

# **High Performance Roof Systems: A Standard of Care for Designers and Contractors**

**Presented by**

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**Emerging Technologies and Roof System Performance**

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# **High Performance Roofing**

- **Relies first on the roof system performing**
- **As Roofing Industry moves deeper into environmental mandates**
  - **The 'Standard of Care' required of designers has been raised**
  - **The 'Customs and Practices' required of contractors has been raised**

# High Performance Roofing

- Recent observations indicate that many roof projects are falling short of this goal
- Architects are not providing a 'Standard of Care'
- Contractors are not providing the 'Customs and Practices' expected
- The results are devastating:
  - Roof deck collapses
  - Roof blow offs
  - Loss of property
  - Expensive Litigation

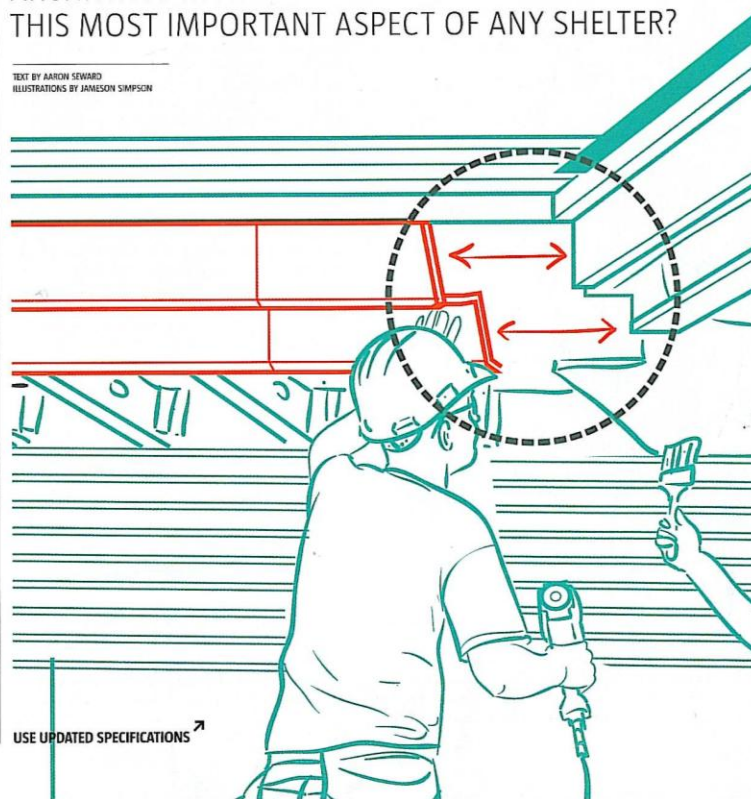


→ CONTINUING EDUCATION

# When it Leaks it Pours

WATER INTRUSION MAKES UP MORE THAN 70 PERCENT OF CONSTRUCTION LITIGATION. ROOFS ARE OFTEN THE CULPRIT, SO WHY AREN'T ARCHITECTS MORE CAREFUL ABOUT DESIGNING THIS MOST IMPORTANT ASPECT OF ANY SHELTER?

TEXT BY AARON SEWARD  
ILLUSTRATIONS BY JAMESON SIMPSON





# **“God is in the Details”**

***-Ludwig Mies van der Rohe***

# Goals

- **Review the increased 'Standard of Care' for architects and 'Customs and Practices' of contractors required to achieve high performance roof systems**
- **Realize it's the small details that matter**
- **Review of examples (issues) of where the lack of 'Standard of Care' and/or 'Customs and Practices' was not met**
- **Provide Lessons Learned**

# **Moisture Drive**

- **No greater issues facing the roofing industry today than moisture drive**
- **Air vapor moves from energy high to low**
  - **Warm air wants to move to cooler locations**
    - **Air doesn't care what building you are, how famous an architect you are, or what current environmental talk of the week you are, it does what it wants and it is never good**

# **Moisture Drive**

- **Single layer insulation is a crime**
  - **Especially with mechanically fastened membrane**
- **Some say it “it isn’t so”**
  - **\$14, 000,000 in roof removal and replacement of less than 3 year old roofs and enormous litigation says it is so**
  - **It’s a physics concern, and the federal physicists who have never been on a roof, don’t get it**

