November Training

Review of the Commercial Provisions of the 2021 OEESC

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Blake Shelide, P.E. – ODOE

November 9th, 2021

Acknowledgements

Pacific Northwest NATIONAL LABORATORY

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U.S. DEPARTMENT OF ENERGY

ASHRAE Oregon Chapter

https://www.energycodes.gov

https://www.orashrae.org/

State of Oregon Building Codes Division

Better Buildings for Oregon

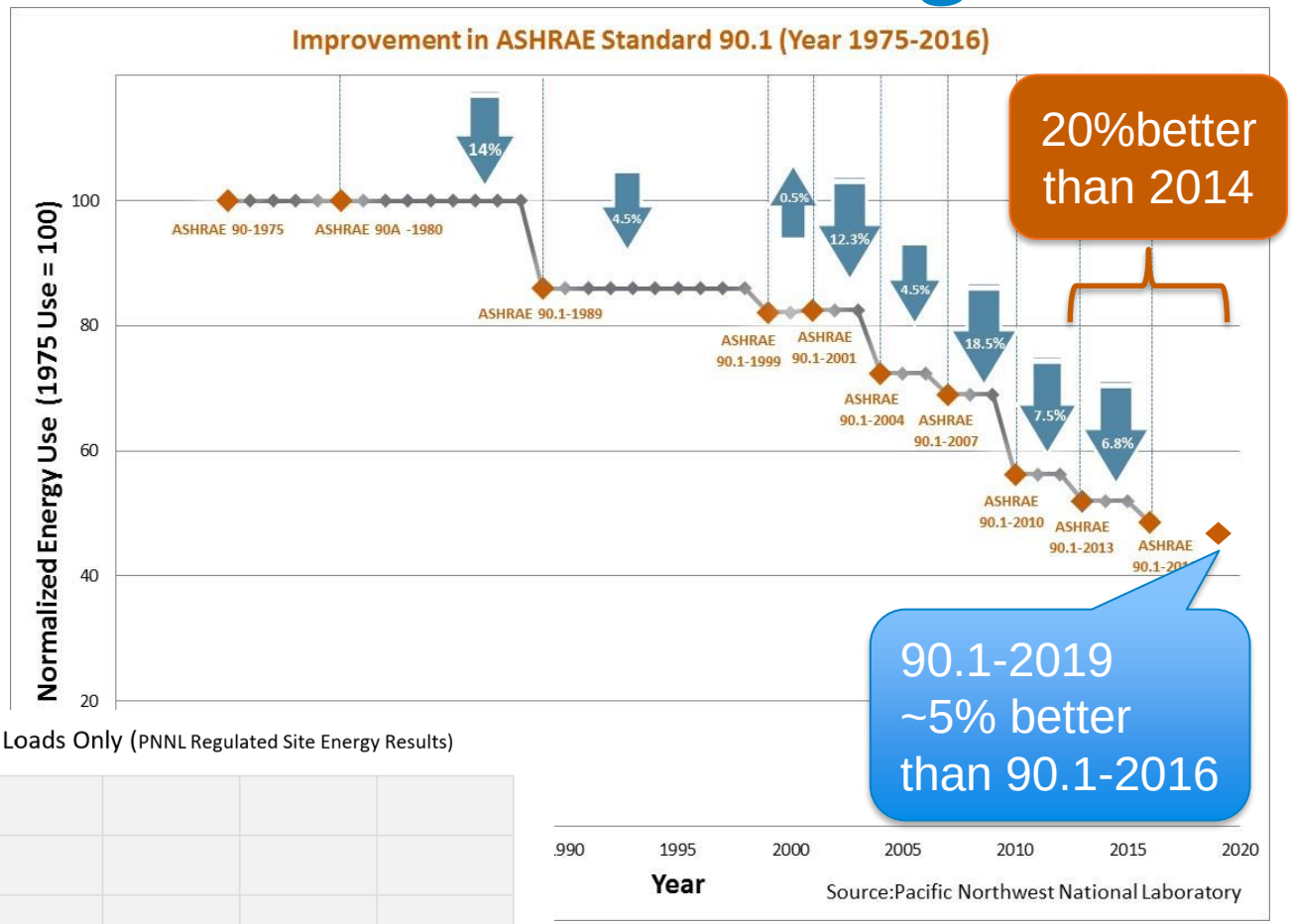
https://www.oregon.gov/bcd/codes-stand/Pages/index.aspx

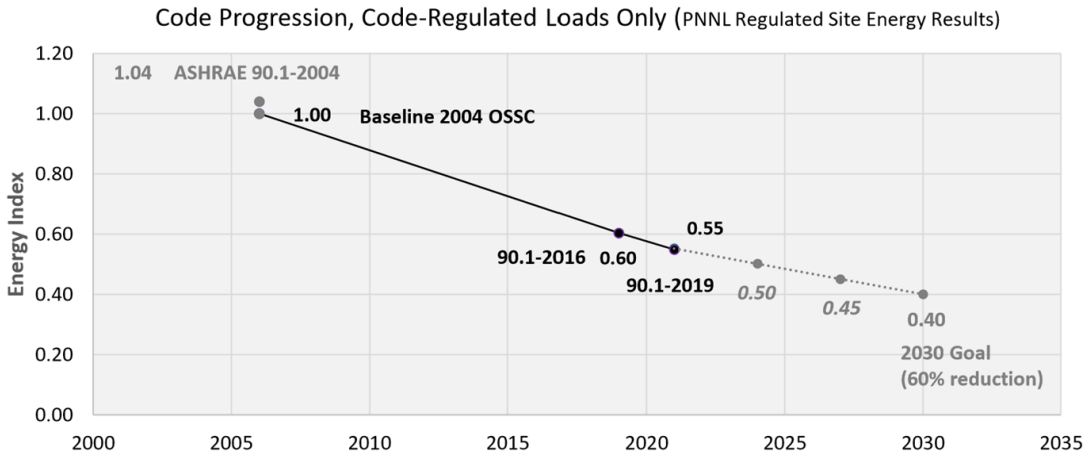
neea

Why Change to ASHRAE 90.1?

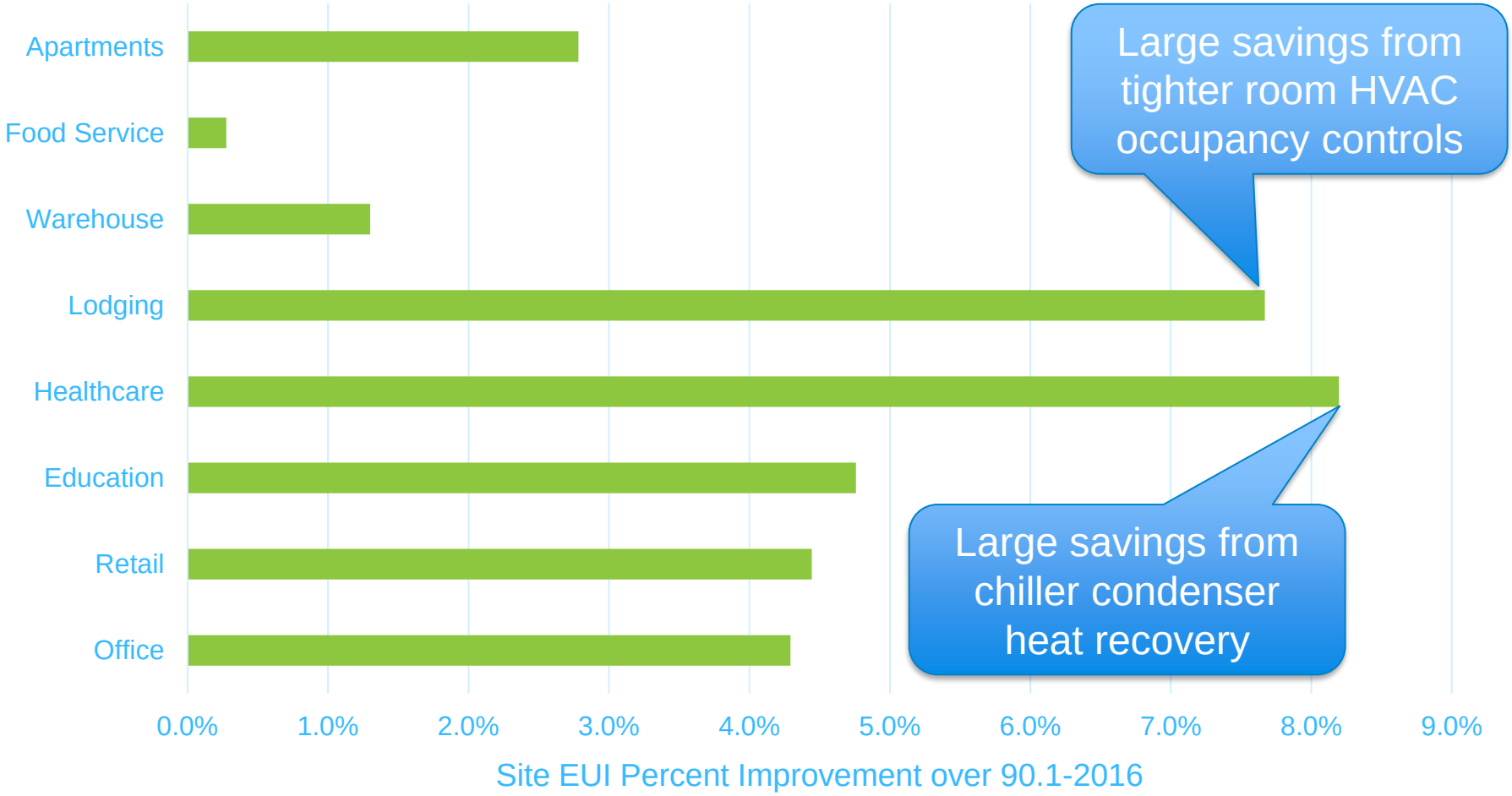
- Repeatable 3-year updates validated by DOE
- Few Oregon state amendments to transfer each cycle
- Consensus based process for updating ASHRAE with technical committees and working groups
- Keeps Oregon an efficiency leader by putting plan in place to update with ASHRAE 90.1
- Lessens time burden on officials to adopt new code
- Supported by DOE COMcheck without modification

ASHRAE Historic Savings





Which Building Types Improved Most?



Current Oregon Energy Code

2021 Oregon Energy Efficiency Specialty Code (OEESC)

Chapter 13 of the Oregon Structural Specialty Code (OSSC)

- Effective April 1, 2021
- Phase-in period ends Oct. 1, 2021
- Based on ASHRAE Standard 90.1-2019
- Significant changes summary

R-2,3,4 structures are subject to this code. The ORSC applies mainly to 1-2 family dwelling units & townhomes ≤ 3 stories

- https://www.oregon.gov/bcd/codes-stand/Pages/energy-commercial-compliance.aspx
- Read only versions of 90.1 are available

Compliance Pathways

OR Code Compliance Pathways

2021 OEESC

(based on 90.1-2019 with OR state amendments)

Became effective April 1,2021 (with 6-month grace period for projects)
Mandatory beginning October 1, 2021

Three Paths Through 90.1

Mandatory Requirements

Plus One

Prescriptive Requirements

Chapter 11 Performance (ECB)

Appendix G Performance (PRM)

Performance Pathways

- Previous 2014 Oregon code contained Section 506 Whole Building Approach, based on 90.1 Ch. 11 Energy Cost Budget
- ASHRAE 90.1 includes two performance paths for code compliance, Ch.11 and Appendix G

Two Performance Paths

Chapter 11 Performance (ECB)

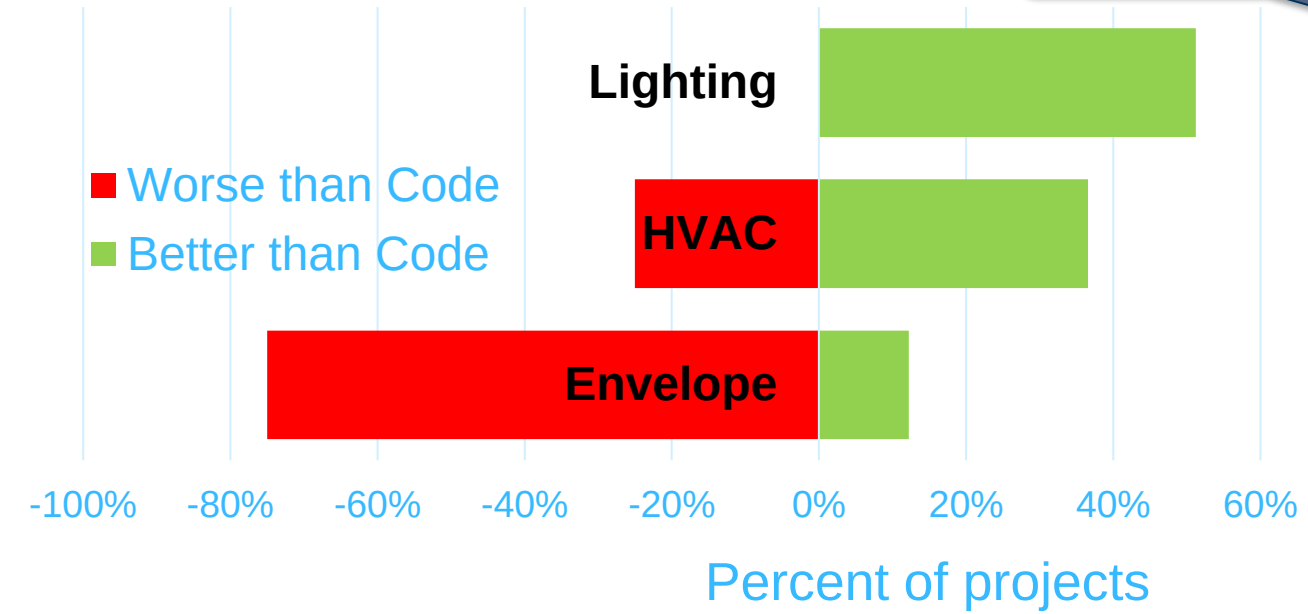
- **Energy Cost Budget Method (ECB) - Chapter 11**
  - Used for minimum code compliance for buildings that do not meet 90.1 prescriptive requirements
  - Requires no greater energy cost than a building that meets those prescriptive requirements

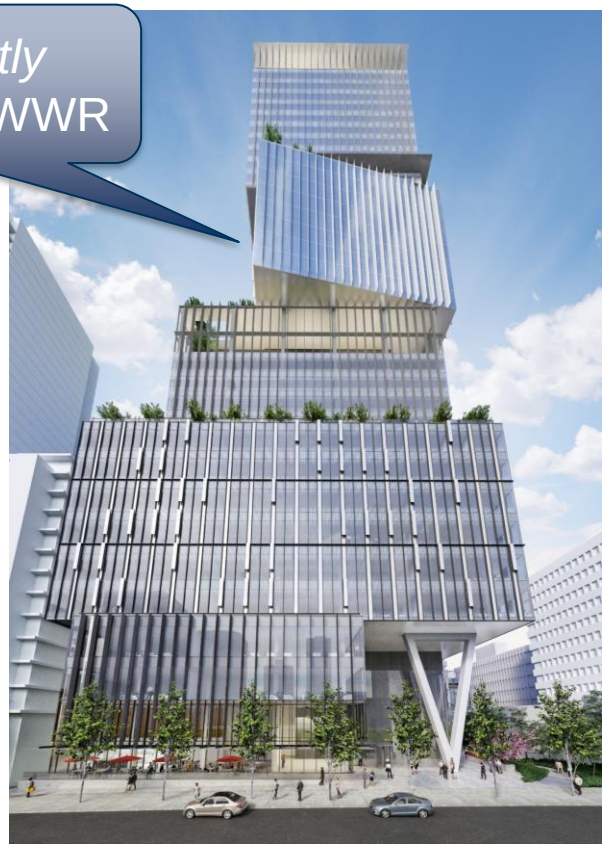
Appendix G Performance (PRM)

- **Performance Rating Method - Appendix G**
  - Previously used to rate building performance "beyond code".
    - » LEED, EPACT tax credits, utility programs, ASHRAE Standard 189.1, IgCC
  - % improvement = 100 x (baseline – proposed) ÷ baseline

Common Trade-offs

Based on a national survey, most projects that use modeling to comply with code trade off worse-than-code envelope for better-than-code lighting and HVAC





Slide credit: Karpman Consulting

Mainly Focus on Prescriptive Path

Prescriptive Requirements

Mandatory Requirements

Plus One

Chapter 11 Performance (ECB)

Appendix G Performance (PRM)

COMcheck Basics

COMcheck Background

Oregon Energy Code Compliance

Yes, this still needs to be filled out when using Appendix G or Section 11.

COMcheck™

Only COMcheck-web has 90.1-2019 available currently.

Code Compliance Form

State of Oregon
Building Codes Division
Better Buildings for Oregon

Part I	**COM*check* information**
Compliance path: ☐ Performance path ☐ Prescriptive path	COM*check* (Standard 90.1-2019) results: ☐ Pass ☐ Fail *For performance path, submit the energy model report with this form.
Prepared by or under the supervision of:	Date:
Part II	**Projected energy use**
Enter the ZERO Code 2.0 Calculator results for projected energy use. Estimated building energy consumption: _____ MBtu/yr	
Part III	**Estimated available renewables for the building**
Enter the ZERO Code 2.0 Calculator results for offsets. Total renewable energy to achieve Net Zero: _____ MBtu/yr On-site PV generational potential: _____ MBtu/yr Remaining off-site renewable energy: _____ MBtu/yr	
CHECKLIST AND APPLICANT SIGNATURE	
COM*check* report and ZERO Code 2.0 Calculator report must be submitted with this form. ☐ COM*check* report is attached ☐ ZERO Code Calculator report is attached	☐ Energy model report is attached (if COM*check* failed) ☐ 2021 OEESC COM*check* supplement report is attached

https://www.oregon.gov/bcd/codes-stand/Documents/oeesc-compliance-form.pdf

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COMcheck Resources

COMcheck

> ***Alert: The BECP Help Desk form is currently experiencing technical difficulties. Please email becp@pnnl.gov if you have questions or issues.***

Getting Started

COMcheck-Web™ is accessible directly from the website without having to download and install.

COMcheck™ Desktop for Windows® may be downloaded and installed directly to your desktop.

- Download via the link at the bottom of the right sidebar.
- See if your state or county can use COMcheck to show compliance.
- View a list of supported software versions for code compliance tools.

Commercial Compliance Using COMcheck™

The COMcheck software product group makes it easy for architects, builders, designers, and contractors to determine whether new commercial or high-rise residential buildings, additions, and alterations meet the requirements of the IECC and ASHRAE Standard 90.1, as well as several state-specific codes. COMcheck also simplifies compliance for building officials, plan checkers, and inspectors by allowing them to quickly determine if a building project meets the code.

COMcheck Support

Have a compliance question or need assistance with the software?

BECP's team of building energy codes experts is available to answer specific questions submitted through our web-based help desk.

Technical Support Document for Version 3.9.1 of the COMcheck Software

LATEST RELEASE

LAUNCH COMCHECK-WEB

DESKTOP VERSION

DESKTOP VERSION/BUILD: 4.1.5.3
PLATFORM: WINDOWS
RELEASE DATE: MAY 25, 2021

RELEASE NOTES

VERSION 4.1.5.3 ADDRESSES THE FOLLOWING:

- 2012 IECC COMPLIANCE INDEX UPDATES HAVE BEEN REACTIVATED.

COMCHECK DESKTOP 4.1.1 SUPPORTED CODES:

2009, 2012, 2015 AND 2018 IECC; ASHRAE STANDARD 90.1-2007, 2010, 2013, 2016; VARIOUS STATE-DEVELOPED ENERGY CODES INCLUDING: COLORADO (BOULDER AND DENVER), NEW YORK CITY (NYCECC), NYSTRETCH, VERMONT; AS WELL AS ONTARIO AND PUERTO RICO.

COMCHECK-WEB SUPPORTED CODES:

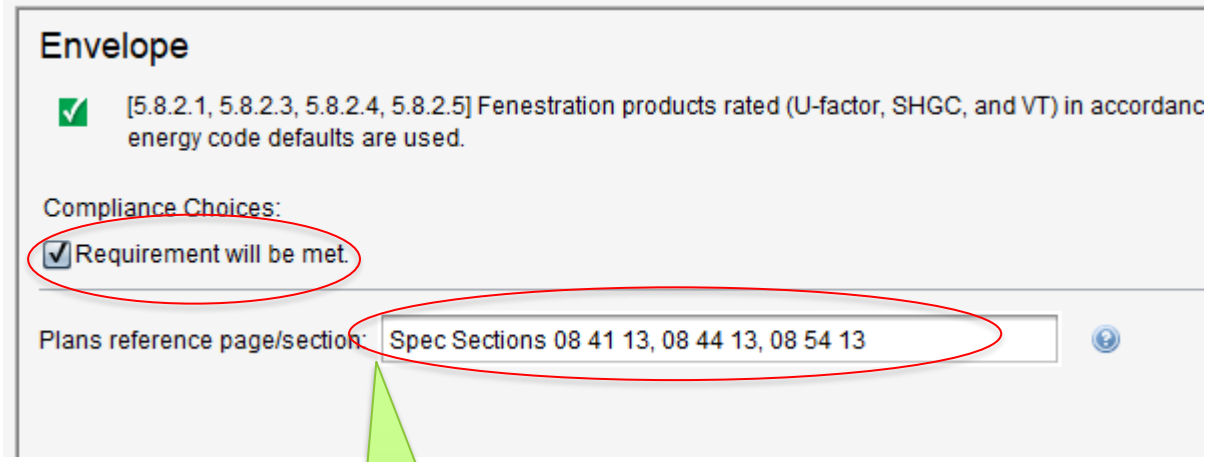
2009, 2012, 2015 AND 2018 IECC; ASHRAE STANDARD 90.1-2007, 2010, 2013, 2016, 2019; VARIOUS STATE-DEVELOPED ENERGY CODES INCLUDING: COLORADO (BOULDER AND DENVER), FLORIDA, MASSACHUSETTS, NEW YORK CITY (NYCECC), NEW YORK STATE (NYECCC), NYSTRETCH, VERMONT; AS WELL AS ONTARIO AND PUERTO RICO.

DOWNLOAD

COMCHECK 4.1.5.3 SETUP .EXE	104.95 MB

https://www.energycodes.gov/comcheck

COMcheck Reports



Designer inputs can simplify review with good plan references

Columns for plans and field checks

Section # & Req.ID	Footing / Foundation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
5.8.2.1, 5.8.2.3, 5.8.2.4, 5.8.2.5 [FR12]²	Fenestration products rated (U-factor, SHGC, and VT) in accordance with NFRC or energy code defaults are used.			☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** Spec Sections 08 41 13, 08 44 13, 08 54 13
5.8.2.2 [FR13]¹	Fenestration and door products are labeled, or a signed and dated certificate listing the U-factor, SHGC, VT, and air leakage rate has been provided by the manufacturer.			☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met.

1	High Impact (Tier 1)	2	Medium Impact (Tier 2)	3	Low Impact (Tier 3)

What Can COMcheck Do For You?

What it is

- Tool for designers to document project parameters to demonstrate compliance
- Tool for Plans examiners & inspectors to verify energy code compliance
- Helpful resource to focus energy code review to certain areas

What it is not

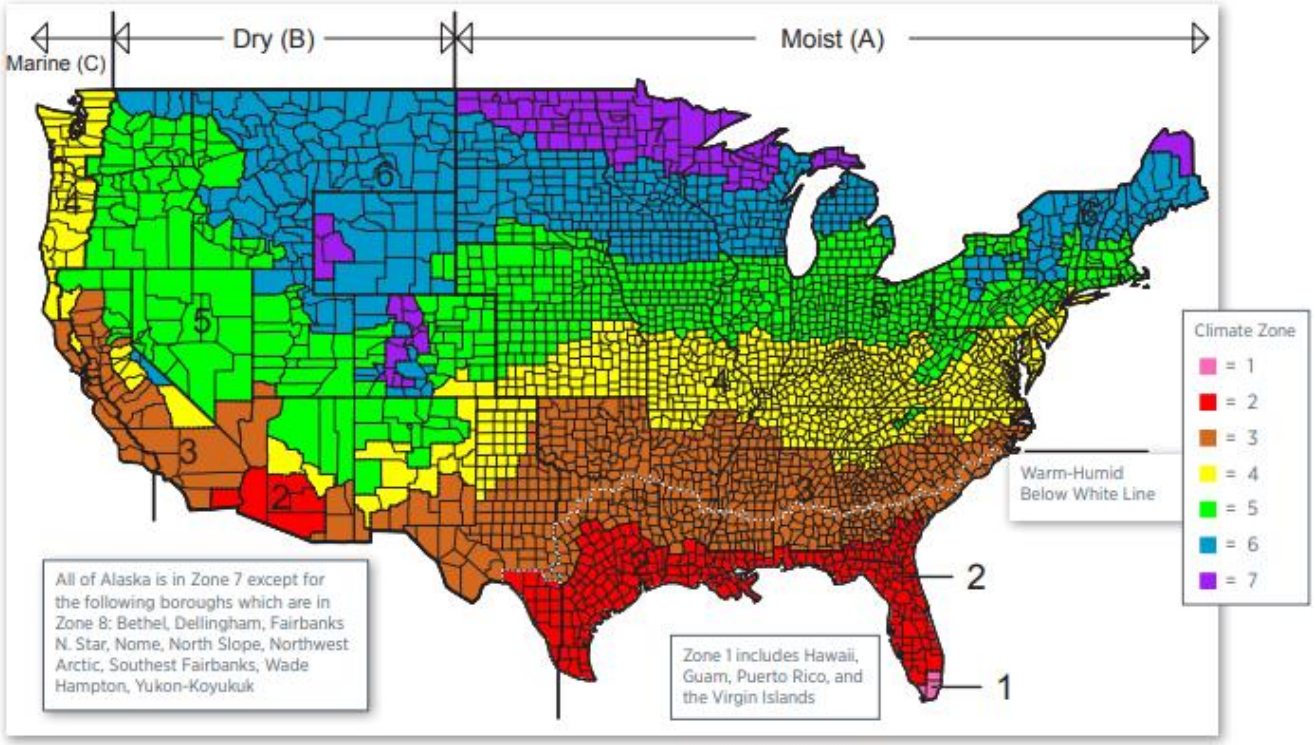
- Not proof that design complies
- Not foolproof
- Not a substitute for documentation on plans and specs

Administration and Scope

Updated climate zone map

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table Annex-1, Figure Annex-1	Performance path modeling

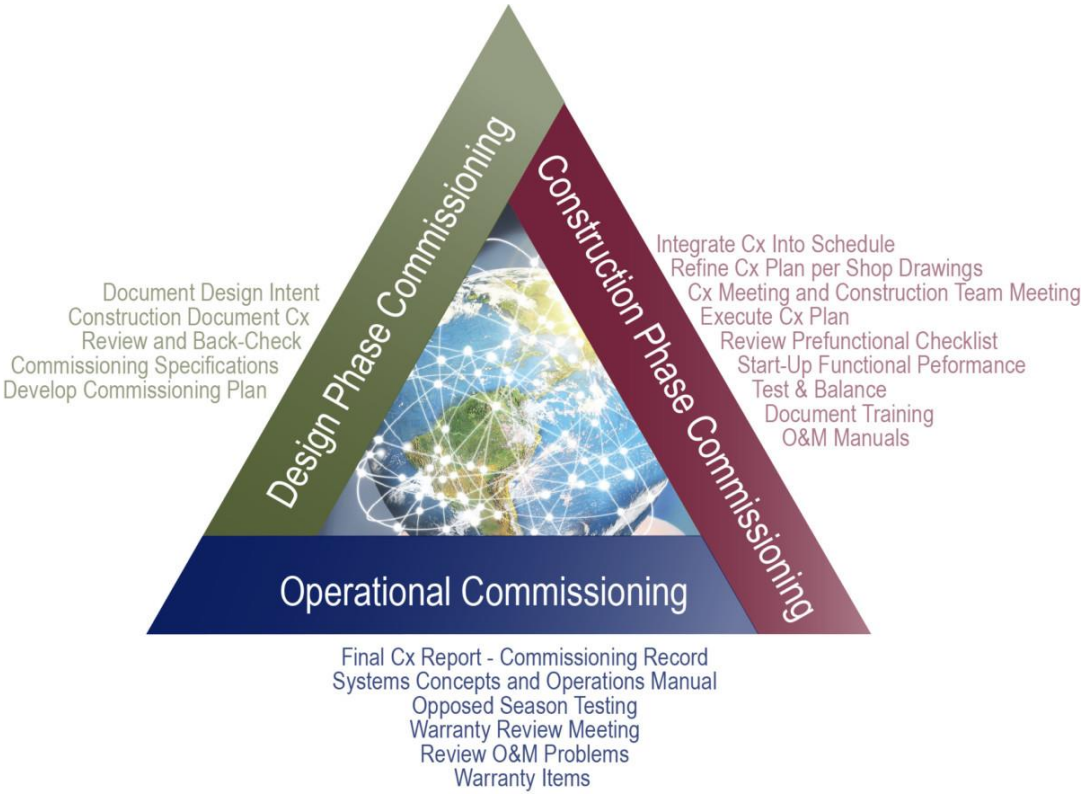
- Aligns with new ASHRAE Standard 169-2013
  - No climate zone changes for Oregon
- Comes into play for envelope features & modeling



Verification, Testing, Commissioning

- Controls “Capable of” changed to add “configured to” throughout
  - Control functions and setpoints required at time of inspection
- Expanded verification and commissioning required in 90.1-2019

- 2014 OEESC - **No** testing or commissioning requirements in
- 2021 OEESC - Plans and specs should include verification and commissioning requirements **but** code official cannot require physical copies of drawings, energy test reports, forms, etc.
  - Building leakage test reports under Section 5.4.3 do need to be submitted (when leakage test path is used)



Overall Scope

- 90.1 provides minimum energy-efficient requirements for the design and construction, and a plan for operation and maintenance of
  - new buildings and their systems,
  - new portions of buildings and their systems,
  - new systems and equipment in existing buildings, and
  - new equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes

- In general it applies to new buildings and their systems, building additions and their systems, and **new systems and equipment in existing buildings**.

i.e. Alterations

Alteration Exceptions

There are a number of exceptions where alterations to envelope are not required to meet code for insulation, air leakage, and fenestrations, provided the alteration will not increase the energy use of the building

- Storm windows over existing glazing (low emissivity coating)
- Replacement of glazing in existing sash and frame, provided U-factor and SHGC are same or better
- Alterations to the roof, wall, or floor cavities that are insulated to full depth with R-3 per inch
- Alterations to walls and floors without framing cavities and no new cavities are created
- Roof recovering
- Removal and replacement of roof membrane where there is existing roof insulation either integral to or below the roof deck
- Replacement of doors does not require the installation of a vestibule
- Replacement of existing fenestration up to 25% of existing building fenestration and provided that U-factor and SHGC are the same or better

Building Envelope

Envelope Compliance paths

- There are two ways to comply with 90.1 envelope requirements
- Performance path may provide more design flexibility when compared to prescriptive table requirements
  - Ex. You can use worse windows if the roof is insulated more
- Can use COMcheck (or other simulation program) to demonstrate compliance

	Prescriptive Option	**Trade-Off Option**
Fenestration area	Vertical fenestration area is limited to 40% of the gross exterior wall area, and skylights are limited to 3% of the roof area (6% as permitted by Section 5.5.4.4.2).	Fenestration area greater than 40% is permitted if the performance of envelope components is improved over that required by the prescriptive requirements.
Area take-offs	It is only necessary to verify that the vertical fenestration area is less than 40% of the gross exterior wall area and that the total skylight area meets the prescriptive requirements.	Surface areas must be calculated for each type and class of construction. Vertical fenestration and wall areas must be separately calculated for surfaces facing the major compass points (N, S, E, W) plus NE, SE, SW, and NW.
U-factor compliance	Not necessary if the R-value option is used.	Required.

