InSite Consulting Architects

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Exterior Building Envelope Maintenance

Glossary

- Barrier Wall
- Cavity Wall
- Rain-screen
- Soft Joint
- Hard Joint
- Vapor *Retarder*
- Vapor *Barrier*
- Air Barrier
- Flashing
- Through-wall
- Counterflashing
- Flashing
- Lime
- Cement
- Aggregate
- Glazing
- Thermally Broken
- Thermal Bridge
- Attenuation
- Batt
- Mineral Wool
- Fiberglass
- Asbestos
- Workmanship
- Thermal Transfer
- Water - Liquid
- Water - Gas
- Water - Vapor
- Light: Infra-red
- Light: Visible
- Light: Ultra-Violet
- Design
- Rust Jacking
- Corrosion
- Window Head
- Window Jamb
- Window Sill
- Spall
- Efflorescence
- Cycle – Freeze/Thaw
- Cycle - Salt
- Weathering

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Building Envelopes (6)

Contemporary Building Envelopes consist of inter-related building enclosure systems that offer the resistance to (or the use of):

Air, Water, Water Vapor, Heat, Light, and Sound

Material and Energy Transfer Management

Building Envelopes (6)

Control the Movement of:

- Air
  - Infiltration, Exfiltration
  - Air Pressure
- Water (Liquid)
  - Roofing, Waterproofing, WRB
  - Hydrostatic Pressure
- Water (Vapor)
  - Vapor Barrier/Retarder
  - Vapor Pressure
- Heat
  - Insulation, thermal barriers/bridges
  - Thermal Transfer
- Light
  - Windows, storefronts, curtainwalls, glass, coatings and films, shades
  - Light, UV Radiation, Heat Gain
- Sound
  - Acoustical insulation, Sealants
  - STC – Sound Transmission Coefficient

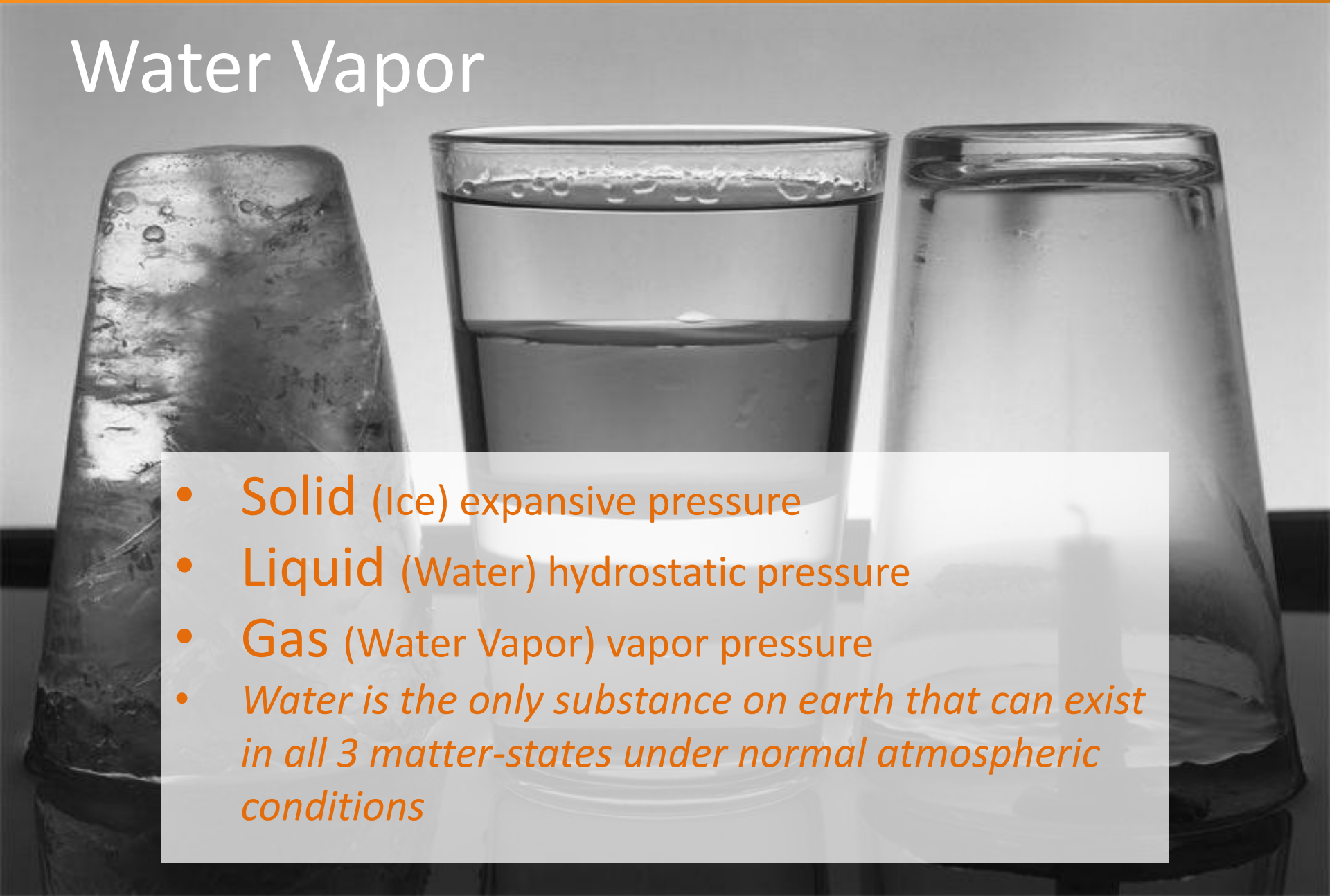
Air

Air

- Wind
- Stack Effect (High Pressure to Low)
- Mechanical Equipment
- *Positively Pressured*
- *Negatively Pressured*
- *Static*