# Moisture Drive



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# Moisture Drive



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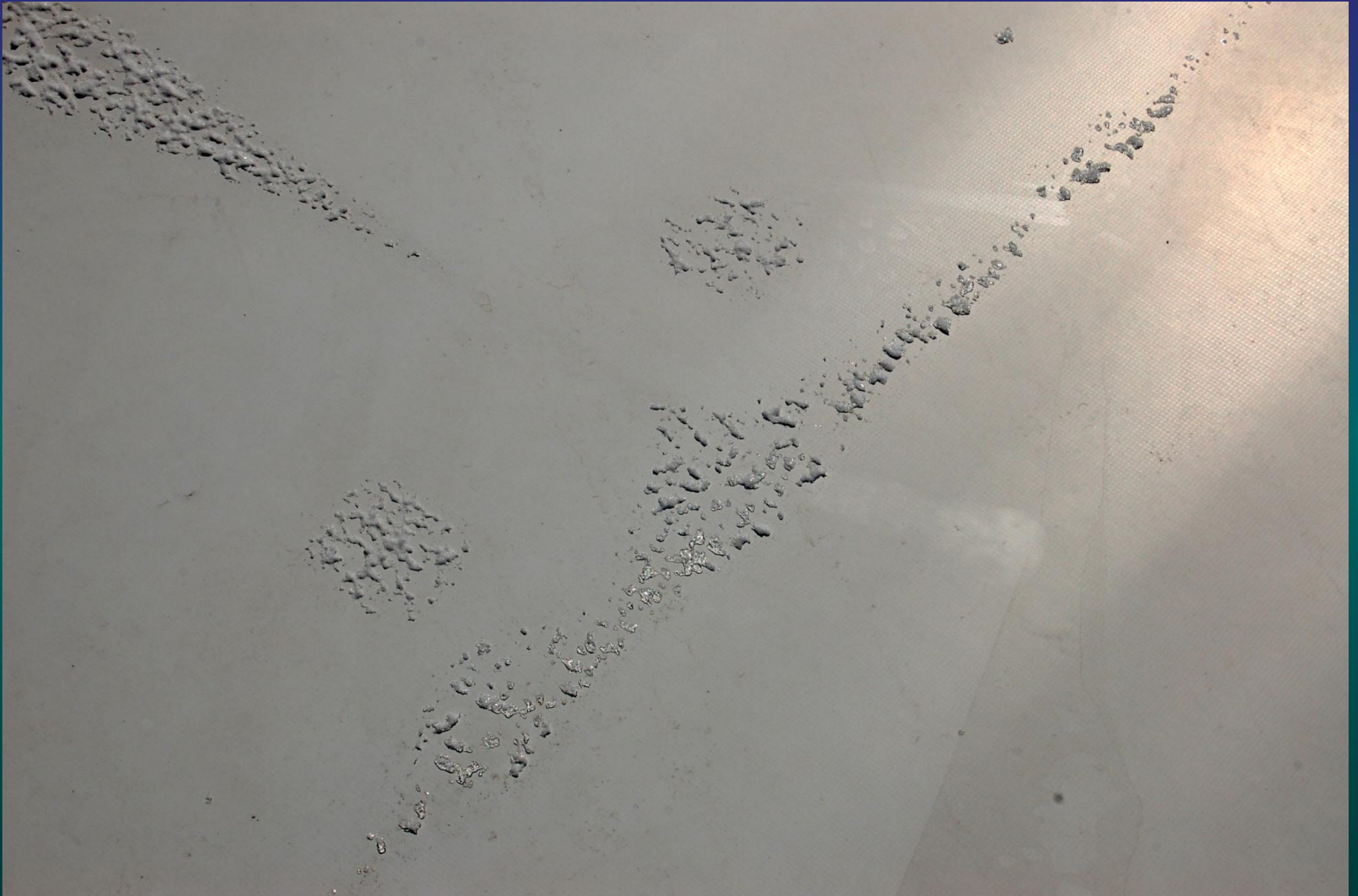


# Moisture Drive



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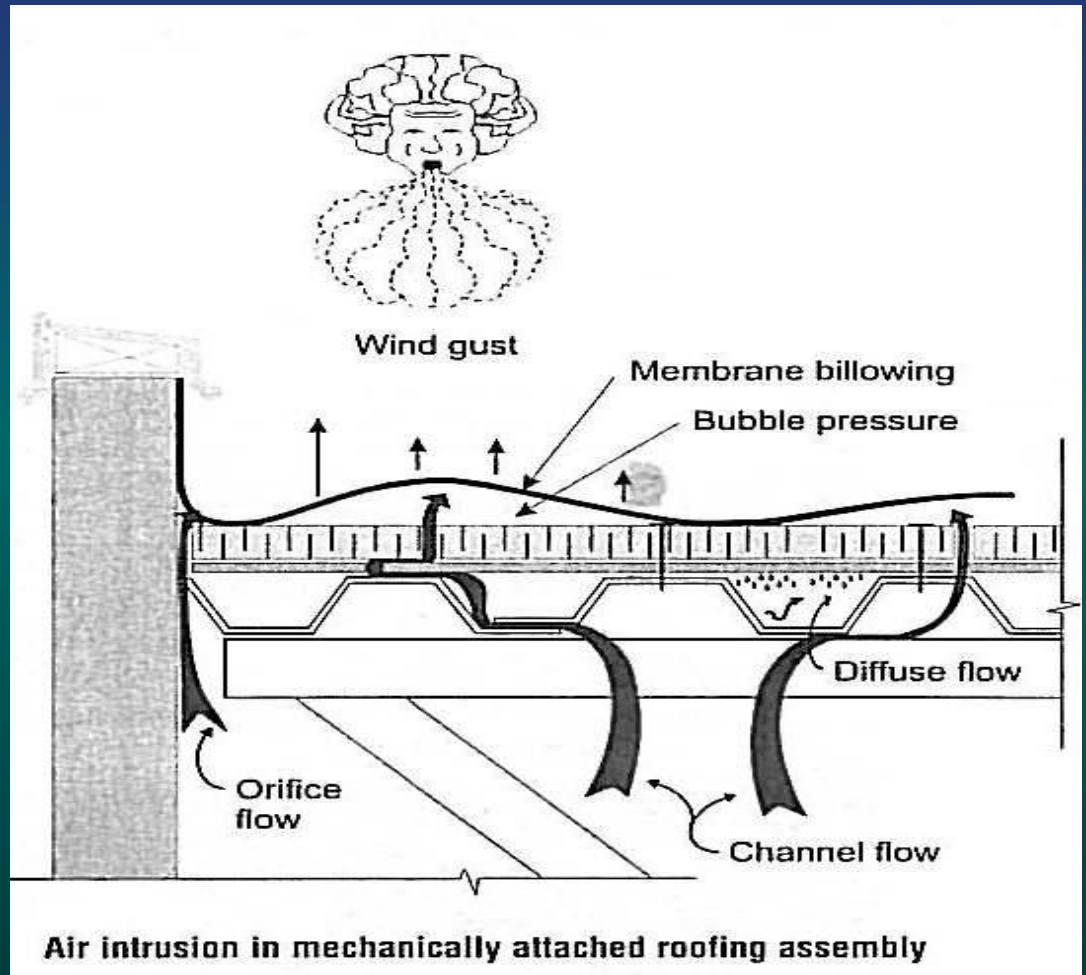
# Moisture Drive



