Performance-Based Energy Code Compliance

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Director of Energy Policy and Code

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Attendee Survey

https://www.apawood.org/presentation-survey

Director of Energy Policy and Code

- 20 years' of experience in the building industry.
- 15 years energy rating, engineering and code development experience.
- Advocate for advancing energy efficiency in a cost-effective manner, balancing energy efficiency and structural design.

Matt Brown, CPG

APA – The Engineered Wood Association

Market Communications Division

Technical Services Division

Market Access and Development

Quality Services Division

Course Description

Understanding today's energy codes already creates a unique new challenge for builders and home energy raters. Determining the builders needs for meeting the energy code while balancing cost and structural requirements can be difficult. This presentation will look at common building construction practices in climate zones 3-5 and identify assemblies and credits that can be utilized for both ERI and simulated performance path compliance. Flexibility is often the key to whole home energy performance and cost effectiveness. This class will explore options that balance energy losses with measures that have greater efficiency gains to deliver a code compliant, energy efficient home.

Learning Objectives

1. Develop understanding of IECC compliance pathways
2. Understand the advantages of performance-based energy code compliance
3. Understand component and material effects on ERI compliance
4. Understand simulated performance compliance and projected exterior wall assemblies

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Today’s Agenda

- Define Energy Code Pathways
- Introduce APA’s Performance Based Energy Code Compliance Publication
- The ERI Compliance Path
- Simulated Performance Assemblies

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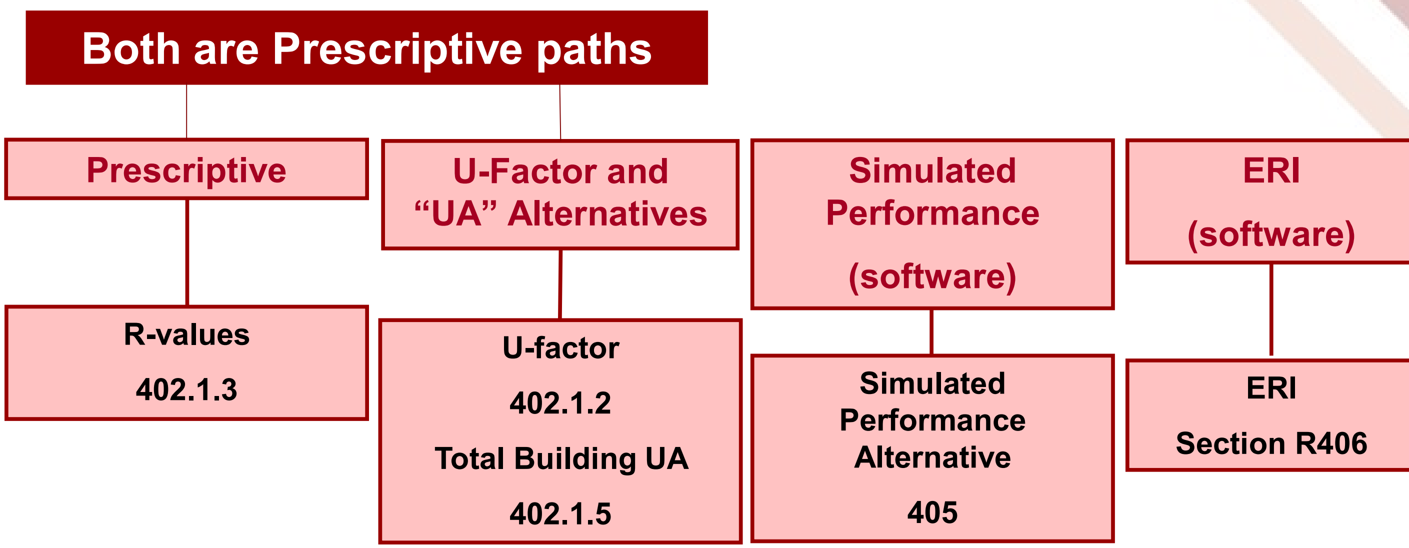
IECC Compliance - Four Options



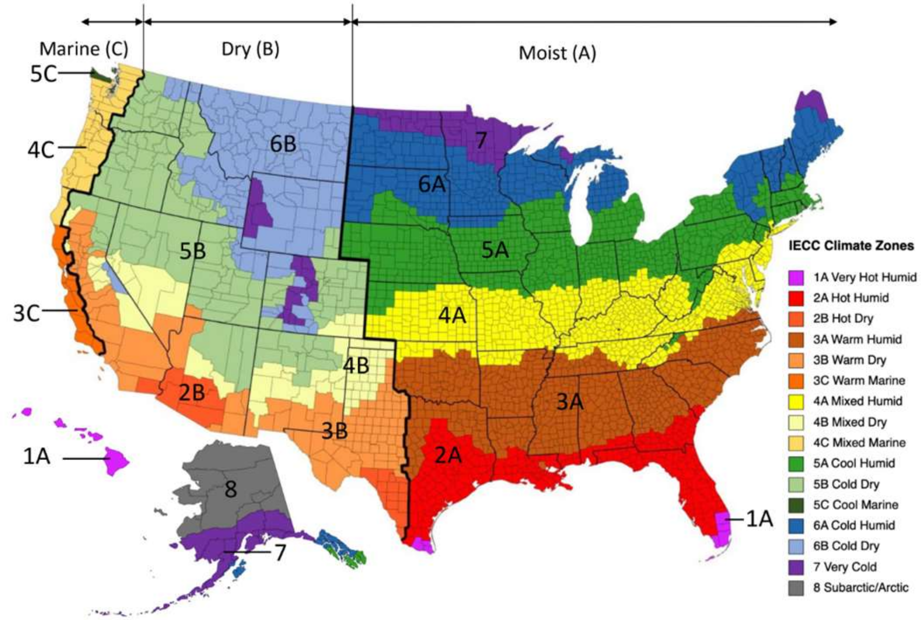
+ Additional Efficiency Options

2021 IECC – Building Envelope

CLIMATE ZONE	FENESTRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WAL R-VALUE[i]	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	10 , 2 ft	5/13
4 except Marine	0.35	0.55	0.40	60	20 +5 or 13+10[h]	8/13	19	10/13	10, 4 ft	10/13
5 and Marine 4	0.32	0.55	NR	60	20+5 or 13+10[h]	13/17	30[g]	15/19	10, 4 ft	15/19
6	0.32	0.55	NR	60	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	60	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

International Energy Conservation Code/Building Science

- 2021 IECC
  - Requires continuous insulation (CI) on wall assemblies from climate zone 4 and north.



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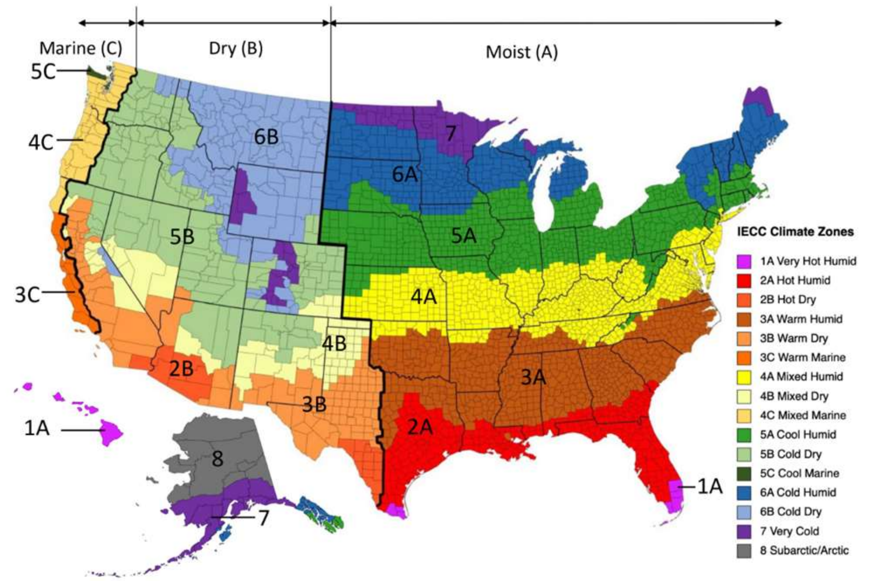
2024 IECC – Building Envelope