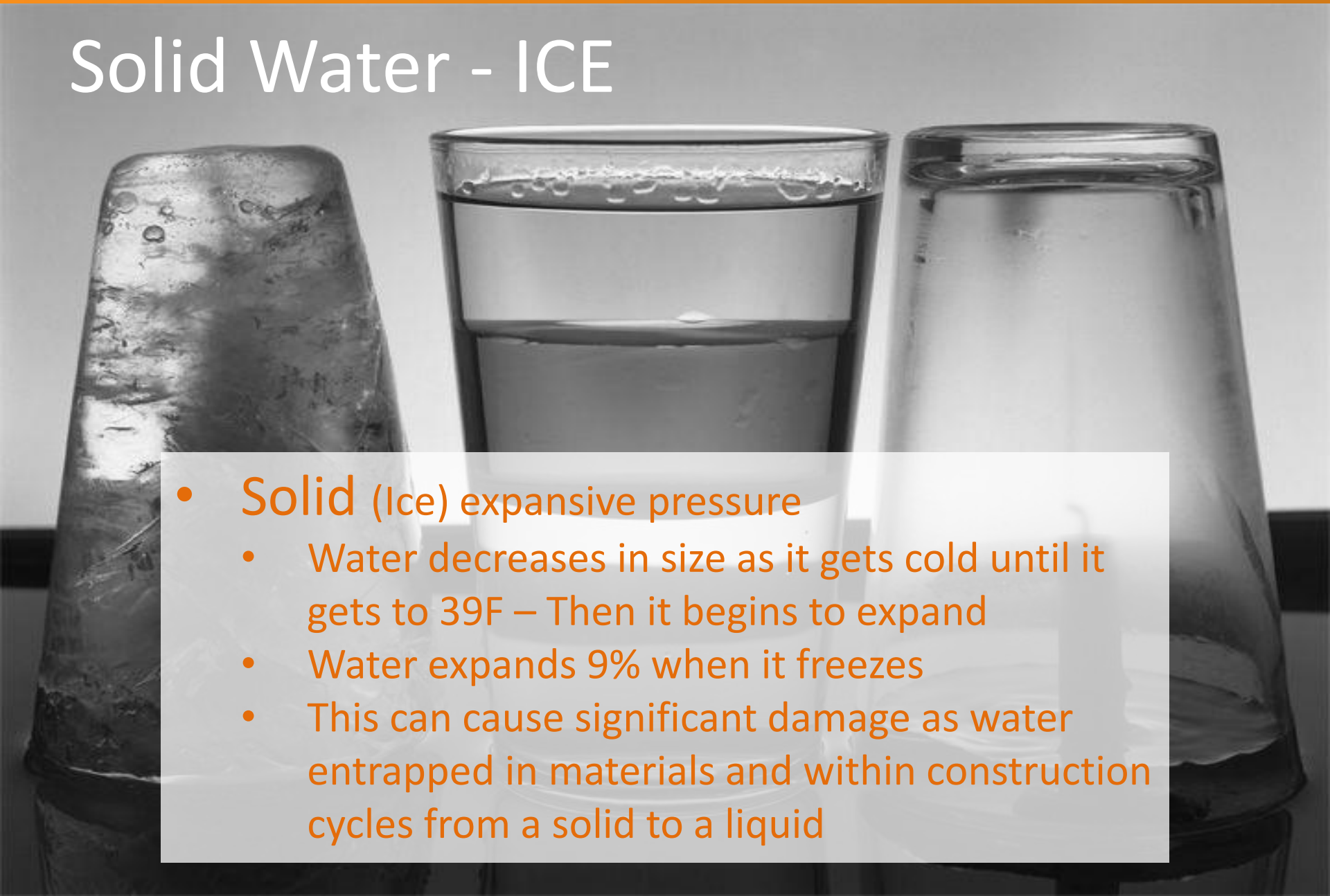
Water

Water Vapor



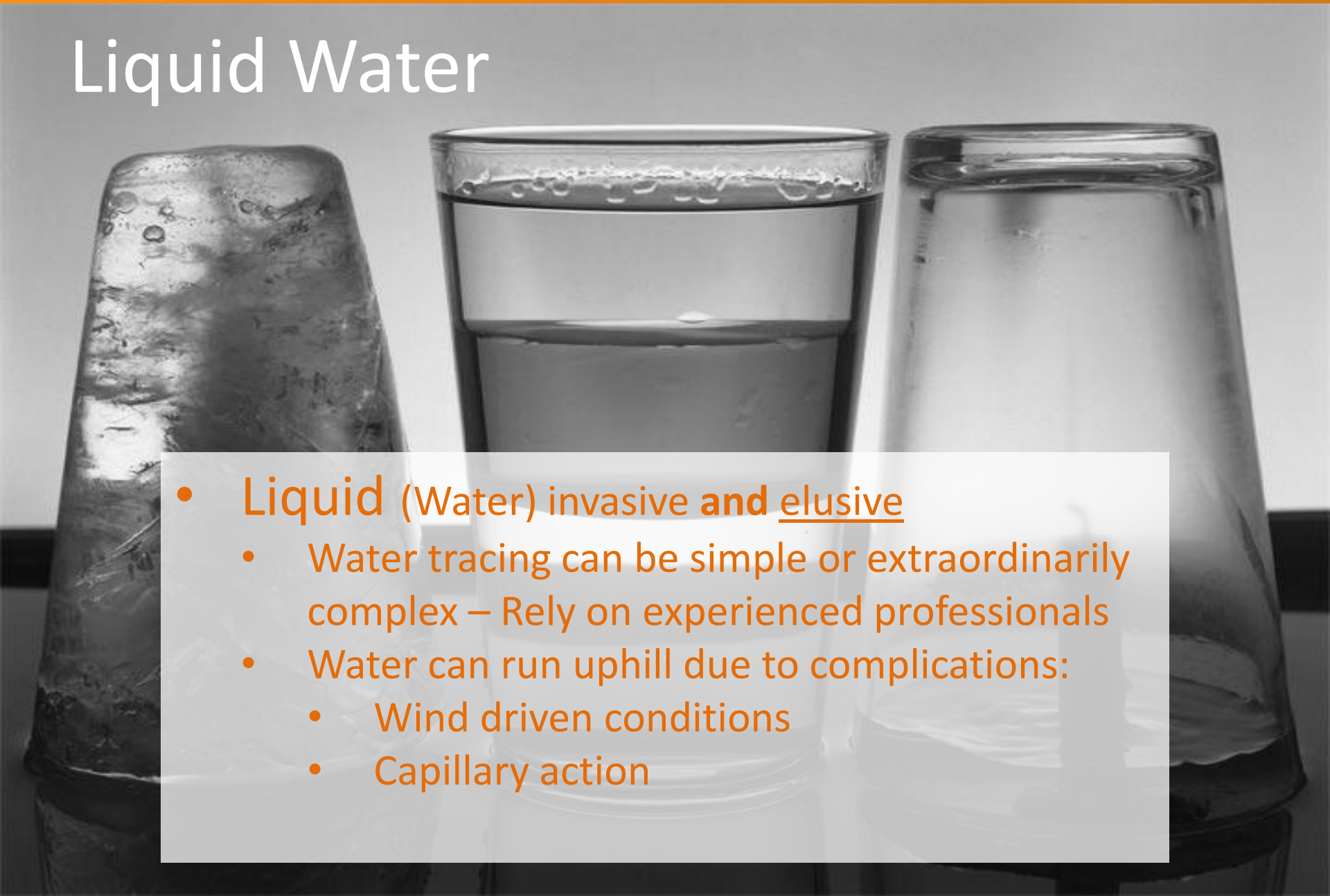
- Solid (Ice) expansive pressure
- Liquid (Water) hydrostatic pressure
- Gas (Water Vapor) vapor pressure
- *Water is the only substance on earth that can exist in all 3 matter-states under normal atmospheric conditions*

Solid Water - ICE