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# Moisture Drive

- Allowing warm moist air to move to a cold building envelope surface is never good





# **Moisture Drive**

## **Lessons Learned**

- **Remember the laws of physics**
  - **Air containing moisture condenses on cold surfaces**
  - **Remove the condition that allows air movement**
    - **i.e. Use a vapor barrier**
  - **Remove cold surface**
    - **Use multiple layers of insulation**
    - **Seal voids**
    - **Do not use loose reflective surface in cold climates**

# **Water-Based Adhesives**

- **Another push by those with no vested interest in the roofing industry to suggest what they feel is an environmental improvement**
- **Roofing is now a 12 month a year activity**
  - **Where in a good portion of the US the temps are below freezing**
  - **Water freezes when the ambient temperature is below freezing**
- **Construction schedules can not be controlled**

# Water-Based Adhesives



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# Water-Based Adhesives





# Water-Based Adhesives



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# **Water-Based Adhesives**

## **Lessons Learned**

- **Know your climate, project schedule and product's ability to resist temperature and moisture to increase potential long-term success**
- **Has the product been used successfully for a number of years in your climate with the materials being used?**



# Spray Foam Adhesives

- **Applied correctly they are tenacious, but they more often then not are installed into the roof system poorly**
  - **The materials to be adhered must actually touch the adhesive**



# **Spray Foam Adhesives**

## **Issues:**

- Unlevel surfaces**
- Contaminates**
- Improper substrate prep**
- Lack of contact**
- Belief by installers that the adhesion is so good that they can 'drop and run'**
- Insulation is too thick**