Simplified Building Method - Envelope

2021 OEESC

Simplified Building Method—Envelope

2021 Oregon Energy Efficiency Specialty Code Compliance Checklist

This checklist may be used to demonstrate compliance with the Oregon Energy Efficiency Specialty Code (OEESC), which is based on ASHRAE Standard 90.1, for new buildings, alterations, and additions. To use this checklist, the building envelope shall comply with ASHRAE 90.1 Section 5.4, mandatory provisions and Section 5.5, Prescriptive Building Envelope Compliance Path.

*Note: This checklist **may not** be used for the Building Envelope Trade-Off Compliance Path, Section 5.6.

PART I – PROPERTY OWNER INFORMATION

Property owner name:	Phone number:
Installation address:	Climate Zone: ☐ 4C ☐ 5B
City: State: Oregon	ZIP:
Installer: ☐ Contractor ☐ Owner (*If owner, skip to Part III*)	☐ Non-Residential ☐ Residential

PART II – CONTRACTOR INFORMATION

Contractor name:	Phone number:
Email address:	
BCD business license #:	Contractor's CCB#:

PART III – COMPLIANCE

Mandatory provisions

The building envelope of new buildings, alterations, or additions must comply with Section 5.4, Mandatory Provisions. Each item below is required to demonstrate compliance with Section 5.4, check the boxes that apply.

- ☐ **Whole-building air leakage:** Compliance with Section 5.4.3.1.1 for whole-building air leakage has been demonstrated and documentation has been provided to the building official
- ☐ **Continuous air barrier:** The entire building envelope is designed and constructed with a continuous air barrier in accordance with Section 5.4.3.1.2.
- ☐ **Loading dock weatherseals:** Cargo doors and loading dock doors comply with Section 5.4.3.2 for weathersealing.
- ☐ **Vestibules and revolving doors:** Building entrances comply with Section 5.4.3.3 for vestibules and revolving doors.
- ☐ **Insulation:** Insulation complies with the product information and installation requirements in Section 5.8.1.
- ☐ **Fenestration and doors:**
  - ☐ Fenestration and doors comply with the product rating and labeling requirements and U-factor, SHGC, and VT determination requirements in Section 5.8.2.
  - ☐ Fenestration and doors comply with the air leakage requirements in Section 5.8.3.

Prescriptive compliance path

To use this checklist, the building envelope must comply with the mandatory provisions in Section 5.4 and Section 5.5 "Prescriptive *Building Envelope* Option." Check the appropriate boxes for each item and fill in the values used2 for compliance as applicable to the project. Select 'N/A' Where that Section is *not* being constructed or altered. Exceptions being used shall be listed at the bottom of the page and will note the Section and Exception numbers. Submittal of a COM*check* report showing the Proposed and Required U-factors is also acceptable for complying with the Prescriptive Path.

BCD Building Codes Division — Department of Consumer and Business Services

Published by Building Codes Division – Oct. 1, 2021

Prescriptive Building Envelope Option (Section 5.5)

- Project complies with the requirements in Table 5.5-____: ☐ Yes ☐ N/A
  (*check one*) ☐ Nonresidential ☐ Residential ☐ Semiheated
- **Opaque Areas.** (5.5.3) All *opaque* surfaces, except *doors*, comply with one of the following methods:
  (*check one*) ☐ Minimum rated *R-value* ☐ Maximum *U-factor*, *C-factor*, or *F-factor*

Roof Insulation. (5.5.3.1)	☐ Insulation entirely above deck ☐ Metal building ☐ Attic and other PROPOSED *R-value or U-factor* ____ REQUIRED *R-value or U-factor* ____	☐ N/A
Above-Grade Wall Insulation. (5.5.3.2)	☐ Mass ☐ Metal building ☐ Steel-framed ☐ Wood-framed and other PROPOSED *R-value or U-factor* ____ REQUIRED *R-value or U-factor* ____	☐ N/A
Below-Grade Wall Insulation. (5.5.3.3)	PROPOSED *R-value or C-factor* ____ REQUIRED *R-value or C-factor* ____	☐ N/A
Floor Insulation. (5.5.3.4)	☐ Mass ☐ Steel joists ☐ Wood-framed and other PROPOSED *R-value or U-factor* ____ REQUIRED *R-value or U-factor* ____	☐ N/A
Slab-on-Grade Floor Insulation. (5.5.3.5)	PROPOSED *R-value or F-factor* ____ REQUIRED *R-value or U-factor* ____	☐ N/A
Opaque Doors. (5.5.3.6)	PROPOSED *U-factor* ____ REQUIRED *U-factor* ____	☐ N/A
Fenestration Area. (5.5.4.2)	☐ Does ***not*** exceed maximum allowed	☐ N/A
Vertical Fenestration. (5.5.4.2.1)	Area: ____ % of Wall ***LIMIT 40%*** PROPOSED *U-factor* ____ REQUIRED *U-factor* ____	
	PROPOSED SHGC ____ VT/SHGC ____ REQUIRED SHGC ____ VT/SHGC ____	☐ N/A
Skylight Fenestration. (5.5.4.2.2, 5.5.4.2.3)	Area: ____ % of Roof ***LIMIT 3%*** PROPOSED *U-factor* ____ REQUIRED *U-factor* ____	
	PROPOSED SHGC ____ REQUIRED SHGC ____	☐ N/A
Fenestration Orientation. (5.5.4.5)	Path 'a' ☐ Path 'b' ☐	

Exceptions to Chapter 5 used:

Location of information on plan set:

Additional project compliance notes/important:

Page **2** of **2**

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Simplified Building Method - Envelope

2021 OEESC

Simplified Building Method—Envelope

2021 Oregon Energy Efficiency Specialty Code Compliance Checklist

This checklist may be used to demonstrate compliance with the Oregon Energy Efficiency Specialty Code (OEESC), which is based on ASHRAE Standard 90.1, for new buildings, alterations, and additions. To use this checklist, the building envelope shall comply with ASHRAE 90.1 Section 5.4, mandatory provisions and Section 5.5, Prescriptive Building Envelope Compliance Path.

*Note: This checklist may not be used for the Building Envelope Trade-Off Compliance Path, Section 5.6.

PART I – PROPERTY OWNER INFORMATION			
Property owner name:		Phone number:	
Installation address:		Climate Zone: ☐ 4C ☐ 5B	
City:	State: Oregon	ZIP:	
Installer: ☐ Contractor ☐ Owner (*If owner, skip to Part III*)		☐ Non-Residential	☐ Residential

PART II – CONTRACTOR INFORMATION			
Contractor name:		Phone number:	
Email address:			
BCD business license #:		Contractor's CCB#:	

Space-conditioning Categories

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.1.2	COMcheck report

Separate envelope component requirements apply to three types of spaces

- *Nonresidential conditioned*
- *Residential conditioned*
- *Semiheated*

- *Nonresidential:* all occupancies other than residential.
  - Defining characteristic is that no one is there at night and whether it is a dwelling unit

- *Residential*: *spaces* in buildings used primarily for living and sleeping
  - ex. dwelling units, hotel/motel guest rooms, hostels, prisons, fire stations

- *Semiheated: spaces* have a heating system with system greater than 3.4 Btu/h·ft^2 but not heated to comfort levels, and not cooled.

Space-conditioning Categories

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.1.2	COMcheck report

COMcheck Software Version COMcheckWeb

Envelope Compliance Certificate

Project Information

Energy Code:	90.1 (2019) Standard
Project Title:	Marvins Gardens
Location:	Salem, Oregon
Climate Zone:	4c
Project Type:	New Construction
Vertical Glazing / Wall Area:	10%
Performance Sim. Specs:	EnergyPlus 8.1.0.009 (EPW: USA_OR_Salem-McNary.Field.726940_TMY3.epw)

Construction Site:
123 Main
Salem, OR 97103

Owner/Agent:

Designer/Contractor:

Building Area	Floor Area
1-Office : Nonresidential	12160
2-Workshop : Semiheated	1000

Semiheated Spaces

- A semiheated space:
  - Has a heating system with a capacity ≥ 3.4 Btu/h.ft^2 of floor area but is not conditioned space
  - Space is not cooled at all
- Spaces are no longer considered semiheated (become "conditioned" space) if heating thresholds exceed the following:

"Conditioned Space" Heating Thresholds, btu/h-ft^2		
Climate Zone	2021 Oregon / 90.1-2019	2014 OEESC
4C	>8	>10
5	>12	>15

Reduced thresholds for "conditioned" space means fewer buildings can qualify as "semiheated"

- Spaces are assumed to be *conditioned space* and comply with requirements of *conditioned space* at time of construction regardless of whether the mechanical or electrical equipment is included in the building permit application or installed at that time
- Exceptions:
  - » Space is designated as semiheated or unconditioned and
  - » Approved as such by the building official
  - » A space with limited radiant heating system meeting the requirements of Section 6.5.8.2 shall be considered an *unconditioned space*.

Unique Oregon exception

Unconditioned Spaces

- *Unconditioned space:* an *enclosed space* within a *building* that is not a *conditioned space* or a *semiheated space*.
  - Crawlspaces, attics, and parking garages with natural or mechanical *ventilation* are not considered *enclosed spaces*.

- Unconditioned spaces are not automatically exempt from all building envelope requirements

- *How to identify:*
  - *An unconditioned space* does not have a space cooling system and either does not have a space heating system or the space heating system has a capacity that is less than 3.4 Btu/h·ft^2. The default assumption is that all spaces are conditioned or semiheated.

- Unique Oregon Definition:
  - ***unconditioned space:*** an enclosed space within a building that is not a conditioned space or a semiheated space, including automatic sprinkler riser rooms and fire pump rooms per Section 902 of the *Building Code*. Crawlspaces, attics, and unheated parking garages with natural or mechanical ventilation are not considered enclosed spaces.

Putting it all together

Impacts Envelope Requirements

Space Conditioning Categories

- Non-residential Conditioned
- Residential Conditioned
- Semiheated

Impacts Heating Requirements

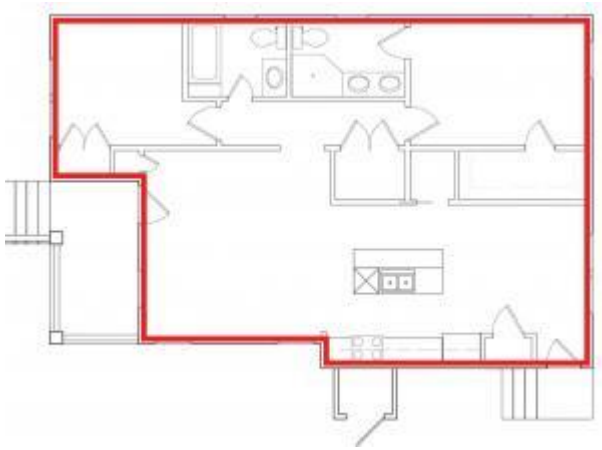
Space Heating Categories

- Conditioned
- Semiheated
- Unconditioned

Air-Leakage

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3	Supplemental OEESC form, Arch plans

Mandatory air-leakage requirements exist for:



Continuous Air Barriers

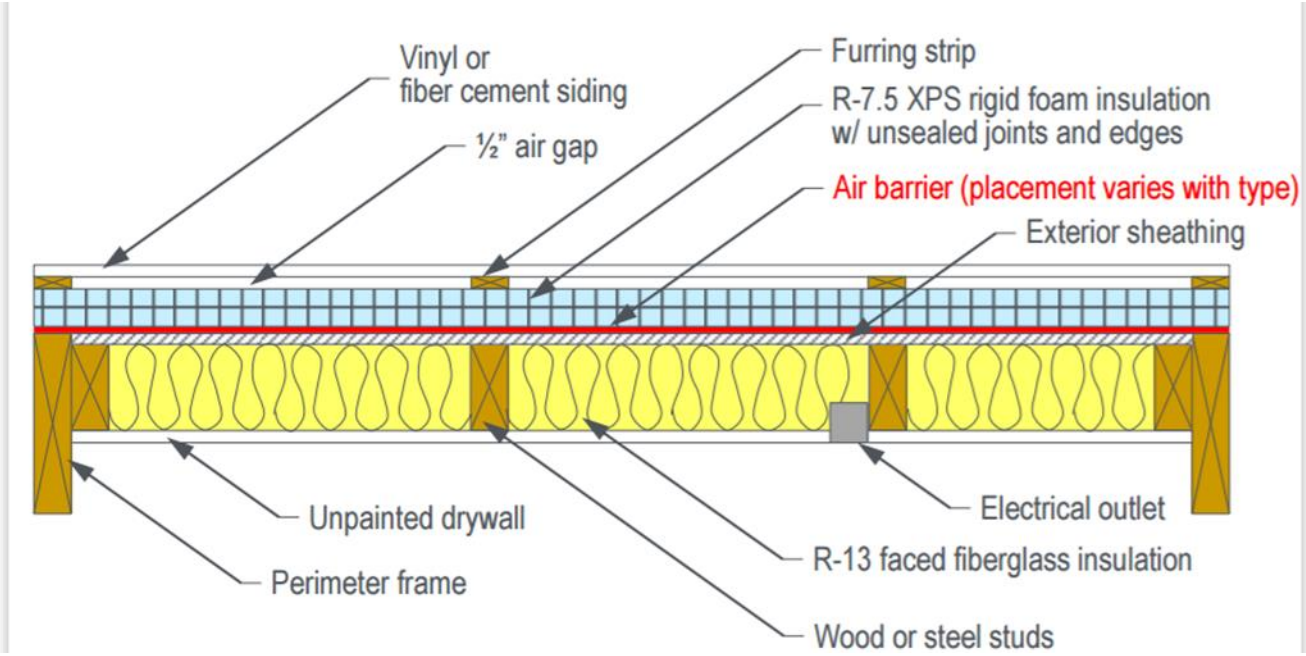
Loading dock weather seals

Vestibules and revolving doors

Air Leakage

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3	Supplemental OEESC form, Arch plans, specs

- Air Leakage compliance in 90.1-2019 consists of:
  - 3rd party whole-building air leakage testing and verification
  - Lab-verified component air-leakage rates

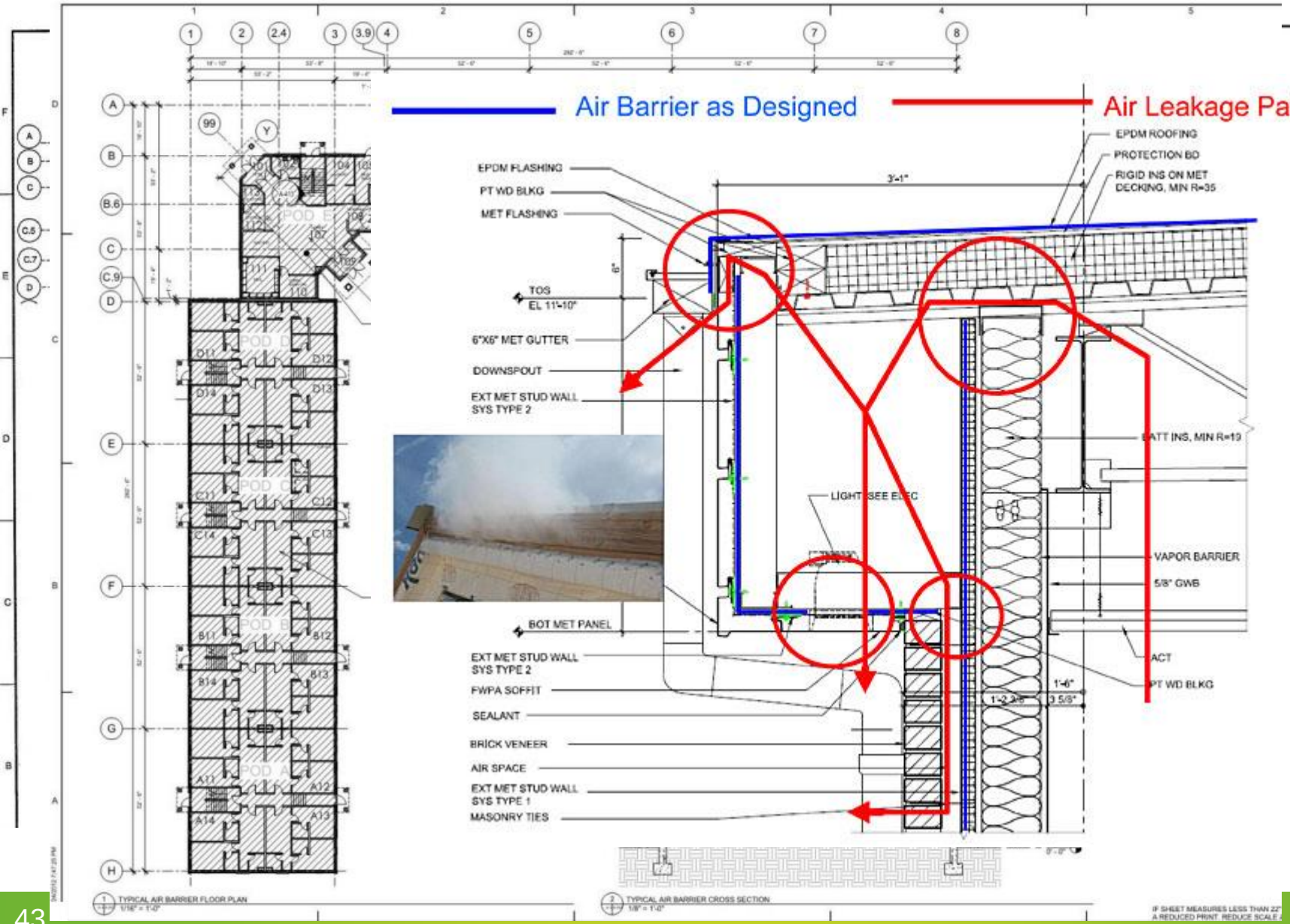


Whole Building Air-Leakage

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3.1.1	Supplemental OEESC form, Arch plans

- Continuous air barrier required in all buildings covered by the Standard except *Semiheated* spaces
  - Measured whole building air-leakage rate not to exceed 0.40 cfm/ft^2 (at a pressure differential of 0.3 in. of water)
- Exceptions
  1. Partial whole-building testing on buildings >50,000 ft^2
  2. Air leakage is > 0.40 cfm/ft^2 and < 0.60 cfm/ft^2 and a tracer gas test/thermal imaging is used to seal remaining leaks
  3. **Not required if meeting continuous air barrier design and installation verification program meeting requirements of 5.9.1.2**
- All components of the air barrier must be specifically identified on the construction plans and specifications, including details of sealing joints, interconnections, and sealing of penetrations.

Air Barrier Documentation



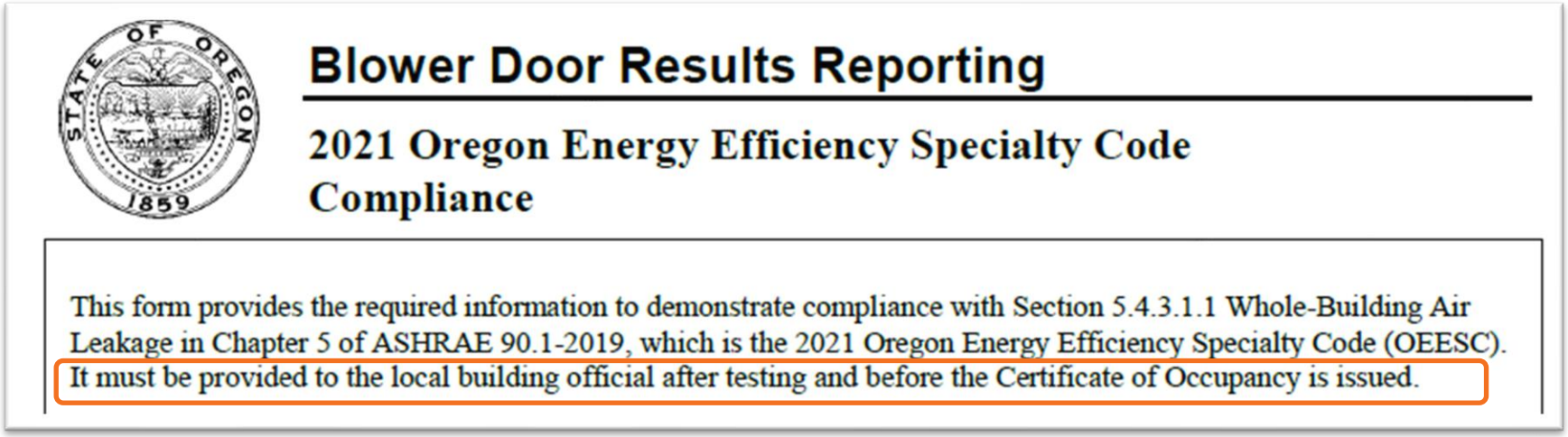
Verification of Air Barrier Design & Installation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.9.1.2	Supplemental OEESC form, Arch plans

- Verification of the design and installation of the *continuous air barrier* shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1:
  a. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2.
  b. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3.
  c. Reporting shall comply with Section 4.2.5.1.2.

OEESC Blower Door Form

- Remember this form provides info on compliance or which exception is being taken
- CofO hinges on this form being submitted



Blower Door Results Reporting

2021 Oregon Energy Efficiency Specialty Code Compliance

This form provides the required information to demonstrate compliance with Section 5.4.3.1.1 Whole-Building Air Leakage in Chapter 5 of ASHRAE 90.1-2019, which is the 2021 Oregon Energy Efficiency Specialty Code (OEESC). It must be provided to the local building official after testing and before the Certificate of Occupancy is issued.

- Verifiers cannot be designers or installers who were directly involved in the project

V&T providers shall be the owner's qualified employees, *commissioning providers*, *design professionals*, qualified designers, or qualified technicians experienced with verification or *FPT* of the designated systems. *V&T providers* shall not be individuals who performed design or installation of the *systems* or assemblies being verified or tested.

Blower Door Results Reporting

2021 Oregon Energy Efficiency Specialty Code Compliance

This form provides the required information to demonstrate compliance with Section 5.4.3.1.1 Whole-Building Air Leakage in Chapter 5 of ASHRAE 90.1-2019, which is the 2021 Oregon Energy Efficiency Specialty Code (OEESC). It must be provided to the local building official after testing and before the Certificate of Occupancy is issued.

Jurisdiction:

COMPANY INFORMATION

Company name:	CCB/EEAST no.:	
Address (Street or P.O. Box):	Phone:	
City:	State:	Zip:
Technician's name:	Email:	

PROJECT INFORMATION

Street address:	Permit no.:	
City:	State: **OR**	Zip:
Building use (from COM*check*):	Number of stories:	
Conditioned floor area (SF):	Conditioned volume (CF):	

5.4.3.1.1 Whole-building air leakage [a]

The measured air leakage rate of the *building envelope* shall not exceed 0.40 cfm/ft² under a pressure differential of 0.3 in. of water, with this air leakage rate normalized by the sum of the above-grade and below-grade *building envelope* areas of the *conditioned space* and *semiheated space*.

I hereby certify that the blower door test results are: _____ cfm/ft² and _____ CFM@75Pa and have been determined using standard industry protocol such as ASTM E779 or ASTM E1827.

☐ PASS
Less than or equal to 0.40 cfm/ft²

☐ FAIL
Greater than 0.40 cfm/ft² (See Exception #2 if less than 0.60 cfm/ft²)

Exception no. 1: Buildings with more than 50,000 ft² gross conditioned floor area

Air leakage testing shall be permitted to be conducted on less than the whole *building*, provided certain portions of the *building* are tested and their measured air leakage is area-weighted by the surface areas of the *building envelope*.[b]

I hereby certify that the area-weighted blower door test results are _____ cfm/ft² and _____ CFM@75Pa and have been determined using standard industry protocol such as ASTM E779 or ASTM E1827.

☐ PASS
Less than or equal to 0.40 cfm/ft²

☐ FAIL
Greater than 0.40 cfm/ft² (See Exception #2 if less than 0.60 cfm/ft²)

continued...

Exception no. 2: Measured air leakage rate exceeds 0.40 cfm/ft² but does not exceed 0.60 cfm/ft²

☐ I hereby certify that a smoke tracer or infrared imaging was conducted while the *building* was pressurized, and any leaks noted were sealed. Such sealing was made without destruction of existing building components.

☐ I hereby certify that a visual inspection of the air barrier was also conducted, and any leaks noted were sealed. Such sealing was made without destruction of *existing building* components.

An additional report identifying the corrective actions taken to seal leaks has been submitted with this form to the *code official* and the *building* owner.

Exception #3: Continuous air barrier design and installation in accordance with Section 5.9.1.2

Verification of the design and installation of the *continuous air barrier* shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1.

☐ A design review was conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2

☐ Periodic field inspection of the *continuous air barrier* materials and assemblies were conducted during *construction* while the *continuous air barrier* was still accessible for inspection and *repair*. This allowed for verification and documentation of compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3.

TECHNICIANS NAME & SIGNATURE

I hereby certify that all reporting complies with Section 4.2.5.1.2 FPT and Verification Documentation. The Functional Performance Testing (*FPT*) documentation includes the results of the *FPT* and verification, was provided to the owner, and shall be retained with the project records. If applicable, a plan for the completion of any deferred *FPT*, including climatic and other conditions required for performance of the deferred tests, is included in this submittal.

Technician (print name)	Signature	Test Date

[a] Where a *building* contains both *conditioned space* and *semiheated space*, compliance shall be shown

a. separately for the *conditioned space* and for the *semiheated space*, with the air leakage rate for the *conditioned space* normalized by the *exterior building envelope* area of the *conditioned space* and the air leakage rate for the *semiheated space* normalized by the *semiexterior building envelope* area of the *semiheated space*; or

b. for the *conditioned space* and for the *semiheated space* together, with the air leakage rate for the overall space normalized by the sum of the *exterior building envelope* area and the *semiexterior building envelope area* minus the *semiexterior building envelope* area that separates the *conditioned space* from the *semiheated space*.

[b] The following portions of the *building* are tested and their measured air leakage is area-weighted by the surface areas of the *building envelope*:

a. The entire *floor* area of all *stories* that have any *spaces* directly under a *roof*.

b. The entire *floor* area of all *stories* that have a *building entrance* or loading dock.

c. Representative *above-grade wall* sections of the *building* totaling at least 25% of the *wall* area enclosing the remaining *conditioned space*. Floor area tested per (a) and (b) shall not be included in the 25%.

Section completed & signed by testing technician

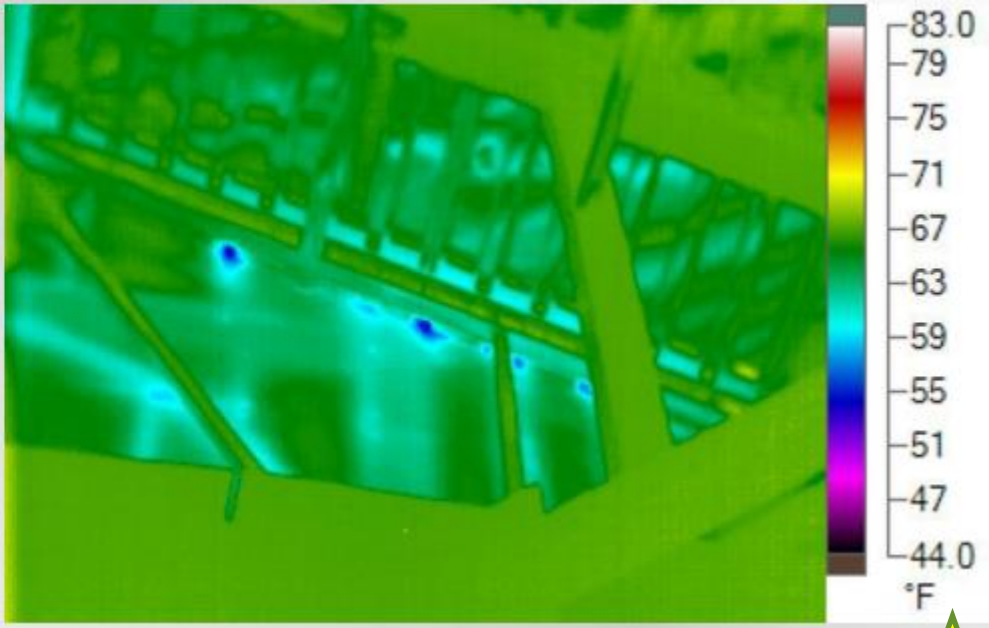
neea

Air Barrier inspections

- Pay special attention to joints and penetrations during installation
- To address this, 90.1 requires approved sealing, caulking, gasketing, or taping in the following locations:
  a) Joints around window and door frames
  b) Junctions between walls and foundations, between walls at building corners, between walls and structural floors or roofs, and between walls and roof or wall panels
  c) Openings at penetrations of utility services through roofs, walls, and floors
  d) Building assemblies used as ducts or plenums
  e) Joints, seams, connections between planes, and other changes in air barrier materials
- A quality air barrier system is largely achieved through careful construction practices and attention to detail.
- 90.1 also has requirements for limiting air leakage through mechanical air intakes and exhausts. These requirements are addressed in the mechanical section, not in the building envelope section

Air Barrier Examples

Preliminary Whole Building Testing with Thermal Imaging



Air Leakage of Components

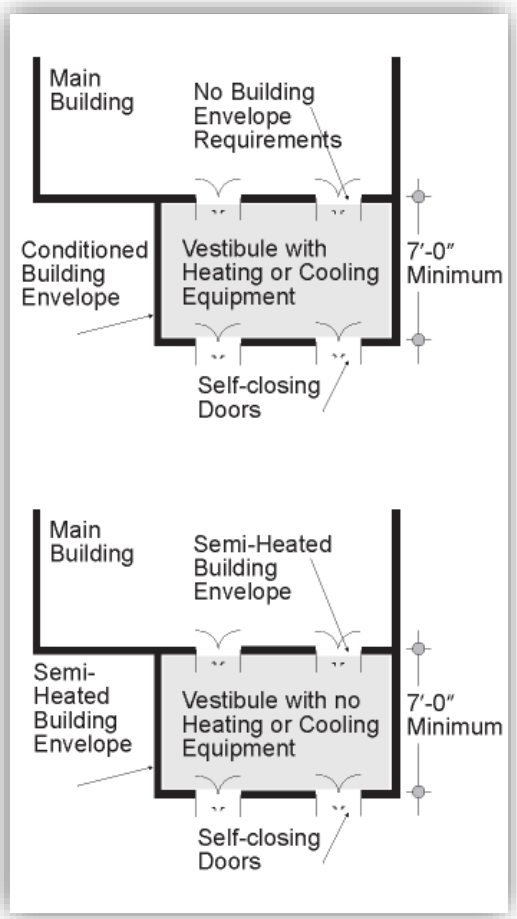
2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.8.3	Arch plans & specs

- Air leakage for materials & assemblies shall be determined by a laboratory accredited by a nationally recognized accreditation organization.
  - For doors/windows also labeled and certified by the manufacturer
  - Tables 5.8.3.1 and 5.8.3.2 list air leakage thresholds and test pressures
- **Exceptions:**
  1. *Field-fabricated fenestration* and *doors*.
  2. Metal coiling *doors* in *semiheated spaces* in Climate Zone 0 through 6 shall have an air leakage not exceeding 1.0 cfm/ft^2 when tested at a pressure of at least 1.57 psf in accordance with ANSI/DASMA 105, NFRC 400, or ASTM E283.
  3. Products in *buildings* that are tested and shown to comply with a whole-*building* air leakage in accordance with Section 5.4.3.1.1 without using Exception 3.