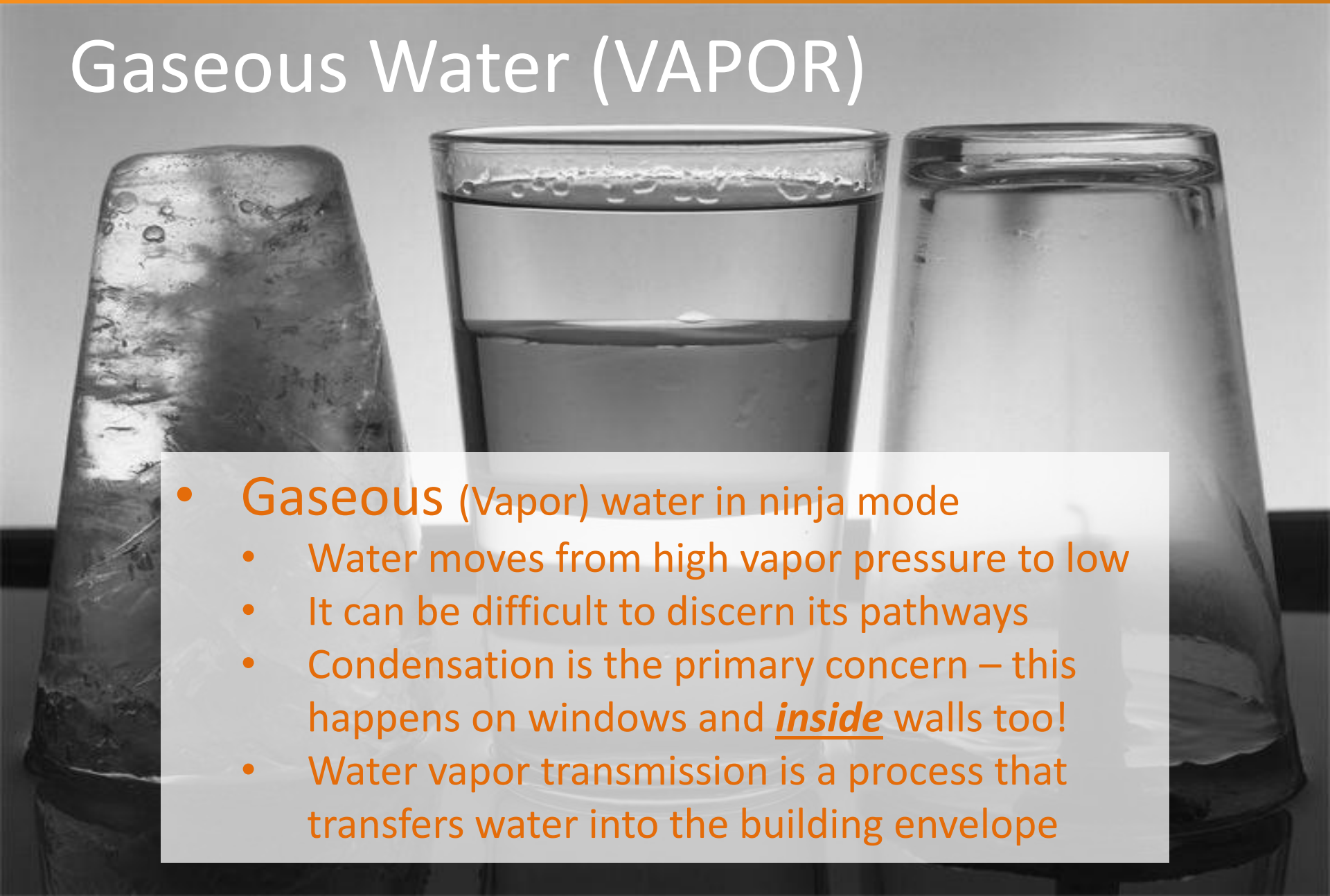
- Solid (Ice) expansive pressure
  - Water decreases in size as it gets cold until it gets to 39F – Then it begins to expand
  - Water expands 9% when it freezes
  - This can cause significant damage as water entrapped in materials and within construction cycles from a solid to a liquid