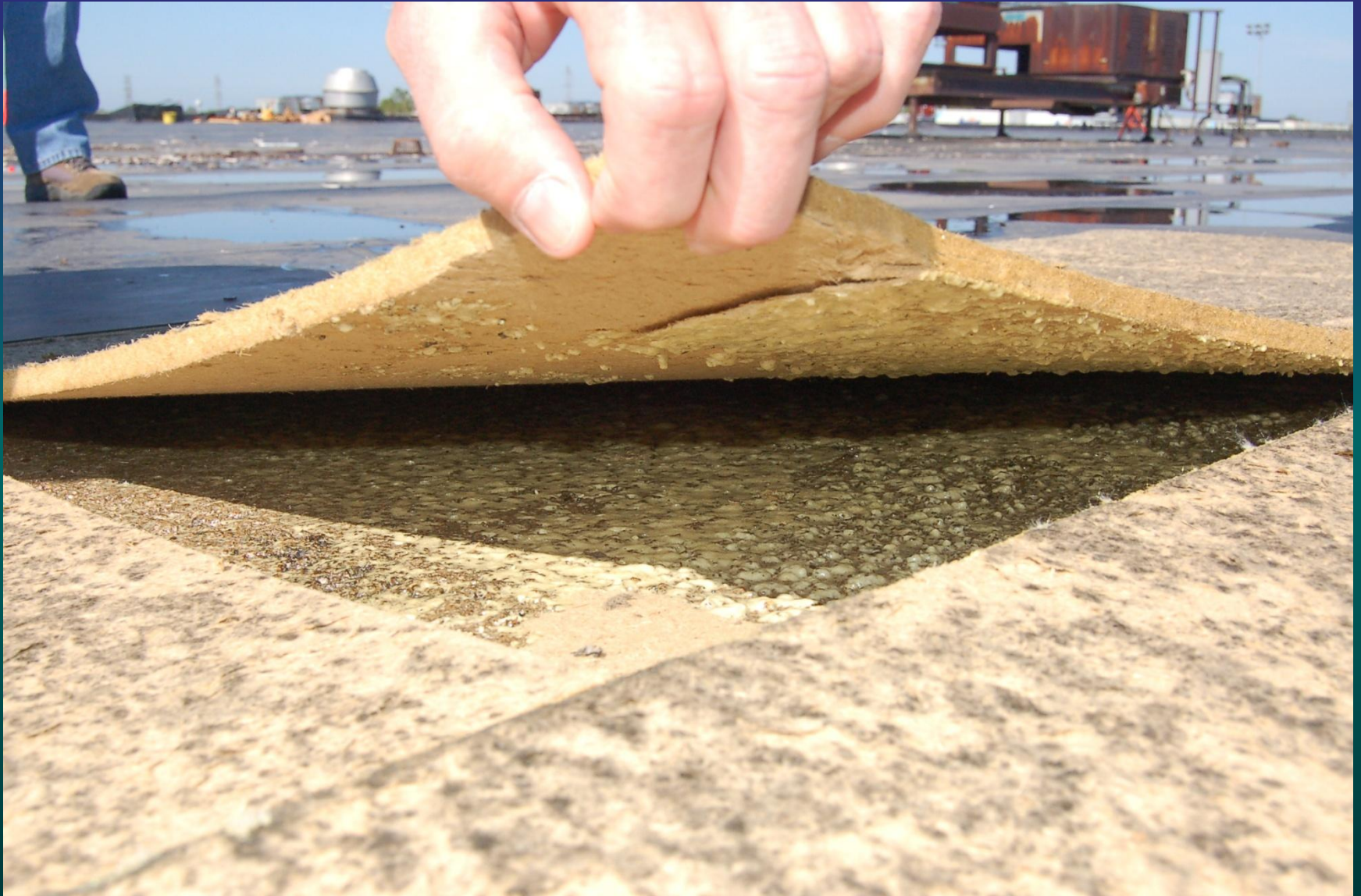
# Spray Foam Adhesives



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# Spray Foam Adhesives



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# Spray Foam Adhesives



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# **Spray Foam Adhesives**

## **Lessons Learned**

- **Insulation, cover boards and membranes installed with spray foam adhesive only can adhere if they touch the adhesive**
- **Rolling the material into the adhesive to assure positive adherence is mandatory**
- **The weighting of the insulation with items such as adhesive cans alone is insufficient**



# Bead Foam Adhesives



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# Bead Foam Adhesives



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# **Bead Foam Adhesives**

- **Specification / Installation Concerns**
  - **Prepare roof deck / substrate preparation**
  - **Spacing & size (diameter) of bead**
    - **4 “ O.C. is this authors recommended minimum**
  - **Allow rise to occur**
  - **Insulation thickness – allow conformity**

# **Bead Foam Adhesives**

- **Specification / Installation Concerns (continued)**
  - **Compression into foam**
    - **To provide proper adhesion**
    - **To eliminate avenues for air & moisture transport**
  - **Stepping or setting boards is not adequate**



# Bead Foam Adhesives



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# Bead Foam Adhesives





# Bead Foam Adhesives



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# **Bead Foam Adhesives**

## **Lessons Learned**

- **Quality Assurance**
  - **Proper surface preparation**
  - **Adherence to proper bead spacing**
  - **Allow adhesive to rise**
  - **Set and compress boards, weight till bonded**
  - **Eliminate air spaces**

# **Concrete Roof Decks**

- **History:**
  - **Concrete was an outstanding substrate**
    - **Perhaps when little if no insulation was installed**
- **Reality:**
  - **Concrete roof decks are seldom a smooth plane**
    - **Depressions**
    - **Waves**
    - **Laitance**
  - **Concrete decks are 'wet'**

