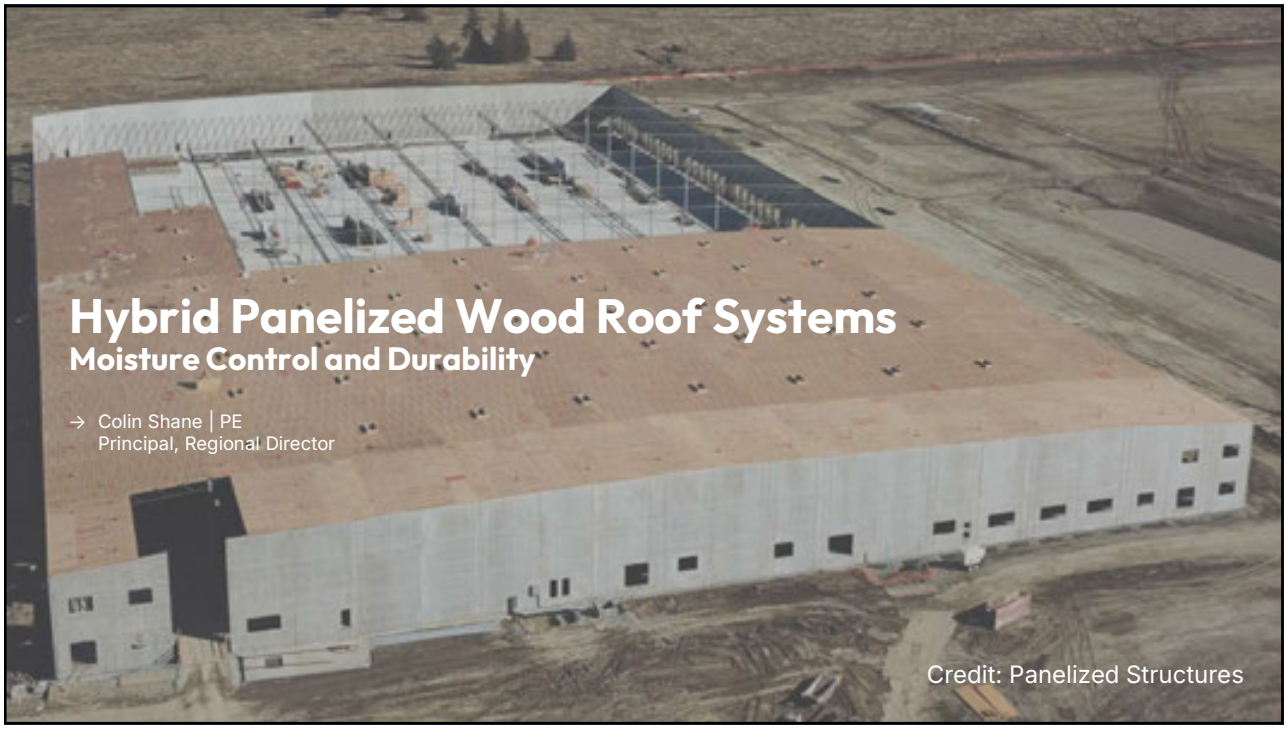


1

1 Fundamentals

2

2

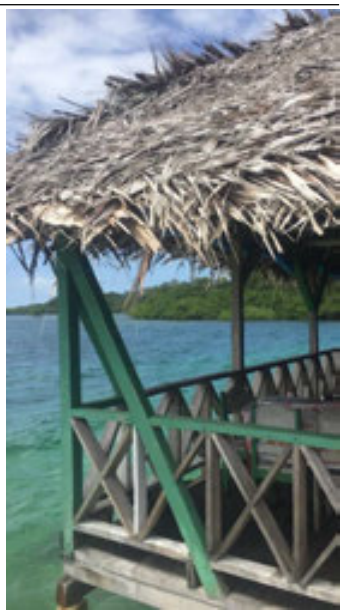
Low Slope Roofs

- → Best Practice Guide: “Any building envelope surface more than 10 degrees from the vertical should be treated as a roof.”
- → 1/4:12 to 3:12 slope considered “low-slope”
- → Can be comprised of a number of varying assemblies and materials
- → Critical element of enclosure system