Liquid Water



- Liquid (Water) invasive **and** elusive
  - Water tracing can be simple or extraordinarily complex – Rely on experienced professionals
  - Water can run uphill due to complications:
    - Wind driven conditions
    - Capillary action

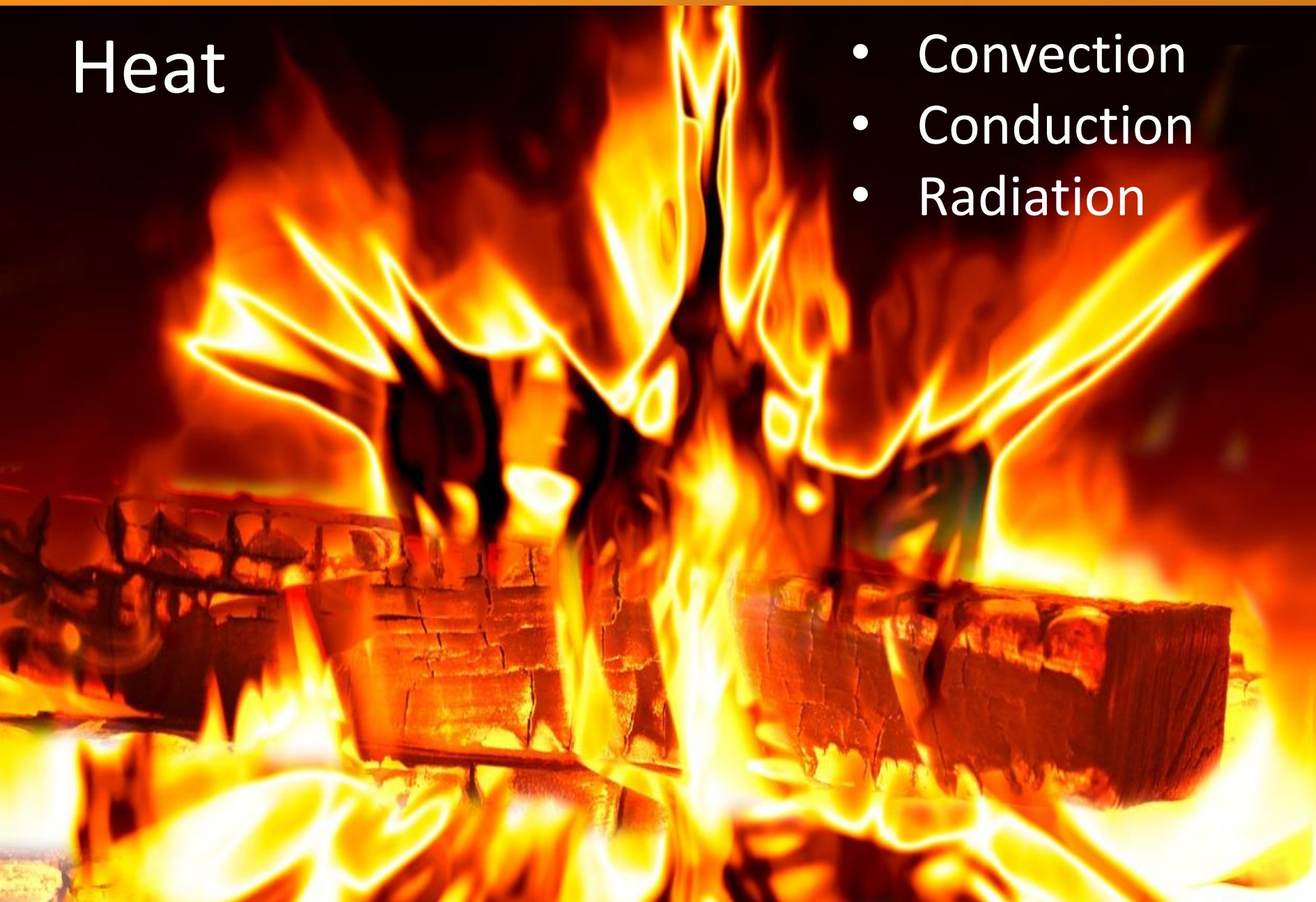
Gaseous Water (VAPOR)



- Gaseous (Vapor) water in ninja mode
  - Water moves from high vapor pressure to low
  - It can be difficult to discern its pathways
  - Condensation is the primary concern – this happens on windows and ***inside*** walls too!
  - Water vapor transmission is a process that transfers water into the building envelope

Heat

- Convection
- Conduction
- Radiation



Heat

- Conduction
- Convection
- Radiation

- Conduction
  - Is an exchange of energy by direct interaction between molecules of a substance containing temperature differences
  - It occurs in gases, liquids, or solids and has a strong basis in the molecular kinetic theory of physics