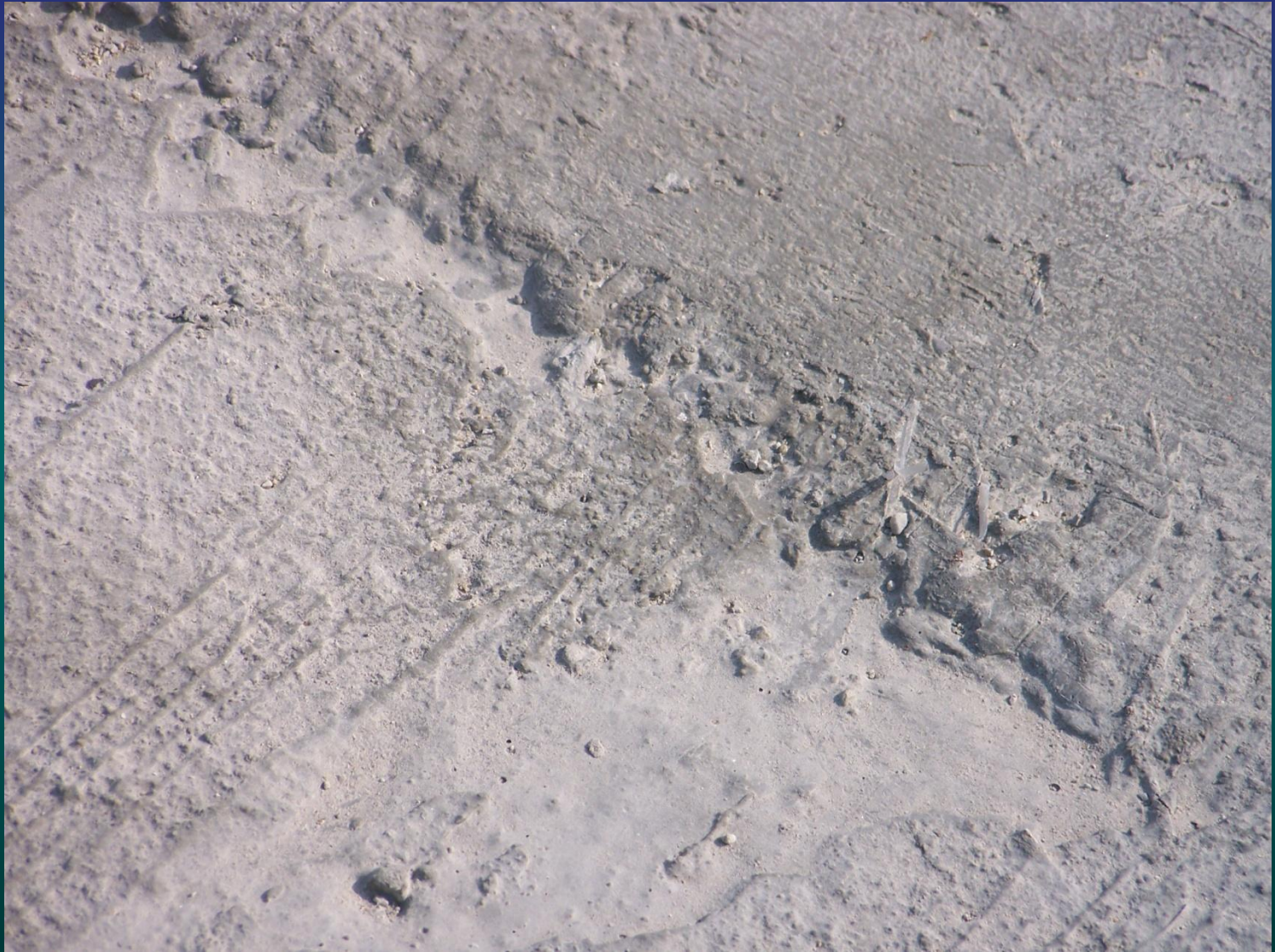


# Concrete Roof Decks

## Curing vs. Drying

- **‘Curing’ is a term used by engineers to describe the time needed to attain strength**
- **‘Drying’ is a function of:**
  - **Underlying substrate**
  - **Temperature**
  - **Climate**
  - **Thickness**
  - **Mix**
  - **Rewetting cycles**