3

Every Roof

- Positive drainage
- Durable coverings
- Adequate securement
- Compatible flashings
- Well-detailed penetrations
- Maintenance access
- Climate specific



4

Building Enclosure + Roof Fundamentals

Support

→ Wind uplift resistance

Control

→ Water penetration

→ Air flow

→ Heat flow and solar radiation

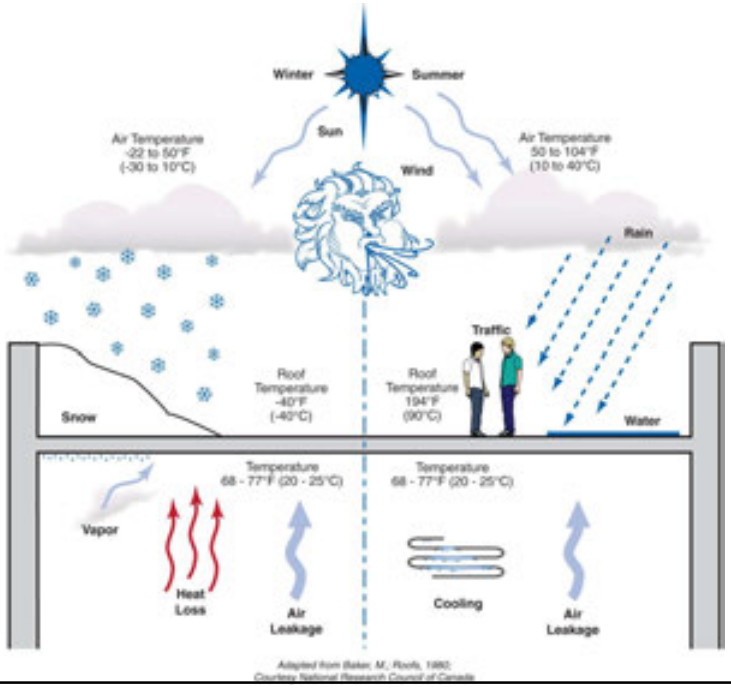
→ Condensation risk

→ Hail impact

→ Fire

Finish

5



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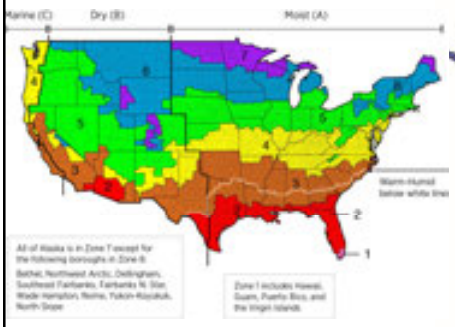
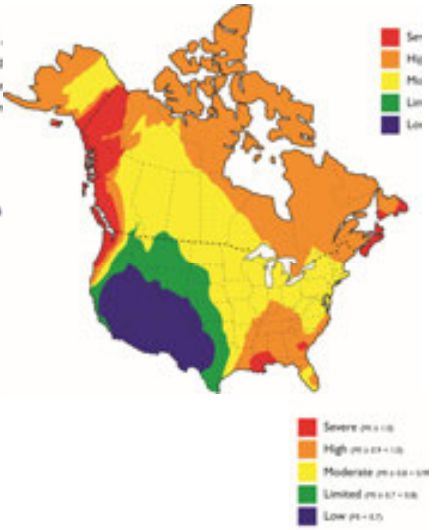
Environmental Loads - Climate