Heat

- Conduction
- Convection
- Radiation

- Convection
  - May be described as conduction in a fluid as enhanced by the motion of the fluid. It is not be a truly independent mode
  - Strongly influenced by geometry, turbulence, and fluid properties

Heat

- Conduction
- Convection
- Radiation

- Radiation
  - Transfer of thermal energy in the form of electromagnetic waves emitted by atomic and subatomic agitation at the surface of a body.
  - Like all electromagnetic waves (light, X-rays, microwaves), thermal radiation travels at the speed of light

Heat

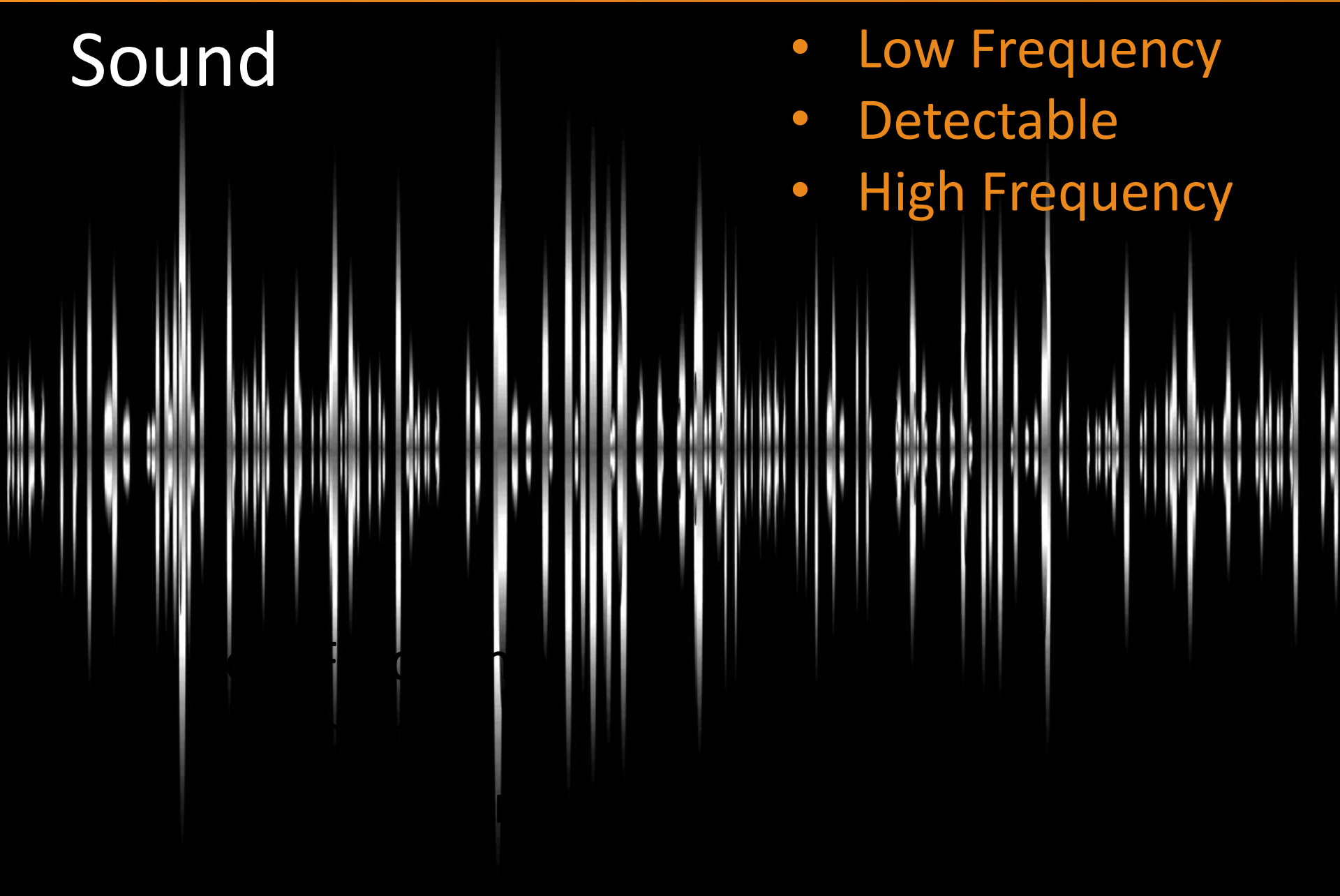
- Conduction
- Convection
- Radiation

- Radiation
  - Radiation passes most easily through a vacuum or a nearly "transparent" gas such as oxygen or nitrogen. Liquids, "participating" gases such as carbon dioxide and water vapor