Vestibules

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3.3	COMcheck, Architectural dwgs

- **Vestibules must have**
  - Self-closing doors
  - Interior and exterior doors not necessary to open at the same time
  - Distance between interior and exterior doors not < 7 ft when in closed position
  - Floor area of each vestibule to not exceed the greater of 50 ft^2 or 2% of the gross conditioned floor area for that level of the building
  - Exterior envelope of conditioned vestibule comply with conditioned space requirements
  - Interior/exterior envelope of unconditioned vestibule comply with semiheated space requirements



Vestibules

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3.3	COMcheck, Architectural dwgs

- **Vestibules (or revolving doors) required for *building entrances***
  - Defined as means ordinarily used to gain access to building
- Vestibules are generally required in commercial spaces, but there are a number of exceptions:

Exceptions to 5.4.3.3

1. *Doors* not intended to be used as a *building entrance*.
2. *Doors* opening directly from a *dwelling unit*.
3. *Building entrances* in *buildings* located in Climate Zone 1 or 2.
4. *Doors* opening into *semiheated spaces*.
5. Enclosed elevator lobbies for *building entrances* directly from parking garages.
6. *Building entrances* in *buildings* that are located in Climate Zone 3, where the *building* is less than four stories above *grade* and less than 10,000 ft^2 in *gross conditioned floor area*.
7. *Building entrances* in *buildings* that are located in Climate *Zone* 0, 4, 5, 6, 7, or 8, where the *building* is less than 1,000 ft^2 in *gross conditioned floor area*.
8. *Doors* that open directly from a *space* that is less than 3,000 ft^2 in area and is separate from the *building entrance*.
9. Self-closing *doors* in *buildings* in Climate Zones 0, 3, and 4 that have an air curtain complying with Section 10.4.5.
10. Self-closing *doors* in *buildings* 15 stories or less in Climate Zones 5 through 8 that have an air curtain complying with Section 10.4.5.
11. Buildings under 25,000 ft^2 (2,322 m^2) meeting the requirements of Section 5.4.3.1.1 with a leakage rate less than 0.30 cfm/ft^2.

Vestibules for large spaces

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.4.3.4	COMcheck, Architectural dwgs

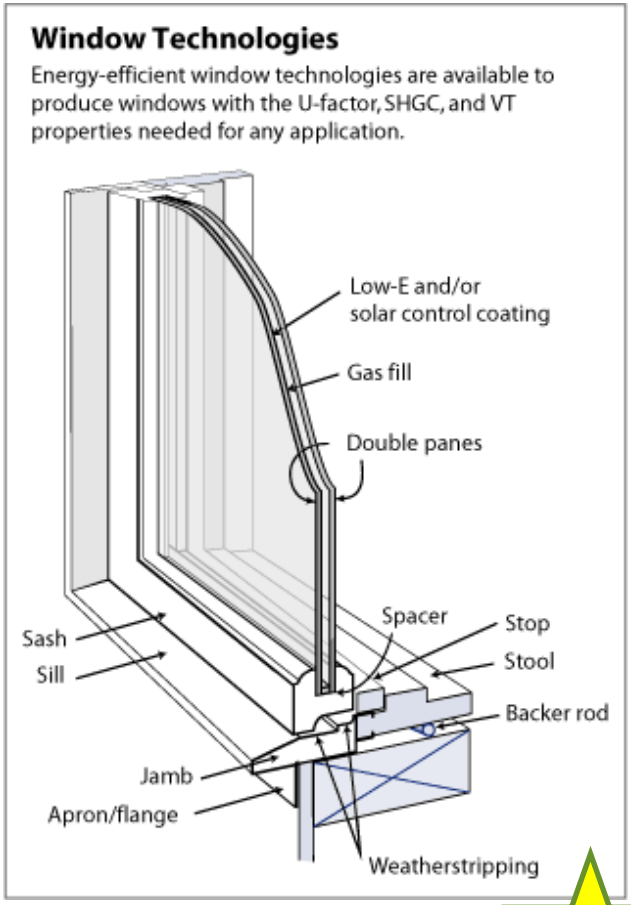
- Where Vestibules are required for:
  - *spaces* having a *gross conditioned floor area* for that level of the *building* of 40,000 ft^2 and greater (such as large retail),
  - and when the *doors* opening into and out of the vestibule are equipped with automatic, electrically driven, self-closing devices,
- the interior and exterior *doors* shall have a minimum distance between them of not less than 16 ft.

Opaque Assemblies & Fenestration

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Tables 5.5-4, 5.5-5	COMcheck, Architectural dwgs, specs

- 90.1-2019 includes a comprehensive update to the fenestration prescriptive requirements

Example	ASHRAE 90.1-2019	OEESC 2014	Reduction
Frame Wall	U-0.064	U-0.064	0.0%
Roof Deck	U-0.032	U-0.048	33.3%
Fixed Metal Windows	U-0.36	U-0.45	20.0%
SHGC	0.36	0.40	10.0%



Opaque Assemblies & Fenestration

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Tables 5.5-4, 5.5-5	COMcheck, Architectural dwgs, specs

- Fenestration is now based on type, not material

Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
Vertical Fenestration, 0% to 40% of *Wall*			
Fixed	0.36	0.36	1.10 (for all types)
Operable	0.45	0.33	
Entrance door	0.63	0.33	

Fenestration	Assembly Max. U	Assembly Max. *SHGC*
Vertical F 0% to 40		l frame
Nonmetal framing		0.45
Metal framin		
Metal fra	0.35	
Metal framing, entrance door	0.68	

Envelope & Fenestration Details

- COMcheck report lists proposed U-factors for envelope and fenestration components

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Floor - Level 1 Radiant: Heated Slab-On-Grade Fully Insulated (user specified perimeter R-value + R-5 under slab), [Bldg. Use 1 - School/University] (d)	68	---	20.0	0.602	0.843
Floor - Level 0: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	368	---	15.0	0.520	0.520
Floor - Level 1: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	308	---	15.0	0.520	0.520
Floor - Gym: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	288	---	15.0	0.520	0.520
Roof: Insulation Entirely Above Deck, [Bldg. Use 1 - School/University]	38868	---	30.0	0.032	0.032
NORTH					
Ext. Wall - Main Bldg North: Wood-Framed, 16in. o.c., [Bldg. Use 1 - School/University]	4436	21.0	8.6	0.038	0.064
Window - Storefront: Metal Frame: Fixed, Perf. Specs.: Product ID 451T Kawneer Storefront w/ SolarBan 70 Glass, SHGC 0.25, VT 0.55, [Bldg. Use 1 - School/University] (c)	442	---	---	0.360	0.380
Window - Fiberglass: Other Window: Fixed, Perf. Specs.: Product ID Cascadia Fiberglass with Cardinal 366CWL - K - 025, SHGC 0.27, VT 0.65, [Bldg. Use 1 - School/University] (c)	425	---	---	0.240	0.310
Ext. Wall - Gym North: Wood-Framed, 16in. o.c., [Bldg. Use 1 - School/University]	2187	21.0	8.6	0.038	0.064

Used for calcs, not code levels

Changes in Window-to-Wall Ratio (WWR)

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Tables 5.5-4, 5.5-5	COMcheck forms

- One large energy saver from 2014 OEESC was limiting WWR to 30%
- ASHRAE 90.1 allows up to 40% WWR for each space conditioning type in Climate Zones 4C & 5B

Table 5.5-4 *Building Envelope* Requirements for Climate Zone 4 (A,B,C)*

Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
Vertical Fenestration, 0% to 40% of *Wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	0.31	0.36	1.10	0.31	0.36	1.10	0.51	NR	NR
Metal framing, fixed	0.38			0.38			0.73		
Metal framing, operable	0.46			0.46			0.81		
Metal framing, entrance door	0.68			0.68			0.77		
Skylight, 0% to 3% of *Roof*									
All types	0.50	0.40	NR	0.50	0.40	NR	1.15	NR	NR

Minimum Skylight Fenestration Area

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.4.2, Tables 5.5-4, 5.5-5	COMcheck forms, Ltg. plans

- In any enclosed space in a building that is
  - 2500 ft^2 and greater;
  - directly under a roof with ceiling heights greater than 15 ft; and
  - one of the following space types: **office, lobby, atrium, concourse, corridor, storage (including nonrefrigerated warehouse), gymnasium, fitness/exercise area, playing area, gymnasium seating area, convention exhibit/event space, courtroom, automotive service, fire station engine room, manufacturing corridor/transition and bay areas, retail, library reading and stack areas, distribution/sorting area, transportation baggage and seating areas, or workshop,**
- the total daylight area under skylights shall be a minimum of half the floor area and either
  - provide a minimum skylight area to daylight area under skylights of 3% with a skylight VT of at least 0.40 or
  - provide a minimum skylight effective aperture of at least 1%.
- These skylights shall have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003. General lighting in the daylight area shall be controlled as described in Section 9.4.1.1(f).

Minimum Skylight Fenestration Area

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.4.2, Tables 5.5-4, 5.5-5	COMcheck forms

- Exceptions:
  - *Enclosed spaces* in Climate Zones 6 through 8
  - *Enclosed spaces* where it is documented that existing structures or natural objects block direct-beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.
  - Enclosed spaces where the daylight area under roof monitors is greater than 50% of the enclosed space floor area.
  - Enclosed spaces where it is documented that 90% of the skylight area is shaded on June 21 in the Northern Hemisphere (December 21 in the Southern Hemisphere) at noon by permanent architectural features of the building.
  - Enclosed spaces where the total area minus the primary sidelighted area and secondary sidelighted area is less than 2500 ft^2 and where the lighting is controlled according to sidelighting requirements described in Section 9.4.1.1(e).

Skylight Compliance Details

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
5.5.4.2.3 [PR7][2]	In buildings > 2,500 ft2, any enclosed spaces directly under a roof with ceiling heights > 15 ft. and used as an office, lobby, atrium, concourse, corridor, storage (including nonrefrigerated warehouse), gymnasium, fitness/exercise area, playing area, gymnasium seating area, convention exhibit/event space, courtroom, automotive service, fire station engine room, manufacturing corridor/transition and bay areas, retail, library reading and stack areas, distribution/sorting area, transportation baggage and seating areas, or workshop, the following requirements apply: The daylight zone under skylights is >= half the floor area and (a) the skylight area to daylight zone is >= 3 percent with a skylight VT >= 0.40 or (b) the minimum skylight effective aperture >= 1 percent. The skylights have a measured haze value > 90 percent.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met.

This could be a great area to describe/point to compliance details

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor[a]
Roof 1: Non-Wood Joist/Rafter/Truss, [Bldg. Use 1 - Office]	6112	40.0	0.0	0.033	0.021
Skylight 1: Metal Frame, Double Pane, Perf. Type: Energy code default, Triple Pane, Tinted , SHGC 0.42, VT 0.22, [Bldg. Use 1 - Office]	112	---	---	0.640	0.500
Floor 1: Slab-On-Grade:Unheated, Vertical 2 ft., [Bldg. Use 1 - Office] (b)	180	---	10.0	0.540	0.520

Overhang Adjustments

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.4.4	COMcheck forms

- 90.1 credits permanent overhangs by adjustment to SHGC
- Size of overhang is determined by projection factor

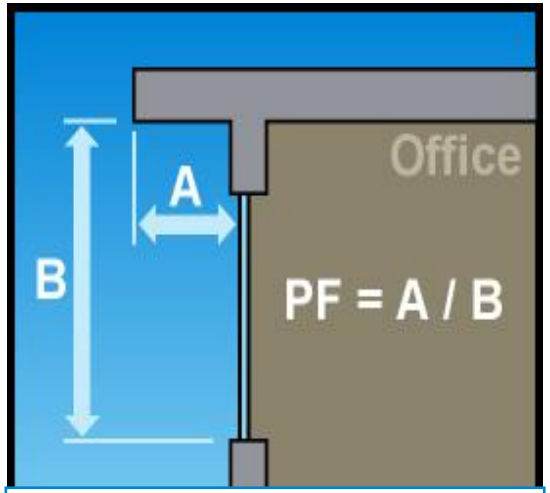


Table 5.5.4.4.1 *SHGC* Multipliers for Permanent Projections

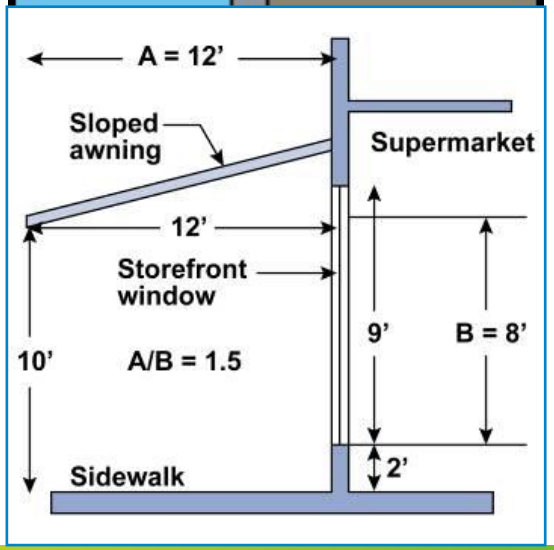
Projection Factor	*SHGC* Multiplier (South, East, and West Orientations)
0 to 0.10	1.00
>0.10 to 0.20	0.91
>0.20 to 0.30	0.82
>0.30 to 0.40	0.74
>0.40 to 0.50	0.67
>0.50 to 0.60	0.61
>0.60 to 0.70	0.56
>0.70 to 0.80	0.51
>0.80 to 0.90	0.47
>0.90 to 1.00	0.44

PF is a COMcheck entry

Projection Factor	
0.50	
0.00	

Window 2: Metal Frame, Double Pane, Perf. Type: Energy code default, Triple Pane, Clear , SHGC 0.60, VT 0.59, [Bldg. Use 1 - Office]

Window 3: Metal Frame:Fixed, Perf. Type: Energy code default, Single Pane, Clear , SHGC 0.82, PF 0.50, VT 0.76, [Bldg. Use 1 - Office]



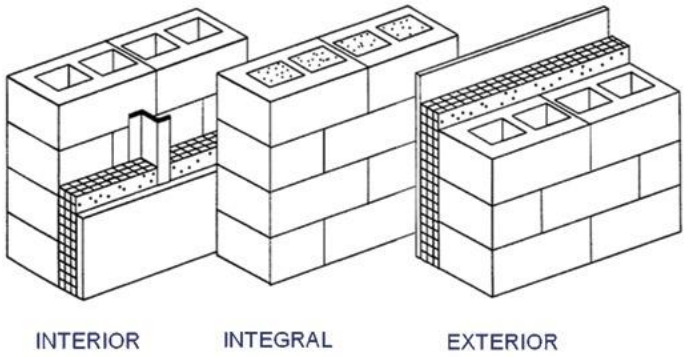
Mass Walls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.3.2, Tables 5.5-4, 5.5-5	COMcheck, Architectural dwgs, specs

- Exception in OEESC for above-grade mass walls (commonly single-wythe CMU) if they are mostly open and/or semiheated spaces
  - Ex. gymnasium, auditorium, arena, kennel, warehouse

	90.1 Climate Zone 4	*90.1 Climate Zone 4*	*OESSC 2014 (5B/4C)*
	Nonresidential	*Semiheated*	*Nonresidential*
***Opaque* Elements**	**Assembly Maximum**	**Assembly Maximum**	**Assembly Maximum**
Walls, above Grade			
Mass	U-0.104	U-0.580	U-0.150
Metal building	U-0.060	U-0.162	U-0.069
Steel-framed	U-0.064	U-0.124	U-0.064
Wood-framed and other	U-0.064	U-0.089	U-0.064

Semiheated space: an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft^2 of floor area but is not a conditioned space
Semiheated spaces are heated, but not to comfort levels, and not cooled



Mass Walls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.3.2, Tables 5.5-4, 5.5-5	COMcheck, Architectural dwgs, specs

Statewide Alternate Method
No. 21-02

Mass walls of insulated masonry units

BCD Building Codes Division
Department of Consumer and Business Services

Code/edition/section: 2021 Oregon Energy Efficiency Specialty Code (OEESC) / ASHRAE 90.1-2019

Date: Aug. 16, 2021

Subject: Alternate thermal compliance path for mass walls found in Statewide Alternate Method 19-01 and the 2018 Washington State Energy Code.

Table 5.5-4 *Building Envelope*
Requirements for Climate Zone 4 (A, B,C)

Opaque Elements	Assembly Maximum
Walls, above Grade	
Mass	U-0.104[b]

Table 5.5-5 *Building Envelope*
Requirements for Climate Zone 5 (A, B,C)

Opaque Elements	Assembly Maximum
Walls, above Grade	
Mass	U-0.090[c]

b. Exception: Integral insulated concrete block walls complying with ASTM C90 with all cores filled shall be considered compliant, when meeting both of the following:

1) at least 50% of cores shall be filled with vermiculite or equivalent fill insulation, and

2) the wall encloses the following building types: gymnasium, auditorium, church chapel, arena, kennel, manufacturing plant, indoor swimming pool, pump station, water and wastewater treatment station, storage facility, restroom and concessions, mechanical and electrical structures, storage areas, warehouse (storage and retail), and motor vehicle facility.

Insulation Installation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.3.1, 5.8.1	COMcheck, Architectural dwgs, specs

- Rated R-value clearly identified by an identification mark applied by manufacturer to each piece of building envelope insulation
  - Exception - provide documentation
- Installed per manufacturer's instructions & best practices
  - Ex. staggered rigid insulation joints, protected from exterior elements
- Achieve rated R-value
  - Metal buildings exception if roof and wall insulation is compressed between roof or wall skin and the structure
- No open-blown or poured loose-fill insulation when ceiling slope is > 3/12
  Insulation materials in ground contact shall have a water absorption rate no greater than 0.3% when tested in accordance with ASTM C272
- If eave vents installed:
  - Provide baffling of air vents to deflect incoming air above the surface of the insulation

Slab-On-Grade Floor Insulation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
5.5.3.5	COMcheck, Architectural dwgs, specs

- Insulation to be installed around the perimeter of the slab-on-grade floor to the distance specified according to Tables 5.5-4 or 5.5-5
  - Heated slabs have HW pipes or heating coils embedded in them, unheated do not
  - Insulation is required for unheated slabs in OR climate zones (except in semiheated buildings)
- If a design can't comply with prescriptive option for this, can always use envelope trade-off option

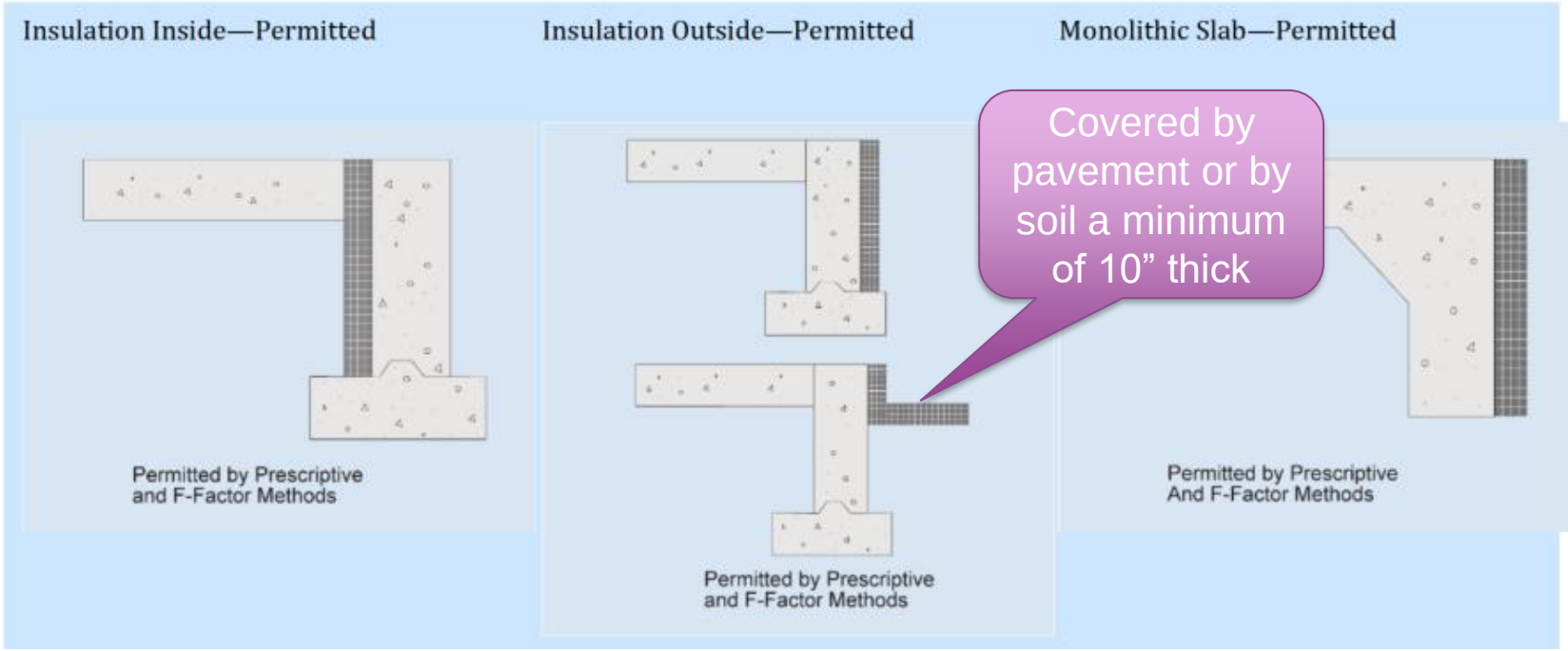
Slab-on-Grade Insulation Comparison

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Tables 5.5-4, 5.5-5	COMcheck, Architectural dwgs, specs

	OEESC-2014	90.1-2019		90.1-2019	
	CZ 5 & Marine 4	CZ 4 (non-res)	CZ 5 (non-res)	CZ 4 (semiheated)	CZ 5 (semiheated)
Insulation					
Unheated Slabs	NR	R-15 for 24" below	R-15 for 24" below	NR	NR
Heated Slabs	R-15 for 24" below	R-20 for 24" below	R-20 for 48" below	R-10 for 24" below	R-10 for 24" below
Assembly Maximum					
Unheated Slabs	F-0.730	F-0.520	F-0.520	F-0.730	F-0.730
Heated Slabs	F-0.860	F-0.843	F-0.688	F-0.900	F-0.900

- Requires insulation for both heated and un-heated slabs for non-residential buildings
- Increase in insulation R-value (and/or depth) for heated slabs compared to OEESC 2014 & 90.1-2016
- Tables give both R-value of insulation and depth.
  - Ex. R-20 for 48” means that insulation with a thermal resistance of 20 must be installed and that the insulation must extend a distance of 48” starting from the top surface of the slab

Slab-On Grade Floor Insulation

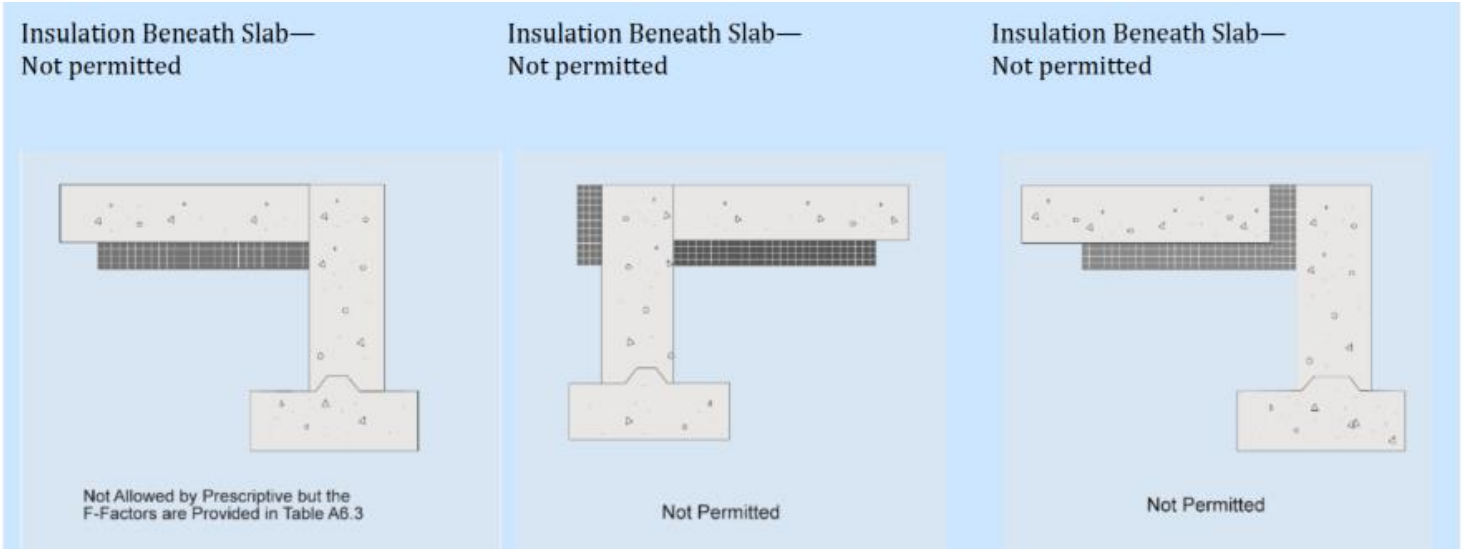


Inside foundation wall extend downward from top of slab a minimum distance specified or to the top of the footing, whichever is less

Outside foundation wall extend from top of the slab or downward to at least the bottom of the slab and then horizontally to a minimum distance specified

Exception: monolithic slab-on-grade floor, insulation to extend from the top of the slab-on-grade to the bottom of the footing

Not Allowed: Slab-On Grade Floor Insulation



Does not thermally isolate edge of the floor from outside temps. Heat flows directly through edge of slab and insulation provides very little benefit. Very unlikely to achieve code prescriptive F-factor

Adding a little vertical insulation helps decrease the edge heat transfer, but still major thermal bridge between interior and exterior insulation. Still unlikely to achieve code prescriptive F-factor

This solves it! But too bad, it routinely gets overlooked in the field so not allowed in prescriptive path

Note: in some situations, horizontal insulation *may* help achieve code prescriptive F-factors. Consult ASHRAE 90.1 Appendix A Table A6.3.1-1 for F-factor table of various assemblies

COMcheck vs. Plans Example

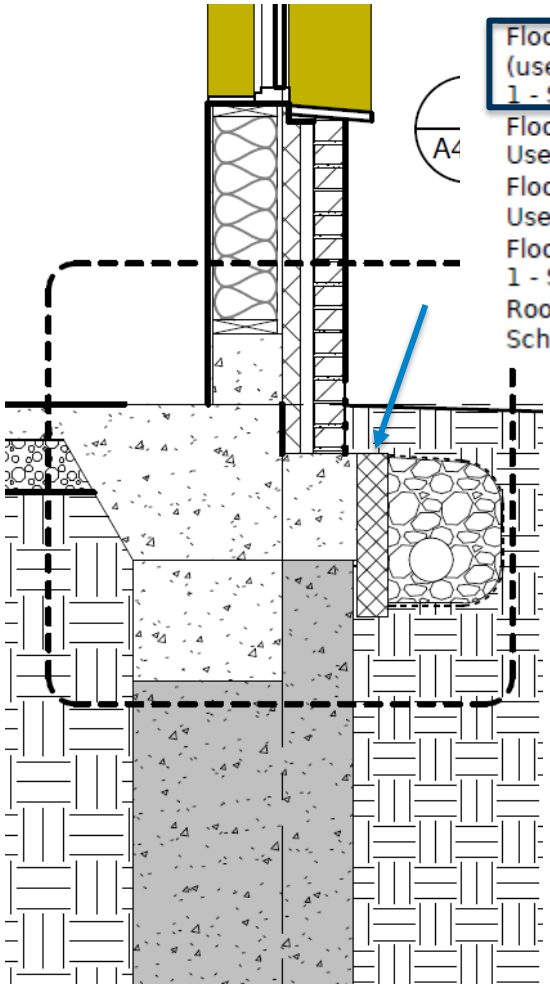
- The envelope components meet code or slightly exceed it for CZ4:
  - Heat Slab: R-20
  - Roof: R-30
  - Walls: R-20 or R-13 +3.8ci
  - Fixed Windows: U-0.36
  - Better Windows: U-0.24
- **REMINDER:** these indicate the values entered into COMcheck comply, not necessarily what is on plans/specs

Envelope Assemblies

Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor
Floor - Level 1 Radiant: Heated Slab-On-Grade Fully Insulated (user specified perimeter R-value + R-5 under slab), [Bldg. Use 1 - School/University] (d)	68	---	20.0	0.602
Floor - Level 0: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	368	---	15.0	0.520
Floor - Level 1: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	308	---	15.0	0.520
Floor - Gym: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	288	---	15.0	0.520
Roof: Insulation Entirely Above Deck, [Bldg. Use 1 - School/University]	38868	---	30.0	0.032
NORTH				
Ext. Wall - Main Bldg North: Wood-Framed, 16in. o.c., [Bldg. Use 1 - School/University]	4436	21.0	8.6	0.038
Window - Storefront: Metal Frame: Fixed, Perf. Specs.: Product ID 451T Kawneer Storefront w/ SolarBan 70 Glass, SHGC 0.25, VT 0.55, [Bldg. Use 1 - School/University] (c)	442	---	---	0.360
Window - Fiberglass: Other Window: Fixed, Perf. Specs.: Product ID Cascadia Fiberglass with Cardinal 366CWL - K - 025, SHGC 0.27, VT 0.65, [Bldg. Use 1 - School/University] (c)	425	---	---	0.240
Ext. Wall - Gym North: Wood-Framed, 16in. o.c., [Bldg. Use 1 - School/University]	2187	21.0	8.6	0.038
Window - Storefront: Metal Frame: Fixed, Perf. Specs.: Product ID 451T Kawneer Storefront w/ SolarBan 70 Glass, SHGC 0.25, VT 0.55, [Bldg. Use 1 - School/University] (c)	102	---	---	0.360
EAST				
Ext. Wall - Main Bldg East: Wood-Framed, 16in. o.c., [Bldg. Use 1 - School/University]	6422	21.0	8.6	0.038
Window - Storefront: Metal Frame: Fixed, Perf. Specs.: Product ID 451T Kawneer Storefront w/ SolarBan 70 Glass, SHGC 0.25, VT 0.55, [Bldg. Use 1 - School/University] (c)	178	---	---	0.360

Envelope PASSES: Design 1% better than code

COMcheck vs. Plans Example



Assembly	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor
Floor - Level 1 Radiant: Heated Slab-On-Grade Fully Insulated (user specified perimeter R-value + R-5 under slab), [Bldg. Use 1 - School/University] (d)	68	---	20.0	0.602
Floor - Level 0: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	368	---	15.0	0.520
Floor - Level 1: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	308	---	15.0	0.520
Floor - Gym: Unheated Slab-On-Grade, Vertical 2 ft., [Bldg. Use 1 - School/University] (d)	288	---	15.0	0.520
Roof: Insulation Entirely Above Deck, [Bldg. Use 1 - School/University]	38868	---	30.0	0.032

insulation details

Problem: Sheet A4.30 & A0.60 don't exist (or at least weren't submitted for permit set)

Problem: Appears insulation only extends a short distance below slab top (needs 24" min)

Specs may call out material, but still needs to be installed correctly in the field

HVAC

New Oregon-specific amendments

- ANSI/ASHRAE Standard 90.4-2019, Energy Standard for Data Centers
- Radiant spot heating

Section 6.5.8.3 Radiant Heating for Enclosed Unconditioned Spaces

Overhead radiant heating systems shall be allowed in *unconditioned spaces* for spot heating of occupied areas. Spot heating shall be limited to 500 ft^2 (46 m^2) or 10 percent of the space floor area, whichever is greater. Control shall be automatic complying with either Section 6.4.3.3.1 (b) or 6.4.3.3.1 (c).