IECC



Rainfall

Moisture Index



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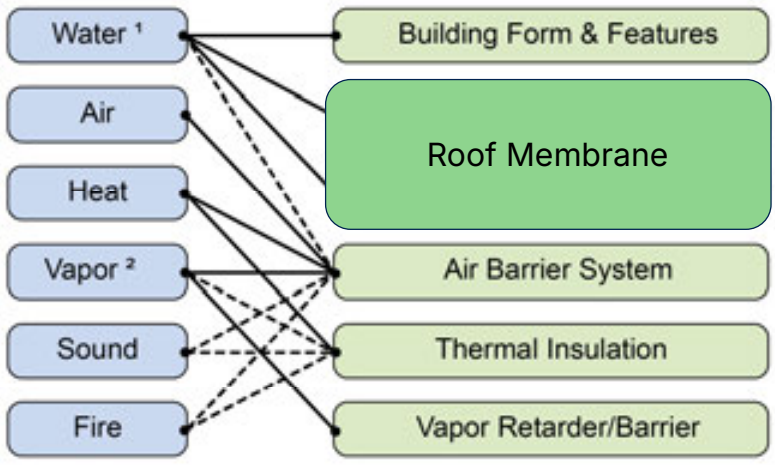
Control Layers to Resist Building-Specific Loads



1 – Water is defined here as precipitation (rain, snow, hail, etc.) and ground water
2 – Vapor is separately defined here as the water vapor in air, as well as condensate moisture

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2 Conventional Roofs

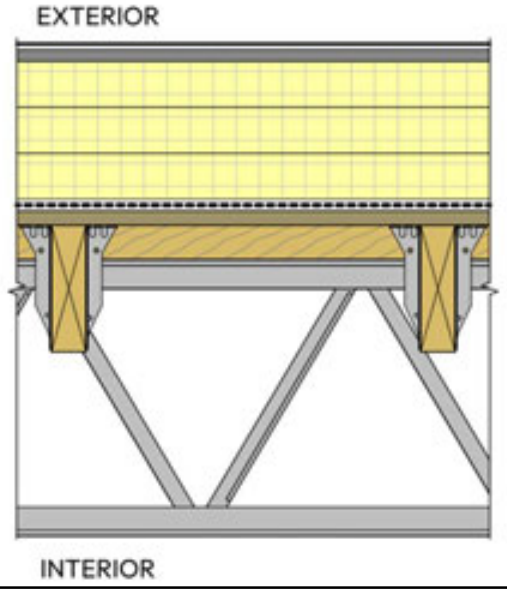
Conditioned Buildings – Best Practices

Control Layer Decisions That Drive Roof Performance

Color/Type/Location of the water control layer – This layer is responsible for shedding rainwater and snowmelt and preventing water leaks. On the surface in conventional roofs.

Location of the air control layer – This is the continuous layer that minimizes indoor and outdoor air transfer across the assembly. It may be the roof membrane, a separate layer applied to the deck, or a layer at the ceiling plane. Its location relative to the insulation can significantly affect assembly performance.

Location of the insulating layers– Thermal insulation may be entirely below the deck (between the sub-purlins), entirely above the deck, or split between the two.



Low Slope Roof - Decks

Concrete

Steel

Wood

Securement to Deck

Loads: ASCE/SE 7-22, Chapter 30 – Wind Loads: Components and Cladding

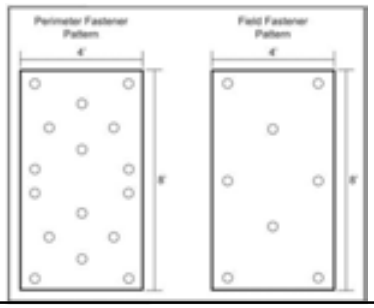
Resistance: IBC 1504.1 Wind Resistance of Roofs, developed by physical testing, found in approval listings, test reports

- Don't confuse ASD and LFRD values

Systems:

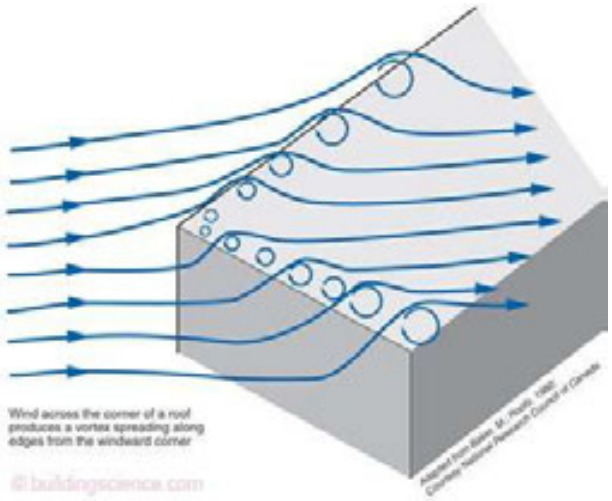
Adhered systems

Mechanically fastened systems



Parapet + Edge Conditions

- Exposed to high suction pressures – nexus of most wind blow-off issues
- Like the roof assemblies themselves, tested and rated securement details for metal flashings, membrane upturns.
- A good air seal between the deck and the perimeter walls can better distribute the wind pressure away from edge components.