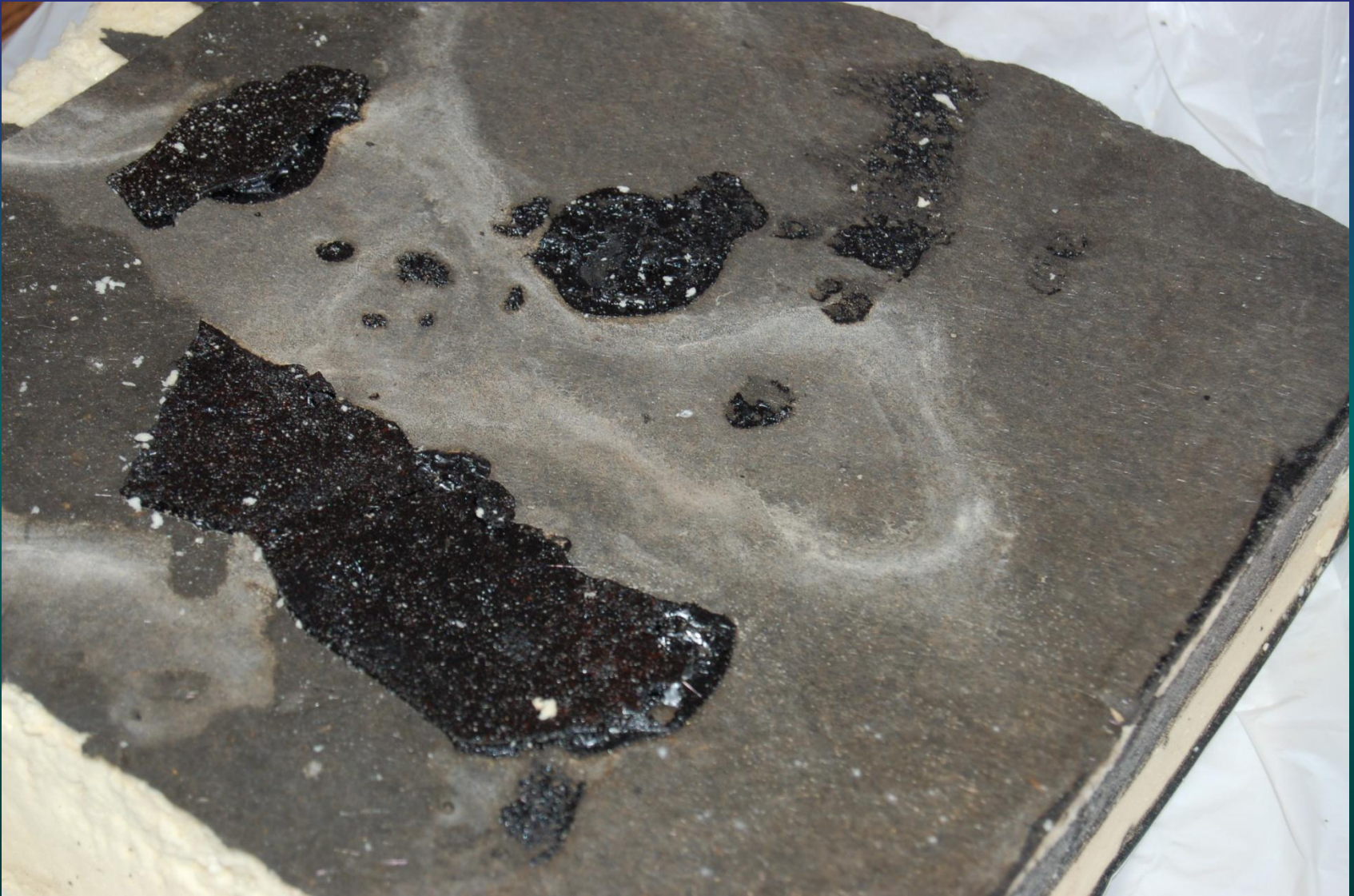
# Concrete Roof Decks



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# Concrete Roof Decks



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# Concrete Roof Decks



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# **Concrete Roof Decks**

## **Lessons Learned**

- **Approach with pragmatism & understanding of conditions that may affect roof system performance**
- **Design:**
  - **Thin, multiple layers of insulation**
  - **Adhesives that can be installed in heavy thicknesses (to fill in those depressions) without loss of integrity**
  - **Know cured vs. dry**

# **Concrete Roof Decks**

## **How Dry is Dry?**

- **When is a new concrete roof deck ready to receive the new roof?**
  - **When it is walkable?**
  - **When its color becomes light?**
  - **When the General Contractor says so?**
  - **When it's dry ... enough ... to allow for the successful application of the roof system**



# **Concrete Roof Decks**

## **How Dry is Dry?**

- **Drying**
  - **Relates to the release of moisture from the hydrating process**
- **How long?**
  - **Months!?**

# **Concrete Roof Decks**

## **How Dry is Dry?**

- **How can dry be defined?**
  - **ASTM D 4263 – Standard Test Method for Indicating Moisture by the Plastic Sheet Method**
  - **Gravimetric Testing**
  - **Moisture Vapor Emissions Tests**
- **Who is responsible? Roofing Contractor? Designer?**
- **Adhesion tests are surface only and cannot confirm moisture content**

# Concrete Roof Decks



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# Concrete Roof Decks



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# Concrete Roof Decks



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# **Concrete Roof Decks - How Dry is Dry?**

## **Lessons Learned**

- **Testing indicates when concrete is dry, NOT the General Contractor**
- **Inform General Contractor well in advance of concerns**
- **Designers: Specify the appropriate tests .. . hold to the spec!**



# **Treated Wood**

- **Why are Architects still specifying treated wood?**
  - **With all the discussion of concerns ... you would think it would have changed!**
- **Experience in the field has revealed little deterioration of aged non-treated wood**
- **Treated sawdust is a “hazardous waste” ..  
 . to be disposed of properly**

# **Treated Wood**

- **If you must use treated wood, specify stainless steel screws and fasteners**
- OR**
- **Specify good ole, natural and organic, Doug Fir**

# **Treated Wood**

## **Lessons Learned**

- **Designers:**
  - **Treated wood will “eat you” (corrode anchorage) into court**
  - **Specify the better choice of wood – Douglas Fir**
- **Contractors:**
  - **If treated wood is specified, a red light should go off, and you should ask for extra money for stainless anchors and nails if they aren’t already specified**



# Membrane Cutouts at Roof Drain

- It is not a contest to see who can cut the smallest of drain outlets



# **Membrane Cutouts at Roof Drain**

- **Roof drain bowl design is based on Bernouli's principle, and successful water removal requires that most of the bowl be exposed to water flow**

# **Membrane Cutouts at Roof Drain**

- **Minimizing the membrane opening:**
  - **Reduce water flow**
  - **Minimize draft, created by cyclonic effect created by the drain bowl**
  - **During heavy rain, ponding can be created**
    - **Temporary deck, structure deflections**
      - **Ponding increases**
    - **Load is increased, destabilization can be created**
    - **Who is at fault?**
    - **\$\$\$\$**
    - **Who will decide?**