- Packaged HVAC equipment with electric heat

b. Section 6.4.3.5.1 Packaged HVAC Equipment with Electric Heat

HVAC equipment for new buildings with a cooling capacity less than 241,000 Btu/h from Table 6.8.1-1 shall not have electric supplemental heat exceeding 21,500 Btu/h (6 kW). Equipment shall have heat pump operation for the first stage of heating and shall be selected from Table 6.8.1-2.

How about Replacements?

Section 6.1.1.3.1

- Direct replacement equipment now needs to meet many of the requirements formerly for new equipment only. For example:
  - Various controls requirements
  - Economizer requirements
  - Fan efficiency
  - Boiler turndown

Full list of requirements

- 6.3, “Simplified Approach Option for HVAC Systems”
- 6.4.1, “Equipment Efficiencies, Verification, and Labeling Requirements”
- 6.4.3.1, “Zone Thermostatic Controls”
- 6.4.3.2, “Set-Point Overlap Restrictions”
- 6.4.3.3, “Off-Hour Controls” except for Section 6.4.3.3.4, “Zone Isolation”
- 6.4.3.4, “Ventilation System Controls”
- 6.4.3.7, “Freeze Protection and Snow/Ice Melting Systems”
- 6.4.3.8, “Ventilation Controls for High-Occupancy Areas” only for single-zone equipment
- 6.4.3.9, “Heated or Cooled Vestibules”
- 6.4.5, “Walk-In Coolers and Walk-In Freezers”
- 6.5.1.1, “Air Economizers” for units located outdoors
- 6.5.1.3, “Integrated Economizer Control”
- 6.5.1.4, “Economizer Heating System Impact”
- 6.5.3.1.3, “Fan Efficiency”
- 6.5.3.2.1, “Supply Fan Airflow Control”
- 6.5.3.6, “Fractional Horsepower Fan Motors”
- 6.5.4.1, “Boiler Turndown”
- 6.5.4.3, “Chiller and Boiler Isolation”
- 6.5.5.2, “Fan Speed Control

HVAC Replacement Exceptions

- When equipment is **repaired but not replaced**. The equipment being repaired does not have to meet the standard's minimum efficiencies; however, the modifications may not increase the equipment's energy use. For instance, if a condenser coil is replaced, the new coil must have an equal or better heat transfer performance than the coil being replaced.
- When the replacement of existing equipment with complying equipment **requires extensive revisions to other systems, equipment, or elements of the building, and where the replacement equipment is a like-for-like replacement**.
- When the **refrigerant in existing equipment is changed** but cannot be replaced with the same refrigerant due to the phase-out of the existing refrigerant. This may reduce the efficiency of the existing equipment but is allowed.
- When **existing equipment is relocated**. For instance, the standard does not apply when an existing hydronic heat pump is moved to another location within the building.
- When **ducts and pipes are located in existing spaces with insufficient space for the code-required insulation**. For example, if the piping in an existing chase needs to be replaced and there is not sufficient space for the new code-required insulation, the piping may be installed with thinner insulation.

Compliance Paths

- ASHRAE 90.1 now includes 90.4 as an alternate compliance path for Data Centers
- Oregon expanded exceptions for Data Centers to require them to comply with ASHRAE 90.4 under these conditions:
  1. *Data Centers* in new buildings shall comply with ASHRAE Standard 90.4 for the HVAC Systems serving the heating, cooling or ventilating needs of the data center.
  2. New HVAC systems added to existing buildings serving only the heating, cooling or ventilating needs of a *data center* shall meet the requirements of ASHRAE Standard 90.4 in accordance with Section 6.5.12.

HVAC Compliance Pathways

HVAC Section 6: 6.1 General, 6.7 Submittals, 6.8 Equipment Efficiency Tables

6.3 Simplified Building Approach

OR

6.4 Mandatory Requirements

Plus One

6.5 Prescriptive Requirements

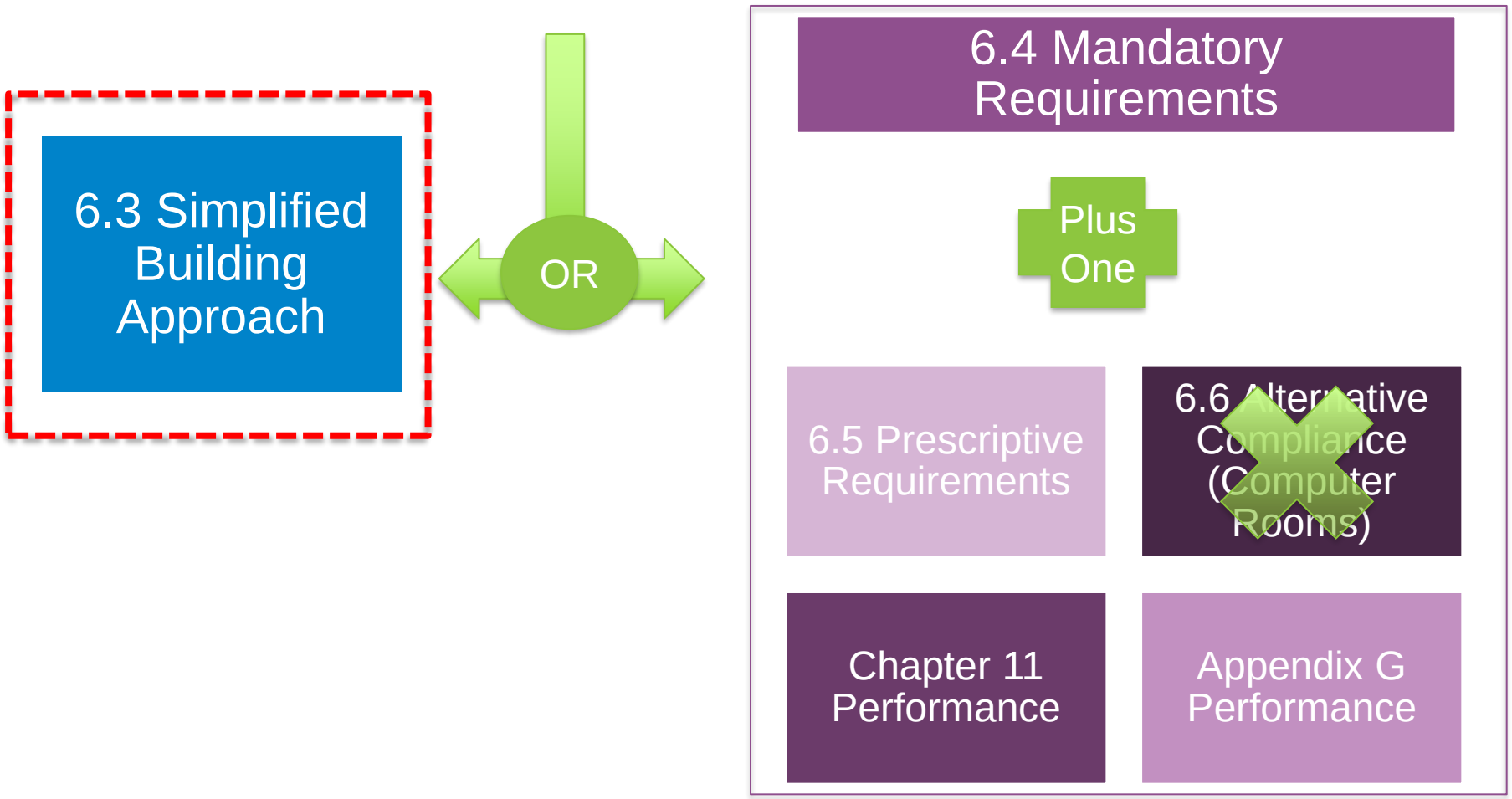
6.6 Alternative Compliance (Computer Rooms)

Chapter 11 Performance

Appendix G Performance

HVAC Compliance Pathways

HVAC Section 6: 6.1 General, 6.7 Submittals, 6.8 Equipment Efficiency Tables



6.3 Simplified Path

- Available if systems and **building meet certain criteria**
  - 2 stories or fewer
  - Floor area < 25,000 ft^2
  - Each HVAC system complies with a list of requirements in 6.3.2 (ALL must be met)

- The **HVAC system must meet the following requirements:**
  - Single zone HVAC
  - Cooling and heating with unitary packaged or split system that meets efficiency tables
  - Supply fan variable flow if >65,000 Btu/h
  - Economizer if >54,000 Btu/h
  - Electric resistance heat limitations for heat pumps
  - Piping and ductwork insulation in accordance with other sections
  - Exhaust air energy recovery in accordance with other sections
  - Manual changeover or dual set-point thermostat
  - No reheat/simultaneous heating and cooling
  - >10,000 CFM requires optimum start controls
  - Plus additional requirements….

Simplified Approach Example

Office Building Example

- 2-story structure
- 10,000 ft^2 designated as office space
- Served by single-zone RTUs, between 54 - 65,000 Btu/h each, equipped with economizers and meeting federal minimum standards

Does this building meet the requirements for a simplified building approach?

6.3 Simplified Path

- Available if systems and **building meet certain criteria**
  - 2 stories or fewer
  - Floor area < 25,000 ft^2
  - Each HVAC system complies with a list of requirements in 6.3.2 (ALL must be met)
  - The COMcheck Inspection Checklist for Mechanical is not required to be submitted

- The **HVAC system must meet the following requirements:**
  - Single zone HVAC
  - Cooling and heating with unitary packaged or split system that meets efficiency tables
  - Supply fan variable flow if >65,000 Btu/h
  - Economizer if >54,000 Btu/h
  - Electric resistance heat limitations for heat pumps
  - Piping and ductwork insulation in accordance with other sections
  - Exhaust air energy recovery in accordance with other sections
  - Manual changeover or dual set-point thermostat
  - No reheat/simultaneous heating and cooling
  - >10,000 CFM requires optimum start controls
  - Plus additional requirements….

Form – Simplified Building Method - Mechanical

Simplified Building Method—Mechanical

2021 Oregon Energy Efficiency Specialty Code Compliance Checklist

This checklist may be used to demonstrate compliance with Section 6.3 Simplified Approach Building Compliance Path for HVAC Systems of the Oregon Energy Efficiency Specialty Code (OEESC)/ASHRAE Standard 90.1.

Base Requirements:

1. The gross floor area of the building is less than 25,000 ft².
2. The building is two stories or fewer in height
3. The HVAC system(s) meets the applicable criteria in Section 6.3.2
4. The COMcheck Inspection Checklist for Mechanical is not required to be submitted

PART I – PROJECT INFORMATION

Title/Site/Permit name: ABC Building

Gross Floor Area: 10,000 | Number of Stories: 2

PART II – COMPLIANCE

HVAC System Criteria from Section 6.3.2. Parts a. thru s. Indicate whether the individual criteria is met. Include location on plans and specs, or whether the criteria are not applicable to the submitted project.

Section 6.3 Criteria	(Check **N/A** if not applicable)
☑ Each HVAC system serves a single HVAC zone.	☐ N/A
☑ The equipment meets the variable flow requirements of Section 6.5.3.2.1.	☐ N/A
☑ Cooling (if any) is provided by a unitary packaged or split-system air conditioner that is either air cooled or evaporatively cooled, with efficiency meeting the requirements shown in Table 6.8.1-1 (air conditioners), Table 6.8.1-2 (heat pumps), or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps) for the applicable equipment category. Section 6.4.3.5.1 of the 2021 OEESC shall be applied to packaged equipment selections under 241,000 Btu/h.	☐ N/A
☑ The system has an air economizer meeting the requirements of Sections 6.5.1 and 6.4.3.12.	☐ N/A
☑ Heating (if any) is provided by a unitary packaged or split-system heat pump that meets the applicable efficiency requirements shown in Table 6.8.1-2 (heat pumps) or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps), a fuel fired furnace that meets the applicable efficiency requirements shown in Table 6.8.1-5 (furnaces, duct furnaces, and unit heaters), an electric resistance heater, or a baseboard system connected to a boiler that meets the applicable efficiency requirements shown in Table 6.8.1-6 (boilers).	☐ N/A
☐ The system meets the exhaust air energy recovery requirements of Section 6.5.6.1.	☑ N/A
☑ The system is controlled by a manual changeover or dual set-point thermostat.	☐ N/A
☑ The system controls do not permit reheat or any other form of simultaneous heating and cooling for humidity	☐ N/A

Supplemental OEESC form

Simplified Building Method—Mechanical

2021 Oregon Energy Efficiency Specialty Code Compliance Checklist

This checklist may be used to demonstrate compliance with Section 6.3 Simplified Approach Building Compliance Path for HVAC Systems of the Oregon Energy Efficiency Specialty Code (OEESC)/ASHRAE Standard 90.1.

Base Requirements:
1. The gross floor area of the building is less than 25,000 ft^2.
2. The building is two stories or fewer in height
3. The HVAC system(s) meets the applicable criteria in Section 6.3.2
4. The COMcheck Inspection Checklist for Mechanical is not required to be submitted

PART I – PROJECT INFORMATION

Title/Site/Permit name:

Gross Floor Area: | Number of Stories:

PART II – COMPLIANCE

HVAC System Criteria from Section 6.3.2. Parts a. thru s. Indicate whether the individual criteria is met. Include location on plans and specs, or whether the criteria are not applicable to the submitted project.

Section 6.3 Criteria	(Check N/A if not applicable)
☐ Each HVAC system serves a single HVAC zone.	☐ N/A
☐ The equipment meets the variable flow requirements of Section 6.5.3.2.1.	☐ N/A
☐ Cooling (if any) is provided by a unitary packaged or split-system air conditioner that is either air cooled or evaporatively cooled, with efficiency meeting the requirements shown in Table 6.8.1-1 (air conditioners), Table 6.8.1-2 (heat pumps), or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps) for the applicable equipment category. Section 6.4.3.5.1 of the 2021 OEESC shall be applied to packaged equipment selections under 241,000 Btu/h.	☐ N/A
☐ The system has an air economizer meeting the requirements of Sections 6.5.1 and 6.4.3.12.	☐ N/A
☐ Heating (if any) is provided by a unitary packaged or split-system heat pump that meets the applicable efficiency requirements shown in Table 6.8.1-2 (heat pumps) or Table 6.8.1-4 (packaged terminal and room air conditioners and heat pumps), a fuel fired furnace that meets the applicable efficiency requirements shown in Table 6.8.1-5 (furnaces, duct furnaces, and unit heaters), an electric resistance heater, or a baseboard system connected to a boiler that meets the applicable efficiency requirements shown in Table 6.8.1-6 (boilers).	☐ N/A
☐ The system meets the exhaust air energy recovery requirements of Section 6.5.6.1.	☐ N/A
☐ The system is controlled by a manual changeover or dual set-point thermostat.	☐ N/A
☐ The system controls do not permit reheat or any other form of simultaneous heating and cooling for humidity control.	☐ N/A
☐ Systems serving spaces other than hotel/motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than 0.75 hp, are provided with a time clock that: (1) can start and stop the system under different schedules for seven different day types per week (2) is capable of retaining programming and time setting during a loss of power for a period of at least ten hours (3) includes an accessible manual override that allows temporary operation of the system for up to two hours (4) is capable of and configured with temperature setback down to 55°F during off hours, and (5) is capable of capable of and configured with temperature setup to 90°F during off hours.	☐ N/A

- Supplemental form has all required checks on it
- No need for COMcheck form
- Similarly, form requires designer to submit but needs to be reconciled with plans & specs
  - Bldg <25,000 ft^2
  - HVAC serves single zone
  - HVAC efficiencies meet requirements
  - Energy recovery
  - Insulation requirements
  - Controls requirements

HVAC Compliance Pathways

HVAC Section 6: 6.1 General, 6.7 Submittals, 6.8 Equipment Efficiency Tables

6.3 Simplified Building Approach

OR

6.4 Mandatory Requirements

Plus One

6.5 Prescriptive Requirements

6.6 Alternative Compliance (Computer Rooms)

Chapter 11 Performance

Appendix G Performance

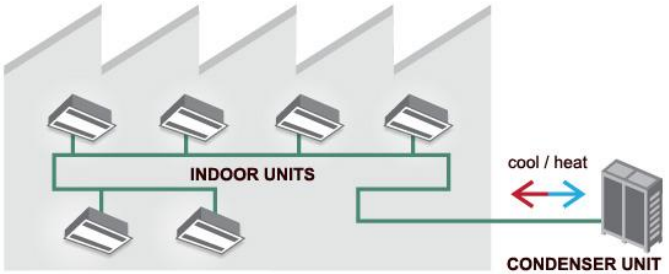
6.4 Mandatory Requirements – Equipment Efficiencies

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.1, Tables 6.8.1-x	Mech. schedules, specs

Updated equipment efficiencies (Tables 6.8.1-1 through -16)

- Generally equivalent to federal minimums
- Increased efficiency for some packaged RTUs, ground loop ACs, SPVAC/HPs, heat rejection equipment, VRF, boilers
- New requirements for: computer room air conditioners, DOAS units

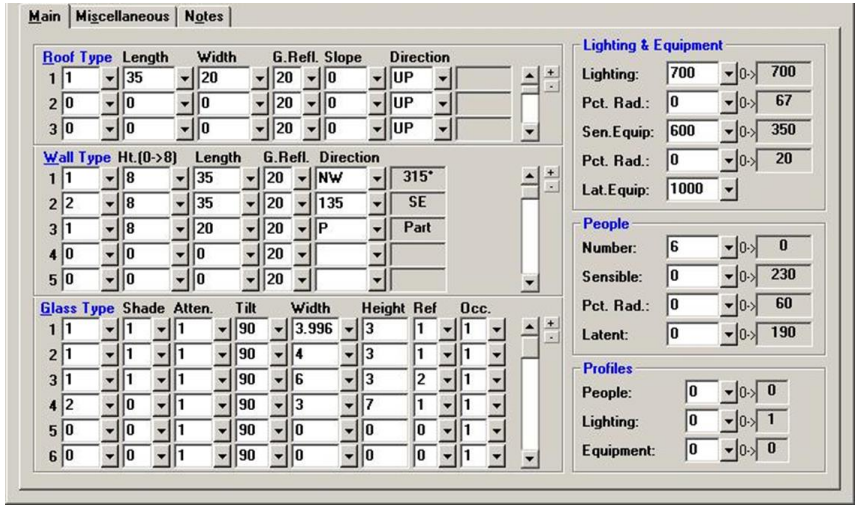
- Previous OEESC was mostly from 90.1-2013



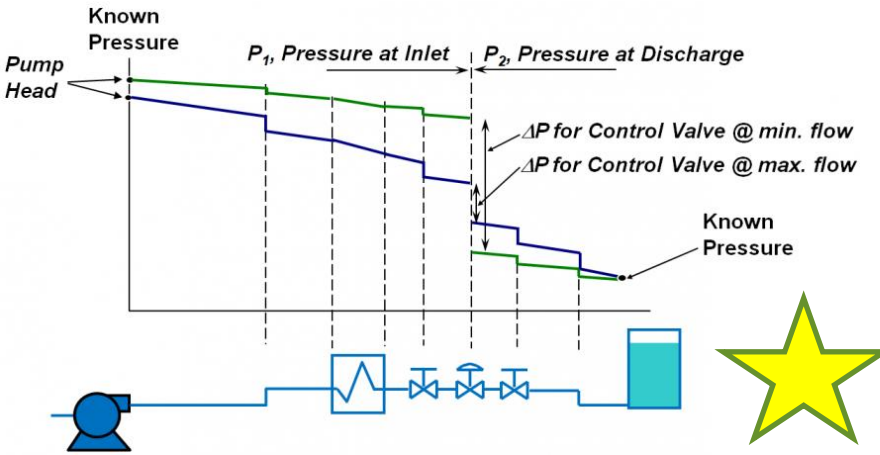
6.4 Mandatory Requirements – Load Calculations

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.2	Supplemental calcs

- Similar requirement for calculation of heating and cooling loads for the purpose of sizing systems and equipment to be done in accordance with ANSI/ASHRAE/ACCA Standard 183



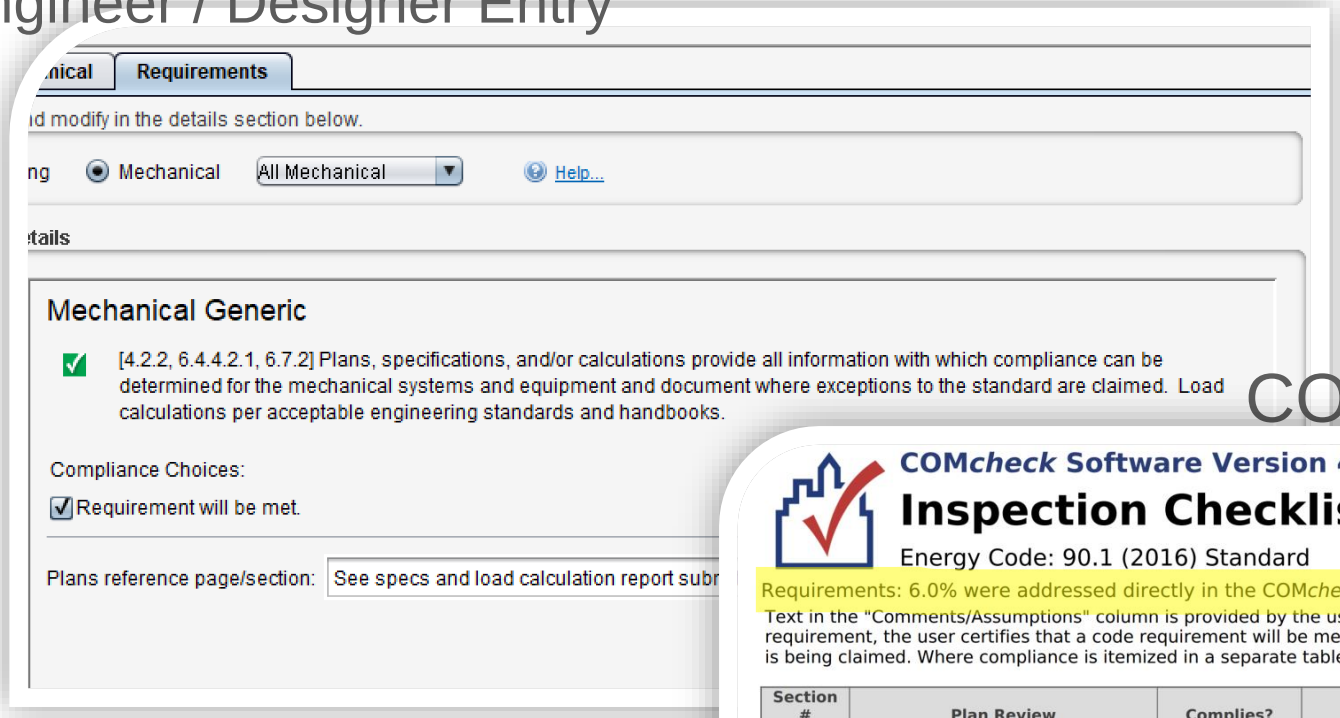
- General requirement for pump differential pressure (head) to be determined in accordance with generally accepted engineering standards. Calculate drop at each device in critical circuit.



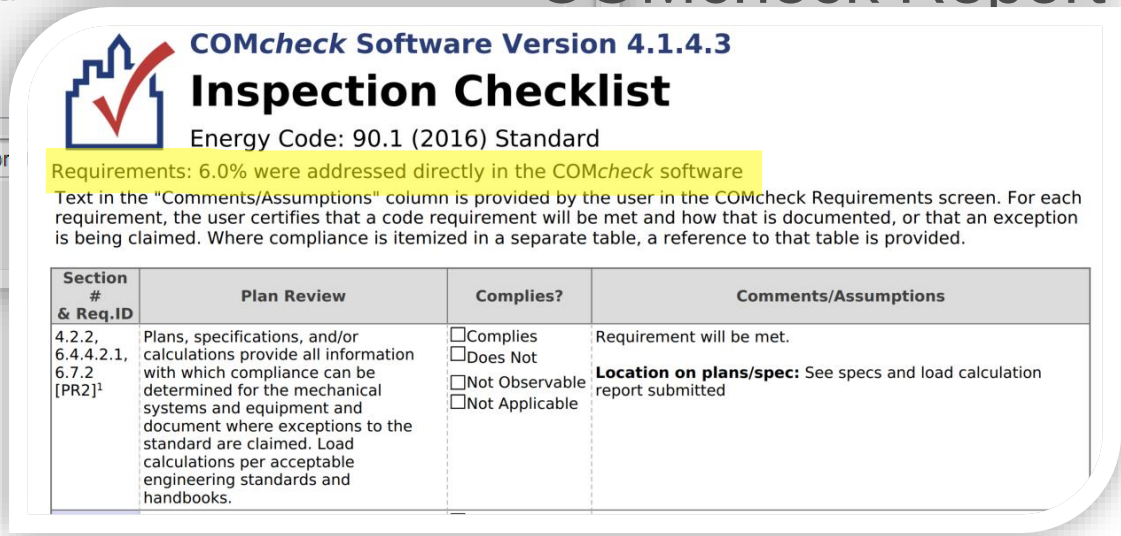
6.4 Mandatory Requirements – Load Calculations

COMcheck reference example

Engineer / Designer Entry



COMcheck Report



6.4 Mandatory Requirements – Dead Band/Setpoint Overlap Restriction

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.2, 6.4.3.1.2	Mech plans, Seq. of Ops, specs., Cx plan

- Similar requirements
- Where used to control both heating and cooling, zone thermostatic controls shall be ***capable and configured to*** a 5°F deadband
- Where heating and cooling are controlled by separate zone thermostatic controls, provide means to prevent heating setpoint from exceeding the cooling setpoint

"Capable and configured to" change throughout the code

COMcheck report reference:

Section # & Req.ID	Final Inspection	Complies?	Comments/Assumptions
6.4.3.1.2 [FI3][3]	Thermostatic controls have a 5 °F deadband.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** see specs section XX.YYY and Sheet M.Z

6.4 Mandatory Requirements – Off Hour Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.3	Mech plans, Seq. of Ops, specs., Cx plan

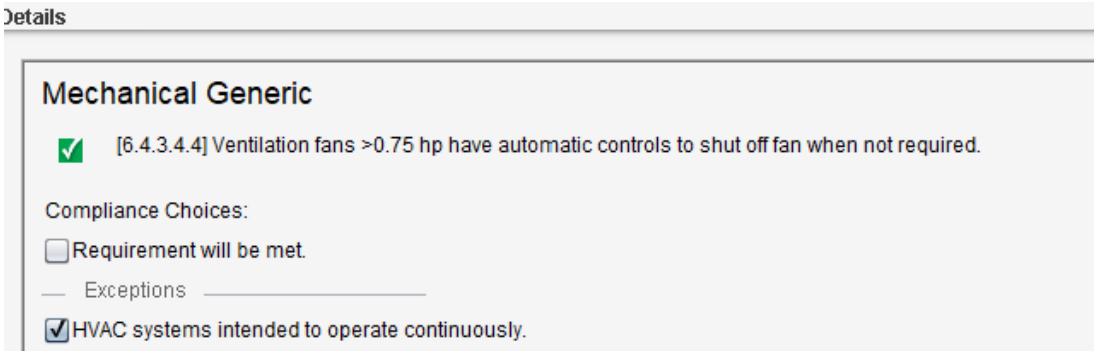
- Automatic Shutdown
  - Time schedule controls (7 day) **OR** occupant sensor **OR** timer (up to 2 hours) **OR** security system interlock
- Setback controls
  - **2014 OEESC**: specified setback capabilities down to 55°F (heating) or up to 85°F (cooling)
  - **90.1-2019**: capable and configured to 10°F below heating setpoint and 5°F above cooling setpoint (or to prevent high humidity levels)
- Optimum start controls
  - **2014 OEESC**: general requirement for optimum start
  - **90.1-2019**: systems with setback controls and DDC shall have optimum start.
    - » **Requires algorithm to be a function of difference between space T, occupied setpoint, OAT, and time until occupancy**
- Zone Isolation – similar requirements, some new exception language

6.4 Mandatory Requirements – Ventilation Fan Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.4.4	Mech plans, Seq. of Ops, specs., Cx plan

- Fans with motors > 0.75 hp shall have automatic controls complying with 6.4.3.3.1 to turn off fans when not required, unless they are intended to operate continuously
- Controls can be time schedules, occupant sensors, manual timer, or security system interlock

COMcheck designer entry



6.4 Mandatory Requirements – Hotel Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.3.5	Mech plans, Seq. of Ops, specs., Cx plan

If > 50 guest rooms, controls capable of and configured for 3 modes of temperature control:

- **Occupied:** HVAC setpoints return to occupied settings
- **Rented & Unoccupied**: within 20 minutes of guest leaving, automatically raise/lower setpoint by 4°F
- **Unrented & Unoccupied**: setpoints automatically reset to 80°F or higher cooling and 60°F or lower heating
- Unrented and unoccupied determined by either:
  - Continuously unoccupied for up to 16 hours
  - Networked guest room control system indicates room is unrented and is unoccupied for 30 minutes

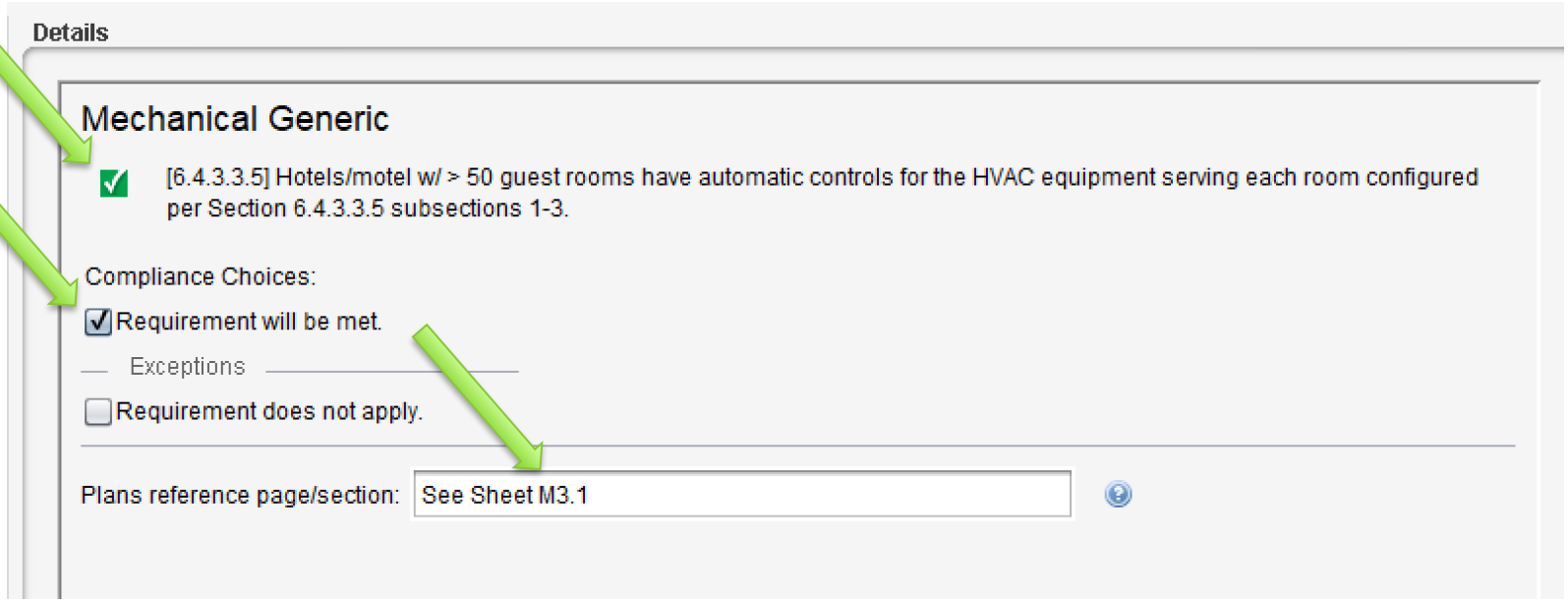
6.4 Mandatory Requirements – Hotel Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.3.5	Mech plans, Seq. of Ops, specs., Cx plan

- Ventilation also shuts off when unoccupied.
  - Within 20 minutes of all occupants leaving the guest room, turn off ventilation and exhaust fans or use isolation devices to shut off outdoor air to the guest room and exhaust air from the guest room.
- **Exception:** Daily preoccupancy outside air purge is allowed for 60 minutes or 1 air change
- Captive key card systems can be used to comply with setpoint and ventilation requirements

6.4 Mandatory Requirements – Hotel Controls

COMcheck reference



6.4 Mandatory Requirements – Shutoff Damper Controls, Leakage

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.4.2-3	Mech plans, Seq. of Ops, specs.

