF systems, where indoor HVAC fans with forced-air distribution are connected to a shared outdoor unit that exceeds 65 kBtuh, are **not** exempt.

MFNC Functional Testing Checklist

Section 3: Indoor HVAC Fan Airflow

	FT Agent Verified	N/A
3.1 The mode with the higher design HVAC fan airflow used, per Item 5.2 of National HVAC Design Report: ☐ Heating ☐ Cooling	☐	-
3.2 Static pressure test holes have been created, and test hole locations are well-marked and accessible	☐	-
Test hole location for **return** external static pressure: ☐ Plenum ☐ Cabinet ☐ Transition ☐ Other: _____	-	-
Test hole location for **supply** external static pressure: ☐ Plenum ☐ Cabinet ☐ Transition ☐ Other: _____	-	-
3.3 Measured **return** external static pressure (Enter value only, without negative sign): _____ IWC	-	-
3.4 Measured **supply** external static pressure (Enter value only, without positive sign): _____ IWC	-	-
3.5 Measured **total** external static pressure = Value-only from Item 3.3 + Value-only from Item 3.4 = _____ IWC	-	-
3.6 **Measured** (Item 3.5) - **Design** (Item 5.2 on National HVAC Design Report) total external static pressure = _____ IWC	-	-
3.7 Measured HVAC fan airflow, using Item 3.5 and fan speed setting: _____ CFM	-	-
3.8 Measured HVAC fan airflow (Item 3.7) is ± 15% of design HVAC fan airflow (Item 5.2 on National HVAC Design Report)	☐	-

MFNC Functional Testing Checklist

Section 4: Air Balancing of Supply Registers & Return Grilles

- This section is recommended, but not required

	FT Agent Verified	N/A
4. Air Balancing of Supply Registers & Return Grilles (Recommended, but not Required) [6]		
4.1 Balancing report attached with room-by-room design airflows from Item 5.2 on National HVAC Design Report, and contractor-measured airflow using ANSI / ACCA 5 QI-2015 protocol	☐	☐
4.2 Room-by-room airflows verified by contractor to be within the greater of ± 20% or 25 CFM of design airflow	☐	☐

MFNC Functional Testing Checklist

Section 5: Indoor/Terminal Units (Rater can complete)

5. Functional Testing: Indoor / Terminal Units - This section must be completed for all heating and cooling equipment located within dwelling units or common spaces, including systems identified in Sections 2 and 3, except where specifically noted. Indoor / terminal units include, but are not limited to, mini-splits, multi-splits, PTAC's, PTHP's, WLHP's, fan coils, and hydronic distribution systems [5]	**Rater Verified**	**FT Agent Verified**	**N/A**
5.1 Installation Checks			
5.1.1 Zone thermostat (or remote zone temperature sensor) in dwelling units installed in design location, within the zone being served, and not on an exterior wall	☐	☐	☐
5.1.2 Where specified by design, external condensate pump installed and condensate drain pan drains to a conspicuous point of disposal in case of blockage	☐	☐	☐

MFNC Functional Testing Checklist

Section 5: Indoor/Terminal Units (Rater can complete)

5.2 Functional Testing	Rater Verified	FT Agent Verified	N/A
5.2.1 Zone temperature displayed on thermostat or sensor is within 5°F of measured zone temperature	☐	☐	☐
5.2.2 System turns on when there is a call for heat and heating is provided. System turns off when the heating setpoint has been met. For forced air systems: Measured discharge air temperature _____ °F	☐	☐	☐
5.2.3 System turns on when there is a call for cooling and cooling is provided. System turns off when the cooling setpoint has been met. For forced air systems: Measured discharge air temperature _____ °F	☐	☐	☐
5.2.4 Measure and record the inlet and outlet condenser, chilled, or hot-water temperatures at the terminal unit. Cooling mode: Inlet _____ °F Outlet _____ °F Heating mode: Inlet _____ °F Outlet _____ °F	☐	☐	☐
5.2.5 Where OA dampers are installed, the damper closes when there is no call for ventilation or when fan is off	☐	☐	☐
5.2.6 If more than one system provides heating or cooling to the same space, controls prevent simultaneous heating and cooling	☐	☐	☐