CLIMATE ZONE	FENE-STRATION U-FACTOR[b]	SKYLIGHT[b] U-FACTOR	GLAZED FENE-STRATION SHGC[b, e]	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WAL R-VALUE[i]	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB[d] R-VALUE & DEPTH	CRAWL SPACE[c] WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	10 , 2ft	5/13
4 except Marine	0.30	0.55	0.40	49	20 +5 or 13+10[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.28	0.55	NR	49	20+5 or 13+10[h]	13/17	30[g]	15/19	10, 4 ft	15/19
6	0.28	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.27	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

International Energy Conservation Code/Building Science

- 2024 IECC
  - Allows flexibility in exterior walls
    - R-20 exterior walls if heat-pump equipment is installed.
  - Lower ceiling insulation requirements
  - Adjustments in foundation insulation
  - Lower fenestration U-factors
  - More trade-off options
  - Additional efficiency items change



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Prescriptive Path

Positives:

- Simple to enforce and understand. Basically, a recipe for the envelope
- Most recognized by architects, engineers and code officials

Negatives:

- Few trade-offs
- Higher cost to build
- Poor return of investment
- Very restrictive

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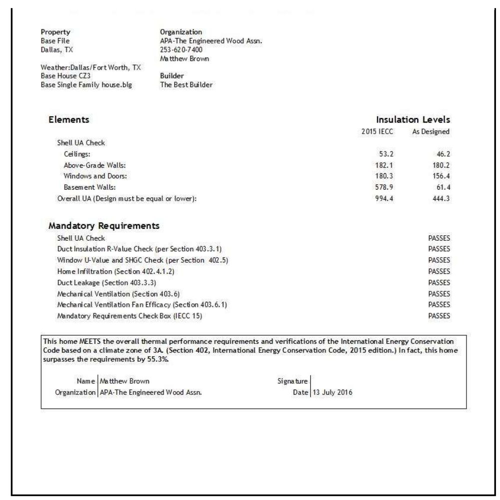
Total UA Trade-off Approach

- Free software from U.S.DOE
- No special training to run software
- Allows limited trade-offs: R-value for R-value trade
- May no longer offer state-specific versions

UA Compliance

- Must meet all mandatory requirements
- Must meet all sections marked "prescriptive"



Property
Base File
Dallas, TX

Weather:Dallas/Fort Worth, TX
Base House CZ3
Base Single Family house.blg

Organization
APA-The Engineered Wood Assn.
253-620-7400
Matthew Brown

Builder
The Best Builder

Elements	**Insulation Levels** 2015 IECC	As Designed
Shell UA Check		
Ceilings:	53.2	46.2
Above-Grade Walls:	182.1	180.2
Windows and Doors:	180.3	156.4
Basement Walls:	578.9	61.4
Overall UA (Design must be equal or lower):	994.4	444.3

Mandatory Requirements	
Shell UA Check	PASSES
Duct Insulation R-Value Check (per Section 403.3.1)	PASSES
Window U-Value and SHGC Check (per Section 402.5)	PASSES
Home Infiltration (Section 402.4.1.2)	PASSES
Duct Leakage (Section 403.3.3)	PASSES
Mechanical Ventilation (Section 403.6)	PASSES
Mechanical Ventilation Fan Efficacy (Section 403.6.1)	PASSES
Mandatory Requirements Check Box (IECC 15)	PASSES

This home MEETS the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 3A. (Section 402, International Energy Conservation Code, 2015 edition.) In fact, this home surpasses the requirements by 55.3%.

Name	Matthew Brown	Signature	
Organization	APA-The Engineered Wood Assn.	Date	13 July 2016

UA Trade-Off Path

Positives:

- Builders can run program
- Allows some trade-offs

Negatives:

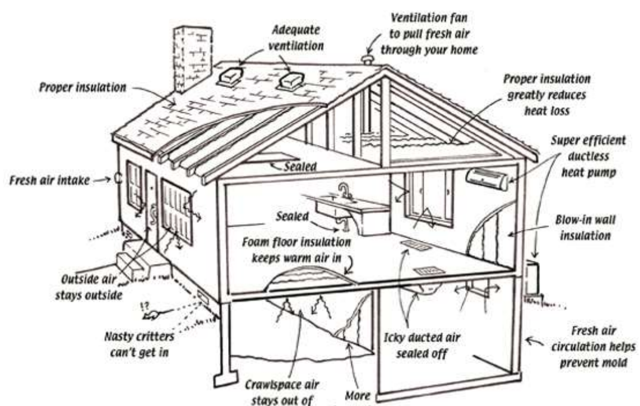
- R-value trades only
- Good infiltration not credited
- Moderate cost
- Still has to meet all provisions of mechanical (R-403)

Simulated Performance Approach (R405)

- Allows greatest flexibility in code
- Credits tight infiltration and ducts
- Go to RESNET.us for qualified rating companies

REM/Rate™

REM/Design™



ekotrope

EnergyGauge®

Energy and Economic Analysis Software

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Performance-Based Compliance

* All mandatory requirements must be met.

HOME CERTIFIED TO MEET THE PROVISIONS OF THE
INTERNATIONAL ENERGY CONSERVATION CODE
This home built at
1234 Efficiency Way, Atlanta, GA
by Best Builders
exceeds the minimum requirements

Building Features

Ceiling Flat	R-60.0	Duct	R-8.0
Sealed Attic:	NA	Duct Leakage to Outside:	90.00 CFM @ 25 Pascals
Vaulted Ceiling	NA	Total Duct Leakage:	90.00 CFM @ 25 Pascals
Above Grade Walls	R-25.0	Infiltration:	Htg: 3.00 Clg: 3.00 ACH50
Foundation Walls	NA	Window	U-Value: 0.280, SHGC: 0.250
Exposed Floor	NA	Heating	Fuel-fired air distribution, Natural gas, 80.0 AFUE.
Slab	R-10.0 Edge, R-1.0 Under	Cooling	Air conditioner, Electric, 14.0 SEER.

The organization below certifies that the proposed building design described herein is consistent with the building plans, specifications, and other calculations submitted with the permit application. The proposed building has been designed to meet the 2018 IECC requirements in compliance with Chapter 4 based on Climate Zone 5A and with all mandatory requirements.

IECC Energy Cost Compliance

Property
Base CZ-5
1234 Efficiency Way

Organization
APA-The Engineered Wood Assn.
Matthew Brown ICC# 8136817

Builder
Best Builders

Weather:Chicago, IL
CZ-5- ERV
2021-CZ-5 ERV.blg

Annual Energy Cost	$/yr 2018 IECC	As Designed
Heating	429	377
Cooling	172	172
Water Heating	97	97
Mechanical Ventilation Fan	31	0
SubTotal - Used to Determine Compliance	**729**	**647**
Lights & Appliances (minus MechVent)	423	544
Photovoltaics	-0	-0
Service Charge	120	120
Total	**1272**	**1311**

Mandatory Requirements	
Annual Energy Cost Check	PASSES
Duct Insulation R-Value Check (per Section 405.2)	PASSES
Window U-Value and SHGC Check (per Section 402.5)	PASSES
Home Infiltration (Section 402.4.1)	PASSES
Duct Testing (Section 403.3.3)	PASSES
Mechanical Ventilation (Section 403.6)	PASSES
Mechanical Ventilation Fan Efficacy (Section 403.6.1)	PASSES
Mandatory Requirements Check Box (2018 IECC)	PASSES

This home MEETS the annual energy cost requirements of Section 405 of the 2018 International Energy Conservation Code based on a climate zone of 5A. In fact, this home surpasses the requirements by 7.4%.

Name	Matthew Brown ICC# 8136817	Signature	
Organization	APA-The Engineered Wood Assn.	Date	22 July 2024

In accordance with IECC, building inputs, such as setpoints, infiltration rates, and window shading may have been changed prior to calculating annual energy cost. Furthermore, the standard reference design HVAC system efficiencies are set equal to those in the design home as specified in the 2018 IECC. These standards are subject to change, and software updates should be obtained periodically to ensure the compliance calculations reflect current federal minimum standards.