90.1-2019

- OA intake and exhaust equipped with motorized dampers that will automatically shut when system or spaces are not in use
- Capable of and configured to automatically shut off during warm-up, cool down, and setback (unless ventilation reduces energy or code-required)
- Leakage performance requirements of 10 cfm/ft^2 motorized, 20 cfm/ ft^2 non-motorized <3 stories
- Exceptions
  - Gravity dampers okay for exhaust and relief in buildings <3 stories
  - Gravity dampers okay in systems with design OA <=300 cfm
  - Unconditioned space ventilation and exhaust
  - Systems serving Type 1 kitchen exhaust

2014 OEESC

- OA supply, exhaust, and relief need Class I motorized damper
- Maximum leakage 4 cfm/ft^2 at 1” wg tested in accordance with AMCA 500D
- Exceptions:
  - Gravity dampers okay if <= 300 cfm
  - Relief dampers integral to packaged equipment
  - Type I grease exhaust

6.4 Mandatory Requirements – Enclosed Parking Garage Ventilation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.4.5	Mech plans, Seq. of Ops, Cx plan

Requirements are mostly similar

2021 Oregon / ASHRAE 90.1-2019

- Automatically detect contaminant levels and reduce flow ~~to 50% or less of design capacity~~ per Section 404 of the Mechanical Code by.
  - Staging fans, or
  - Modulating fan airflow
- Exceptions:
  1. Garages <30,000 ft^2 with no mechanical cooling or heating
  2. ~~Garages that have a garage area to *ventilation system motor nameplate horsepower* ratio that exceeds 1500 ft^2/hp and do not utilize *mechanical cooling*~~
  3. Where not permitted by AHJ

2014 OEESC

- Group S-2 only
- Same 30,000 ft^2 threshold
- Specified contaminant (CO) and ppm to maintain
- Minimum ventilation rate specified

6.4 Mandatory Requirements – Heat Pump Auxiliary Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.5	Mech schedules, Seq. of Ops, specs., Cx plan

- Requires heat pumps with internal resistance heat to have controls that prevent supplemental heater operation when the heat pump alone can meet the load:
  - During both steady-state operation and setback recovery
  - Supplemental heat is okay during defrost cycles
- And as previously mentioned, Oregon-specific requirement for packaged HVAC equipment:

b. Section 6.4.3.5.1 Packaged HVAC Equipment with Electric Heat

HVAC equipment for new buildings with a cooling capacity less than 241,000 Btu/h from Table 6.8.1-1 shall not have electric supplemental heat exceeding 21,500 Btu/h (6 kW). Equipment shall have heat pump operation for the first stage of heating and shall be selected from Table 6.8.1-2.

6.4 Mandatory Requirements – Demand Controlled Ventilation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.8	Mech plans, Seq. of Ops, Cx plan

- Similar requirements as OEESC 2014
- Continues to apply to spaces > 500 ft^2, with design occupancy for ventilation of >= 25 people per 1000 ft^2 and served by systems with either
  - Air-side economizer
  - Automatic modulating control of OA damper, or
  - Design OA flow > 3000 cfm
- Slightly different exceptions:

Exceptions to 6.4.3.8

1. *Systems* with exhaust air *energy* recovery complying with Section 6.5.6.1.
2. Multiple-zone *systems* without *DDC* of individual zones communicating with a central *control* panel.
3. *Systems* with a design outdoor airflow less than 750 cfm.
4. *Spaces* where >75% of the *space* design outdoor airflow is required for *makeup air* that is exhausted from the *space* or *transfer air* that is required for *makeup air* that is exhausted from other *spaces*.
5. *Spaces* with one of the following occupancy categories as defined in ASHRAE Standard 62.1: correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.

6.4 Mandatory Requirements – Demand Controlled Ventilation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.8	Mech plans, Seq. of Ops, Cx plan

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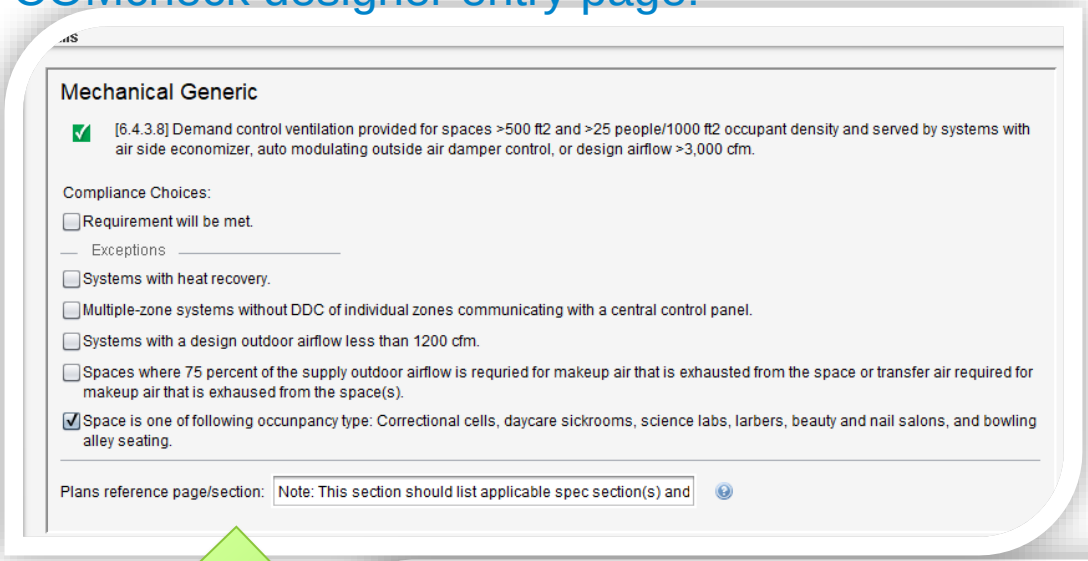


COMcheck Mechanical Report

6.4.3.8 [ME6][1]	Demand control ventilation provided for spaces >500 ft2 and >25 people/1000 ft2 occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow >3,000 cfm.		☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Systems with heat recovery. **Location on plans/spec:** Note: This section should list applicable spec section(s) and sheet(s) for the building official to verify design compliance

6.4 Mandatory Requirements – Heated or Cooled Vestibules

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.9	Mech plans, Seq. of Ops, Cx plan

- Automatic off required for vestibule heating when OAT > 45°F
- Maximum 60°F heating setpoint, minimum 85°F cooling setpoint
  - Exceptions: if energy used to condition the vestibule is from site-recovered energy or transfer air that would otherwise be exhausted

6.4 Mandatory Requirements – DDC

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.10	Seq. of Ops, Specs., Cx plan

DDC required in many situations (6.4.3.10)

Table 6.4.3.10.1 *DDC* Applications and Qualifications

Building Status	Application	Qualifications
New *building*	Air-handling *system* and all zones served by the *system*	Individual *systems* supplying more than three zones and with fan *system* bhp of 10 hp and larger
	Chilled-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger
	Hot-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger
Alteration or addition	Zone *terminal* unit such as *VAV* box	Where existing zones served by the same air-handling, chilled-water, or hot-water *system* have *DDC*
	Air-handling *system* or fan coil	Where existing air-handling *systems* and fan coils served by the same chilled- or hot-water plant have *DDC*
	New air-handling *system* and all new zones served by the *system*	Individual *systems* with fan *system* bhp of 10 hp and larger and supplying more than three zones and more than 75% of zones are new
	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger
	New or upgraded hot-water plant	Where all *boilers* are new and plant design heating capacity is 300,000 Btu/h and larger

6.4 Mandatory Requirements – DDC Requirements

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.10	Seq. of Ops, Specs., Cx plan

- Where DDC IS required, certain capabilities are required:

6.4.3.10.2 DDC Controls

Where *DDC* is required by Section 6.4.3.10.1, the *DDC system* shall be capable of and configured with all of the following, as required, to provide the *control* logic required in Section 6.5:

a. Monitoring zone and *system demand* for fan pressure, pump pressure, heating, and cooling.

b. Transferring zone and *system demand* information from zones to air *distribution system* controllers and from air *distribution systems* to heating and cooling plant controllers.

c. Automatically detecting those zones and *systems* that may be excessively driving the *reset* logic and generate an alarm or other indication to the *system* operator.

d. Readily allowing operator removal of zones from the *reset* algorithm.

6.4 Mandatory Requirements – CHW Plant Monitoring

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.11	Seq. of Ops, Specs., Cx plan

- For electric motor-driven CHW plants
  - In new buildings
  - New plants in existing buildings

- Monitoring and measurement for energy use and efficiency (kW/ton) is required for all chiller plants over a certain capacity, which for Oregon climate zones is:
  - Water-cooled CHW plants: > 1500 tons peak cooling capacity
  - Air-cooled CHW plants: > 860 tons peak cooling capacity

6.4 Mandatory Requirements – Economizer Fault Detection and Diagnosis

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.12	Seq. of Ops, Specs., Cx plan

- Air cooled DX units with an economizer installed in accordance with 6.5.1 shall include fault detection and diagnostics (FDD) with a host of required sensors and capabilities

6.4.3.12 Economizer Fault Detection and Diagnostics (FDD)

Air-cooled direct-expansion cooling units listed in Tables 6.8.1-1 and 6.8.1-2, wher *economizer* is installed in accordance with Section 6.5.1, shall include a fault detec diagnostics (FDD) *system* complying with the following:

a. The following temperature sensors shall be *permanently installed* to monito operation:
   1. *Outdoor air*
   2. Supply air
   3. Return air, where required for economizer *control*

b. The *system* shall have the capability of displaying the value of each sensor.

c. The FDD *system* or unit *controls* shall be capable of and configured to provide *system* status by indicating the following:
   1. Free cooling available
   2. Economizer enabled
   3. Compressor enabled
   4. Heating enabled
   5. Mixed-air low-limit cycle active

d. The FDD *system* or unit *controls* shall have provisions to manually initiate each operating mode so that the operation of compressors, economizers, fans, and the heating *system* can be independently tested and verified.

e. The FDD *system* shall be capable of and configured to detect the following faults:
   1. Air temperature sensor failure/fault
   2. Not economizing when the unit should be economizing
   3. Economizing when the unit should not be economizing
   4. Damper not modulating
   5. Excess *outdoor air*

f. The FDD *system* shall be capable of and configured to report faults to a fault management application or *DDC system* accessible by operating or *service* personnel, or annunciated locally on zone *thermostats*.

6.4 Mandatory Requirements – Economizer Fault Detection and Diagnosis

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.3.12	Seq. of Ops, Specs., Cx plan

COMcheck report reference:

6.4.3.12 [FI200][3]	Air economizer has a fault detection and diagnostics (FDD) system (see details for configuration and operational requirements).	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. **Location on plans/spec:** This section should list where to find specs / mechanical drawing #s / control sequences to document compliance

6.4 Mandatory Requirements – HVAC Duct Insulation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.4.1.2	Mech. Plans, Specs.

90.1-2019

- Based on location, heating and/or cooling
- Generally increased from R-5 to R-6 for unconditioned space
- Exterior requirement will depend on system type and CZ

Table 6.8.2 Minimum Duct Insulation R-Value[a]

Climate Zone	Duct Location		
	Exterior [b]	*Unconditioned Space* and Buried Ducts	*Indirectly Conditioned Space* [c,d]
Supply and Return Ducts for Heating and Cooling			
0 to 4	R-8	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Heating Only			
0 to 1	None	None	None
2 to 4	R-6	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Cooling Only			
0 to 6	R-8	R-6	R-1.9
7 to 8	R-1.9	R-1.9	R-1.9

2014 OEESC:

- Unconditioned spaces: R-5
- Exterior: R-8
- Exceptions
  - When inside equipment
  - Inside/outside duct DT <15°F

6.4 Mandatory Requirements – HVAC Piping Insulation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.4.1.3	Mech. Plans, Specs.

- No changes. Requirements (for heating) are:

Table 6.8.3-1 Minimum *Piping* Insulation Thickness Heating and Hot Water Systems[a,b,c,d,e] (Steam, Steam Condensate, Hot-Water Heating and Domestic Water *Systems*)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft^2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$, where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu·in/h·ft^2·°F]; and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on *energy efficiency* considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c. For *piping* smaller than 1.5 in. and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

d. For direct-buried heating and hot-water *system piping*, reduction of these thicknesses by 1.5 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

e. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per metre than a steel pipe of the same size with the insulation thickness shown in the table.

6.4 Mandatory Requirements – HVAC Piping Insulation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.4.1.3	Mech. Plans, Specs.

- No changes. Requirements (for cooling) are:

Table 6.8.3-2 Minimum *Piping* Insulation Thickness Cooling *Systems* (Chilled Water, Brine, and Refrigerant)[a,b,c,d]

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft^2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
40 to 60	0.21 to 0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20 to 0.26	50	0.5	1.0	1.0	1.0	1.5

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$, where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu·in/h·ft2·°F]; and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on *energy efficiency* considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

c. For direct-buried cooling *system piping*, insulation is not required.

d. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.

6.4 Mandatory Requirements – Walk-In Coolers and Freezers

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.4.5	Arch/Mech/Specialty Plans, Specs.

- 6.4.5 is a new section of energy code for Oregon, but not a new requirement
- Oregon has had standards for walk-in coolers and walk-in freezers since 2009
- Requirements in ASHRAE 90.1 are essentially a duplication of what are already federal standards that are preempted from state modification
- Also 6.5.11 has new requirements for refrigeration systems with remote compressors and condensers

HVAC Compliance Pathways

HVAC Section 6: 6.1 General, 6.7 Submittals, 6.8 Equipment Efficiency Tables

6.3 Simplified Building Approach

OR

6.4 Mandatory Requirements

Plus One

6.5 Prescriptive Requirements

6.6 Alternative Compliance (Computer Rooms)

Chapter 11 Performance

Appendix G Performance

Economizer Requirements

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1	Mech schedules, Seq. of Ops, Specs., Cx plan

- Same general threshold for economizer requirement **(capacity ≥ 54,000 btu/hr)**
- Mandatory FDD
- New high efficiency cooling equipment exemptions
- Other exceptions related to specific scenarios
- New required economizer controls (6.5.1.1.2)
  - Can't be controlled by MAT alone (except single-zone systems)
  - Economizer enabled when OAT<75F
  - Sensor calibration and accuracy requirements
- Integrated economizer controls (6.5.1.3)
  - Economizer interlocked with mechanical cooling to provide partial cooling even when some mechanical cooling is required.

Economizer Requirements

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1	Mech schedules, Seq. of Ops, Specs.

- New efficiency improvement alternative to economizers
- Other exceptions related to specific scenarios:
  - Chilled-water cooling systems without a fan or that use induced airflow, where the total capacity of these systems is less than 1,000,000 Btu/h in Climate Zone 4; less than 1,400,000 Btu/h in Climate Zones 5
  - Non-particulate air treatment
  - Hospitals and processes with humidity requirements
  - Condenser heat recovery is present
  - Smaller residential systems
  - Low load or load operating hours
  - Supermarkets with affected open refrigeration

Table 6.5.1-2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling *Efficiency*

Climate Zone	*Efficiency* Improvement[a]
2A	17%
2B	21%
3A	27%
3B	32%
3C	65%
4A	42%
4B	49%
4C	64%
5A	49%
5B	59%
5C	74%
6A	56%
6B	65%
7	72%
8	77%

a. If a unit is rated with an *IPLV*, *IEER*, or *SEER*, then to eliminate the required economizer, the minimum cooling *efficiency* of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full-load metric like *EER* cooling then these must be increased by the percentage shown.

Airside Economizers – Capacity and Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1.1.2	Mech schedules, Seq. of Ops, Specs.

- Capable and configured to require high-limit shut-off
- Sensor calibration and accuracy requirements

Table 6.5.1.1.3 High-Limit Shutoff *Control* Settings for *Air Economizers*[b]

Control Type	Allowed Only in Climate Zone at Listed *Set Point*	Required High-Limit *Set Points* (Economizer Off when):	
		Equation	Description
Fixed dry-bulb temperature	0B, 1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	$T_{OA} > 75°F$	*Outdoor air* temperature exceeds 75°F
	5A, 6A	$T_{OA} > 70°F$	*Outdoor air* temperature exceeds 70°F
	0A, 1A, 2A, 3A, 4A,	$T_{OA} > 65°F$	*Outdoor air* temperature exceeds 65°F
Differential dry-bulb temperature	0B, 1B, 2B, 3B, 3C, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	$T_{OA} > T_{RA}$	*Outdoor air* temperature exceeds return air temperature
Fixed enthalpy with *fixed* dry-bulb temperature	All	$h_{OA} > 28$ Btu/lb[a] or $T_{OA} > 75°F$	*Outdoor air* enthalpy exceeds 28 Btu/lb[a] of dry air[a] or *outdoor air* temperature exceeds 75°F
Differential enthalpy with *fixed* dry-bulb temperature	All	$h_{OA} > h_{RA}$ or $T_{OA} > 75°F$	*Outdoor air* enthalpy exceeds return air enthalpy or *outdoor air* temperature exceeds 75°F

a. At altitudes substantially different than sea level, the *fixed* enthalpy limit shall be set to the enthalpy value at 75°F and 50% rh. As an example, at approximately 6000 ft elevation, the *fixed* enthalpy limit is approximately 30.7 Btu/lb.

b. Devices with selectable rather than adjustable *set points* shall be capable of being set to within 2°F and 2 Btu/lb of the *set point* listed.

Fluid Economizers – Capacity and Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1.2	Mech schedules, Seq. of Ops, Specs.

- Fluid economizer systems capable of providing up to 100% of the expected system cooling load at:
  - General requirement: 50°F dry bulb / 45°F wet bulb OAT
  - Computer rooms with water-cooled economizers: 30°F dry bulb / 25°F wet bulb OAT
  - Computer rooms with air-cooled economizers: 25°F dry bulb (4C) or 20°F dry bulb (5B)
  - Systems with dehumidification limitations: 45°F dry bulb / 40°F wet bulb OAT
- New maximum hydronic pressure drop requirements for fluid economizers
  - Maximum 15’ pressure drop through coils/HX or secondary loop so that economizer coil pressure drop is not seen by the loop in normal (non-economizing) mode

Integrated Economizer Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1.3	Mech schedules, Seq. of Ops, Specs., Cx plan

- Economizer interlocked with mechanical cooling to provide partial cooling even when some mechanical cooling is required.
- Units with economizers must also have:
  - Interlocking to limit OA damper closing for frost protection until leaving air temperature is less than 45°F
  - > 65,000 btu/hr units that control the capacity of mechanical cooling based on occupied space temperature shall have minimum 2 stages of cooling
  - All other DX units that control space temperature by modulating airflow to the space shall comply with:

Table 6.5.1.3 DX Cooling Stage Requirements for Modulating Airflow Units

Rating Capacity, Btu/h	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement[a]
≥65,000 and <240,000	3	≤35% of full load
≥240,000	4	≤25% full load

a. For mechanical cooling stage *control* that does not use variable compressor displacement the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

Economizer Heating, Humidification System Impact

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.1.4, 6.5.1.5	Seq. of Ops, Specs.

- Economizer controls and system design shall not increase the building heating energy use during normal operation
  - Exception for zone-level heating for VAV systems

- Systems with hydronic cooling and humidification systems that are designed to maintain a dew point > 35°F shall use a fluid economizer, if an economizer is required

Reheat/Simultaneous Heating & Cooling

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.2.1	Seq. of Ops, Specs., Cx plan

- Supply air temperature reheat limits (6.5.2.1)
  - Dual maximum VAV control
  - Max SAT of 20°F above room Setpoint
- New provisions to prevent reheat when humidity control is provided (6.5.2.3)
- New requirements for preheat coil control; can't run when AC is on or unit is economizing (6.5.2.5-6)

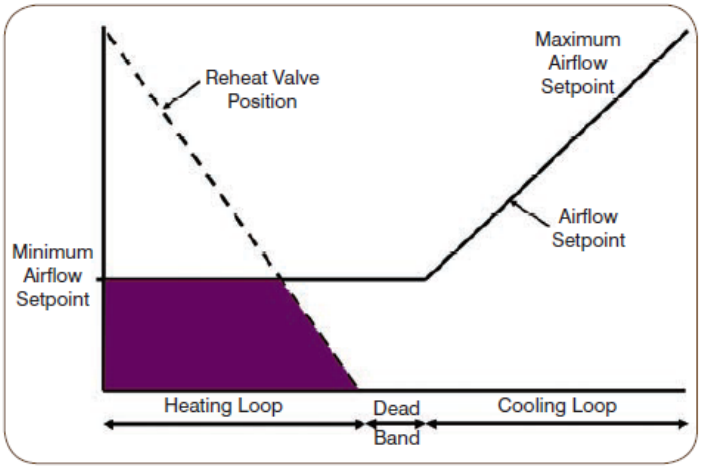


Figure 1: Conventional VAV reheat control diagram.

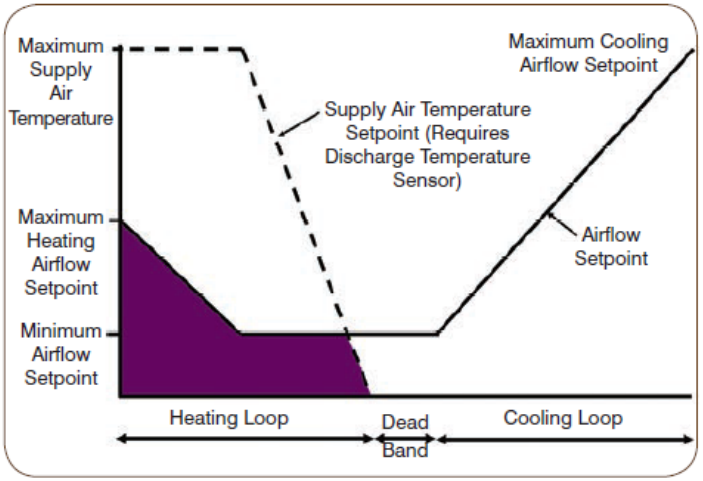


Figure 2: Dual maximum VAV reheat control diagram.

Simultaneous Heating and Cooling

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.2.1	Seq. of Ops, Specs., Cx plan

- Zone thermostatic controls to prevent reheating, recooling, mixing, simultaneous heating and cooling to the same zone (but there are a number of exceptions to this to look at and be aware of)
  - *Previous limit of reheat, recooled, or mixed in peak heating demand was to 50% of zone peak supply rate*

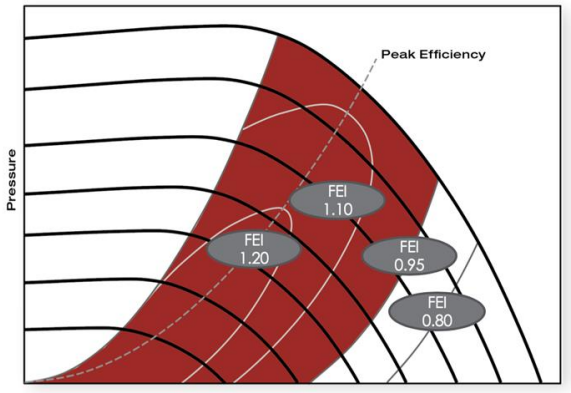
Exceptions to 6.5.2.1

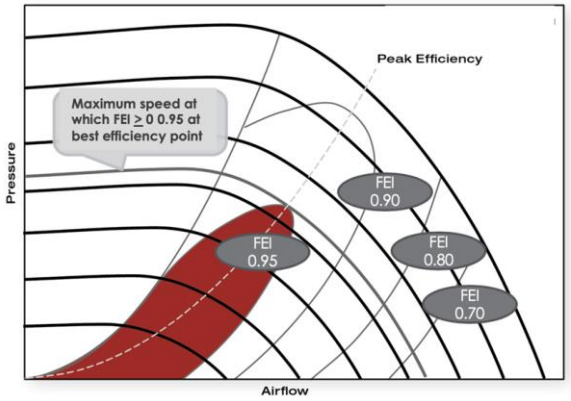
1. Zones for which the volume of air that is reheated, recooled, or mixed is less than the larger of the following:
   a. Twenty percent of the zone design peak supply for *systems* with *DDC* and 30% for other *systems*.
   b. The outdoor airflow rate required to meet the *ventilation* requirements of ASHRAE Standard 62.1 for the zone.
   c. Any higher rate that can be demonstrated, to the satisfaction of the *authority having jurisdiction*, to reduce overall *system* annual *energy* use by offsetting *reheat/recool energy* losses through a reduction in *outdoor air* intake for the *system*.
   d. The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
2. Zones with *DDC* that comply with all of the following:
   a. The airflow rate in *dead band* between heating and cooling does not exceed the larger of the following:
      (1) Twenty percent of the zone design peak supply rate.
      (2) The outdoor airflow rate required to meet the *ventilation* requirements of ASHRAE Standard 62.1 for the zone.
      (3) Any higher rate that can be demonstrated, to the satisfaction of the *authority having jurisdiction*, to reduce overall *system* annual *energy* use by offsetting *reheat/recool energy* losses through a reduction in *outdoor air* intake.
      (4) The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
   b. The airflow rate that is reheated, recooled, or mixed shall be less than 50% of the zone design peak supply rate.
   c. The first stage of heating consists of modulating the zone supply air temperature *set point* up to a maximum *set point* while the airflow is maintained at the *dead band* flow rate.
   d. The second stage of heating consists of modulating the airflow rate from the *dead band* flow rate up to the heating maximum flow rate.
3. Laboratory exhaust *systems* that comply with Section 6.5.7.3.
4. Zones where at least 75% of the *energy* for *reheating* or for providing warm air in mixing *systems* is provided from *site-recovered energy* (including condenser heat) or *site-solar energy*.

Fan Energy Index

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.1.3	Mech schedules, specs, supp. calcs

- Replaced Fan Efficiency Grade (FEG) efficiency metric with Fan Energy Index (FEI)
- FEG mainly requires good fan peak efficiency; does not concentrate as much on good selections
- FEI mainly requires good fan selections
  - kW input must be below a calculated value AT THE SCHEDULED OPERATING POINT
  - So the fan must be fairly good too
  - Manufacturers selection software should tell you “Compliant with FEI” or NOT or just not list non-compliant products
- Exceptions for embedded fans, safety fans, ceiling fans, fans outside scope of AMCA 208
  - No exception for powered roof ventilators
- Power threshold lowered from 5 HP to 1 HP





Images courtesy of AMCA

Fan Energy Index

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.1.3	Mech schedules, specs, supp. calcs

- FEI is a true wire-to-air method
- Requirement:
  - Constant speed: FEI ≥ 1.0
  - VAV – FEI ≥ 0.95

$$FEI = \frac{\text{Reference Fan Electrical Input Power}}{\text{Fan Electrical Input Power}}$$

Images courtesy of AMCA

Fan System Power Limitation

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.1.1, 6.5.3.1.2	Mech schedules, specs, supp. calcs

- Still applies to systems with total fan system motor nameplate hp > 5
- Same Fan Power Limitation equation

Table 6.5.3.1-1 Fan Power Limitation[a]

	Limit	Constant Volume	Variable Volume
Option 1: Fan *system* motor nameplate hp	Allowable *motor nameplate hp*	$hp \le cfm_S \times 0.0011$	$hp \le cfm_S \times 0.0015$
Option 2: Fan *system* bhp	Allowable fan *system* bhp	$bhp \le cfm_S \times 0.00094 + A$	$bhp \le cfm_S \times 0.0013 + A$

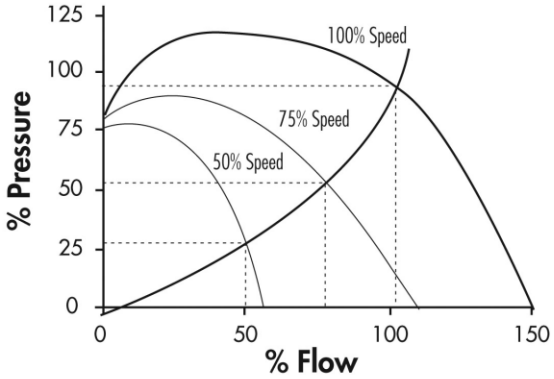
  - Pressure drop adjustments:
    - » Credits mostly the same (change for ERV credit)
    - » New deductions required for systems without central cooling, heating, or with central electric resistance heat
- Still requirement to select fan motor no larger than the first available motor size greater than the bhp, with indication of bhp on design documents
  - Same exceptions as before, plus **new exception for fans with nameplate < 1 hp**

More Fan Requirements

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.2.1	Mech schedules, specs, supp. calcs

- **Fan speed control** (6.5.3.2.1)
  - Fan speed controls required for:

Cooling *System* Type	Fan Motor Size, hp	*Mechanical Cooling* Capacity, Btu/h
DX cooling	Any	>=65,000
Chilled-water and evaporative cooling	>=1/4	Any



- **Fractional horsepower fan motors (between 1/12hp and 1hp)** (6.5.3.6)
  - ECM or have a minimum efficiency of 70%

VAV Systems

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.2	Mech plans, specs, Seq. of Ops, Cx plan

VAV static pressure setpoint

- Multi-zone VAV systems with fans >5 HP required to have static pressure setpoint re-set (6.5.3.2.3)
- Other systems required to locate static pressure sensors such that the setpoint is ≤ 1.2” (wg 6.5.3.2.2)

Multizone VAV ventilation optimization control (6.5.3.3)

- Systems with DDC to zone level must include a means to reduce OA rates below design rates in response to changes in system ventilation efficiency (from 62.1 Appendix A)
- Exceptions:
  - » VAV systems with zonal transfer fans, dual-duct dual-fan VAV systems, and systems with fan-powered terminal units
  - » Systems where design exhaust is > 70% of total design OA rate

Ventilation Design

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.7	Mech plans, specs, Supp. calcs

Requires one of the following for OA ventilation systems:

- Design ventilation limited to 135% of the required minimum OA rate (larger or 62.1, exhaust, or other applicable codes/standards.
- Dampers, ductwork, and controls required to allow the system to supply no more than the required minimum OA rate with a single set-point adjustment
- System includes exhaust air energy recovery in compliance with other parts of 90.1

Occupied-Standby Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.8	COMcheck forms, Arch/Mech/Ltg. Plans

- Required for zones serving rooms required to have partial or full off controls per lighting controls section 9.4.1.1.
- Refer to ASHRAE 62.1 occupancy categories that allow ventilation air to be reduced to 0 when space is in occupied-standby mode
  - *occupied-standby mode*: when a zone is scheduled to be occupied, and an occupant sensor indicates no occupants are within the zone.
- Requires that:
  a) Active heating set point shall be setback at least 1°F.
  b) Active cooling set point shall be setup at least 1°F.
  c) All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

- **Exception**: Multiple zone systems without automatic zone flow control dampers.