MFNC Functional Testing Checklist

Section 6: VRF Outdoor Unit

6. VRF Outdoor Unit - This section must be completed for all VRF outdoor units serving dwelling units or common spaces	**FT Agent Verified**	**N/A**
6.1 Installation Checks		
6.1.1 Pressure testing on refrigerant piping has been completed for this system (indicate exact test in / test out pressure (psig) / time (hours)): _____/_____/_____	☐	☐
6.1.2 Vacuum testing has been completed (indicate exact test in / test out pressure (psig) / time (hours)): _____/_____/_____	☐	☐
6.1.3 Refrigerant line lengths and height differences have been recorded from as-built shop drawings or field measured, and documentation of the measurement is available, if requested	☐	☐
6.1.4 Indicate required additional charge amount (lbs): _____	☐	☐
6.2 Functional Testing		
6.2.1 In cooling mode, the outdoor unit fan is ON and heat is being rejected.[7] Measure and verify that outdoor unit fan discharge air temperature is warmer than the ambient air temperature	☐	☐
6.2.2 In heating mode, the outdoor unit fan is ON and heat is being absorbed.[7] Measure and verify that outdoor unit fan discharge air temperature is colder than the ambient air temperature	☐	☐
6.2.3 Using the central maintenance tool or controller, none of the outdoor units or connected indoor units are showing an alarm	☐	☐
6.2.4 Using the central maintenance tool, the manufacturer's representative confirmed refrigerant charge test per manufacturer's guidelines	☐	☐

MFNC Functional Testing Checklist

Section 7: Central Boilers

7. Central Boilers - This section must be completed for all central boilers serving dwelling units or common spaces	FT Agent Verified	N/A
7.1 Installation Checks		
7.1.1 Piping pressure testing is completed and all accessible boiler piping, fittings, and accessories are free from leaks. FT agent may conduct the test or witness the test being conducted by the installing contractor	☐	☐
7.1.2 Boiler relief valves and discharge piping do not show signs of weeping or leakage	☐	☐
7.1.3 No signs of blockage, leakage, or deterioration in the fresh air intake or flue gas vent piping	☐	☐
7.1.4 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer	☐	☐
7.1.5 Boiler supply / header temperature sensor and, where applicable, outdoor air temperature sensor, are located as specified by HVAC Designer	☐	☐
7.1.6 Indicate boiler header / supply setpoint type: ☐ Fixed ☐ Seasonal ☐ Outdoor temperature reset ☐ Indoor temperature reset ☐ Other: _____	☐	☐
7.1.7 Where outdoor air temperature reset schedule is applicable, indicate reset schedule (e.g., 180°F Supply @ 10°F outdoor, 120°F supply @ 55°F outdoor) _____ @ _____ , _____ @ _____	☐	☐
7.1.8 Where Warm Weather Shut Down (WWSD) is applicable, list temperature (NA if boilers and system pumps also serve DHW)	_____ °F	☐

MFNC Functional Testing Checklist

Section 7: Central Boilers

7.2 Functional Testing: Boilers	FT Agent Verified	N/A
7.2.1 Measure the combustion gas efficiency at high fire and low fire for one of the boilers. Note which one and record information _____% ☐ high fire _____% ☐ low fire	☐	☐
7.2.2 Boiler combustion air intake dampers open / close with boiler operation	☐	☐
7.2.3 If each boiler has its own dedicated boiler circulator pump, it operates only when the respective boiler is firing. (Circulator pump may run for a short period of time before or after the boiler fires, as recommended by the equipment manufacturer)	☐	☐
7.2.4 When there is a call for heating, the boiler(s) are enabled according to their design sequence of operation	☐	☐
7.2.5 When multiple boilers are supposed to operate at the same time, they operate according to the Engineer of Record's sequence of operation and the on / off sequencing is observed	☐	☐
7.2.6 Cycle the boilers on and off 3 times. Boiler(s) modulate / step down to the minimum firing rate before shutting off	☐	☐
7.2.7 Boiler(s) do not short cycle (i.e., the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the boiler manufacturer to prevent short cycling)	☐	☐
7.2.8 Condensing Boiler: Return temperature enables condensing Design / OEM temp: _____°F Measured temp: _____°F	☐	☐
7.2.9 Boiler supply / header temperature sensor is reading within 3°F of measured boiler supply / header temperature	☐	☐
7.2.10 Boiler minimum flow rate and change in flow rate are maintained within the manufacturer's stated limits throughout the sequence of operation	☐	☐