Low Slope Roof – Air/Vapor Barriers

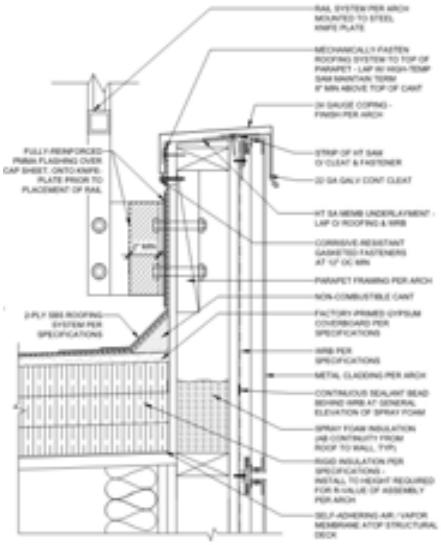
- → Provide temporary protection to structure
- → Act to block air leakage and vapor diffusion into and within assembly
- → Locate on warm-in-winter side of insulation

Self-adhered membrane over wood deck

Torch-applied modified bitumen membrane over concrete deck

Low Slope Roof Insulation

- All thermal value is above deck, directly atop air/vapor membrane (uninterrupted thermal plane).
- Continuous air barrier easily achievable, and protected by insulation above



Low Slope Roof - Cover Boards

- Impact Resistance
- Insulation protection
- Fire resistance
- Wind uplift protection
- Sound resistance
- Membrane substrate

Glass mat-faced gypsum board

High density wood fiberboard

Water Control

- Slope to drain – typically 2% minimum
  - Sloped structural deck
  - Tapered insulation above a flat deck
  - One-way structural slope with crickets at drains
- Membranes / Roof Coverings
  - Built-up, modified bitumen, single-ply
  - Flashings extending over parapets, curbs, penetrations
  - Lots of contractors, manufacturers, consultants, book, industry organizations, warranty providers are well versed in doing this well

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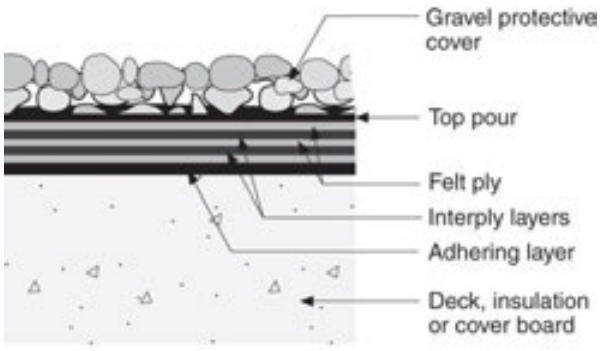
Low Slope Roof – Membranes



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Low Slope Roof – Membranes

Modified Bitumen (Mod-Bit)

- Not the same as BUR
- Asphalts are modified to improve flexibility and ductility.
- Multiple plies - base(s) and cap sheet
  - Base ply is the waterproofing. Cap sheet protects from UV and traffic
- Can be adhered, torched, fastened

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Low Slope Roof – Membranes

Single-Ply

- Reinforced for tensile strength and puncture resistance (recommend)
- Seams are welded or adhered
- Thickness from 36 to 90 mils or more
- Can be fully-adhered, mechanically attached, or induction welded
- Mech. attached can cause thermal bridging and tenting from wind uplift.
- Sheet width, fastener density, embedment drives wind uplift resistance