Light

- Infrared
- Visible
- Ultraviolet

Sound



- Low Frequency
- Detectable
- High Frequency

Building Related Considerations


Material

Workmanship

Design

Weathering – Chemical

Weathering – Physical

Weathering – Biological

Leaks

Common Issues

Mortar Joints

Cracks

Rust Jacking

Salts

Mold

Water

Common Issues

Mortar/Repointing

Common Issues

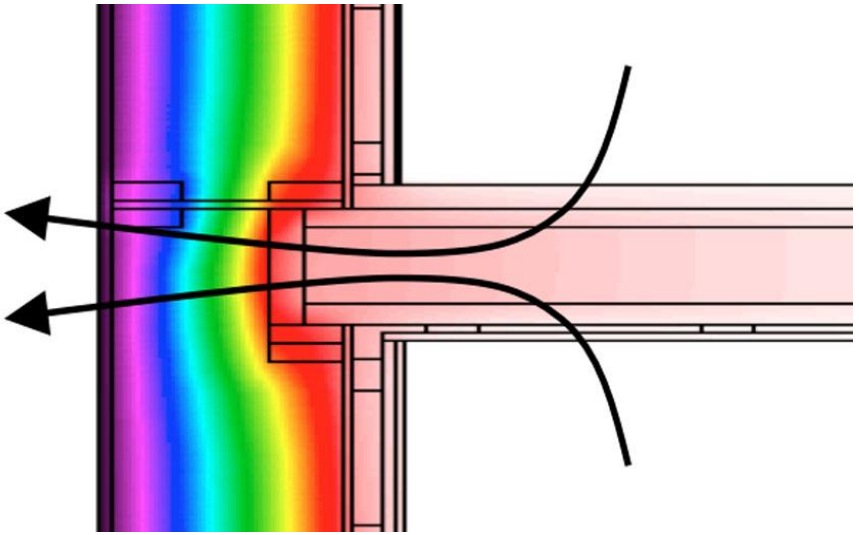
Sealant Failure

Common Issues

Condensation

Common Issues

- Thermal Bridging



Thermal Transfer

Common Issues

Differential Movement

Common Issues

Control Joint Failure

Common Issues

Through-Wall Flashings

Common Issues

Sills/Water Tables

Common Issues

Seals

Common Issues

Differential Materials

Common Issues

Debris

Common Issues

Terminations

Common Issues

Penetrations

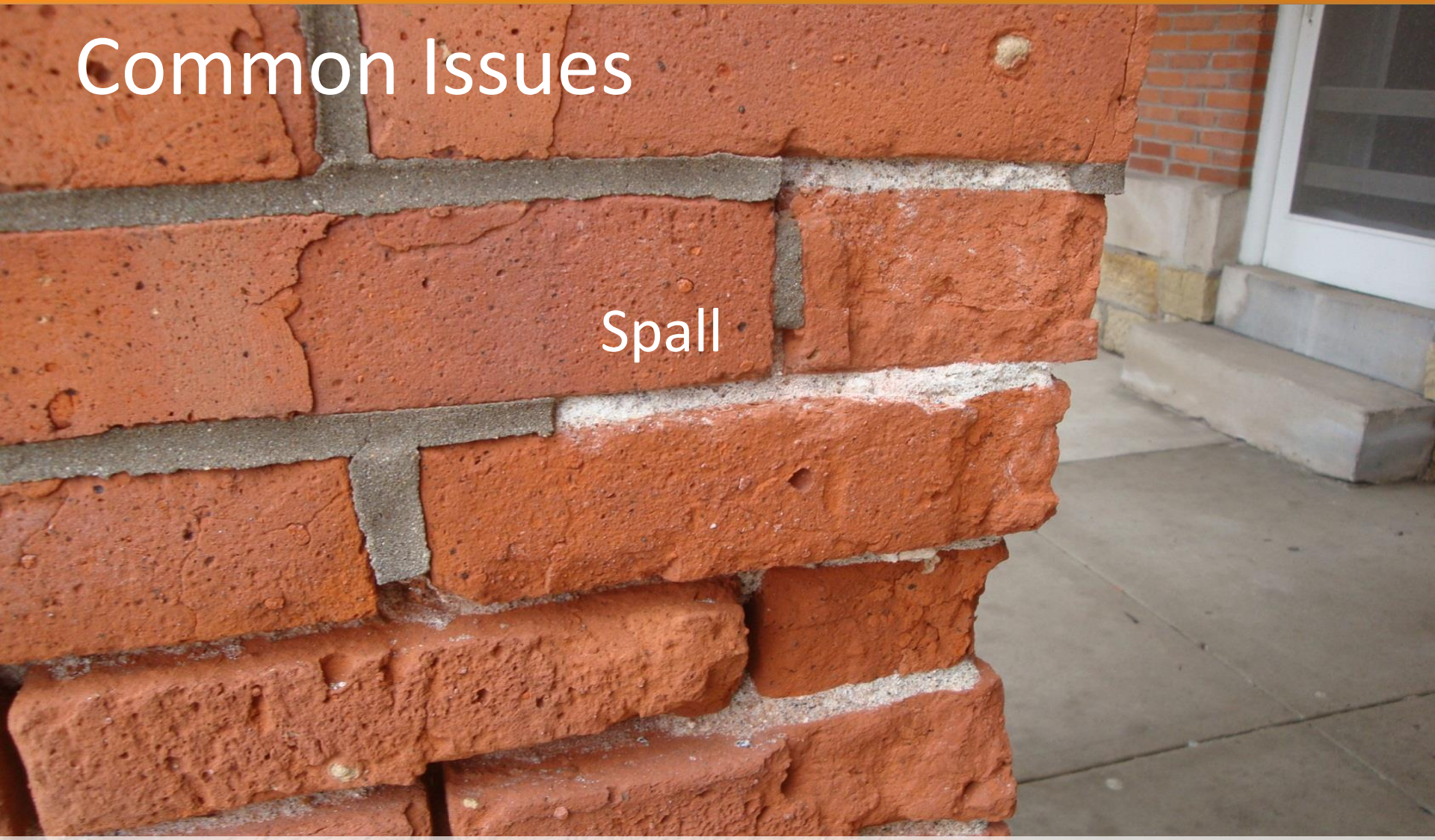
Common Issues

Transitions

Common Issues

Efflorescence

Common Issues



Spall

Common Issues

Differential Movement

Case Study #1

Elementary School District in Southeast Wisconsin – Building Envelope Failure Study