MFNC Functional Testing Checklist

Section 7: Central Boilers

7.3 Functional Testing: Heating System Pumps	FT Agent Verified	N/A
7.3.1 Where heating system pumps (i.e., the pumps which are responsible for moving the water through the terminal units) are equipped with a VFD which is responding to a pressure sensor within the system or a sensorless pumping system, indicate which one: ☐ VFD+Sensor ☐ Sensorless	☐	☐
7.3.2 If a variable speed pumping system is installed, the VFD increases and decreases pump speed in response to changes in the system	☐	☐
7.3.3 If a variable speed pumping system is installed, system prevents "dead-heading". (May be tested under real or simulated low flow conditions.) Select the method of water flow bypass: ☐Minimum Flow Bypass Valve ☐ 3 way valves on specific terminal units ☐Other: _____	☐	☐
7.3.4 Pumps are off when outside air temperature is above WWSD (N/A if pumps serve DHW as well as heating)	☐	☐

MFNC Functional Testing Checklist

Section 8: Cooling Towers

8. Cooling Towers - This section must be completed for all cooling towers serving dwelling units or common spaces	**FT Agent Verified**	**N/A**
8.1 Installation Checks		
8.1.1 Cooling Tower piping and all components are free from leaks	☐	☐
8.1.2 Temperature gauges, check valves, tower bypass valve and all other piping components installed as specified by HVAC Designer	☐	☐
8.1.3 Condenser Water Supply setpoint type: ☐ Fixed ☐ Outdoor temperature reset ☐ Seasonal / based on free cooling	-	☐
8.1.4 All control sensors (condenser water supply temperature, outdoor air humidity, etc.) are located as specified by HVAC Designer	☐	☐

MFNC Functional Testing Checklist

Section 8: Cooling Towers

	FT Agent Verified	N/A
8.2 Functional Testing: Tower Fans		
8.2.1 Tower fan(s) do not short cycle (i.e., the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the manufacturer to prevent short cycling)	☐	☐
8.2.2 Cooling Tower fan(s) do not run unless associated cooling tower pump(s) are running	☐	☐
8.2.3 If installed, basin heater is not enabled when the basin water temperature is above the setpoint	☐	☐
8.2.4 Condenser Water Supply Sensor is reading within 3°F of measured temperature	☐	☐
8.3 Functional Testing: Cooling Tower Pumps		
8.3.1 Cycle the cooling tower pumps on and off 3 times. Cooling tower pumps only operate when controls call for operation (N/A if tower pumps are set to run year round)	☐	☐

MFNC Functional Testing Checklist

Section 9: Chillers

9. Chillers - This section must be completed for all chillers serving dwelling units or common spaces	FT Agent Verified	N/A
9.1 Installation Checks		
9.1.1 Chiller piping and all components are free from leaks	☐	☐
9.1.2 If multiple chillers, water flow is balanced across chillers using (indicate which one): ☐ Balancing valves ☐ Reverse return piping ☐ Individual chiller pumps ☐ Other:	☐	☐
9.1.3 Temperature, pressure gauges, air eliminator, expansion tank, check valves and all other piping components installed as specified by HVAC Designer	☐	☐
9.1.4 Chilled Water Supply temperature sensor (and outdoor air temperature sensor where applicable) are located as specified by HVAC Designer	☐	☐

MFNC Functional Testing Checklist

Section 9: Chillers

	FT Agent Verified	N/A
9.2 Functional Testing: Chillers		
9.2.1 When there is a call for cooling, chillers are operating and maintaining chilled water setpoint	☐	☐
9.2.2 When multiple chillers are supposed to operate at the same time, they operate according to the Engineer of Record's sequence of operations and the on / off sequencing is observed	☐	☐
9.2.3 Chiller(s) do not short cycle (i.e., the minimum on time is 5 minutes and the minimum off time is 5 minutes, or as recommended by the chiller manufacturer to prevent short cycling)	☐	☐
9.2.4 Chilled Water Supply Sensor is reading within 3°F of measured chiller temperature	☐	☐
9.2.5 Chiller minimum flow rate and change in flow rate are maintained within the manufacturer's stated limits throughout the sequence of operation	☐	☐