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Performance Path

Positives:

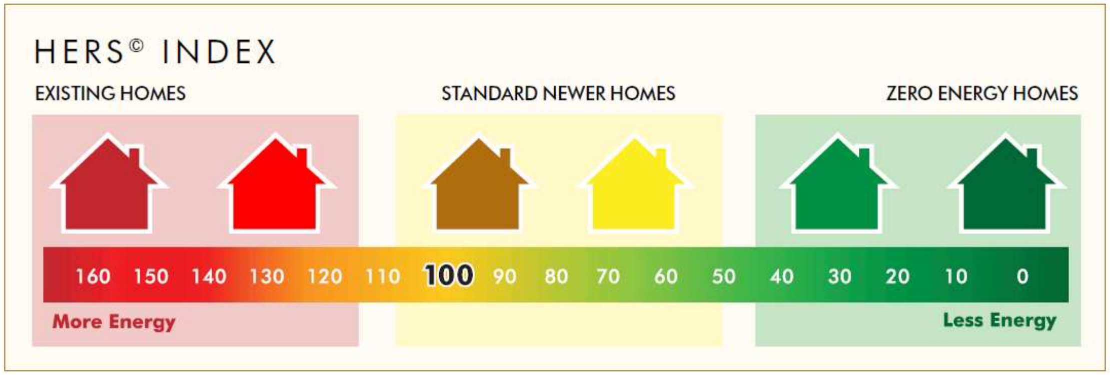
- Allows flexibility in building design
- Credits low infiltration and tight ducts
- Lower cost compared to prescriptive path

Negatives:

- Builders and code officials often not as familiar
- Requires third-party infiltration testing
- Does not credit efficient equipment in 2021 IECC.

IECC ERI Method

- Envelope must meet backstop requirements
- Allows for credit for advanced HVAC systems



Zone	2021	2024
1	52	51
2	52	51
3	51	50
4	54	53
5	55	54
6	54	53
7	53	52
8	53	52

ERI (HERS) Path

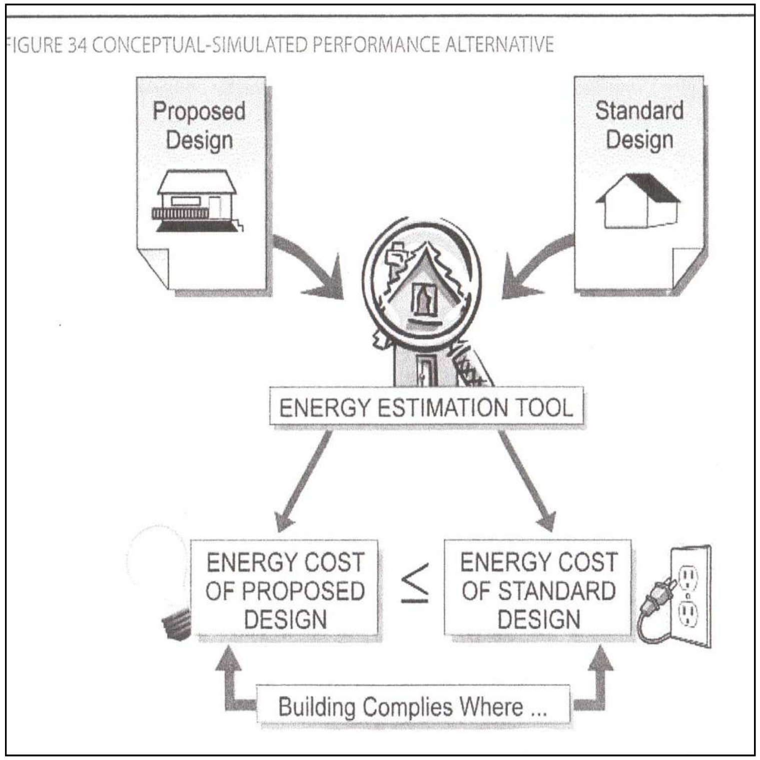
Positives:

- Allows flexibility in building design
- Credits low infiltration and tight ducts
- Lower cost compared to prescriptive path
- Credits high-efficiency equipment

Negatives:

- Builders and code officials often not as familiar
- Requires third-party modeling and testing