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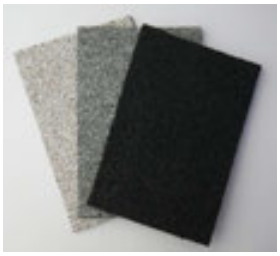
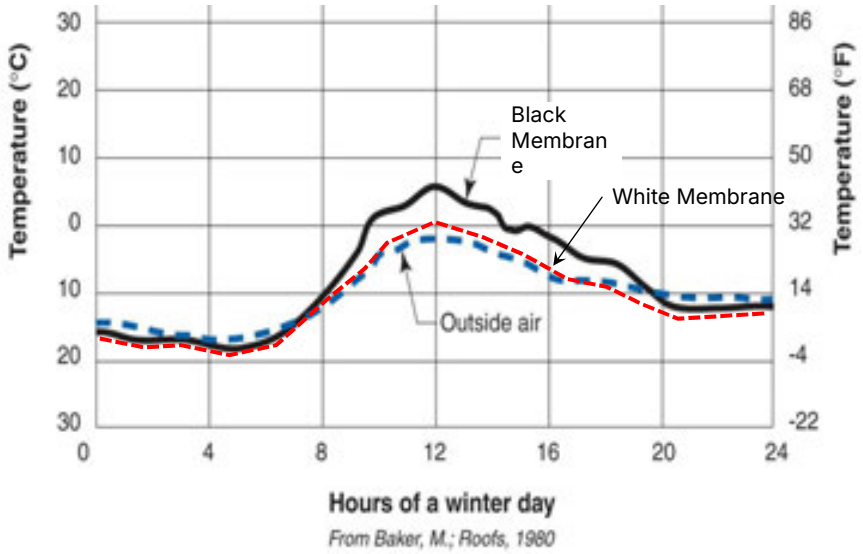
Membrane Color



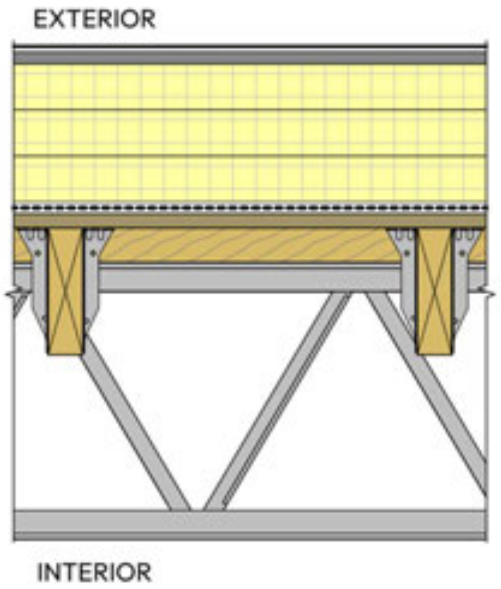
- **Darker Colours** (more absorptive, less reflective)
  - Higher temperatures, more movement and membrane stress, higher cooling loads, lower heating loads
- **Lighter Colours** (less absorptive, more reflective)
  - Lower temperatures, less movement and membrane stress, lower cooling loads, higher heating loads
- LEED points for use of highly reflective roofs regardless of energy implication and local climate
- Balance needed between membrane durability, assembly movement, heating and cooling loads