MFNC Functional Testing Checklist

Section 9: Chillers

	FT Agent Verified	N/A
9.3 Functional Testing: Chilled Water System Pumps		
9.3.1 Where Chilled Water System pumps (i.e., the pumps which are responsible for moving the chilled water through the terminal units) are equipped with a VFD, which is responding to a pressure sensor within the system or a sensorless VFD system, indicate which one: ☐ VFD+Sensor ☐ Sensorless	☐	☐
9.3.2 If a variable speed pumping system is installed, confirm that the VFD increases and decreases pump speed in response to changes in the system	☐	☐
9.3.3 If a variable speed pumping system is installed, system prevents "dead-heading". (May be tested under real or simulated low flow conditions.) Select the method of water flow bypass: ☐Minimum Flow Bypass Valve ☐ 3 way valves on specific terminal units ☐Other: _____	☐	☐
9.3.4 Pumps are off when cooling is not required (N/A if chilled water is required year round)	☐	☐

MFNC Functional Testing Checklist: FAQ

Q: My commissioning credential isn't on the pre-approved list.

A: Submit it for consideration!

Q: Can I be the Rater & Functional Testing Agent for a project?

A: Yes, if you take the FTA Orientation & have the credential.

Q: I have a 4 ton ducted forced air heat pump serving the 1st floor community room. What sections of the checklist apply?

A: Section 2 (Refrigerant Charge), Section 3 (HVAC Fan Airflow), and Section 5 (Indoor/Terminal units)

Q: Are ducted mini-splits exempt from any sections?

A: Exempt from Section 2 and 3, still have to do Section 5.

MFNC Rev. 01

- Optional to use for permits before July 1, 2020
- If choosing MFNC (over Certified Homes or MFHR) in 2020, must use Rev. 01 documents for projects permitted on or after July 1, 2020

MFNC Rev. 01 Highlights

Changes

- Reinstated ventilation override control req't for Townhouse
- Added compartmentalization sampling procedure requirements and CO alarm recommendation for units adjacent to garage
- Developed an alternative central exhaust test leakage option
- Set ASHRAE 62.2 and 62.1 as the lowest measured value allowed

MFNC Rev. 01 Highlights

Change

- Set ASHRAE 62.2 and 62.1 as the lowest measured value allowed

Rater-measured ventilation rate is within either ± 15 CFM or ±15% of dwelling unit design values (2.7), and meets or exceeds rates required by ASHRAE 62.2-2010

MFNC Rev. 01 Highlights

Changes

- Reinstated ventilation override control req't for Townhouse
- Added compartmentalization sampling procedure requirements and CO alarm recommendation for units adjacent to garage
- Developed an alternative central exhaust test leakage option
- Set ASHRAE 62.2 and 62.1 as the lowest measured value allowed
- Ceiling fans removed from Reference Design so only need to meet 90% ENERGY STAR lighting req't
- Functional Testing agent may witness testing
- 15% over-ventilation allowed before ASHRAE modeling penalty

MFNC Rev. 01 Highlights

Clarifications

- Individual Rater performing verification must take ENERGY STAR MF Training
- When ERI Path available for buildings > 5 stories
- Applicability of advanced framing thermal bridging option
- CA requirements based on Title 24-2016 (California PR)
- Furnace over-sizing limits only apply in-unit (HVAC-D)
- Booster pump energy must be included in ASHRAE model (SG)
- No FT Agent needed for building with only mini-splits (if Rater completes section 5 of FT Checklist)

Relevant changes from Certified Homes Revision 10, including preparation for the future availability of HVAC Grading

Current Issues Under Review

- Sampling Policies* (Common Spaces, Functional Testing)
- ASHRAE Path Performance Target equivalency options
- Clarifications on what is equivalent to a HERS Rater credential
- Thermal Bridging Details for Podiums*
- Functional Testing Section 5 adjustments*
- Streamlining processes

Future Resources

Training – Let us know what topics would be most helpful

- Videos of key tests
- Additional examples for Rater training
- Webinars

Sales, Marketing, and Recruitment

- Builder/Developer recruitment technical bulletin
- Additional resources?

Revision 02 / Policy Record Updates

- Additional clarifications, adjustments

Learn More

Webinars:

- Recorded Introductory Webinars
- Technical Series
  - Multifamily Workbook
  - Rater QA Checklist (for QADs and MROs)

Requirements: www.energystar.gov/mfnc

- Comparison documents ESCH vs MFNC, MFHR vs MFNC
- Certification Process

Email questions to energystarhomes@energystar.gov

Questions?