# Concrete Roof Decks



# **Membrane Cutouts at Roof Drain**

## **Lessons Learned**

- **Keep the roof drain as open as possible:**
  - **Cut back the single plies to within 1/2 inch of clamping ring**
  - **A cloverleaf shape is most effective**
  - **Do this at the time of installation**
  - **Designers—you need to verify this has been done and/or place on 'Punch List'**

# Pipe Penetrations

- **Personal 'pet' peeve ... Why ?... MOISTURE INTRUSION!**
  - **Condensation**
  - **Rain**
  - **Snow – snow melt**
  - **Multiple penetrations per a portal**
  - **Personal 'pet' peeve**
- **Good idea**
  - **Never designed**
  - **Never coordinated**
  - **Never installed correctly**



# Pipe Penetrations



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# Pipe Penetrations



# Pipe Penetrations



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# Pipe Penetrations



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# Pipe Penetrations

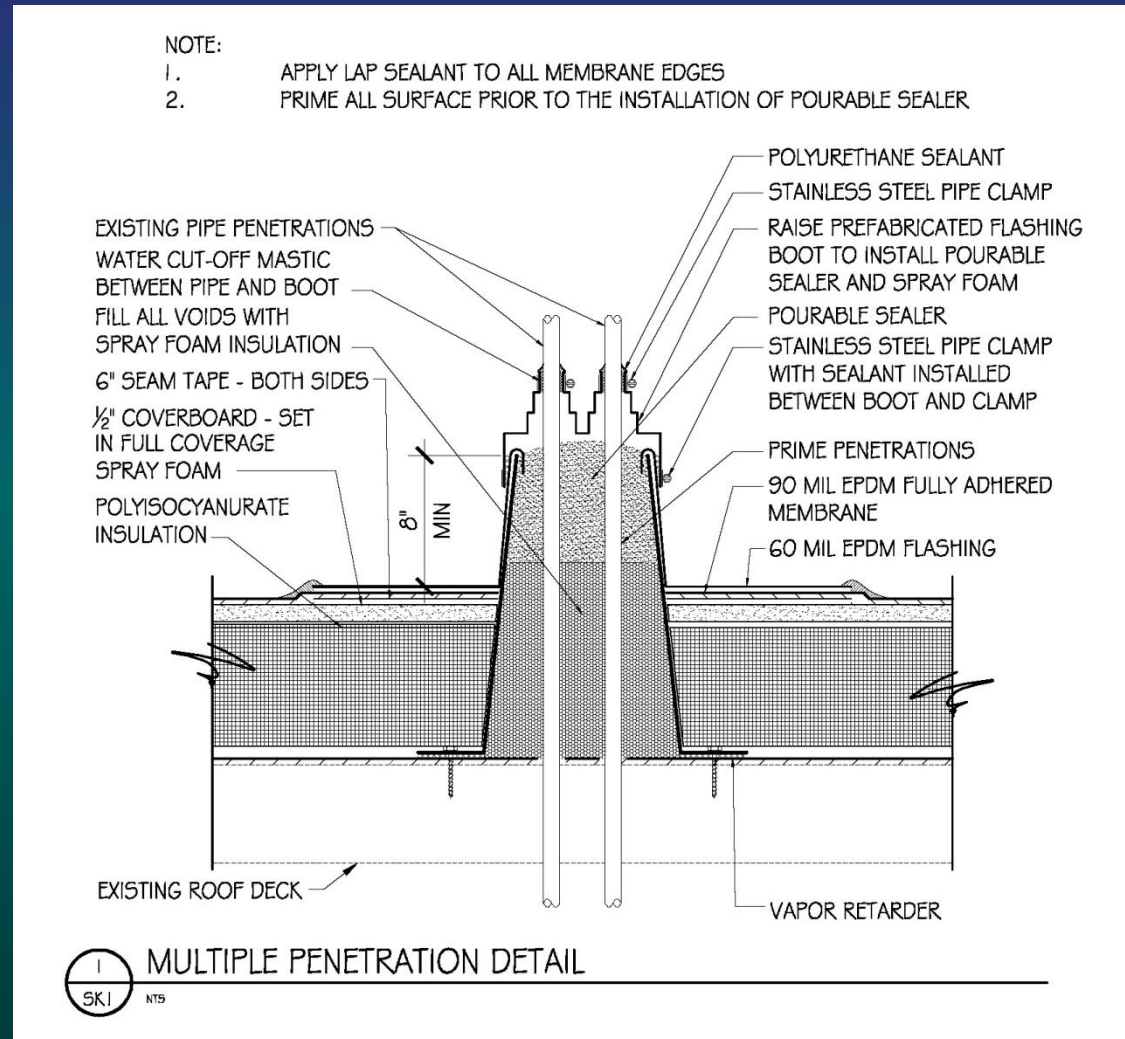


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# Pipe Penetrations

- **Interior air flow results in condensation**
- **Designers must detail and coordinate**





# **Pipe Penetrations**

## **Lessons Learned**

- **HVAC components that interface with the roof need to be designed and coordinated**
- **Roof Drawings**
  - **‘M’ Drawings**
  - **‘P’ Drawings**
    - **Coordinate them all!**