Occupied-Standby Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.8	COMcheck forms, Arch/Mech/Ltg. Plans

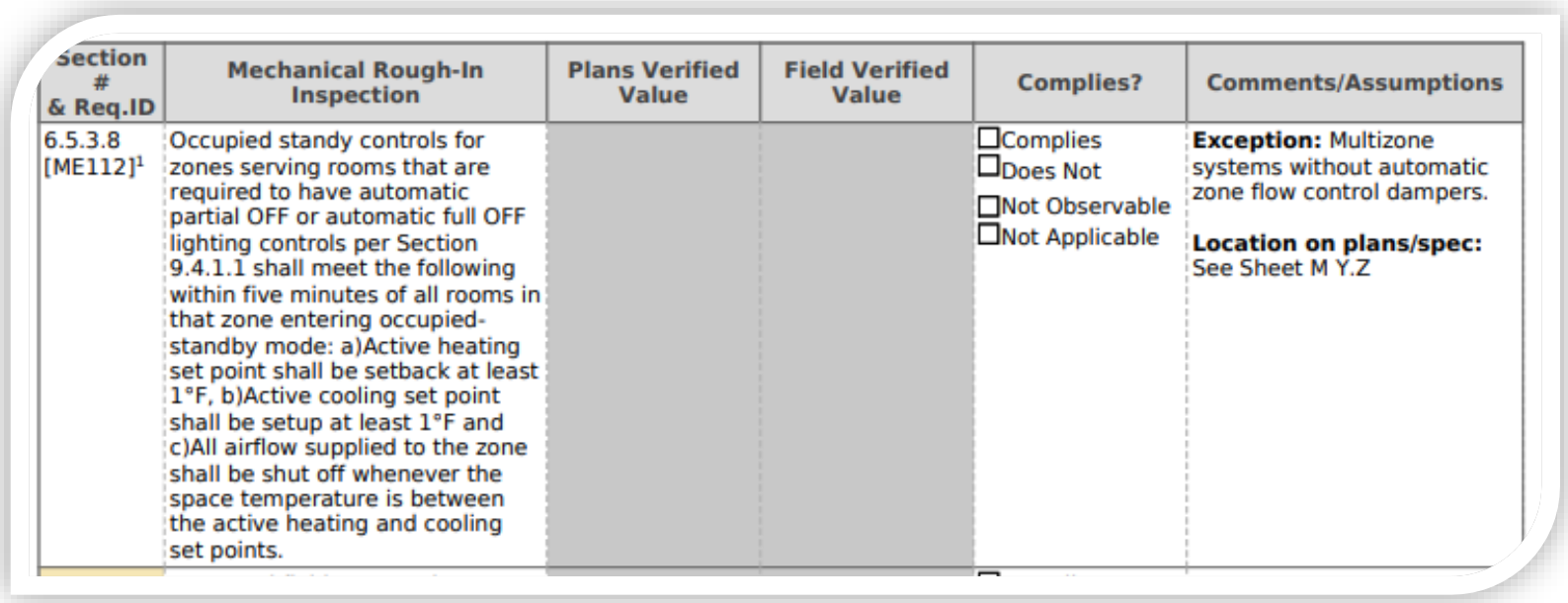
- Categories ASHRAE 62.1 says acceptable to reduce to zero ventilation air during *occupied-standby* hrs
- Requires coordination between arch/mech/elec plans
- **Significant energy saver**

Occupancy Category	Occupancy Category
Educational Facilities	**Miscellaneous Spaces**
Lecture classroom	Bank vaults/safe deposit
Lecture hall (fixed seats)	Banks or bank lobbies
Music/theater/dance	Computer (not printing)
Multiuse assembly	Transportation waiting
General	**Public Assembly Spaces**
Break rooms	Auditorium seating area
Coffee stations	Places of religious worship
Conference/meeting	Courtrooms
Corridors	Legislative chambers
Hotels, Motels, Resorts, Dormitories	Lobbies
	Museums/galleries
Bedroom/living room	**Transient Residential**
Barracks sleeping areas	Dwelling unit
Lobbies/prefunction	Common corridors
Multipurpose assembly	**Retail**
Office Buildings	Mall common areas
Main entry lobbies	Barbershop
Office space	Supermarket
Reception areas	**Sports and Entertainment**
Telephone/data entry	Spectator areas
	Disco/dance floors
	Stages, studios

Occupied-Standby Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.3.8	COMcheck forms, Arch/Mech/Ltg. Plans

COMcheck Report Reference:



Section # & Req.ID	Mechanical Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
6.5.3.8 [ME112][1]	Occupied standy controls for zones serving rooms that are required to have automatic partial OFF or automatic full OFF lighting controls per Section 9.4.1.1 shall meet the following within five minutes of all rooms in that zone entering occupied-standby mode: a)Active heating set point shall be setback at least 1°F, b)Active cooling set point shall be setup at least 1°F and c)All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.			☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	**Exception:** Multizone systems without automatic zone flow control dampers. **Location on plans/spec:** See Sheet M Y.Z

Boiler Turndown

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.1	Mech. Schedules, Specs

- Boiler systems with a design input larger than 1,000,000 btu/hr required to meet turndown ratio
  - Table 6.5.4.1 Boiler Turndown

Boiler System Design Input, Btu/h	Minimum Turndown Ratio
≥1,000,000 and ≤5,000,000	3 to 1
>5,000,000 and ≤10,000,000	4 to 1
>10,000,000	5 to 1

  - Previous requirements were for a multi-stage or modulating burner for boilers > 500,000 btu/hr

Hydronic Variable Flow Systems

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.2	Mech plans, Seq. of Ops, specs.

- HVAC pumping systems with three or more control valves designed to modulate or step open and close as a function of load shall be
  - Designed for variable fluid flow
  - Capable of reducing flow rates to ≤ 25% of design flow rate or equipment minimum
- Individual or parallel pumps serving variable flow systems with a motor hp (or combined parallel hp) at least the power in Table 6.5.4.2 shall have controls and/or devices resulting in pump motor demand ≤ 30% of design wattage at 50% of design water flow
  - For OR climate zones 4C and 5B
    - » CHW pumps: ≥ 7.5 hp
    - » HW pumps: ≥ 10 hp
  - Control as function of desired flow or differential pressure (with specifications for delta P control, dP setpoint reset, etc.)
- Previous requirements were for either hydronic supply temperature reset **OR** flow reduction (VFD required if > 5 hp)

Hydronic Variable Flow Systems

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.2	Mech plans, Seq. of Ops, specs.

- Exceptions to hydronic variable flow systems control requirements
  - Differential pressure setpoint reset not required when valve position is used to comply with CHW and HW temperature reset controls
  - Variable flow control not required on heating water pumps where more than 50% of annual heat is generated by an electric boiler
  - Variable flow not required for primary pumps in a primary/secondary system
  - Variable flow not required for a coil pump provided for freeze protection
  - Variable flow not required for heat recovery coil runaround loops

CHW and HW Temperature Reset Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.4	Mech plans, specs, Seq. of Ops, Cx plan

- Same threshold as before (300,000 btu/hr design capacity)
- Previous requirements to reset temperature **OR** reduce flow.
  - 90.1 has requirements for both, with mutual exceptions
- Requirement remains to include controls to automatically reset supply water temperatures by representative building loads (return temperature) or OA temperature
- Previous specification for reset by 25% of difference between design supply-to-return temperature no longer applied
- Where DDC is used to control valves, the set point shall be reset based on valve positions until one valve is nearly wide open or setpoint limits of the system equipment or application have been reached
- Exceptions: where CHW supply is already cold (district heating), process temperature requirements, or where valve position is used to comply with 6.5.4.2

Pipe Sizing

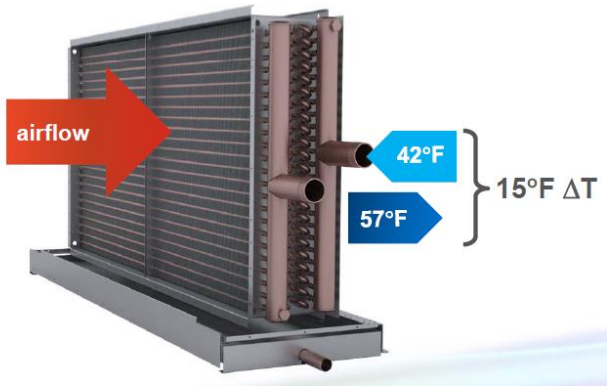
2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.6	Supp. Calcs, specs

- Applies to CHW and condenser water piping
- Maximum flow rates shall not exceed the value provided for the given pipe size and operating hours
- Increased maximum values (allowances) for variable flow/variable speed systems
- Exceptions
  - Piping sections not in the critical circuit at design conditions (and not expected to be in critical circuit for more than 30% of operating hours)
  - Other piping systems with same or less total pressure drop than values in table as applied to standard weight steel pipe

Chilled Water Coil Selection

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.4.7	Mech. Schedules, Supp. Calcs, specs

- Minimum 15°F water temperature delta T
- Minimum 57°F LWT at design conditions
- Exceptions
  1. Coils with an air-side pressure drop exceeding 0.70 in. of water when rated at 500 fpm face velocity and dry conditions (no condensation).
  2. Individual fan-cooling units with a design supply airflow rate 5,000 cfm and less.
  3. Constant-air-volume systems.
  4. Coils selected at the maximum temperature difference allowed by the chiller.
  5. Passive coils (no mechanically supplied airflow).
  6. Coils with design entering chilled-water temperatures of 50°F and higher.
  7. Coils with design entering air dry-bulb temperatures of 65°F and lower.



Energy Recovery

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.6.1	Mech. Schedules, specs

- Previous 2014 OEESC:
  - Required for systems ≥ 5,000 cfm and ≥ 70% OA
- New 90.1-2019:
  - For systems operating < 8,000 hours/yr**, no requirement**
  - For systems operating ≥ 8,000 hours/yr, based on cfm and OA %. If cfm exceeds value, **energy recovery is required**

Table 6.5.6.1-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

Energy Recovery

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.6.1	Mech. Schedules, specs

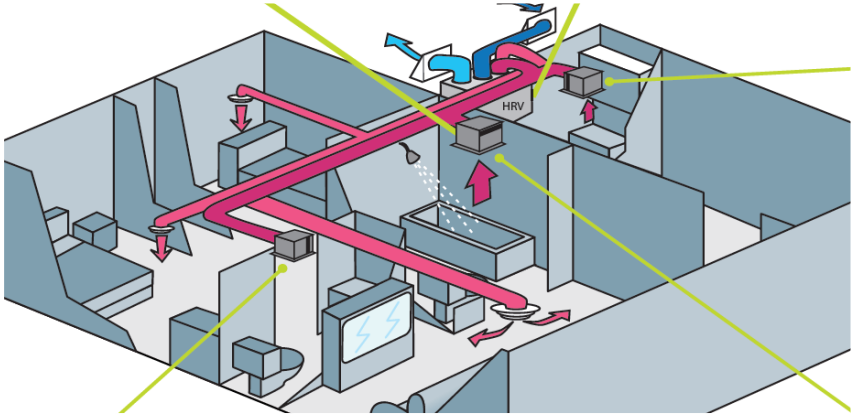
- Result is some cases that would have required ERV before may not now, and vice versa
- Recovery system effectiveness ≥ 50%
- Number of exceptions
  - Lab systems meeting 6.5.7.3
  - Systems serving uncooled spaces that are heated to < 60°F
  - Where > 60% of outdoor heating energy is provided from site-recovered or site solar energy
  - Cooling energy recovery in climate zones 3c, **4c, 5b,** 5c, 6b, 7, and 8
  - Where sum of airflow rates exhausted and relieved within 20 ft of each other is < 75% of the design outdoor airflow
  - Systems requiring dehumidification that employ energy recovery in series with the cooling coil
  - Systems operating < 20 hrs/week at outdoor air % in Table 6.5.6.1-1

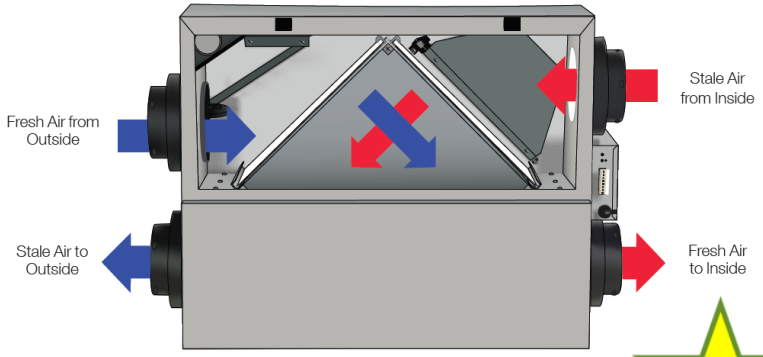
Exhaust Air Energy Recovery Non-Transient Dwelling Units

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.6.1.1	Mech schedules, specs, supp. calcs

- New energy recovery requirements for *nontransient* dwelling units (apartments & condos)
  - Enthalpy recovery ratio (ERR) at design conditions
    - ≥50% ERR at cooling
    - ≥ 60% ERR at heating
    - Unless one of the modes is not required
    - ERR is different than AHRI efficiency rating
  - Exceptions based on unit floor area and CZs
    - Not required in OR climates for 500ft^2 or less apts

Images courtesy of American Aldes





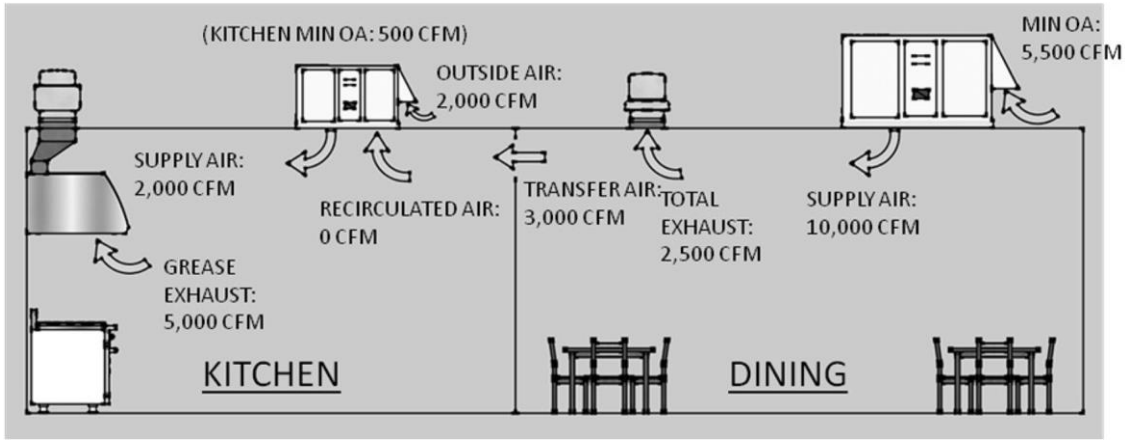
Kitchen Exhaust

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.7.2	Mech plans & schedules, Seq. of Ops

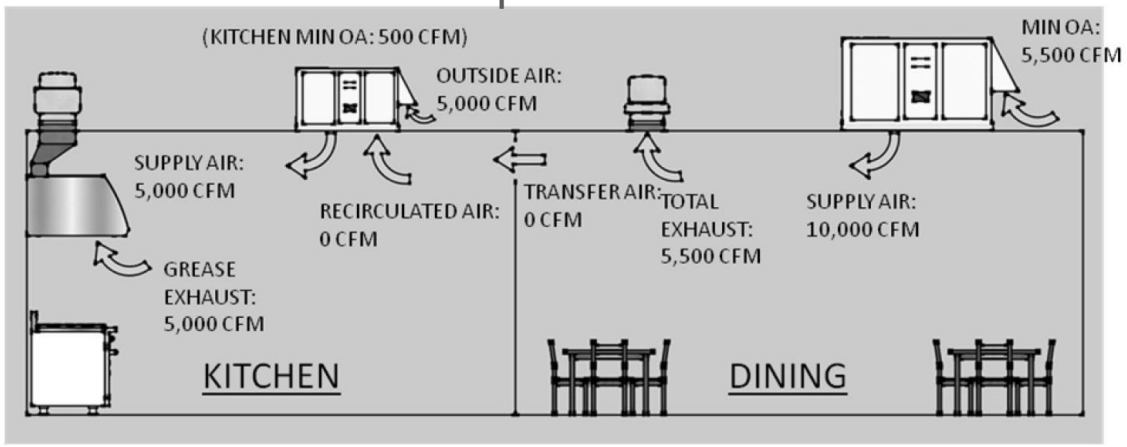
- Mostly the same requirements
- Replacement air introduced directly into the hood cavity of kitchen exhaust hoods shall not exceed 10% of the hood exhaust flow rate
- If total kitchen exhaust > 5000 cfm, then each hood shall comply with the maximum exhaust rate (cfm/linear foot) for that type of hood and equipment
- If total kitchen exhaust > 5000 cfm, then either
  - 50% of replacement air is transfer air that would otherwise be exhausted
  - Demand ventilation on at least 75% of exhaust air (existing requirement)
  - Energy recovery (sensible) of 40% on half of total exhaust

Kitchen Exhaust

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.7.2	Mech plans & schedules, Seq. of Ops



Partial transfer/make-up



No transfer/make-up

- The 5,000 cfm threshold was developed based on small restaurants with separate kitchens from national changes and larger areas
- Exception provided where at least 75% of the replacement air is transfer air that would otherwise be exhausted

Radiant Heating

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.8	Arch & Mech plans

- Unenclosed Spaces
  - Radiant heating required when heating unenclosed spaces (except loading docks with air curtains)
- Enclosed spaces
  - Must conform to other portions of 90.1 (hydronic, VAV system requirements when used in conjunction, etc.)
- Radiant Heating for Enclosed Unconditioned Spaces
  - Overhead radiant heating allowed for spot heating occupied areas
    - » Limited to 500 ft^2 or 10% of space floor area and needs automatic shutdown controls

Hot Gas Bypass

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.9	Mech schedules, Specs

- Maximum allowable hot gas bypass % reduced

90.1-2019

Rated Capacity	Maximum Hot-Gas Bypass, % of total capacity
≤ 240,000 Btu/hr	15%
> 240,000 Btu/hr	10%

OEESC-2014

Rated Capacity	Maximum Hot-Gas Bypass, % of total capacity
≤ 240,000 Btu/hr	50%
> 240,000 Btu/hr	25%

- Applied in systems with stepped or continuous unloading
- Limitation also pertains to chillers
- Hot gas bypass not to be used on constant-volume units

Door Switches

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.10	Specs, Seq. of Ops, Cx Plan

- New requirement for controls that will, when door is open:
  - Disable heating or adjust setpoint to 55°F within 5 minutes
  - Disable cooling or adjust setpoint to 90°F within 5 minutes
- Exceptions:
  - Entries with automatically closing devices
  - Spaces with no thermostat
  - Alterations to existing buildings
  - Loading docks

Data Centers

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.12 ~~6.6.1~~	Mech schedules, Supp. Calcs.

- 90.1-2019 introduced alternate compliance path for Data Centers (≥ 20 W/ft^2 **and** ≥ 10kW instant load) to follow 90.4
- 2021 OEESC moved this from alternate compliance path to mandatory (created new section 6.5.12)
  - Also referenced 90.4-2019 instead of 90.4-2016
    - » Large change in mechanical efficiency values in 2019 version

- Created clearer definitions for data center vs. computer room
  - ***computer room:*** a room whose primary function is to house *ITE* for the processing and storage of electronic data.
  - ***data center:*** a computer room (or series of computer rooms that share *data center systems*) serving a total *ITE* load greater than 10 kW and 20 W/ft2 (215 W/m2) of conditioned floor area.

Data Center vs. Computer Room

Computer Room

A room whose primary function is to house *ITE* for the processing and storage of electronic data.

Data Center

A computer room (or series of computer rooms that share *data center systems*) serving a total *ITE* load greater than 10 kW and 20 W/ft^2 of conditioned floor area.

Data Centers

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.5.12 ~~6.6.1~~	Mech schedules, Supp. Calcs.

MLC is the sum of all power required for cooling, fans, pumps, heat rejection, etc. divided by the power for the data center IT equipment

$$(Annualized\ Mechanical\ Load\ Component) = \frac{\left(\begin{array}{l}\text{Mech\_}Energy25\% + \text{Mech\_}Energy50\% + \\ \text{Mech\_}Energy75\% + \text{Mech\_}Energy100\%\end{array}\right)}{\left(\begin{array}{l}\text{Data Center } ITE\ Energy25\% + \\ \text{Data Center } ITE\ Energy50\% + \\ \text{Data Center } ITE\ Energy75\% + \\ \text{Data Center } ITE\ Energy100\%\end{array}\right)} \quad (6.5)$$

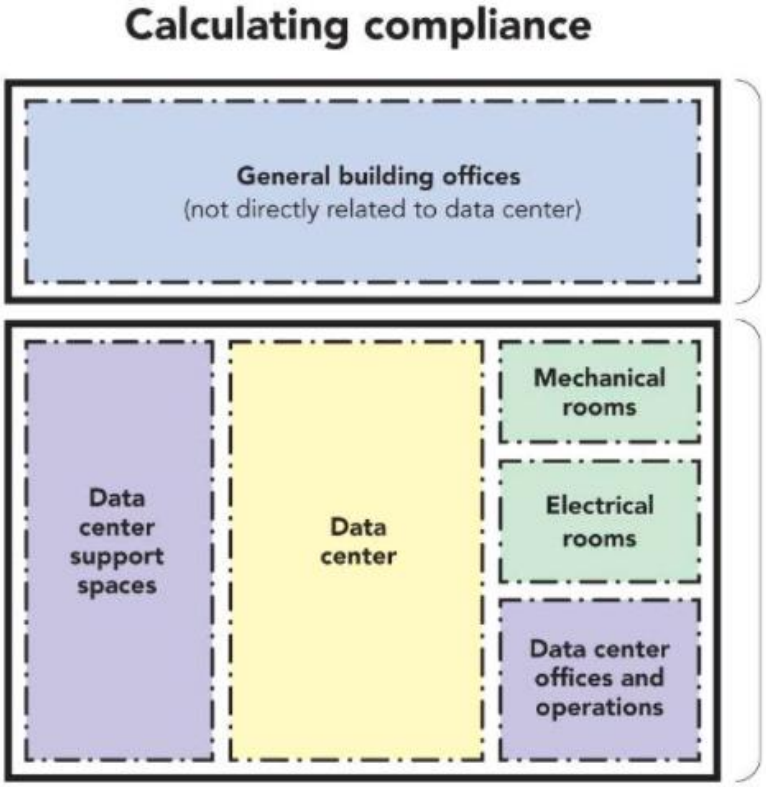
where

$$\text{Mech\_}EnergyX\% = \text{Total Annual } Cooling\ Energy + \text{Pump } Energy + \text{Heat Rejection Fan } Energy + \text{Air-Handler Fan } Energy$$

where each term is a constant value calculated at each of the following *ITE* loads: 25%, 50%, 75%, 100%.

Climate Zones as Listed in ASHRAE Standard 169	**HVAC Maximum *Annualized MLC* for *Data Center ITE Design Power* > 300 *kW***	**HVAC Maximum *Annualized MLC* for *Data Center ITE Design Power* ≤ 300 *kW***
4B	0.14	0.24
5C	0.14	0.23

What is Included?



- Ensure system types serving data centers are captured in MLC calcs
- ITE load (denominator) should include other loads related to data center, not just servers

information technology equipment (ITE): *ITE* includes computers, data storage, servers, and network/communication equipment.

Mech Sections w/ Minor Changes

- **Heat Recovery for Service Water Heating**
  - Same threshold requirements of 6MMBtu and service water heating load > 1 MMBtu
  - **New** requirement for 24 hours/day facility operation before requirement applies
- **Laboratory Exhaust**
  - Just moved to new section rather than an exception to ERVs
- **Radiant Heating**
  - Same requirements as before
- **Supply Air Temp Reset Controls**
  - Same requirements, just changes from minimum reset of **35% to 25%** of difference between design SAT and design room air temperature
- **Chiller & Boiler Isolation Controls**
  - Same requirements for buildings with more than 1 chiller or boiler to shut off all flow to the chiller/boiler when that equipment is shut down
- **Tower Flow Turndown**
  - Same requirements as before

Submittals / Completion

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.7	Submittals

90.1-2019

- Construction documents shall require that :
  - within 90 days after system acceptance, record drawings and O&M manual **delivered to owner**
  - All HVAC systems be balanced with generally accepted engineering standards, and air and hydronic systems first balanced to minimize losses and then to meet design flow conditions
  - Written TAB report be **provided to owner** for zones > 5,000 ft^2
  - Detailed **Cx instructions** for HVAC systems shall be provided in the construction documents
  - **General requirement for requirements to be on the plans, but building official shall not require copies of any reports or drawings**

OEESC-2014

- Requirement to provide a means for system balancing
- Requirement to construction documents specify delivery of O&M manual to building owner

Submittals / Completion

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
6.7	Submittals

Plans and specifications shall include applicable requirements for submittal information and record documents required by Sections 5.7, 6.7, 7.7, 8.7, 9.7, and 10.7 of Standard 90.1. Plans and specifications shall include building commissioning requirements per Section 4.2.5.2 of Standard 90.1. Plans and specifications shall include verification and testing requirements per Section 4.2.5.1 of Standard 90.1. The *building official* shall not require or expect physical copies of record drawings, manuals, functional performance test reports, or energy reporting unless specifically noted in this section. Section 5.4.3.1.1 of Standard 90.1 building leakage test report shall be submitted to the *building official* where applicable. Materials shall be listed and labeled per Section 4.2.3 of Standard 90.1.

Exception: The *building official* is authorized to waive the requirements for *construction documents*, COM*check* reports, or other supporting data if the code official determines these are not necessary to confirm compliance with this code.

Whole building air leakage

COMcheck report reference for HVAC building submittal sections:

6.7.2.1 [FI7][3]	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met.
6.7.2.2 [FI8][3]	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met.
6.7.2.3	An air and/or hydronic system	☐Complies	

Service Water Heating & Misc. Equipment

Service Water Heat Scope

- **New Buildings** required to comply
- **Additions** to existing buildings required to comply
  - Exception: When the *service water heating* to an addition is provided by existing *service water-heating systems* and *equipment* shall not be required to comply with this standard.
- **Alterations** where equipment is a direct replacement for existing equipment must comply
  - Compliance shall not be required where there is insufficient *space* or access to meet these requirements.

High Capacity Service Water Heating

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
7.5.3	Plumbing dwgs, supp. calcs

- Large service water heating systems with total installed input capacity ≥ 1,000,000 Btu/hr are required to have:
  - Weighted average thermal efficiency ≥ 90% calculated as:

$$\text{Capacity Weighted Average Efficiency} = \frac{\sum(\text{Input Capacity} \times \text{Efficiency})}{\sum \text{Input Capacity}} = \frac{\text{Total Output Capacity}}{\text{Total Input Capacity}}$$

- Exceptions
  - Where 25% of annual service water heating requirement is provided by solar or site-recovered energy
  - Equipment is installed in individual dwelling units
  - Individual gas water heaters with input capacity < 100,000 btu/hr

Pressure Boost Systems

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.2	Plumbing dwgs, specs

- *Service* water pressure-booster *systems* shall be designed such that the following apply:
  - One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical *fixtures* that determine the pressure required, or logic shall be employed that adjusts the *set point* to simulate operation of remote sensors.
  - No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster *system* pump or booster *system*, except for safety devices.
  - No booster *system* pumps shall operate when there is no *service* water flow.

Elevators

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.3	Specialty dwgs, specs

- OEESC referenced Oregon Elevator Specialty Code, primarily focused on life safety
- 90.1 lists several efficiency requirements:
  - **Lighting:** *luminaires* in each elevator cab, not including signals and displays, the sum of the lumens divided by the sum of the watts shall be no less than 35 lm/W
  - **Mechanical:** *ventilation* fans for elevators without air conditioning shall not consume over 0.33 W/cfm at maximum speed
  - **Standby Mode:** When stopped and unoccupied with *doors* closed for over 15 minutes, cab interior lighting and *ventilation* shall be de-energized until required for operation
  - **Documentation**: Design docs need to list use category and energy efficiency class A-G (per ISO 25745-2, Table 7)

Air Curtains

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.5	Arch/Mech dwgs, specs.

- Shall be tested in accordance with ANSI/AMCA 220 or ISO 27327-1 and installed and commissioned in accordance with the manufacturer's instructions to ensure proper operation
- Shall have a jet velocity of not less than 6.6 ft/s at 6.0 in. above the floor and direction not less than 20 degrees towards the opening.
- Automatic controls shall be provided that will operate the air curtain with the opening and closing of the door.

Whole Building Monitoring

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.5.1	Specialty, dwgs, Specs, Seq. of Ops.

- Measurement devices shall be installed to monitor the *building* use of the following types of *energy* supplied by a utility, *energy* provider, or plant that is not within the *building*:
  - Natural gas.
  - *Fuel* oil.
  - Propane.
  - Steam.
  - Chilled water.
  - Hot water.

Clean Water Pumps

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.7	Plumbing dwgs, specs, supp. calcs.