- Small Elementary School District in SE Wisconsin
- Persistent leak issues
- Mystery leaks
- Brick Damage (only 1 color of a 4 color blend)

Case Study #1

- No air space
- Head joint mortar incomplete
- Membrane not adhered
- Rope wick not installed properly

Case Study #1

- Flashing not terminated properly
- Membrane unsupported
- Ends are turned down
- No end dams
- Flashing installed over insulation

Case Study #1

- No sill flashing
- Head joints not ‘full’
- Bed joints not ‘full’
- Brick sill, not good in WI
- Brick sill, no slope, not good anywhere

Case Study #1

- Brick window sill back-sloped
- Brick spall at sill
- Efflorescence below sill
- Back-fill up to brick

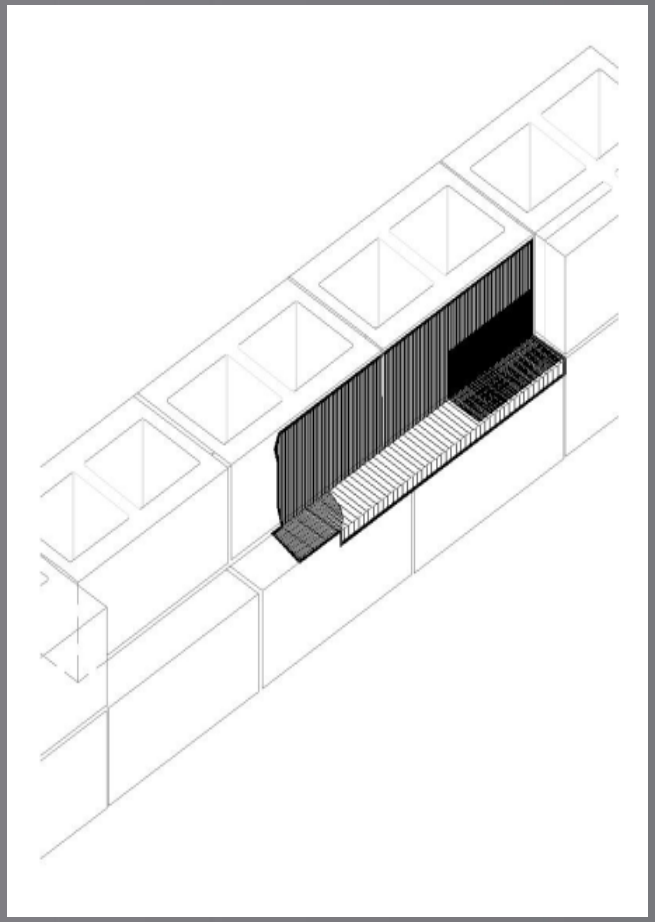
Case Study #1

- No air space
- Head joints not ‘full’
- Signs of prolonged liquid moisture

Case Study #2

- High school district in southern Wisconsin
- Rapidly growing student population
- Well established AE team
- Large, highly regarded CM and GC
- Union mason
- Project budget was left essentially intact throughout process

Case Study #2



- Addition roof flashed into existing wall
- No through-wall flashing was installed
- Significant ‘leaker’ from day 1
- Because the wall was a single wythe, the assumption was made that a through-wall flashing could not be installed

Case Study #2

- Existing wall was a stacked bond split faced single wythe wall.
- The wall was investigated using invasive investigative techniques
- Findings: The single wythe block was an insulated 3 shell, 2 cell block
- The inside cell was cast with extruded polystyrene in its core
- The outside cell was a void
- Repair: The outside shell was removed and the center shell was prepared for the new through-wall flashing.

Case Study #2

- The new through-wall flashing was installed utilizing self-adhering membrane (2-layers) and stainless steel
- When the new flashing was installed the assembly was water tested and the exterior shell was replaced, at the bottom by a new smooth faced CMU

Case Study #2

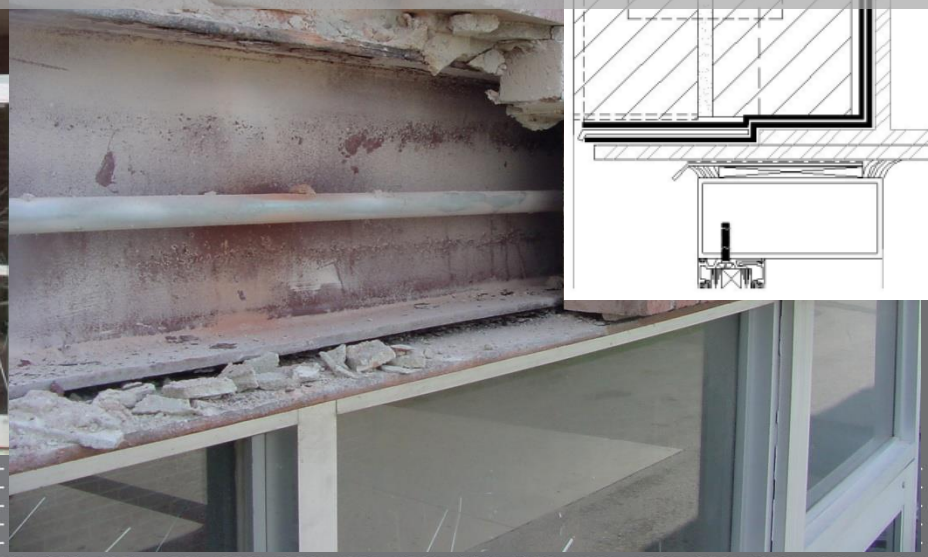
- Several areas of staining were cleaned
- Plant growth was removed from several building areas
- Overhanging trees were cut back or removed