Performance & ERI Modeling

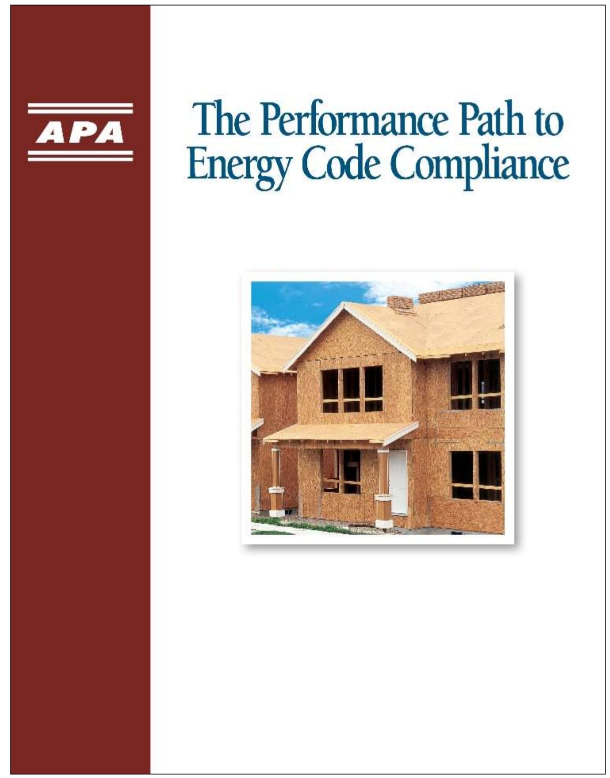


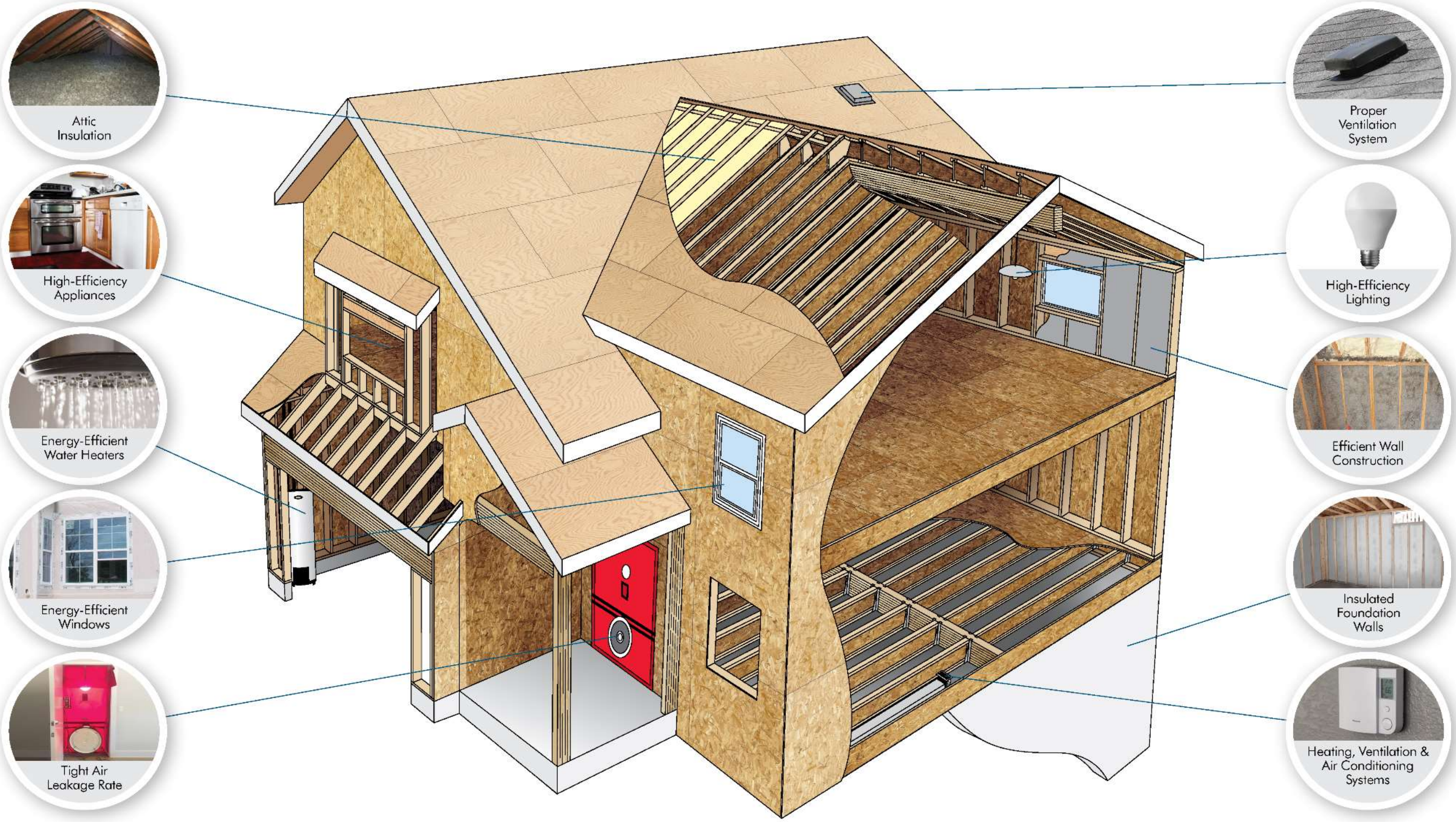
Today's Agenda

- Define Energy Code Pathways
- Introduce APA's Performance Based Energy Code Compliance Publication
- The ERI Compliance Path
- Simulated Performance Assemblies

Performance Energy Code Publication

- Intended to be a guide to generate conversations between raters and builders
- All assemblies must be modeled by an energy rater




Attic Insulation
High-Efficiency Appliances
Energy-Efficient Water Heaters
Energy-Efficient Windows
Tight Air Leakage Rate
Proper Ventilation System
High-Efficiency Lighting
Efficient Wall Construction
Insulated Foundation Walls
Heating, Ventilation & Air Conditioning Systems

Modeling Basis

- DOE prototype single-family home for determining the cost-effectiveness of the 2021 IECC
- Provides a consistent, rational basis for energy modeling
- Assembly reference models use the 2021 IECC U-Factor table

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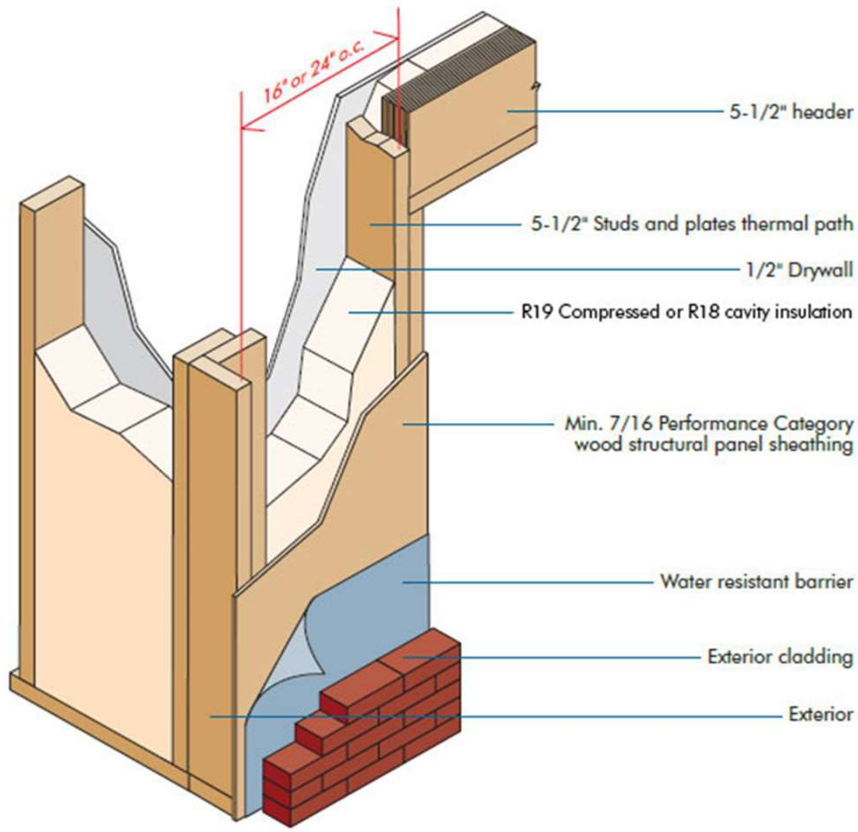
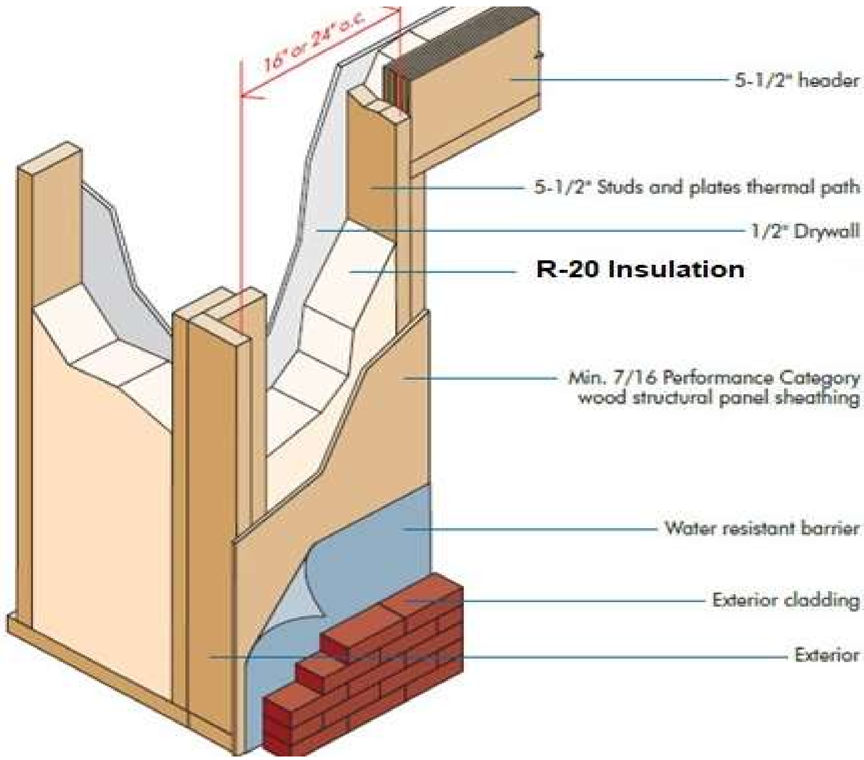
Wall Assemblies