White Membranes stay colder



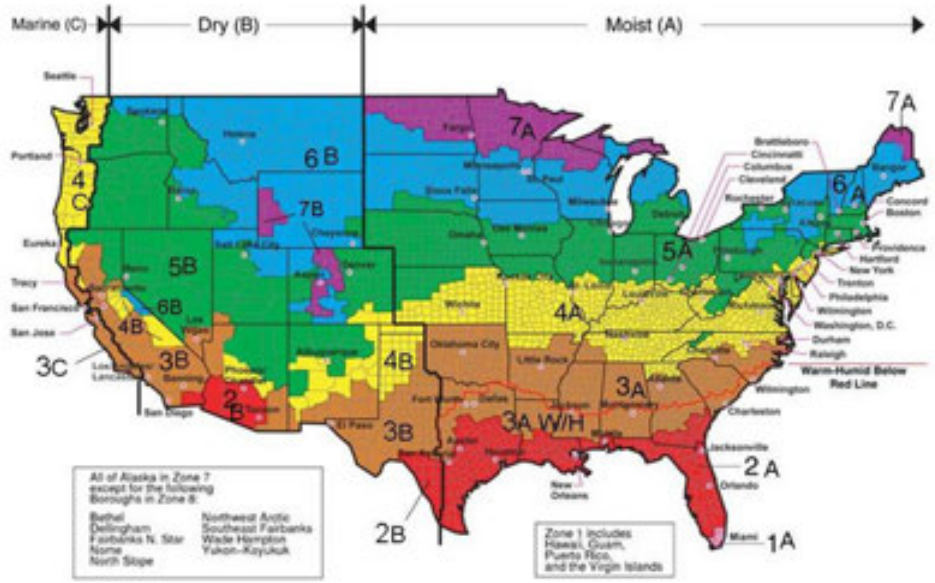
Conventional Roof Best Practices

- Widely installed, works in all climate zones
- Variations abound – climate and building specific decisions:
  - Below-deck insulation enticing in some applications
  - Omitting deck level air barrier common in many climates and building types
  - Adhered vs. mechanically fastened
  - Deck material
  - Roof membrane materiality, color, and detailing
  - Coverboards not universally installed



3 Other Considerations

Climate Zones



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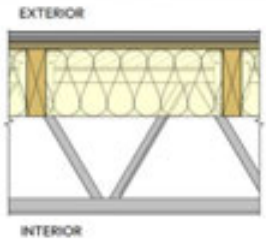
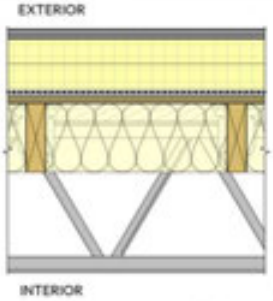
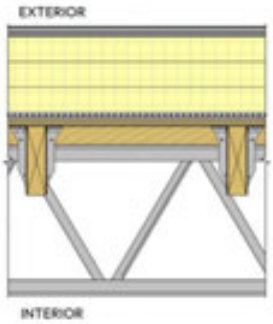
Control Layer Placement Options for PWR

a) Insulation Below Deck	b) Split Insulation	c) Insulation Above Deck
		
Caution	Get the ratio right	Best

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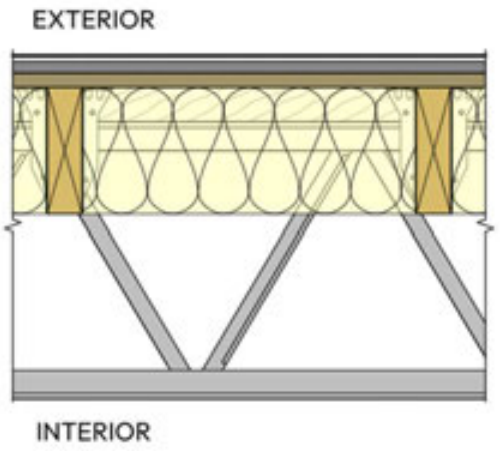
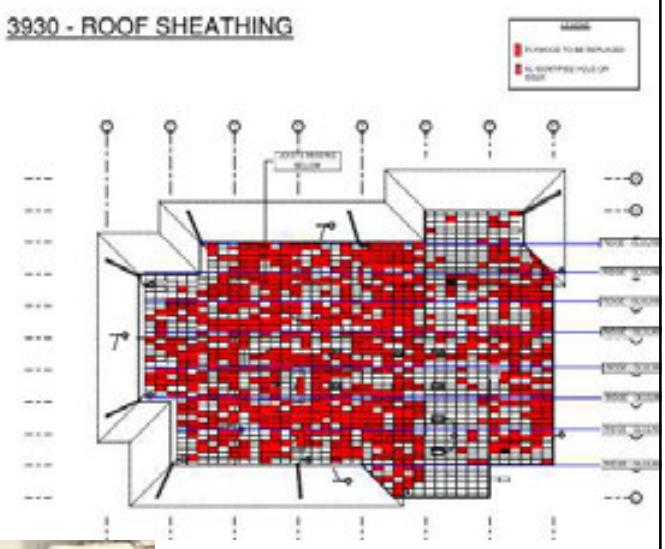
Interior Insulated Assemblies