# Conclusions

- **Current economic times have many seeking legal remedies to roof and moisture intrusion concerns**
- **The cause of these concerns can be traced to:**
  - **Design:**
    - **Poor or minimal design effort**
    - **Poor design quality . . . A lack of 'Standard of Care'**
    - **Poor attention to small detail**
    - **Poor coordination with related disciplines**

# Conclusions

- **The cause of these concerns can be traced to [continued]:**
  - **Installation:**
    - **Improper use of materials**
    - **Lack of attention to field conditions**
    - **Hurried construction**
- **Roof service lives are being reduced, or being terminated all together**
- **Legal settlements are costing hundreds of thousands of \$\$\$**



# Conclusions

- **The 'Standard of Care' of Architects needs improvement**
- **Contractors' 'Customs & Practices' must improve**

# **Conclusions**

## **SUSTAINABILITY IS ALL ABOUT LONG TERM SERVICE LIFE**



**Waukegan Public SD 60 - Waukegan, IL - 1986**

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# **Conclusions**

## **SUSTAINABILITY IS ALL ABOUT LONG-TERM SERVICE LIFE**



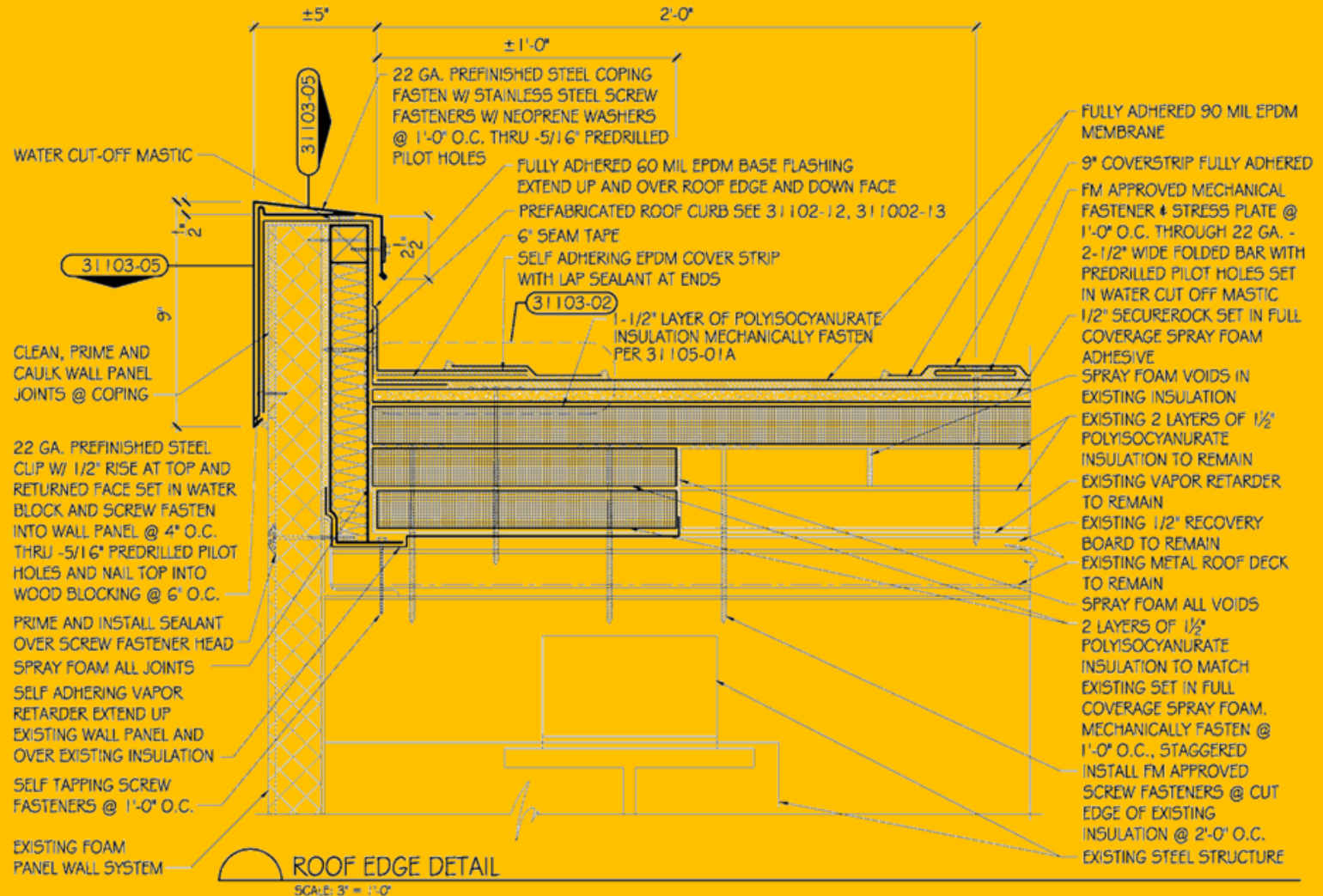
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# 'GOD IS IN THE DETAILS'

## 'IT'S ABOUT KAIZAN'



# Thank You!

## Questions?

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