- Advanced Framing
- Wall R-Value Analysis
- Continuous Insulation

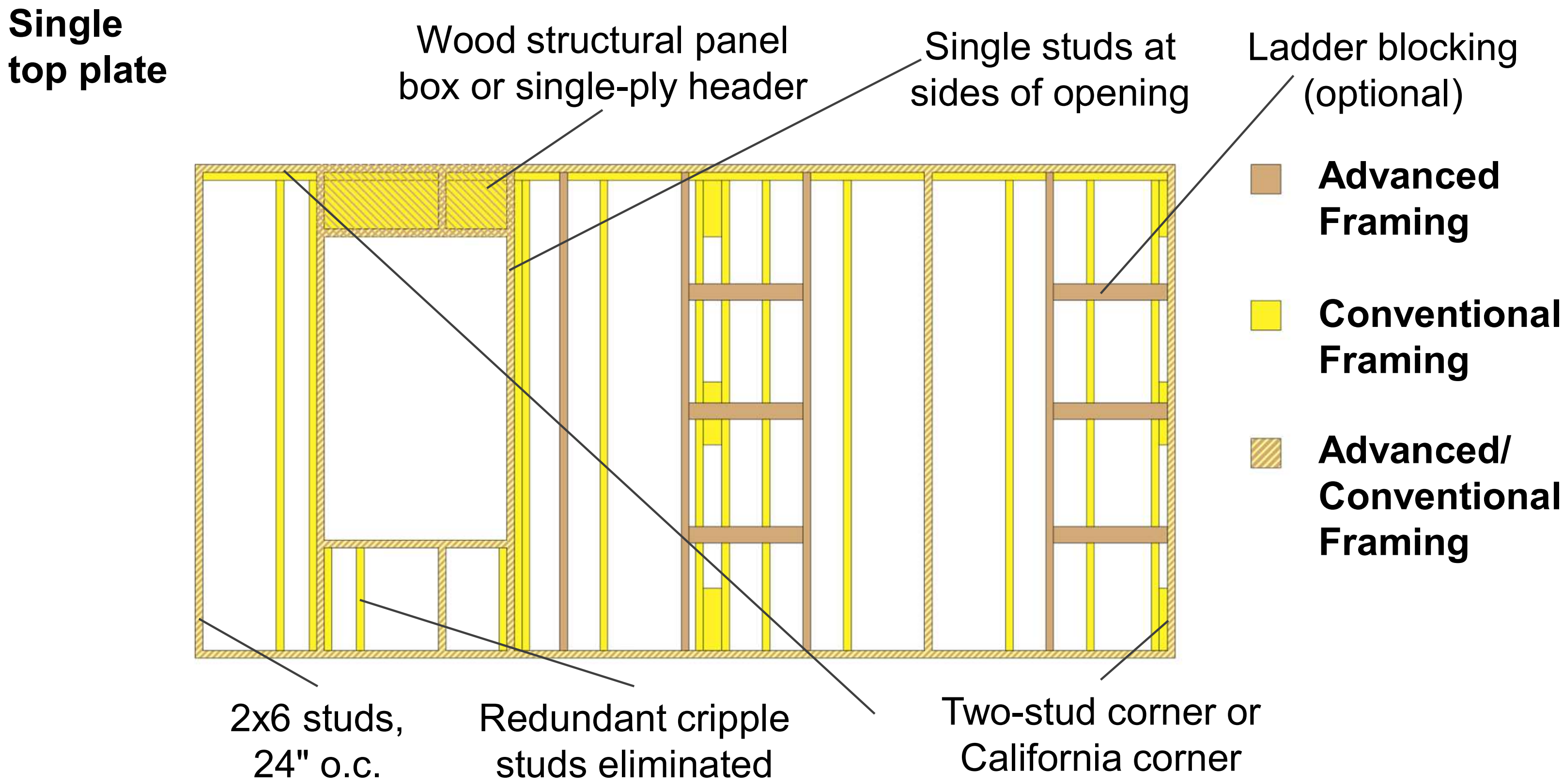
2x6 R-18 Advanced Frame Wall



2x6 R-20 & R-23 Advanced Frame Wall

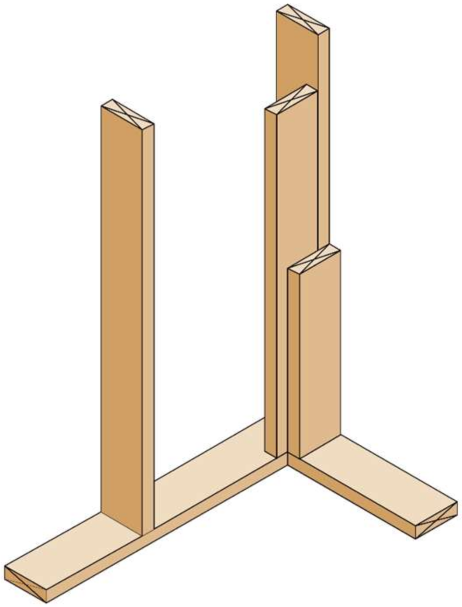


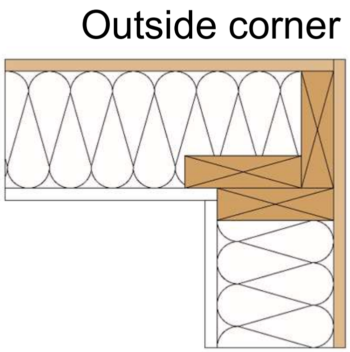
Wall Frame Comparison



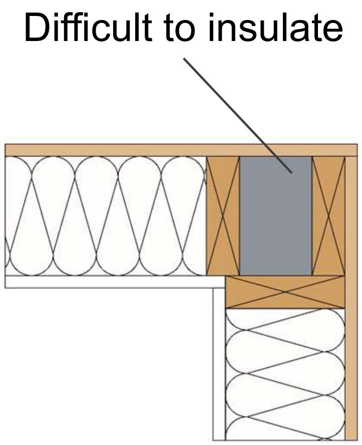
Three-stud Corners

Insulated Three-Stud Corner (California Corner)





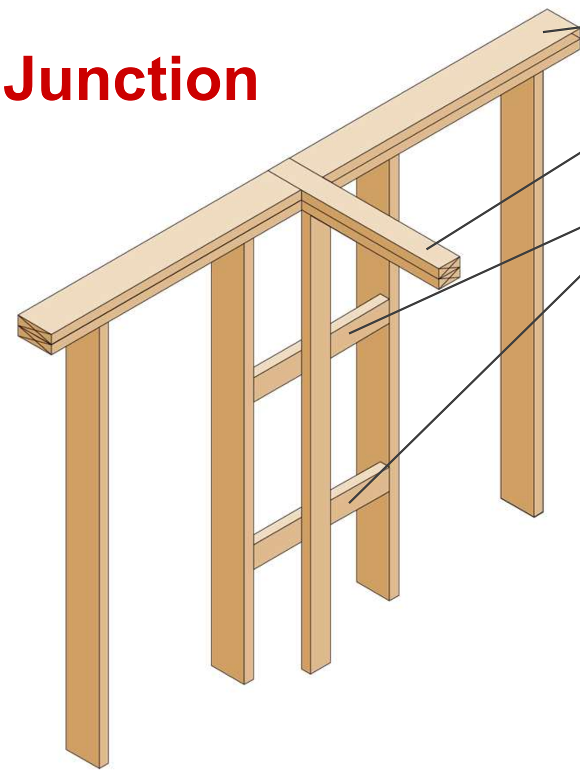
Traditional Corner



Interior Wall

Intersection Options

Ladder Junction



Double top plate

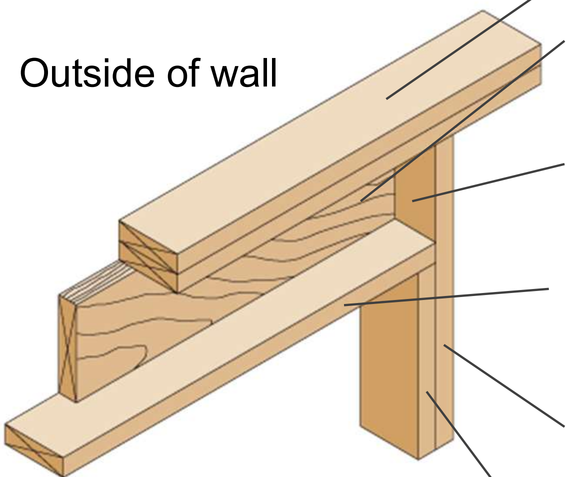
Interior wall

2x ladder blocking at 24"o.c.

Install blocking with wide face vertical for maximum backing to wall finish and for maximum insulation in exterior walls.

Engineered Wood & Lumber Headers

Single-Ply Header at Top Plate

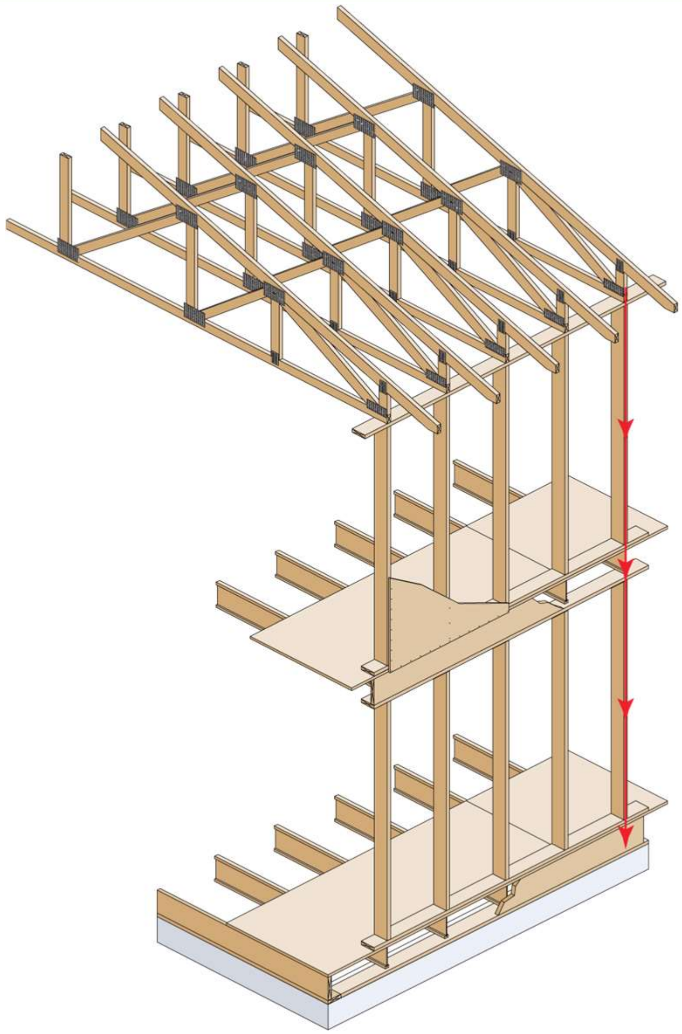


2012 IRC Section R602.7.1

Structural Integrity

- Stacked framing provides direct load path
- 2x6 studs @ 24" o.c. are 2-1/2 times stiffer than 2x4 studs at 16" o.c.*