- Roof deck condensation risk in cold weather
- Very sensitive to interior humidity levels; consider interior occupancy
- Potential solutions involve interior air control and/or venting above the insulation plane; be cautious outside of well-established approaches
- Consider impact of interior TI work



Interior Insulation Challenges – Cold Surfaces + Airflow

Interior Insulation Challenges – Cold Surfaces + Airflow



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Interior Insulation Challenges – Cold Surfaces + Airflow

STAINING ONLY AT INSULATED AREAS

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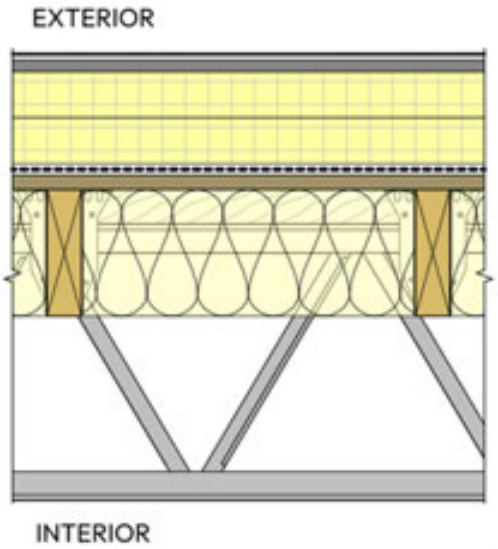
Split-Insulated Assemblies

- Appropriate level of exterior insulation a function of exterior climate and the interior conditions
  - A pool in Tahoe are not the same thing as a warehouse building in Dallas
- Risk reduction as ratio of exterior insulation increases



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Provisions in IBC >2015

Applies to “enclosed rafter spaces”, but the physics is the same regardless of ceiling finish

TABLE 1203.3
INSULATION FOR CONDENSATION CONTROL

CLIMATE ZONE	MINIMUM R-VALUE OF AIR-IMPERMEABLE INSULATION[a]
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

Exceptions:

1. Section 1203.3 does not apply to special use structures or enclosures such as swimming pool enclosures, data processing centers, hospitals or art galleries.
2. Section 1203.3 does not apply to enclosures in Climate Zones 5 through 8 that are humidified beyond 35 percent during the three coldest months.

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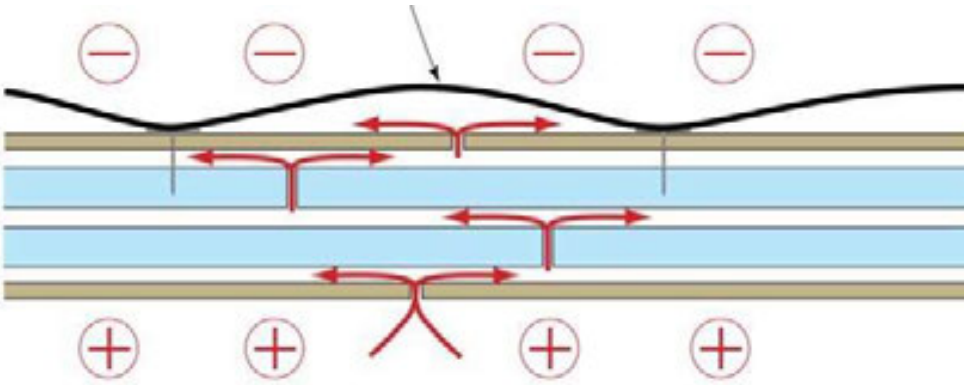
Air Control



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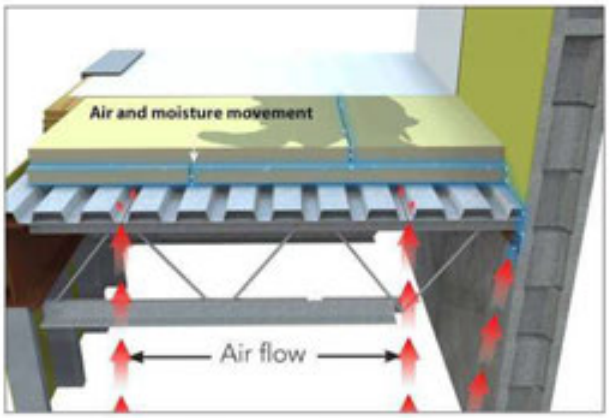
Air Control

Where is the air barrier?