- Table of maximum PEI values for given pumps
  - Use variable load for pumps sold with VFDs

Table 10.8-6 Maximum Pump Energy Index (PEI)

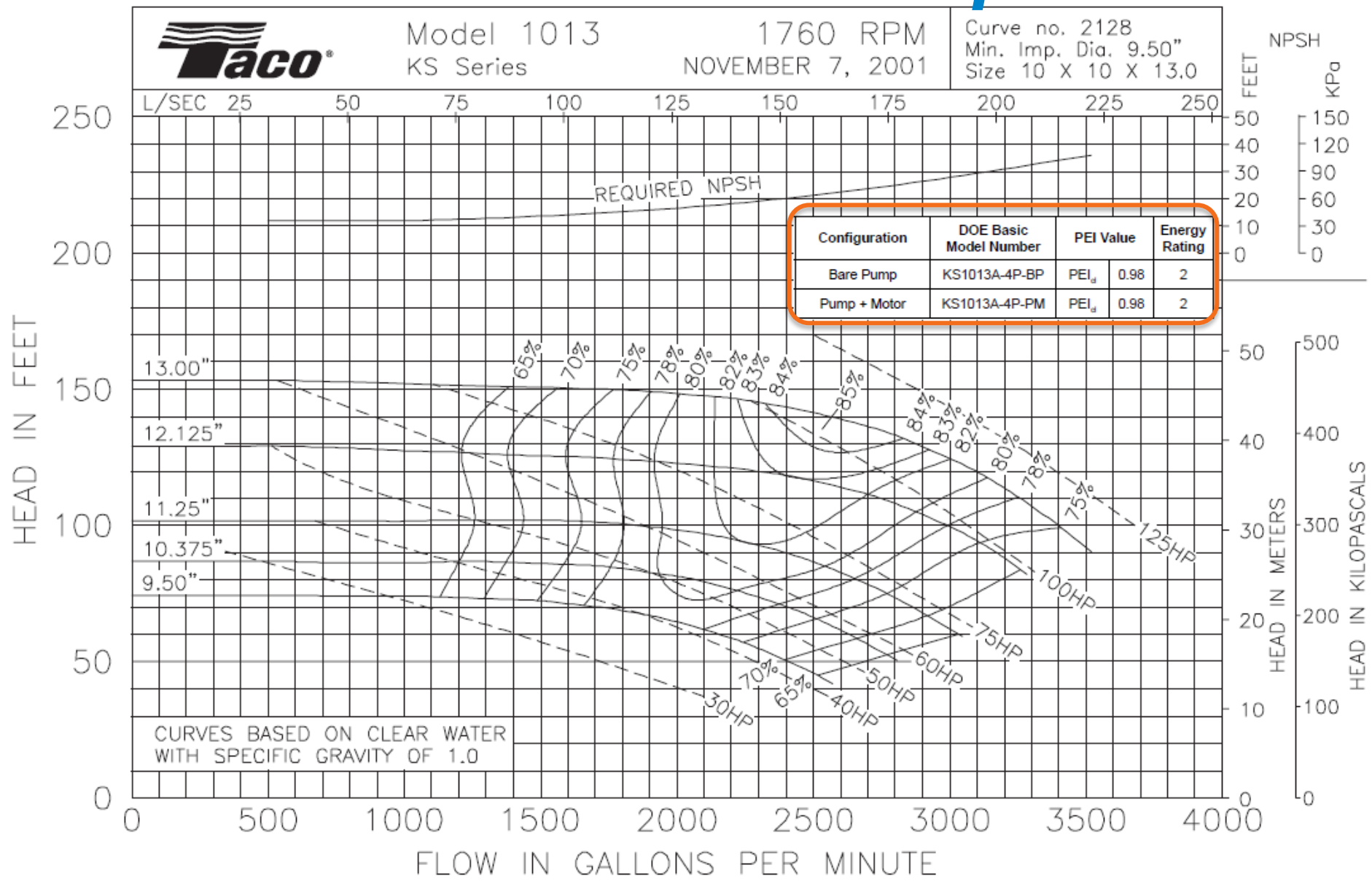
Maximum PEI for Pumps Manufactured on or after January 27, 2020					
Pump Type	**Nominal Speed of Rotation (RPM)**	**Operating Mode**	**Maximum PEI [a]**	**C-Value [b]**	**Test Procedure**
End suction, close coupled	1800	Constant load	1.00	128.47	10 CFR Part 431
End suction, close coupled	3600	Constant load	1.00	130.42	10 CFR Part 431
End suction, close coupled	1800	Variable load	1.00	128.47	10 CFR Part 431
End suction, close coupled	3600	Variable load	1.00	130.42	10 CFR Part 431
End suction, frame mounted	1800	Constant load	1.00	128.85	10 CFR Part 431
End suction, frame mounted	3600	Constant load	1.00	130.99	10 CFR Part 431
End Suction, frame mounted	1800	Variable load	1.00	128.85	10 CFR Part 431
End suction, frame mounted	3600	Variable load	1.00	130.99	10 CFR Part 431

Clean Water Pumps

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.4.7	Plumbing dwgs, specs, supp. calcs.

- Requirements apply to pumps 1-200 HP only
- Several exceptions for niche applications. Namely:
  1. Fire pumps.
  2. Self-priming pump.
  3. Prime-assist pumps.
  4. Magnet-driven pumps.
  5. Pumps designed to be used in a nuclear facility
  6. Pumps meeting the design and construction requirements set forth in U.S. Military Specifications

Clean Water Pumps



Verification & Commissioning

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
10.9	Commissioning plan

- Need to verify or commission pressure boost systems, elevator standby controls, whole building energy monitoring
- Verify that they work in accordance with their respective sections.

Power

Data Center Power

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.2.1 & 8.5	Elec. dwgs, supp. calcs.

- The 2021 OEESC changed the wording so that power systems serving new data centers also complied with 90.4. Section 8.2.1 states:
  - Power *distribution systems* and *equipment* serving a data center shall comply with Section 8.5.

- Then section 8.5 states:
  - Power *distribution systems* and *equipment* serving a data center shall comply with ASHRAE Standard 90.4, Energy Standard for Data Centers.

Data Center Power

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.2.1 & 8.5	Elec. dwgs, supp. calcs.

- Divide the total electrical system losses by the ITE load. If results are less than the maximum values below, the design complies

Table 8.5 Maximum *Design Electrical Loss Component* (*Design ELC*) and ELC Segments *Systems* (IT Design Load <100 *kW*) [a]

UPS Redundancy Configuration	Single-Feed *UPS* (*N*, *N+1*, etc.) or No *UPS* [b]		Active Dual-Feed *UPS* (*2N*, *2N+1*, etc.) [c]	
Calculation Percentage	100% of IT design load segment ELC	50% of IT design load segment ELC	50% of IT design load segment ELC	25% of IT design load segment ELC
Segments of ELC and Overall ELC	*Loss / efficiency*	*Loss / efficiency*	*Loss / efficiency*	*Loss / efficiency*
Incoming Electrical Service Segment	15.0% / 85.0%	11.0% / 89.0%	11.0% / 89.0%	10.0% / 90.0%
UPS Segment	8.0% / 92.0%	10.0% / 90.0%	10.0% / 90.0%	13.5% / 86.5%
ITE Distribution Segment	6.0% / 94.0%	4.0% / 96.0%	4.0% / 96.0%	3.0% / 97.0%
Electrical *Loss* / *Efficiency* Total	26.5% / 73.5%	23.1% / 76.9%	23.1% / 76.9%	24.5% / 75.5%
ELC	0.265	0.231	0.231	0.245

a. ***Informative Note:*** Example calculations are shown in Informative Appendix C.

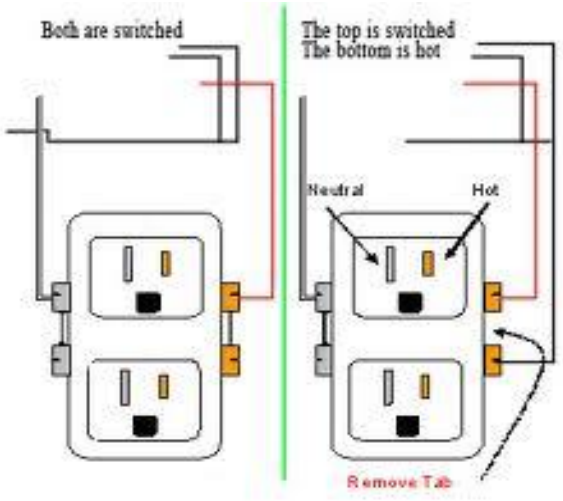
b. ***Informative Note:*** These columns apply to electrical configurations resulting in a single output feed from the *UPS* irrespective of the number of *UPS* modules that may be paralleled prior to the output feed or the number of branches or subfeeders into which that output feeder may be divided.

c. ***Informative Note:*** These columns apply to electrical configurations made up of two distinct and electrically separated *UPS systems* resulting in two distinct and electrically separate output feeds, either of which is capable of independently supporting the total design load. *Systems* that meet these criteria may be made up of any number of *UPS* modules that are paralleled prior to each output feed. Crossties and/or transfer switches downstream of the independent feeds shall not continually tie the two output sections together.

Automatic Receptacle Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.2	Elec. dwgs, specs.

- Min 50% receptacles in private offices, conference rooms, printing rooms, break rooms, open offices and classrooms required to be controlled by auto device (timeclocks or occ sensors)
- 25% of branch circuits for modular furniture
- Power strips with integrated occ sensor doesn't comply
- Controlled receptacles must be marked and uniformly distributed



Automatic Receptacle Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.2	Elec. dwgs, specs.

- Controlled by one of the following:
  - scheduled time-of-day that turns receptacles off at specific programmed times
    - » an independent program schedule shall be provided for controlled areas of no more than 5000 ft^2 and not more than one *floor* (the occupant shall be able to manually override the *control device* for up to two hours);
  - an *occupant sensor* to turn receptacles off within 20 minutes of all occupants leaving a *space*; or
  - *control* or alarm *system* that turns receptacles off within 20 minutes after determining that the area is unoccupied.
- Controlled receptacles must be clearly marked to differentiate from a standard receptacle

Automatic Receptacle Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.2	Elec. dwgs, specs., OEESC form, COMcheck

- A few exceptions
- Receptacles for the following shall not require an *automatic control device*:
  1. Receptacles specifically designated for *equipment* requiring continuous operation (24/day, 365 days/year).
  2. *Spaces* where an *automatic control* would endanger the safety or security of the room or *building* occupants.
  3. The building complies with one of the following:
     a. Results of performance compliance under Section 11 or Appendix G are at least 5% better than the minimum.
     b. COMcheck envelope compliance report passes by minimum of 3%.
     c. COMcheck lighting report passes by a minimum of 5%.

Unique Oregon Exception

Electrical Energy Monitoring

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.3.1	Elec. dwgs, specs

- Measurement devices shall be installed in new *buildings* to monitor the electrical *energy* use for each of the following separately:
  a. Total electrical energy
  b. HVAC systems
  c. Interior lighting
  d. Exterior lighting
  e. Receptacle circuits

- For buildings with multiple tenants, the above must be separately monitored for total building and for each tenant (excluding shared systems)

Exception:

- up to 10% of each separate load (other than total) can be from other electrical loads

Electrical Energy Reporting

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.3.2	Elec. dwgs, specs

- Energy use must be automatically recorded a minimum of every 15 minutes
- Use must be reported at least hourly, daily, monthly, and annually
- Data for tenants must be made available to that tenant
- Buildings with BMS need to graphically display energy use data and retain data for at least 36 months

Electrical Energy Monitoring & Reporting

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
8.4.3.2	Elec. dwgs, specs

- **Exceptions to Sections 8.4.3.1 and 8.4.3.2**
  1. *Building* less than 25,000 ft^2.
  2. Individual tenant *spaces* less than 10,000 ft^2.
  3. *Dwelling units*.
  4. *Residential buildings* with less than 10,000 ft^2 of common area.
  5. Critical and *Equipment* branches of NEC Article 517.

Lighting

New Compliance Method for Lighting in Simple Buildings

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
9.3	OEESC form, elec. dwgs

- Allowed if at least 80% of floor area is office, retail, or school
- Can be used for new buildings or tenant improvements < 25,000 ft^2
- Single interior and exterior LPD targets that cover the entire building, LPAs are lower than other methods
- Requires occupancy sensor lighting control in most spaces with some exemption where life safety concerns apply
- All power from all lights must be counted towards the Interior Lighting Power Allowance (ILPA) **No Exemptions** ⇦

New Compliance Method for Lighting in Simple Buildings

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.3.1	N/A

Table 9.3.1-3 Simplified Building Method for School *Buildings*

Interior *Space* Type	Interior Lighting Power Allowance	*Controls* [a]
All *spaces* in school *buildings* other than parking garages, stairwells, and corridors	0.70 W/ft^2	All lighting shall be *automatically* controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. (**Exception:** Lighting load not exceeding 0.02 W/ft^2 multiplied by the gross lighted area of the *building* shall be permitted to operate at all times.) Each *space* shall have a *manual control* device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off.
Classrooms, offices *spaces*, conference rooms, meeting rooms, library, storage rooms, and break rooms	0.70 W/ft^2	These *spaces* shall also be controlled by *manual-ON occupant sensors*.
Gymnasiums and cafeterias	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors*.
Restrooms	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors*.
Stairwells and corridors in school *buildings* and parking garages	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors* that reduce the lighting power by a minimum of 50% when no activity is detected for not longer than 20 minutes and be controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied.
Parking garages	0.13 W/ft^2	All lighting shall be *automatically* controlled to turn off during garage nonoperating hours. Lighting shall also be controlled by *occupant sensors*. *Controls* shall reduce the power by a minimum of 50% when no activity is detected for not longer than 20 minutes. No device shall control more than 3600 ft^2.

a. All lights in the space shall be controlled.

New Compliance Method for Lighting in Simple Buildings

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.3.2	N/A

Table 9.3.2 Simplified Building Method for *Building* Exteriors

Exterior Area Type	*Exterior Lighting Power Allowance*[a,b]	*Controls*[c]
Base allowance	200 W	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Façade lighting and special feature areas, walkways, plazas	0.10 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Landscape	0.04 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Entry doors	14 W/linear foot	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Stairs and ramps	0.7 W/ft^2	No additional *controls* required.
Parking lots and drives	0.05 W/ft^2	*Luminaires* mounted 25 ft or less above grade shall be controlled to reduce the power by at least 50% when no activity is detected for not longer than 15 minutes.
All other areas not listed	0.20 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.

a. To calculate the exterior allowance, multiply the *space* or area square footage by the allowed W/ft^2 and sum the exterior allowances and the base allowance. Façade lighting shall be calculated separately by multiplying the façade area by the allowed W/ft^2. Façade allowance shall not be traded with other exterior areas or between separate *façade areas*.
b. For *buildings* in Lighting Zone 2, as defined in Table 9.4.2-1, decrease exterior allowances by 20%. For *buildings* in Lighting Zone 4, as defined in Table 9.4.2-1, increase exterior allowances by 25%.
c. All exterior lighting shall be automatically controlled by either a photocell or an astronomical time switch to shut off the lighting when daylight is available.

OEESC Simplified Lighting Form

Simplified Building Method—Lighting Compliance Checklist

2021 Oregon Energy Efficiency Specialty Code Compliance

This checklist can be used to demonstrate compliance with the Simplified Building Method, Section 9.3 of the Oregon Energy Efficiency Specialty Code (OEESC)/ASHRAE Standard 90.1 in either office buildings, retail buildings, or school buildings. This form is in addition to the COM*check* compliance report.

Notes:
1. For the Simplified Building Method, the building shall be less than 25,000 ft^2.
2. Lighting Compliance Checklist is not required to be submitted
3. Certificate may show lighting results as "FAILS"
4. Report must be for Building Area Method, not Area Category (Space-by-Space)

PART I – PROJECT INFORMATION

Title/Site/Permit name:

Floor area:

PART II – COMPLIANCE

Lighting power allowance: The total lighting power allowance (W/ft^2) for the building shall be less than the allowance from Tables 9.3.1-1 through 9.3.1-3.

Building type: Select the building type, which shall not be less than 80% of the total building conditioned floor area.

- ☐ **Office** Allowed lighting power: 0.70 W/ft^2
- ☐ **Retail** Allowed lighting power: 1.0 W/ft^2
- ☐ **School** Allowed lighting power: 0.70 W/ft^2
- ☐ **Garage** Allowed lighting power: 0.13 W/ft^2 (must be associated with occupancy listed above)

COM*check* Interior Lighting Compliance Certificate results:

Enter the specified results from the COM*check* Interior Lighting Compliance Certificate.

*No exemptions or allowances are permitted

1. Proposed Interior Lighting Power (Total) _____ Watts
2. Building floor area from COM*check* report: _____ ft^2
3. Lighting Power Density (Total W /Floor Area): _____ W/ ft^2 (Divide line 1 by line 2)

* The Lighting Power Density must be less than the allowed lighting power for the building type as noted above.

Where an interior garage is provided, repeat the calculation: 1. _____ Watts 2. _____ ft^2 3. _____ W/ft^2

☐ **Check if the proposed interior lighting power density does not exceed the Section 9.3.1 allowances.**

- Oregon still requires a designer run the design through COMcheck, but it's ok if it "fails"
- Indicate LPD for whole building, not space-by-space
- Use COMcheck total watts/bldg. floor area to show compliance

OEESC Simplified Lighting Form

IIIA. OFFICE BUILDINGS—SIMPLIFIED BUILDING METHOD (TABLE 9.3.1-1)

Automatic controls—All spaces in an office building, other than parking garages, stairwells, and corridors, require automatic controls to turn off lighting when the building is either unoccupied or scheduled to be unoccupied, **except** that lighting loads not exceeding 0.02 W/ft^2 multiplied by the gross lighted area of the building shall be permitted to operate at all times.

Use the following checklist to demonstrate compliance with the lighting control requirements in each interior space type.

	Interior Space Type	Controls (All lighting shall be controlled)	Location on the plans
☐	Office spaces ≤ 250 ft^2 Classrooms Conference rooms Meeting rooms Training rooms Storage rooms Break rooms	☐ Automatic controls turn all lighting off when building is unoccupied or scheduled to be unoccupied **OR** ☐ Exception: Lighting loads not exceeding 0.02 W/ft^2 × gross lighted area operate at all times ☐ Manual control device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off ☐ Manual-ON occupancy sensors	
☐	Office spaces > 250 ft^2 Restrooms	☐ Automatic controls to turn lighting off when building is unoccupied or scheduled to be unoccupied **OR** ☐ Exception: Lighting loads do not exceed 0.02 W/ft^2 × gross lighted area ☐ Manual control device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off. ☐ Occupancy sensors (May be automatic ON)	
☐	Stairwells and corridors in office buildings	☐ Automatic controls to turn lighting off when building is unoccupied or scheduled to be unoccupied **OR** ☐ Exception: Lighting loads do not exceed 0.02 W/ft^2 × gross lighted ☐ Occupancy sensor to reduce the power by a minimum of 50% after no activity is detected for not longer than 20 minutes	
☐	Parking garages	☐ Automatic controls to turn lighting off during nonoperating hours. ☐ Occupancy sensors to reduce the power by a minimum of 50% after no activity is detected for not longer than 20 minutes No device shall control more than 3600 ft^2	

- Simple check of which controls are being used for each area
- Each bldg. type has different list of spaces/reqmnts

New Construction

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.1.1	N/A

- Interior spaces of buildings

- Exterior lighting powered through building's electrical service

Exceptions:

- *Emergency lighting (auto off)*
- *Required by health/safety statute, ordinance, regs*

Lighting Alteration

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.1.2	COMcheck, elec. dwgs.

- Alterations (retrofits) revised: Interior and Exterior LPD and all Control requirements must be met when **20%** or more of the total lighting load is replaced (< 20% exempt as long as they do not increase lighting power)

- One-for-one luminaire replacement or replacement of light source and ballast/driver must meet LPD and auto lighting shutoff
- **Interior** retrofits must now also comply with occupancy and scheduled full and partial shutoff and bi-level switching where specified for that space type.

- **Exterior** retrofits must now also comply with astronomical control and/or scheduled shutoff control where specified for each application.

Interior Lighting Power

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.2.2.3	Supp. calcs., Elec. schedules

- Primarily based on improved efficacy of LED lighting
- Installed interior lighting power must be ≤ lighting power allowance

  Installed interior lighting power calculation method
  - Calculation requirements
  - Lots of exemptions

- Two LPD calculation Methods:

  - **Building Area Method**
  - Simplified approach for demonstrating compliance

  - **Space-by-Space Method**
  - Alternative approach allows flexibility

Interior Lighting Power

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.3	COMcheck forms, lighting plans, specs

- Not less than ~~75%~~ 100% of the permanently installed lighting fixtures shall use lamps with an efficacy of at least 55 lm/W or have a total luminaire efficacy of at least 45 lm/W. Dwelling unit floor area shall be excluded from total building floor area under the Building Area Compliance Method (9.5.1).

- Exceptions:
  1. Lighting that is controlled with dimmers or controlled in accordance with Section 9.4.1.1(h). (Auto-off)
  2. Hotel/motel guest rooms. The requirements for hotel/motel guest rooms are covered in Table 9.6.1 and Section 9.4.1.3(b).

Installed Lighting Power Calculation Requirements

- These requirements apply to both interior and exterior
  - Installed Lighting Power shall include all power used by the luminaires, including lamps, ballasts/drivers, transformers, and controls
    - » **Exception**: where two independent lighting systems exist in the same space or area and are controlled to prevent simultaneous operation, only the system with the highest total wattage must be included
- Luminaire Wattage for various systems shall be determined in accordance with details in Section 9.1.4

Luminaire Wattage Calculation Requirements

- These requirements apply to both interior and exterior
  - Wattage of lighting equipment connected to line voltage = manufacturers' labeled max. wattage
  - Luminaires with ballasts/drivers or transformers = total input wattage of all components. For luminaires with factory adjustable ballast factors (not user changeable), apply the ballast factor to be used in the space)
  - Line voltage track = actual wattage with a min. 30 W per foot OR wattage limit of system's circuit breaker OR wattage limit of other permanent-current-limiting device(s) on the system
  - Low voltage track = transformer wattage
  - DC low-voltage with flexible cabling for plug-in connection and remote power supply = labeled maximum wattage of power supply minus wattage of connected non-lighting equipment
  - All others as specified on equipment

Installed Interior Lighting Power Calculation Exemptions

Lighting that does not have to be included in the installed lighting power calculation:

- Theatrical, stage, broadcast studio, film, and video production
- Medical and dental procedures
- Exhibit displays for museums, monuments, and galleries
- Integral to equipment, medical equipment or instrumentation installed by manufacturer
- Integral to both open and glass-enclosed refrigerator and freezer cases
- Retail display windows, provided the display is enclosed by ceiling-height partitions
- Food warming and food preparation equipment
- Interior spaces specifically designated as registered interior historic landmarks
- Integral part of advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Lighting in sporting activity areas for television broadcasting
- Casino gaming areas
- Furniture-mounted supplemental task lighting
- For use in areas specifically designed for life support of nonhuman life forms
- Mirror lighting in dressing rooms
- Accent lighting in religious pulpit and choir areas
- Parking garage transition lighting
- Photographic processes

Building Area Method of Calculating Interior Lighting Power Allowance

- Can be used for entire building or separate building type occupancies

- Advantages
  - Fewer calculations

- Limitations
  - Limited building area type selection - use reasonably equivalent type
  - Insensitive to specific space functions and room configurations
  - Generally more restrictive that space-by-space method

- Calculation Process
  1. Determine gross lighted area for each building type area using:
     a) Exterior faces of exterior walls
     b) Centerline of interior walls
  2. Calculate the area power allowance by multiplying the gross lighted area by the applicable building type allowance from Table 9.5.1
  3. Sum all the allowances (if more than one building type area)

LPD - Building Area Method

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.5.1	COMcheck form, Elec. schedules, specs

Building Area Type[a]	*LPD*, W/ft^2
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: Bar lounge/leisure	0.80
Dining: Cafeteria/fast food	0.76
Dining: Family	0.71
Dormitory	0.53
Exercise center	0.72
Fire station	0.56
Gymnasium	0.76
Health-care clinic	0.81
Hospital	0.96
Hotel/motel	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multifamily	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious facility	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

- **Building area LPDs** – Almost all reduced as much as **34%** with overall avg reduction across all building types of **12%**
- Some went down compared to 90.1-2016

Building Area Method – Lighting Power Densities (w/sq. ft.)

Building Type	90.1 2016	⇨	90.1 2019
Office	0.79	⇨	0.64
Hotel/Motel	0.75	⇨	0.56
Manufacturing Facility	0.90	⇨	0.82
Parking Garage	0.15	⇨	0.18
Retail	1.06	⇨	0.84
School/University	0.81	⇨	0.72
Warehouse	0.48	⇨	0.45

LPD - Space-By-Space Method

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.6.1	COMcheck form, Elec. schedules, specs

Space-by-Space LPDs – Average LPD reduction from 2016: **5%**

The *control* functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1 For each *space* type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Informative Note: This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.

Common *Space* Types[1]	*LPD* Allowances, W/ft²	*RCR* Threshold	a	b					h	i
			Local *Control* (See Section 9.4.1.1[a])	Restricted *Manual* O (See Sect 9.4.1.1[b])					*Automatic* Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
Atrium										
<20 ft in height	0.39	NA	REQ	ADD1					ADD2	ADD2
≥20 ft and ≤40 ft in height	0.48	NA	REQ	ADD1					ADD2	ADD2
>40 ft in height	0.60	11	REQ	ADD1					ADD2	ADD2
Audience Seating Area										
Auditorium	0.61	6	REQ	ADD1					ADD2	ADD2
Gymnasium	0.23	6	REQ	ADD1					ADD2	ADD2
Motion picture theater	0.27	4	REQ	ADD1					ADD2	ADD2
Penitentiary	0.67	4	REQ	ADD1					ADD2	ADD2
Performing arts theater	1.16	8	REQ	ADD1	ADD1	REQ	REQ	REQ	ADD2	ADD2
Religious facility	0.72	4	REQ	ADD1	ADD1	REQ	REQ	REQ	ADD2	ADD2
Sports arena	0.33	4	REQ	ADD1	ADD1		REQ	REQ	ADD2	ADD2
All other audience seating areas	0.23	4	REQ	ADD1	ADD1		REQ	REQ	ADD2	ADD2

Space-by-Space Method – Lighting Power Densities (w/sq. ft.)

Space Type	90.1 2016	⇨	90.1 2019
Office, open plan	0.81	⇨	0.61
Guest room	0.77	⇨	0.41
Lobby, hotel	1.06	⇨	0.51
Parking area, interior	0.14	⇨	0.15
Retail sales Area	1.22	⇨	1.05
Classroom/lecture/training	0.92	⇨	0.71
Warehouse, med. To bulky items	0.35	⇨	0.33

COMcheck Report

- Shows whether LPD complies with either Space-by-space or whole building method

Allowed Interior Lighting Power

A Area Category	B Floor Area (ft2)	C Allowed Watts / ft2	D Allowed Watts
1-Common Space Types:Office - Open Plan	1000	0.61	610
2-Retail:Sales Area	5000	1.05	5250
3-Common Space Types:Workshop	2700	1.26	3402
		Total Allowed Watts =	9262

Proposed Interior Lighting Pow

A Fixture ID : Description / Lamp	B Lamps/ Fixture	C # of Fixture	D Fixture Watt.	E (C X D)
1-Common Space Types:Office - Open				
T8 / T12 Fluorescent 1: A: 2x4 Troffer, parabolic [illegible] T8 32W: Electronic:	3	10	95	950
Compact Fluorescent 1: F: Down light, twin tu[illegible] Tube 18W: Magnetic:	2	10	46	460
2-Retail:Sales Area				
T8 / T12 Fluorescent 3: C: 4 ft. Wall mout, [illegible] ap-around: 48" T8 32W: Premium efficiency:	2	30	65	1950
LED: J: Low bay, pendant mount: LED PAR 7W:	1	10	7	70
3-Common Space Types:Workshop				
T8 / T12 Fluorescent 5: E: 8 ft. Industrial, pendant mount: 96" T8 75W: Electronic:	2	30	130	3900
HID 1: I: Recessed mtl halide down light: Metal Halide: --:	1	2	67	134
		Total Proposed Watts =		7464

Lamp Type
Fixture ID
Description &
watts/lamp

Interior Lighting PASSES: Design 19% better than code

Interior Lighting Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Table 9.6.1	COMcheck form, Elec. schedules, specs

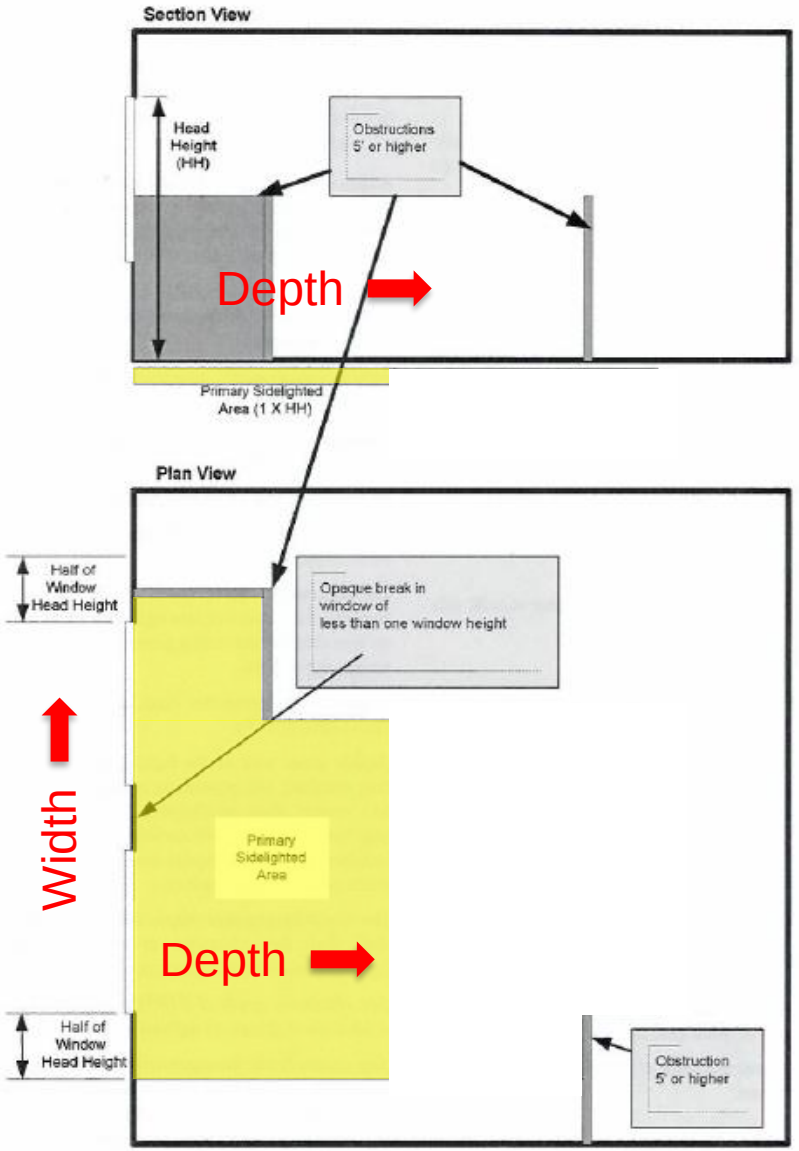
- ASHRAE table format that includes Space-By-Space LPDs and control requirements (small part shown below)

Informative Note: This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.			The *control* functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1 For each *space* type: (1) All REQs shall be implemented. (2) At least one ADD1 (when present) shall be implemented. (3) At least one ADD2 (when present) shall be implemented.								
Common *Space* Types[1]	*LPD* Allowances, W/ft^2	*RCR* Threshold	Local *Control* (See Section 9.4.1.1[a])	Restricted to *Manual* ON (See Section 9.4.1.1[b])	Restricted to Partial *Automatic* ON (See Section 9.4.1.1[c])	Bilevel Lighting *Control* (See Section 9.4.1.1[d])	*Automatic* Daylight Responsive *Controls* for Sidelighting (See Section 9.4.1.1[e][6])	*Automatic* Daylight Responsive *Controls* for *Toplighting* (See Section 9.4.1.1[f][6])	*Automatic* Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	*Automatic* Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Atrium											
<20 ft in height	0.39	NA	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
≥20 ft and ≤40 ft in height	0.48	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
>40 ft in height	0.60	11	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Audience Seating Area											
Auditorium	0.61	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Gymnasium	0.23	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Motion picture theater	0.27	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Penitentiary	0.67	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Performing arts theater	1.16	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Religious facility	0.72	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Sports arena	0.33	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
All other audience seating areas	0.23	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2

COMcheck Inspection Report

Section # & Req.ID	Rough-In Electrical Inspection	Complies?	Comments/Assumptions
9.4.1.1 [EL1]²	Automatic control requirements prescribed in Table 9.6.1, for the appropriate space type, are installed. Mandatory lighting controls (labeled as 'REQ') and optional choice controls (labeled as 'ADD1' and 'ADD2') are implemented.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1a [EL2]²	Independent lighting controls installed per approved lighting plans and all manual controls readily accessible and visible to occupants.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1b [EL26]²	No lighting shall be automatically turned on - restriced to manual.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1c [EL27]²	<= 50% of general lighting power shall be allowed to be automatically turned on.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1d [EL28]²	Bilevel lighting control - <= 50% of general lighting controlled with one intermediate step between full off and full on.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1e [EL29]²	Automatic daylight responsive controls for sidelighting >= 150 watts controlled by photocontrols.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02
9.4.1.1f [EL30]²	Automatic daylight responsive controls for toplighting >= 150 watts controlled by photocontrols.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	Requirement will be met. Plans reference page/section: E2.00, E2.01, E2.02

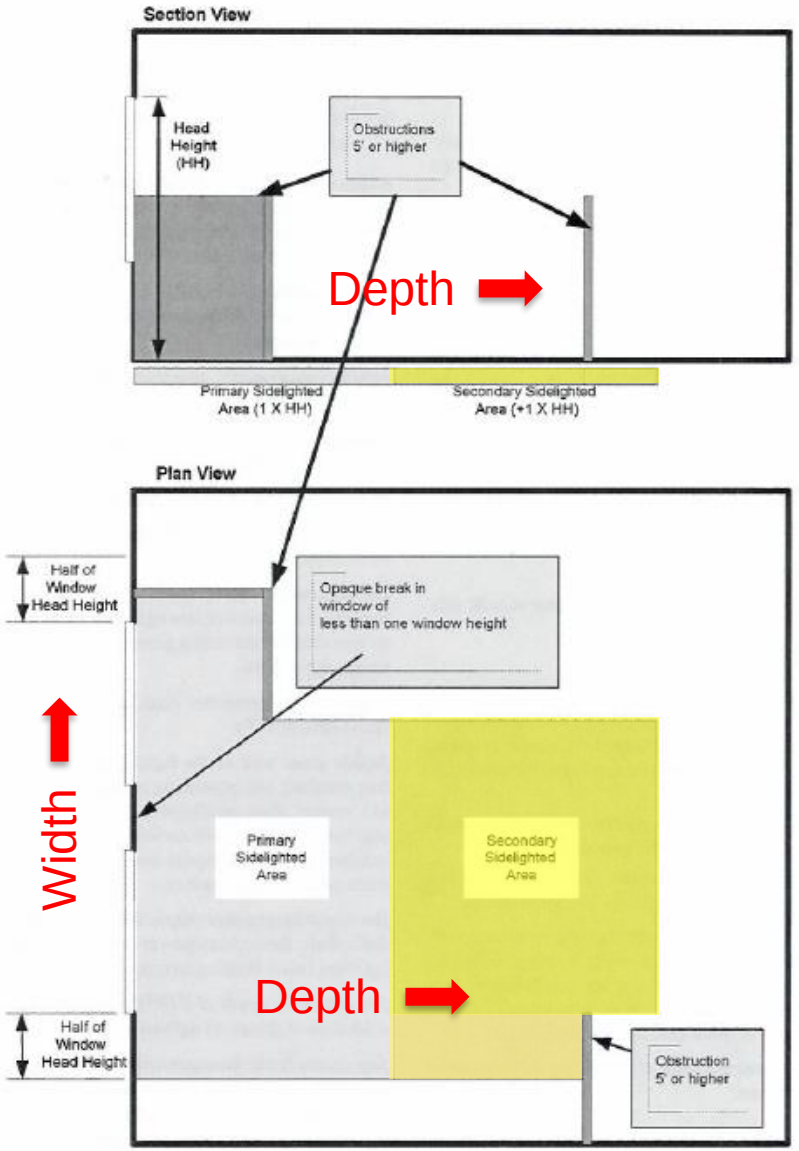
Primary Sidelighted Area



2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.1.1 [e] & [f]	Supp. calcs.