* Moment of inertia comparison



Advanced Framed Walls

IECC Climate Zones	2	3	4	5	6	7
2x6 Advanced Framing R-18	-4	-1	+2	+2	+2	+3
2x6 Advanced Framing R-20	-4	-1	+1	+2	+1	+2
2x6 Advanced Framing R-23	-4	-2	+1	+1	0	+1

Assumes 18% framing factor, double top plates and R-12 insulated headers

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Wall Insulation

Wall Insulation

IECC Climate Zones	2	3	4	5	6	7
R-13 2x4 Wall	0	+3	+6	NR	NA	NA
R-15 2x4 Wall	-1	+2	+5	+7	NA	NA
R-21 2x6 Wall	-3	-1	+1	+2	+2	+3

Spray-in-Place Cellulose, fiberglass, and mineral wool

Blanket Batts and Rolls

Spray-in-Place Foam

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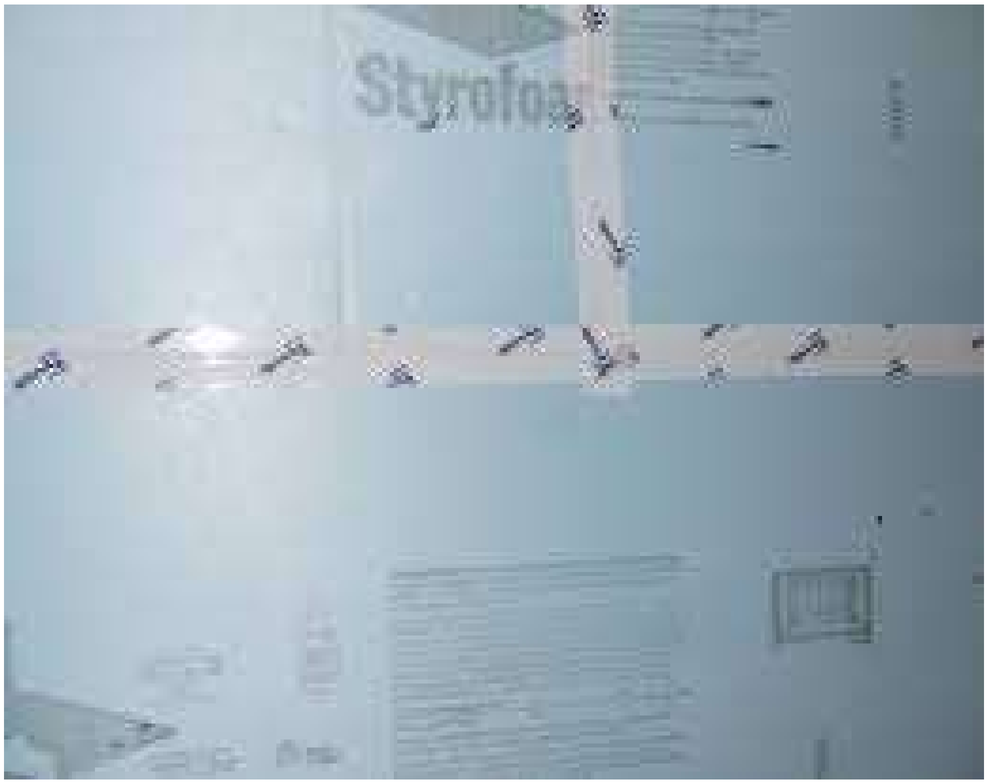
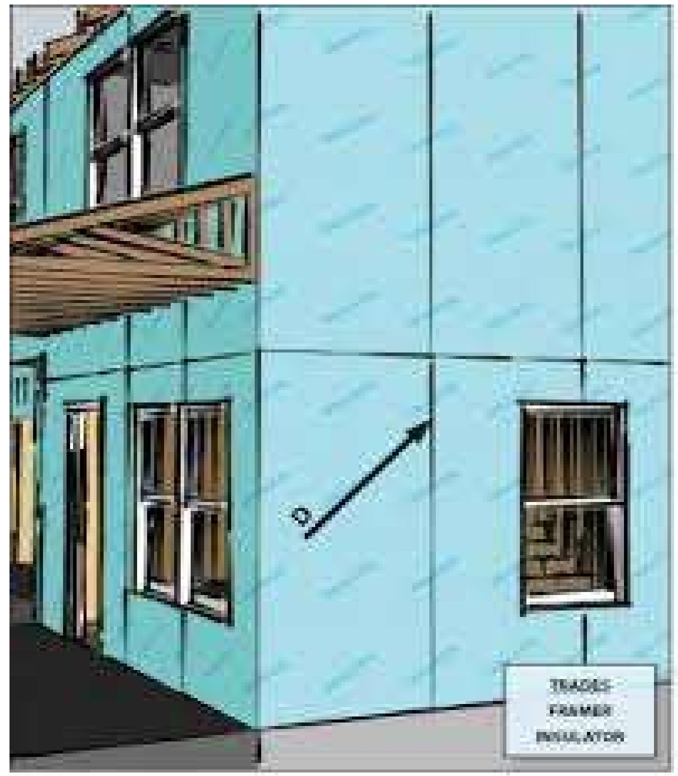
Continuous Insulation





Continuous Insulation

IECC Climate Zones	2	3	4	5	6	7
R-3 Continuous Insulation	-2	-1	1	1	NR	NR
R-5 Continuous Insulation	-3	-2	0	0	0	0

Windows

IECC Climate Zones	2	3	4	5	6	7
R-3 Continuous insulation	-2	-1	1	1	NR	NR
R-5 Continuous insulation	-3	-2	0	0	0	0

Types of Windows

Roof Systems

- Radiant Barrier
- Deeply Buried Ducts
- Ducts in Conditioned Space

IECC Climate Zones	2	3	4	5	6	7
Radiant Barrier Sheathing	-3	-2	-1	-1	See Foot note K	
Deeply Buried Ducts	-2	-2	-2	-1	-2	-2
Ducts considered in conditioned space	-5	-6	-7	-8	-8	-9

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Radiant Barrier Roofs

IECC Climate Zones	2	3	4	5	6	7
Radiant Barrier Sheathing	-3	-2	-1	-1	See Foot note K	

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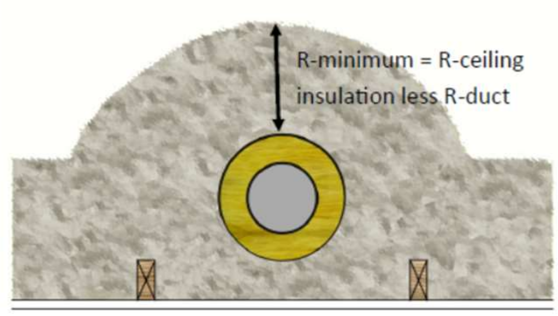
Ducts Considered in Conditioned Space

IECC Climate Zones	2	3	4	5	6	7
Ducts considered in conditioned space	-5	-6	-7	-8	-8	-9

Buried Ducts considered Inside Conditioned Space –

When using a simulated energy performance analysis, buried ducts may be considered as ducts inside conditioned space (ICS) provided the air distribution system complies with the general buried duct criteria above (need not comply with deeply buried ducts) and these additional requirements:

1. the air handler is located inside conditioned space (not in the attic)
2. duct leakage is within prescribed, more stringent limits (see sidebar for details)
3. the R-value of insulation above the duct is at least the proposed ceiling insulation R-value, used in the model, less the R-value of the duct insulation (Figure 5)



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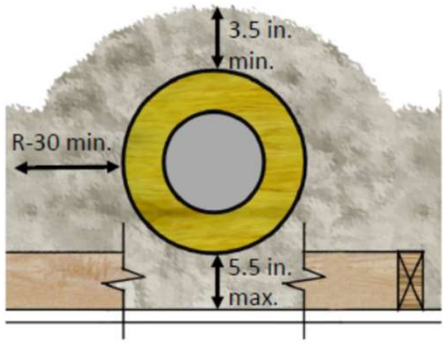
Ducts- Deeply Buried

IECC Climate Zones	2	3	4	5	6	7
Deeply Buried Ducts	-2	-2	-2	-1	-2	-2

Deeply Buried Ducts —

When using a simulated energy performance analysis, an effective duct insulation value of R-25 may be used in the energy model for sections of ducts that comply with the general buried duct criteria above and these three additional requirements (see Figure 4):

1. the duct is located directly on the ceiling or within 5.5 in. of the ceiling
2. the duct is surrounded with ceiling insulation of at least R-30
3. the duct is covered on top with at least 3.5 in. of ceiling insulation (approximately R-11 assuming a minimum R-value of R-3.2 per in.)



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HVAC Equipment

- 95% AFUE Furnace
- 18 SEER Air Conditioning
- Ductless Heat-Pump
- Energy Recovery Ventilator (ERV)

95% AFUE Furnace

IECC Climate Zones	2	3	4	5	6	7
95% AFUE Furnace	-2	-3	-3	-5	-6	-8

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18 SEER Air Conditioning

IECC Climate Zones	2	3	4	5	6	7
18-SEER Air Conditioning	-5	-4	-3	-2	N/A	N/A

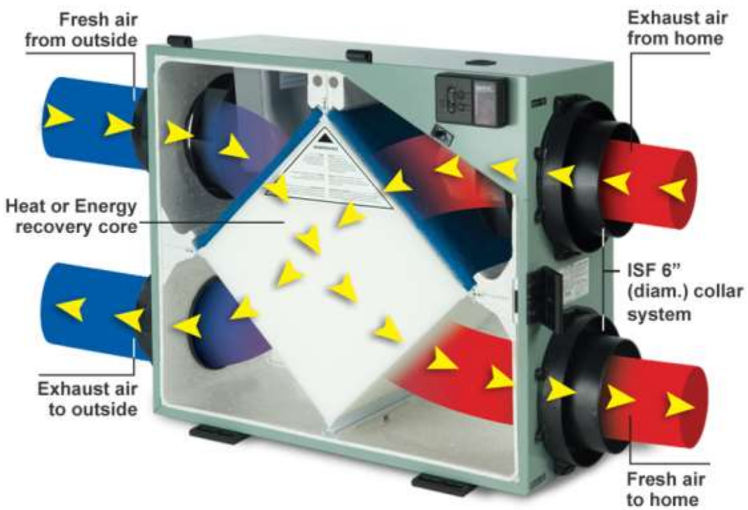
Ductless Heat Pump

IECC Climate Zones	2	3	4	5	6	7
Ductless Heat Pump	-11	-11	-7	-3	N/A	N/A

Image curtesy of Building America

Energy Recovery Ventilator (ERV)

IECC Climate Zones	2	3	4	5	6	7
Energy Recovery Ventilator	-2	-2	-3	-2	-2	-2



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Simulated Performance Climate Zone 3

Climate Zone	3	
IECC	2021	2024
Exterior Walls	R-13	R-13
Attic/Ceiling	R-38	R-38
Windows	U-0.40	U-0.40
Heating	80% AFUE	80% AFUE
Cooling	16 SEER	16 SEER
Ventilation	Exhaust	Exhaust
Radiant Barrier	Yes	Yes

- 2x4 Framed Walls
- Credits Radiant Barrier

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Simulated Performance- Climate Zone 4

Climate Zone	4	
IECC	2021	2024
Exterior Walls	R-15	R-15
Attic/Ceiling	R-49	R-49
Windows	U-0.35	U-0.30
Heating	95% AFUE	95% AFUE
Cooling	14 SEER	14 SEER
Ventilation	Exhaust	Exhaust
Radiant Barrier	No	No

- 2x4 Framed Walls
- High Efficiency Furnace

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Simulated Performance- Climate Zone 5

Climate Zone	5	
IECC	2021	2024
Exterior Walls	R-21	R-20
Attic/Ceiling	R-49	R-49
Windows	U-0.28	U-0.28
Heating	95% AFUE	95% AFUE
Cooling	14 SEER	14 SEER
Ventilation	ERV	ERV
Radiant Barrier	No	No

- ERV
- High Efficiency Furnace

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Simulated Performance- Climate Zone 6

Climate Zone	6	
IECC	2021	2024
Exterior Walls	R-23	R-21
Attic/Ceiling	R-49	R-49
Windows	U-0.28	U-0.28
Heating	95% AFUE	95% AFUE
Cooling	14 SEER	14 SEER
Ventilation	ERV	ERV
Radiant Barrier	No	No

- ERV
- High-Efficiency Furnace

High-Performance Wall Systems

- Value-added WSP and Foam Panels
- Dual Layer Sheathed Walls
- Double Walls

Today's Agenda

- Define Energy Code Pathways
- Introduce APA's Performance-Based Energy Code Compliance Publication
- The ERI Compliance Path
- Simulated Performance Assemblies

Questions?

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214-930-7075

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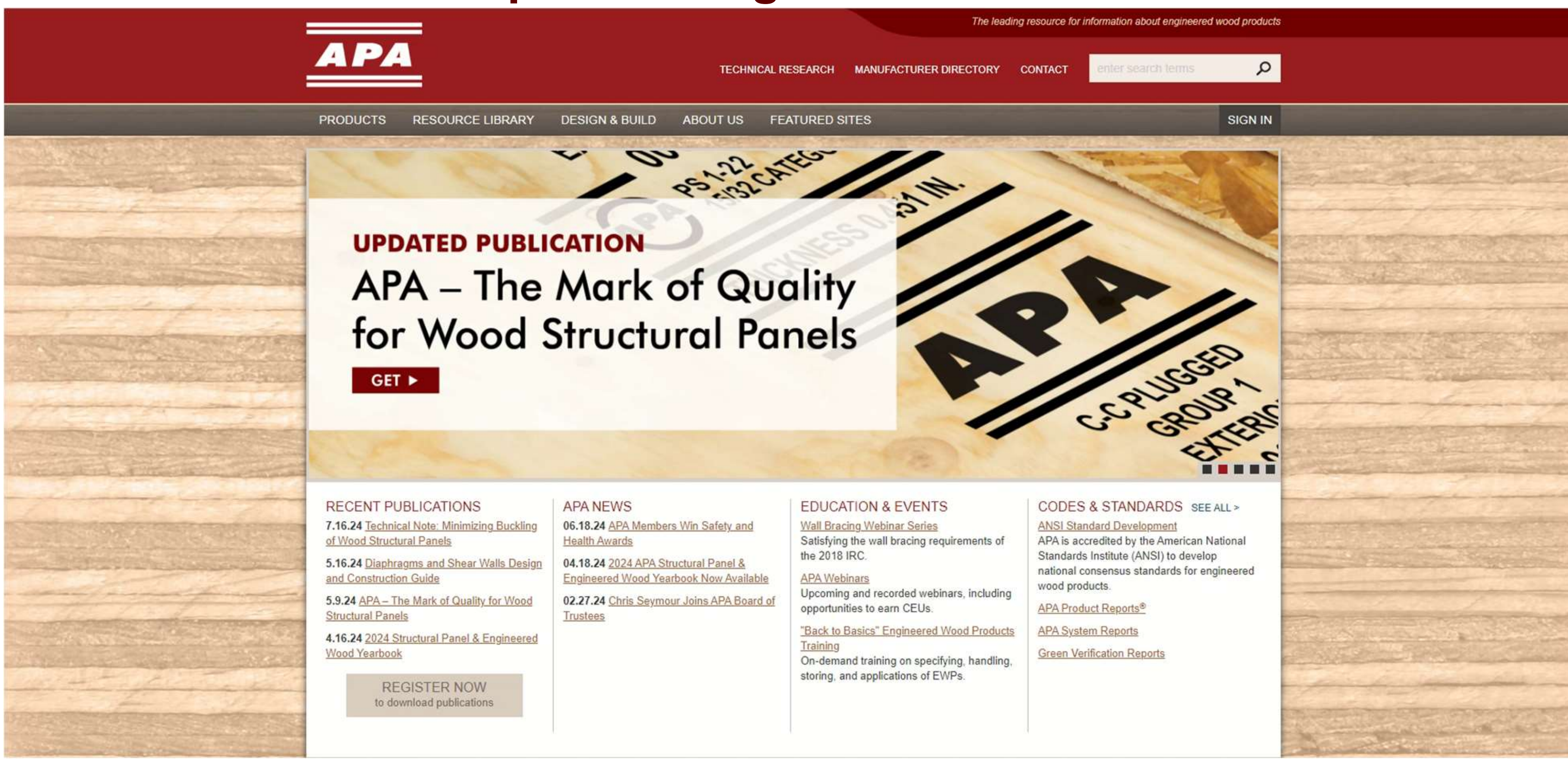