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WESTERN STATES ROOFING CONTRACTORS ASSOCIATION
(WSRCA)
TECHNICAL BULLETIN No. 2014-L
Winter, 2014

To: Roofing Contractor Members, Design Professionals, and Roofing Industry Members

From: WSRCA's Low-Slope Roofing Committee

Subject: Vapor Retarder Technical Information – "Vapor Retarders 201"

****

More Reports of Condensation and Moisture Accumulation with Loose-laid and Mechanically-attached, Light-colored Single-plies:

With the recent mass trend toward "cool roofs" and white- or light-colored single plies, even being specified in predominately heating-climates[1], there are relatively new roof condensation problems being reported. Wind-flutter and the pumping of internal building generated and/or occupancy generated moisture, combined with night-time radiative cooling of the roof's surface, are reported as causing frost formation-related condensation and melting drip-back moisture problems, which are reportedly contributing to moisture problems within some building types that lack roof vapor retarders, and/or proper exterior wall vapor retarders. This relatively new issue or phenomenon is reportedly being discovered more often with mechanically attached single plies, located on buildings that lack vapor retarders and are situated in predominately winter-time heating climates.

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Non-Conditioned Buildings

Key Considerations

- → Wind uplift resistance
- → Roof membrane, slope to drain
- → Resistance to exterior fire / embers
- → Maintenance, solar, interior occupancy / conditions

- → No longer worried about condensation risk from air/vapor flow driven by temperature and pressure differentials
- → Radiant heat transfer from the roof becomes dominant heat transfer mechanism

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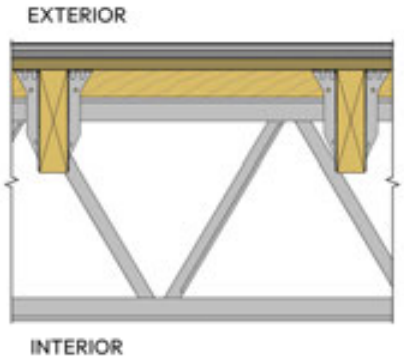
Radiative Heat Transfer

- Hot surfaces radiate infrared energy to cold surfaces
- Day conditions: Hot roof transfers heat to interior space
  - Can be effective at reducing interior heat gain
  - Consider vapor permeability and wetting/drying balance
- Night conditions: roof radiates heat to a clear night sky, cooling roof deck below ambient



Condensation – High Humidity, Clear Night Skies




Night Sky Radiation

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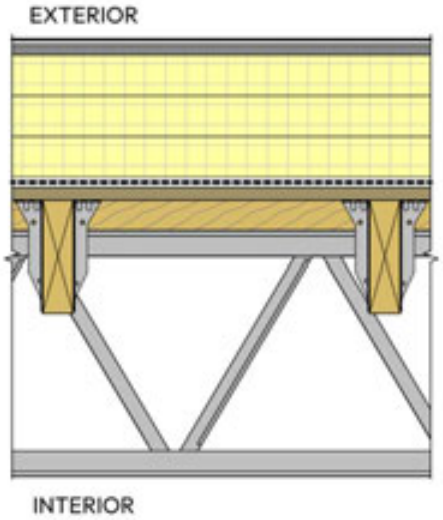

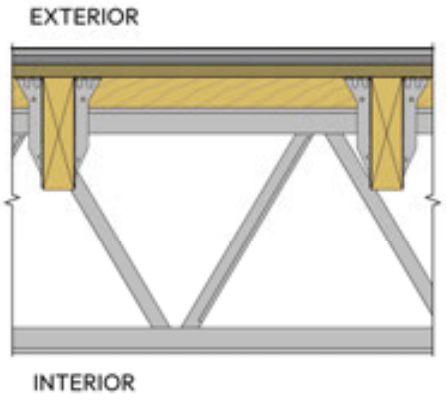

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