- **Width** = width of vertical fenestration plus, on each side, the smaller of:
  - half of vertical fenestration floor-to-head height or
  - the distance to any 5 ft or higher vertical obstruction
- **Depth** = horizontal distance perpendicular to vertical fenestration; begins at glazed wall, ends at the smaller of:
  - one vertical fenestration floor-to-head height or
  - the distance to any 5 ft or higher opaque vertical obstruction.

Secondary Sidelighted Area



2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.1.1 [e] & [f]	Supp. calcs.

- **Width** = width of vertical fenestration plus, on each side, the smaller of:
  - half of vertical fenestration floor-to-head height or
  - the distance to any 5 ft or higher vertical obstruction
- **Depth** = horizontal distance perpendicular to vertical fenestration; begins at edge of primary sidelighted area depth, ends at the smaller of:
  - one vertical fenestration floor-to-head height or
  - the distance to any 5 ft or higher opaque vertical obstruction.

Parking Garage Lighting Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.1.2	Elec. dwgs & schedules, specs

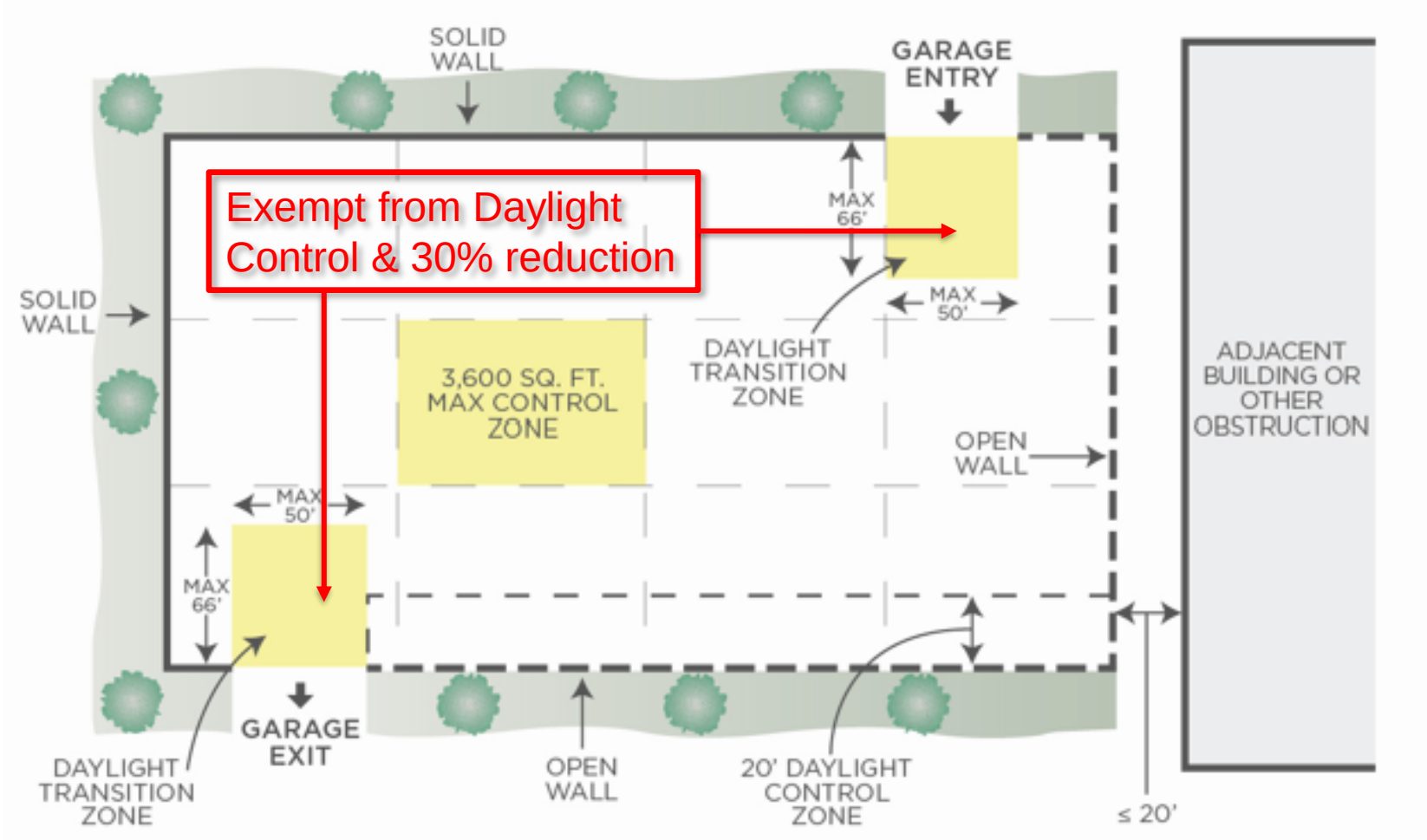
- Scheduled automatic lighting shutoff per 9.4.1.1(i)
- Must reduce lighting power by minimum of 50% when no activity is detected for 10 minutes within a lighting zone ≤ 3,600 ft^2
- Parking garage daylight transition lighting exempt per Section 9.2.3.1 to be separately controlled to automatically reduce lighting to no more than general light level from sunset to sunrise
- Automatically reduce power through continuous dimming in response to daylight for luminaires within 20 ft of any perimeter wall openings totaling at least 24 ft^2

Exceptions to perimeter continuous dimming

- Parking garage daylight transition lighting exempt per 9.2.3.1
- Where permanent screens or architectural elements obstruct > 50% of opening
- Where top of any existing adjacent structure or natural object is at least twice as high above the openings as its horizontal distance from opening

Parking Garage Lighting Control

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.1.2	Elec. dwgs & schedules, specs



Exterior Lighting Controls

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.1.4	Elec. dwgs & schedules, specs

- Auto Daylight shutoff required – dawn to dusk
- Decorative façade and landscape ltg requires auto shutoff between midnight or closing, and 6am or opening time.
- Other lighting & signage req's auto reduction by min 50% from midnight to 6am, or when no activity detected for 15 mins
- Parking lot poles 24 ft or less auto controlled so that ltg is reduced by min 50% when no activity detected for 15 min
- 1500 W limit to controlled lighting groups
- Astronomical timeclocks, time switches, daylight and motion sensors

Exterior Lighting Power

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.4.2	COMcheck form, Elec. schedules, specs

- Exterior Building Lighting Power must meet prescribed power limits.
  - The total exterior lighting power allowance is the sum of the base site allowance plus individual lighting power densities (LPD) for the applicable “lighting power zone”
  - Trade-offs are allowed only among “Tradable Surfaces” applications
  - Some exemptions apply

Functional Testing

2021 Oregon / ASHRAE 90.1-2019	Plan Review Location
Section 9.9	Commissioning plan, specs

- Confirm devices have been functionally tested
  - Occ sensors – location and aiming
  - Photosensors – calibrated and properly located
  - Timeclocks/switches – schedules, battery backup
- Testing party cannot be part of design or construction team
  - But lighting control manufacturer is allowed to do the testing

Oregon Energy Code Compliance Form / Supplemental Forms

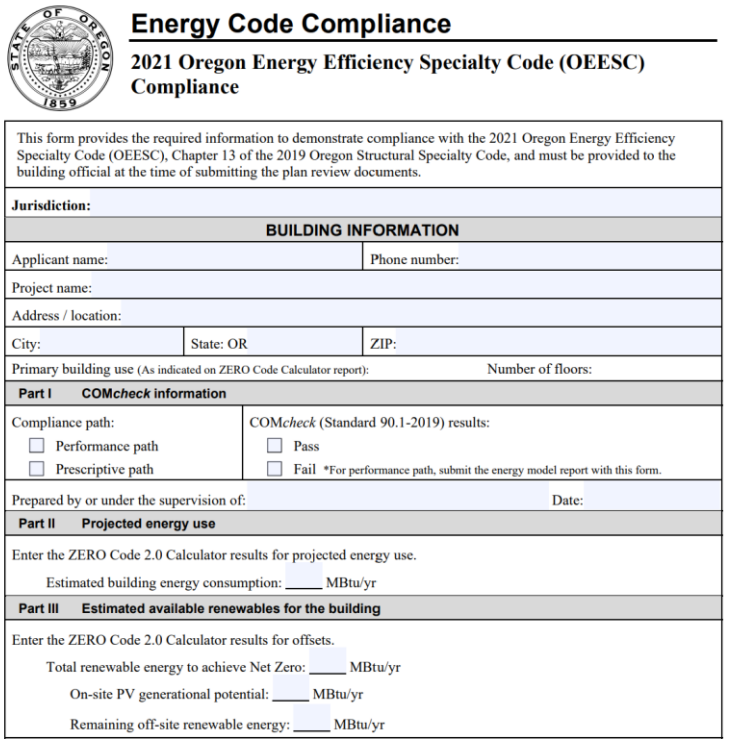
Commercial Energy Code Compliance

COMcheck™

Yes, this still needs to be filled out when using Appendix G.

Code Compliance Form

State of Oregon
Building Codes Division
Better Buildings for Oregon



Energy Code Compliance

2021 Oregon Energy Efficiency Specialty Code (OEESC) Compliance

This form provides the required information to demonstrate compliance with the 2021 Oregon Energy Efficiency Specialty Code (OEESC), Chapter 13 of the 2019 Oregon Structural Specialty Code, and must be provided to the building official at the time of submitting the plan review documents.

Jurisdiction:

BUILDING INFORMATION

Applicant name: | Phone number:

Project name:

Address / location:

City: | State: OR | ZIP:

Primary building use (As indicated on ZERO Code Calculator report): | Number of floors:

Part I COMcheck information

Compliance path:
- ☐ Performance path
- ☐ Prescriptive path

COMcheck (Standard 90.1-2019) results:
- ☐ Pass
- ☐ Fail *For performance path, submit the energy model report with this form.

Prepared by or under the supervision of: | Date:

Part II Projected energy use

Enter the ZERO Code 2.0 Calculator results for projected energy use.

Estimated building energy consumption: ____ MBtu/yr

Part III Estimated available renewables for the building

Enter the ZERO Code 2.0 Calculator results for offsets.

Total renewable energy to achieve Net Zero: ____ MBtu/yr

On-site PV generational potential: ____ MBtu/yr

Remaining off-site renewable energy: ____ MBtu/yr

https://zero-code.org/energy-calculator/

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ZERO Code Calculator Report

ABOUT YOUR BUILDING

Code Pathway: ○ Prescriptive ○ Performance

Standard: ZERO Code 2.0 *

Country: United States *

State: Oregon

City: Portland *

Number of Stories: 1 *

Add Another Use: *

Selected Use Type(s):

Office

OFFICE

delete

Gross Floor Area: 20000 * sq.ft *

ON-SITE PV SYSTEMS

Enter on-site PV system generation potential below, or estimate on-site PV system generation potential using PVWatts. If your building has multiple PV systems enter them below.

○ Use PVWatts ○ Enter Generation Potential

Set Default Values

delete

Estimated Area for Collectors: 500 * sq.ft *

Module Type: Standard *

Losses (%): 10 *

Array Type: Fixed - Open Rack *

RESULTS

○ metric ○ imperial

RENEWABLE ENERGY REQUIREMENTS

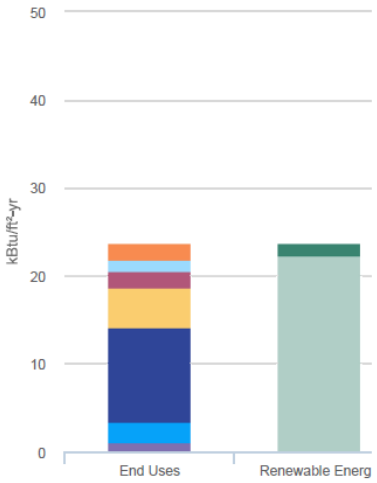
Energy Consumption & Generation

	kBtu/ft²-yr	MBtu/yr
Estimated Building Energy Consumption	23.6	472.5
Total Renewable Energy Required	23.6	472.5
On-Site PV Generation Potential	1.4	27.2
Remaining Off-Site Procured Renewable Energy	22.3	445.3

On-Site PV System

Rated Capacity (kW)	7
Estimated Area for Collectors (ft²)	500

ESTIMATED BUILDING ENERGY CONSUMPTION



Building Energy Consumption and End Uses are based on a code compliant prototype building modeled by Pacific Northwest National Laboratory. Actual building energy consumption will vary from modeled results.

Energy Code Compliance

2021 Oregon Energy Efficiency Specialty Code (OEESC) Compliance

This form provides the required information to demonstrate compliance with the 2021 Oregon Energy Efficiency Specialty Code (OEESC), Chapter 13 of the 2019 Oregon Structural Specialty Code, and must be provided to the building official at the time of submitting the plan review documents.

Jurisdiction:

BUILDING INFORMATION

Applicant name: Phone number:

Project name:

Address / location:

City: State: OR ZIP:

Primary building use (As indicated on ZERO Code Calculator report): Number of floors:

Part I COMcheck Information

Compliance path:
- ☐ Performance path
- ☐ Prescriptive path

COMcheck (Standard 90.1-2019) results:
- ☐ Pass
- ☐ Fail *For performance path, submit the energy model report with this form.

Prepared by or under the supervision of: Date:

Part II Projected energy use

Enter the ZERO Code 2.0 Calculator results for projected energy use.

Estimated building energy consumption: _____ MBtu/yr

Part III Estimated available renewables for the building

Enter the ZERO Code 2.0 Calculator results for offsets.

Total renewable energy to achieve Net Zero: _____ MBtu/yr

On-site PV generational potential: _____ MBtu/yr

Remaining off-site renewable energy: _____ MBtu/yr

CHECKLIST AND APPLICANT SIGNATURE

COMcheck report and ZERO Code 2.0 Calculator report must be submitted with this form.

- ☐ COMcheck report is attached
- ☐ Energy model report is attached (if COMcheck failed)
- ☐ ZERO Code Calculator report is attached
- ☐ 2021 OEESC COMcheck supplement report is attached

Print Name	Signature	Date

BCD Building Codes Division, Department of Consumer and Business Services

Published by Building Codes Division – Aug. 18, 2021

neea

Supplemental Form – for Oregon-specific amendments

COM*check* Supplement

2021 Oregon Energy Efficiency Specialty Code Compliance

Include this supplement with the Oregon Energy Efficiency Specialty Code Compliance Checklist.

Jurisdiction:

BUILDING INFORMATION

Applicant name: Phone number:

Project name:

Address / location:

City: State: **OR** ZIP:

☐ **Check here if not applicable and no items apply**

COMPLIANCE

DATA CENTERS

ASHRAE 90.4-2019 compliance (Sections 6.2.2, 6.5.11, 8.2.1, and 8.5) ☐ **Check if not applicable**

Mechanical design – Registered design professional	**Power design – Registered design professional**
Printed name:	Printed name:
Registration number:	Registration number:
Signature: Date	Signature: Date

Supplemental Form – for Oregon-specific amendments

SECTION 5: ENVELOPE COMPLIANCE

5.1.2.3: Unconditioned space with limited radiant heating ☐ **Check if not applicable**

(See Oregon amendment 6.5.8.3 HVAC)

☐ Space is identified on plans. Coverage area with limited radiant heating is identified on plans and the lesser of 500 ft^2 or 10% of floor area per 6.5.8.3

☐ Automatic controls for radiant spot heating per 6.5.8.3.

Plans and specs.:

5.4.3.3: Vestibules: additional exception ☐ **Check if not applicable**

This project shall furnish a whole-building air leakage report in lieu of providing a vestibule per the following:

☐ Building is less than 25,000 ft^2.

☐ Reported whole-building air leakage testing per Section 5.4.3.1.1 is less than 0.30 cfm/ft^2.

☐ Plans and specifications shall identify building entry door(s) meeting this exception.

Responsible party to provide test results:

SECTION 6: HVAC

6.4.3.5.1: Packaged HVAC Equipment with Electric Heat ☐ **Check if not applicable**

☐ Packaged HVAC systems with less than 241,000 Btu/h cooling capacity, with electric heating capacity of 21,500 Btu/h or greater have heat pump operation for first stage of heating

Plans and specs.:

6.5.8.3: Radiant Heating for Enclosed Unconditioned Spaces ☐ **Check if not applicable**

☐ Overhead radiant heating for occupied areas of the lesser of 500 ft^2 or 10% of floor area

☐ Automatic control: manual time switch or occupancy sensor

Plans and specs.:

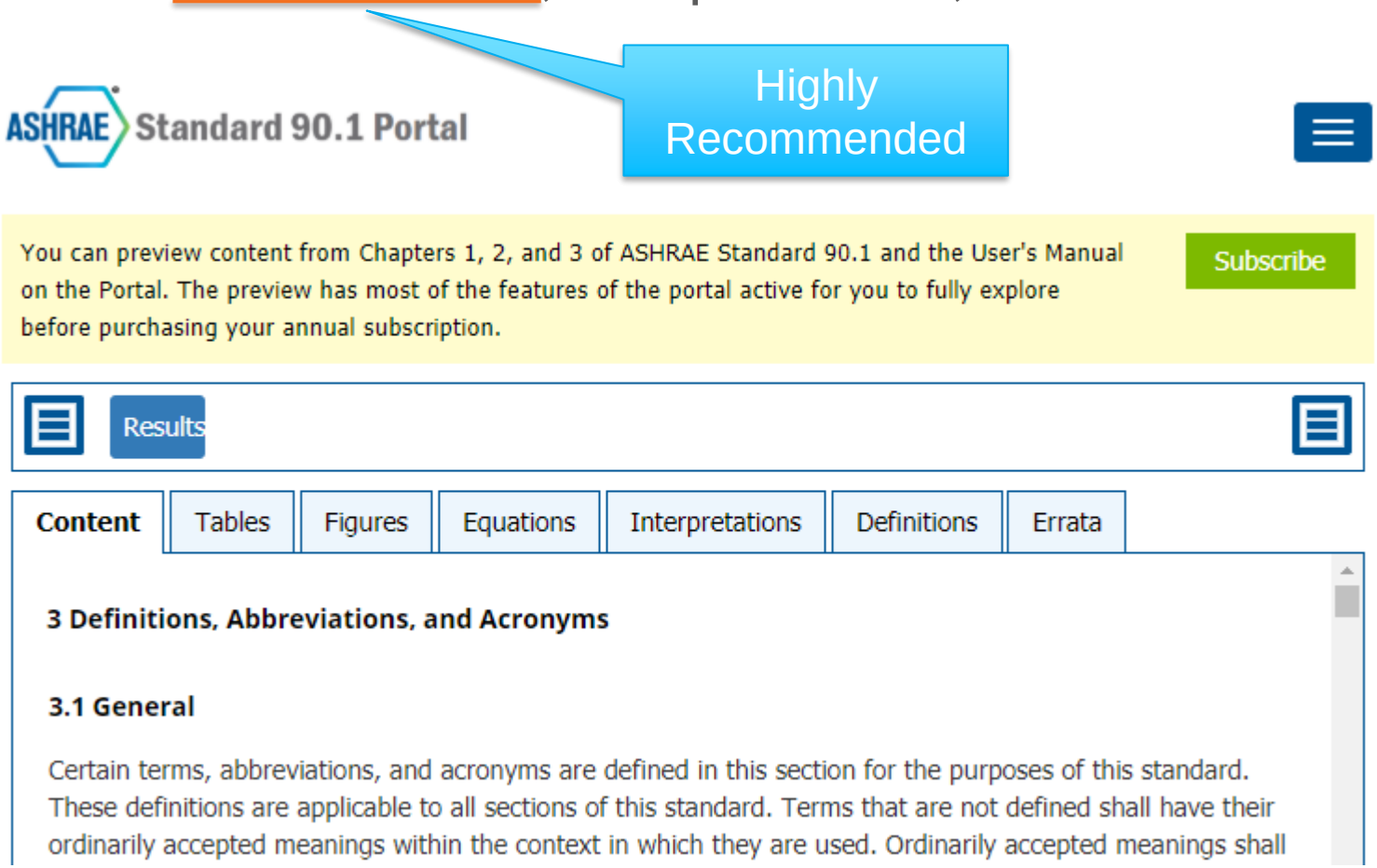
Supplemental Form – for Oregon-specific amendments

SECTION 8: POWER	
8.4.2: Receptacle Control Exception	☐ **Check if not applicable**
Building is not providing controlled receptacles required per Section 8.4.2. Additional efficiency provided with the following method (select one) ☐ Performance Compliance report showing minimum 5% better performance than minimum ☐ Section 11 ECB report included **or** ☐ Appendix G report included ☐ COMcheck Envelope Compliance report showing minimum 3% passing or higher ☐ ASHRAE 90.1-2019 COMcheck forms included ☐ COMcheck Lighting report showing minimum 5% passing or higher ☐ ASHRAE 90.1-2019 COMcheck forms included	
Printed name Registered design professional	Signature / Registration number / Date
SECTION 9: LIGHTING	
9.4.3: Dwelling units	☐ **Check if not applicable**
☐ Dwelling units lighting with 100% high efficacy lamps	
Plans and specs.:	

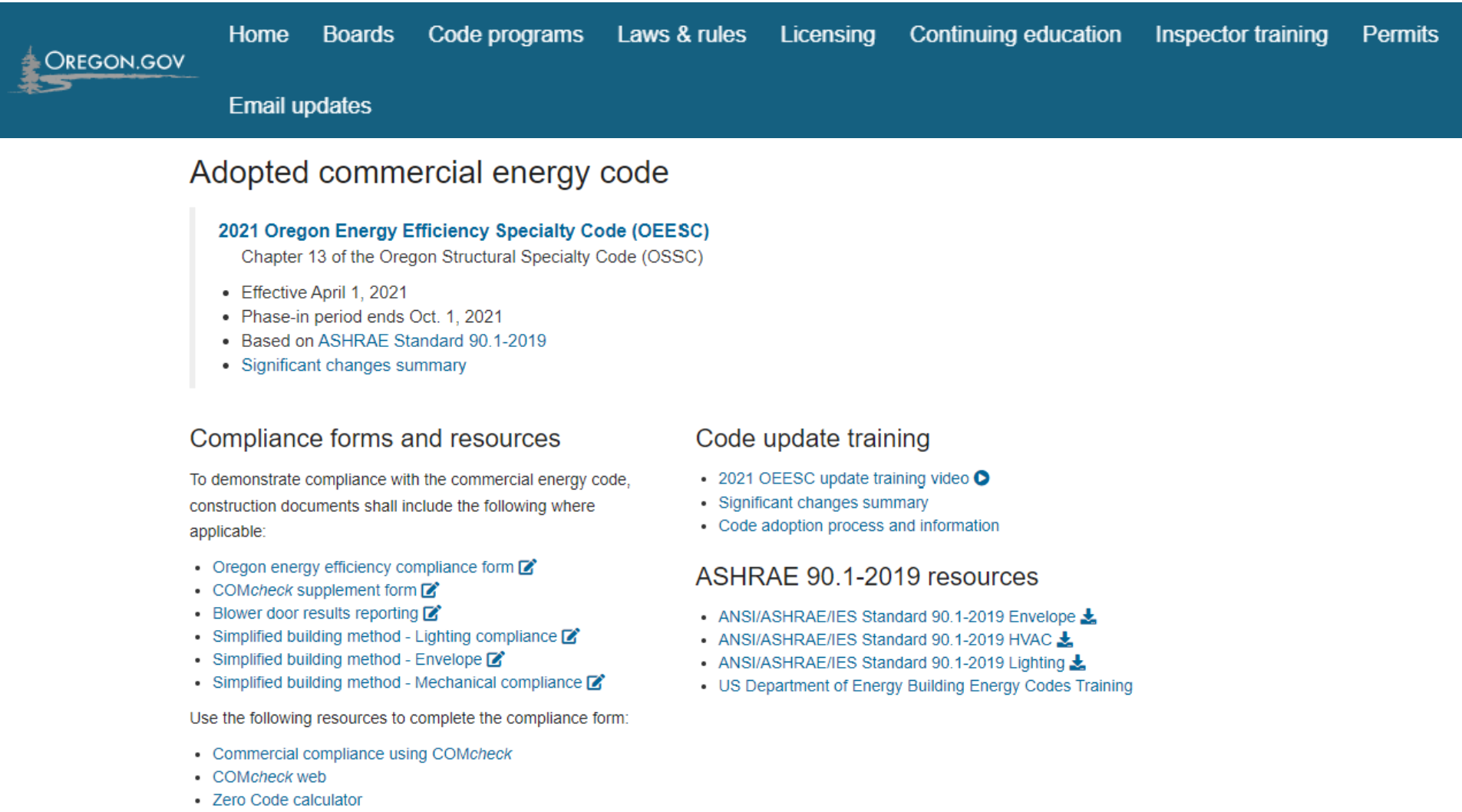
Resources & Open Discussion

ASHRAE 90.1 Portal

ASHRAE 90.1 online portal (annual subscription)
https://www.ashrae.org/technical-resources/90-1-portal
Includes user's manual, interpretations, redline & notes



Oregon Specific Resources



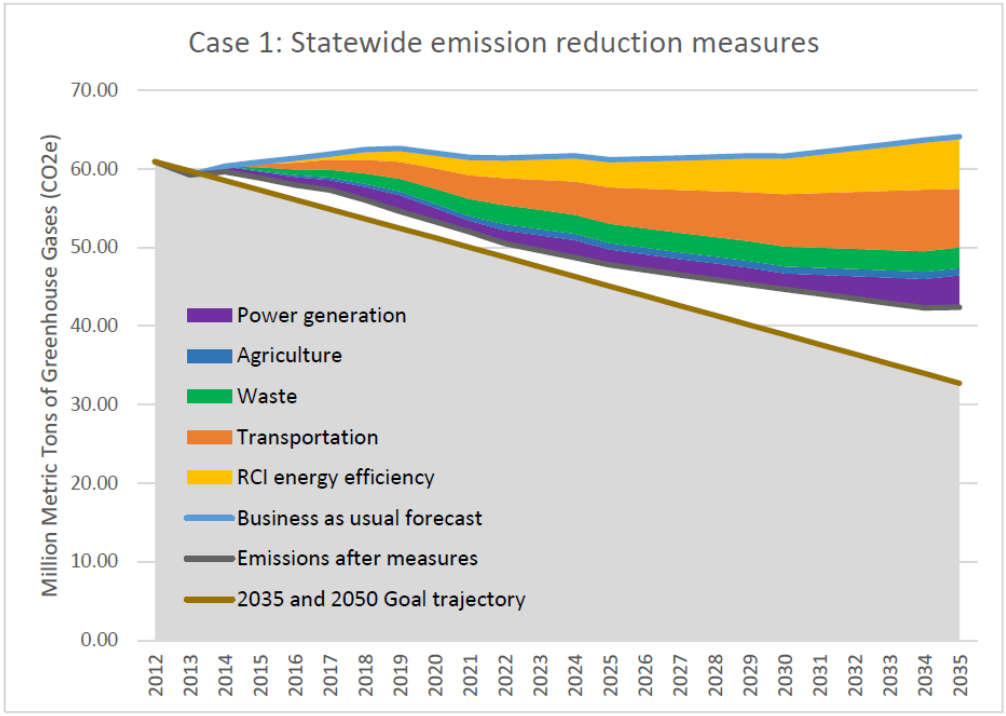
https://www.oregon.gov/bcd/codes-stand/Pages/energy-commercial-compliance.aspx

Appendix G Performance Rating Method Resources

- 90.1-2016 Performance Rating Method Reference Manual
- https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf
- Modelers: Use to build proposed design model
- Code Officials: Use to understand modeling requirements and interpretations

Why Building Code Updates Matter

- Improve the energy efficiency and reduce the associated GHG emissions of new building stock
- Critical piece of broader greenhouse gas reduction goals
- Combined with many other generation and demand side efficiency and renewable initiatives, contribute to progress toward goals



Oregon Global Warming Commission, Biennial Report to the Legislature 2015

Reduce GHG emissions to 80% below 1990 levels by 2050

Thank You!
Questions?

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OREGON DEPARTMENT OF ENERGY

ENERGY 350