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UPCOMING WEBINAR

Designing Engineered Wood Diaphragm Systems

***Wednesday, May 22** | 10-11 a.m. PDT*

Diaphragms play a vital role in a building's lateral load path. Whether that lateral load is from seismic activity or wind forces, the diaphragm is responsible for distributing that lateral load to the shear walls. This session provides guidance on the proper design of engineered wood diaphragm

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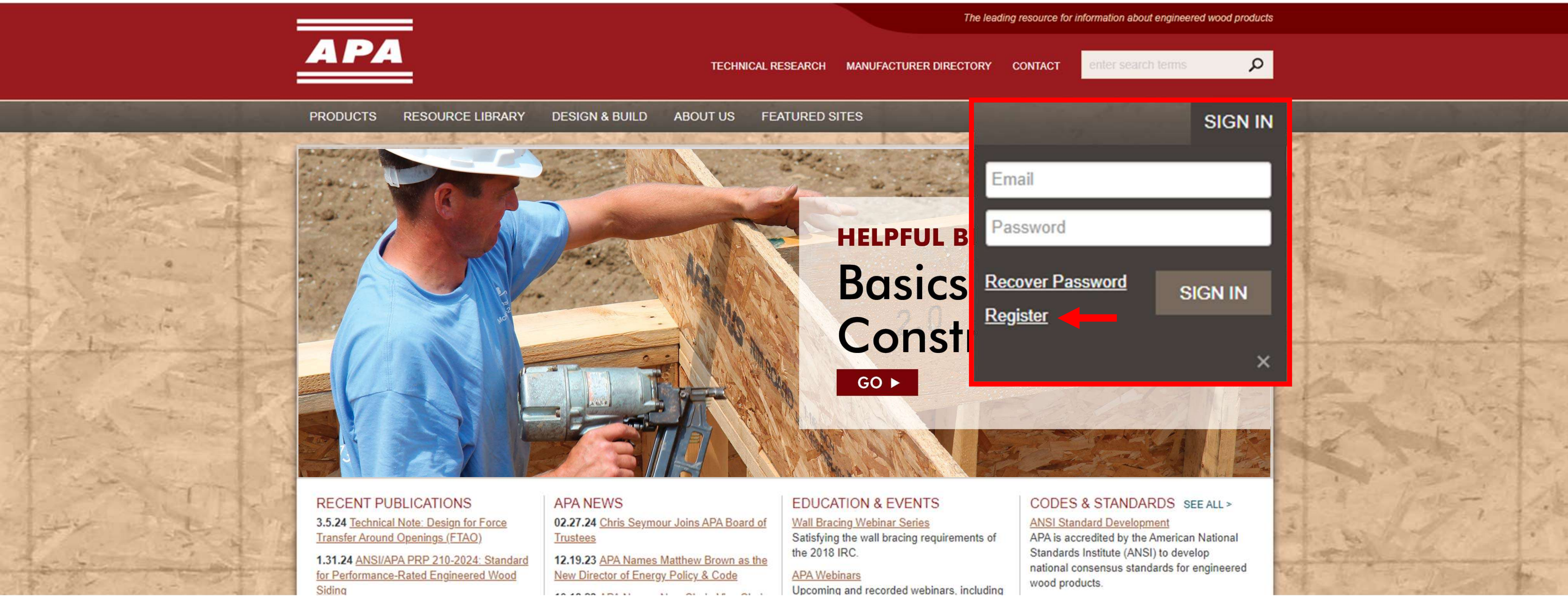

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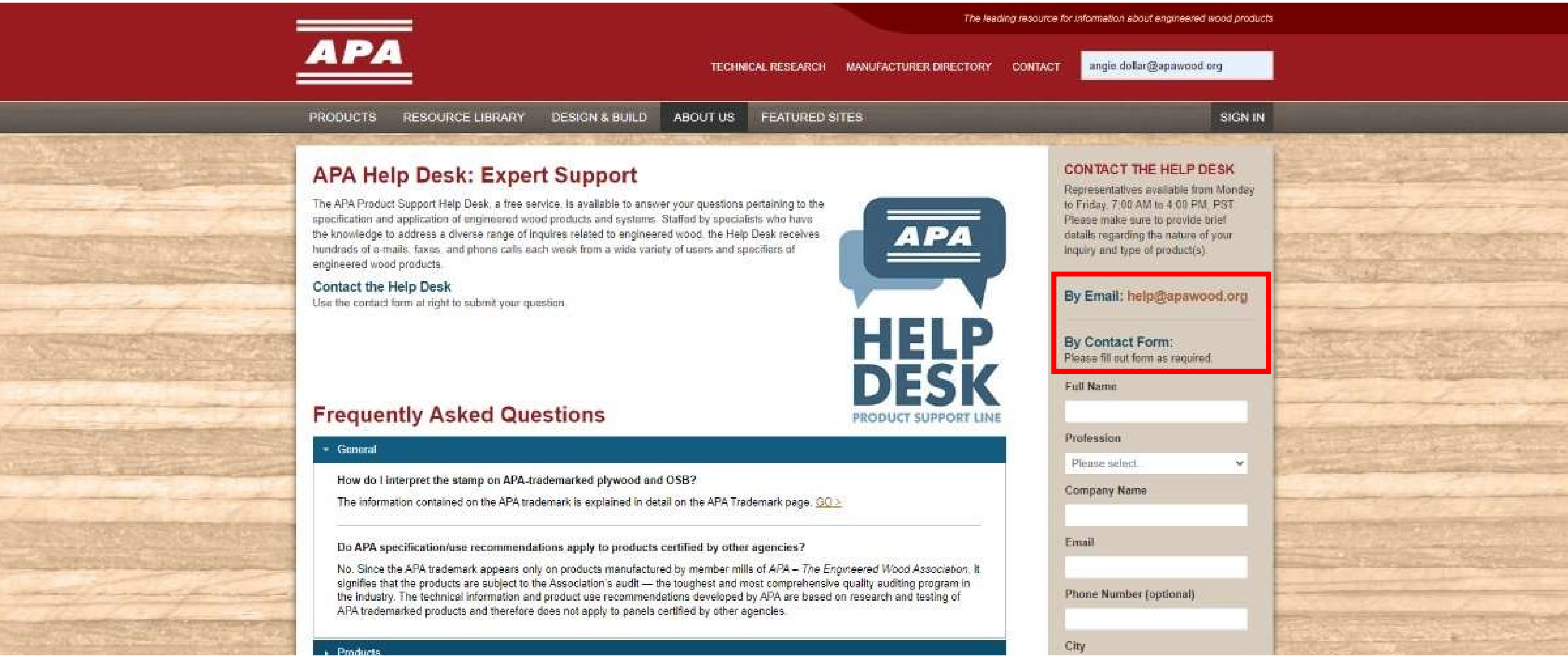

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Attendee Survey

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Thank you for attending.

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