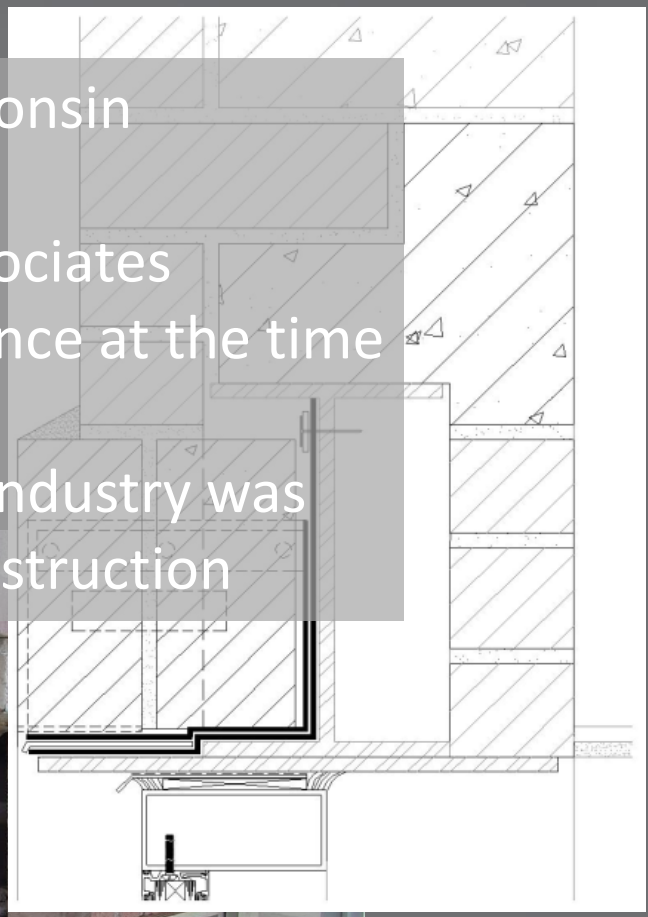
Case Study #2

- The entire wall was coated with an elastomeric paint

Case Study #3

- Large school district in southeastern Wisconsin
- Aggressive B&G expansion program
- 1965 construction. AE team: Flad and Associates
- Local general contractor, 80 years experience at the time
- Union mason
- Designed and built at the time when the industry was beginning the transition to cavity wall construction





Case Study #3

- Masonry wall is hybrid between cavity wall and solid masonry
- It was designed as a solid wall and built with cavity wall characteristics
- 16 foot masonry opening at egress doors
- Lintel is a steel wide-flange beam with a plate steel extension welded to the bottom flange

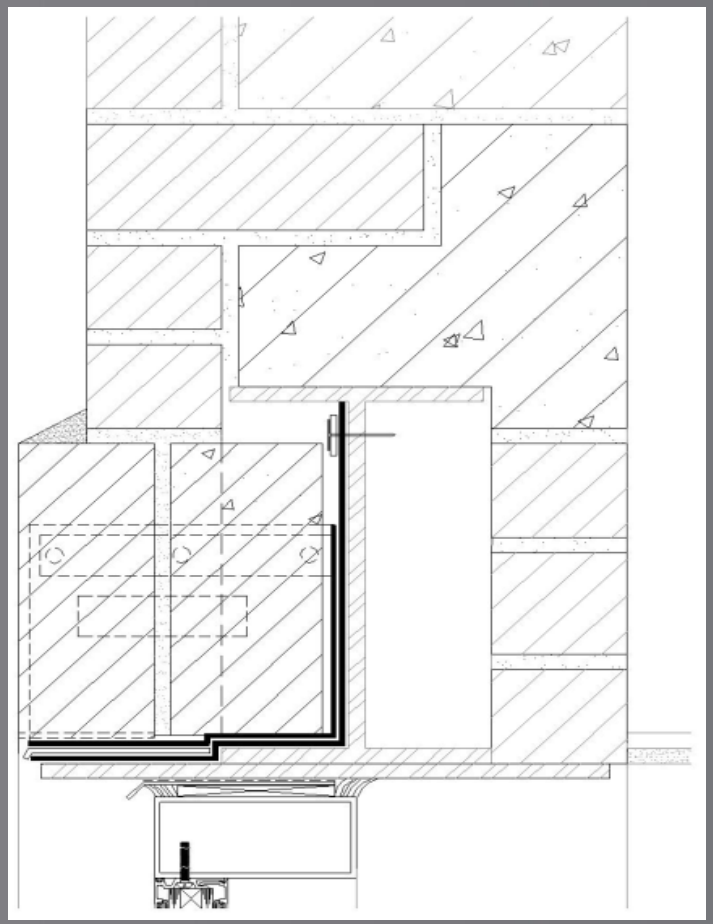
Case Study #3

- View inside lintel construction
- Lintel extension has separated from the lintel beam
- No flashings were installed
- Water that passes through exterior wythe travels down to the lintel assembly
- Water passes through the wall at the bottom of the lintel, inside and out
- Corrosion and rust-jacking breaks the welds between the lintel and the lintel extension plate

Case Study #3

- View inside lintel construction
- Primary leak location at inside of lintel

Case Study #3



- Repair detail included extensive masonry replacement
- Replacement of the steel lintel assembly
- Membrane flashings installed, with terminations at lintel assembly

Case Study #4

- Large school district in southern Wisconsin
- Former main high school, now an “alternative” high school
- Historic structure
- Significant cultural/emotional attachment to the facility
- Very large scale; city block in size
- Indiana Limestone deterioration noted in several areas

Case Study #4

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Q & A

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