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BUILDING ENCLOSURE CONFERENCE
RESTON VA
2022
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This Won’t Go Away – Mold In Office Buildings

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LEARNING OBJECTIVES

- Understand the critical importance of airtightness in buildings.
- That the enclosure and mechanical system must work together to ensure a heathy indoor environment.
- Recognize the importance of operating a building as it was intended by the designer and If not done so, the result is poor indoor air quality.
- Show how building failures are not necessarily caused by the obvious issues.
- Demonstrate a step by step approach in a forensic evaluation of a failed building enclosure.

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Outline: Mold in Office Buildings

- ✓ The Problem
- ✓ The Assignment
- ✓ The Signs
- ✓ The Approach
- ✓ Background
- ✓ The Evidence (Findings)
- ✓ Conclusions

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The Problem

- All types of buildings can experience significant mold
- Design, construction or operational defects allow moisture entry
- Design, construction or operational defects allow air infiltration / exfiltration
- Facility staff often do not understand the critical nature for the proper operation of the building systems
- Inadequate O & M (Operations and Maintenance) procedures
- High turnover of facility staff

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The Problem

- Mold requires
  - ➢ Moisture
  - ➢ Temperature
  - ➢ Oxygen
  - ➢ Food source – Organic Material

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The Problem

- Temperature in most buildings very suitable for mold growth:

- Once localized relative humidity levels increase past 70%...conditions are right for MOLD GROWTH.
  - Damp masonry cavity
  - Direct sunlight
  - Introduction of masonry cavity air into building’s interior

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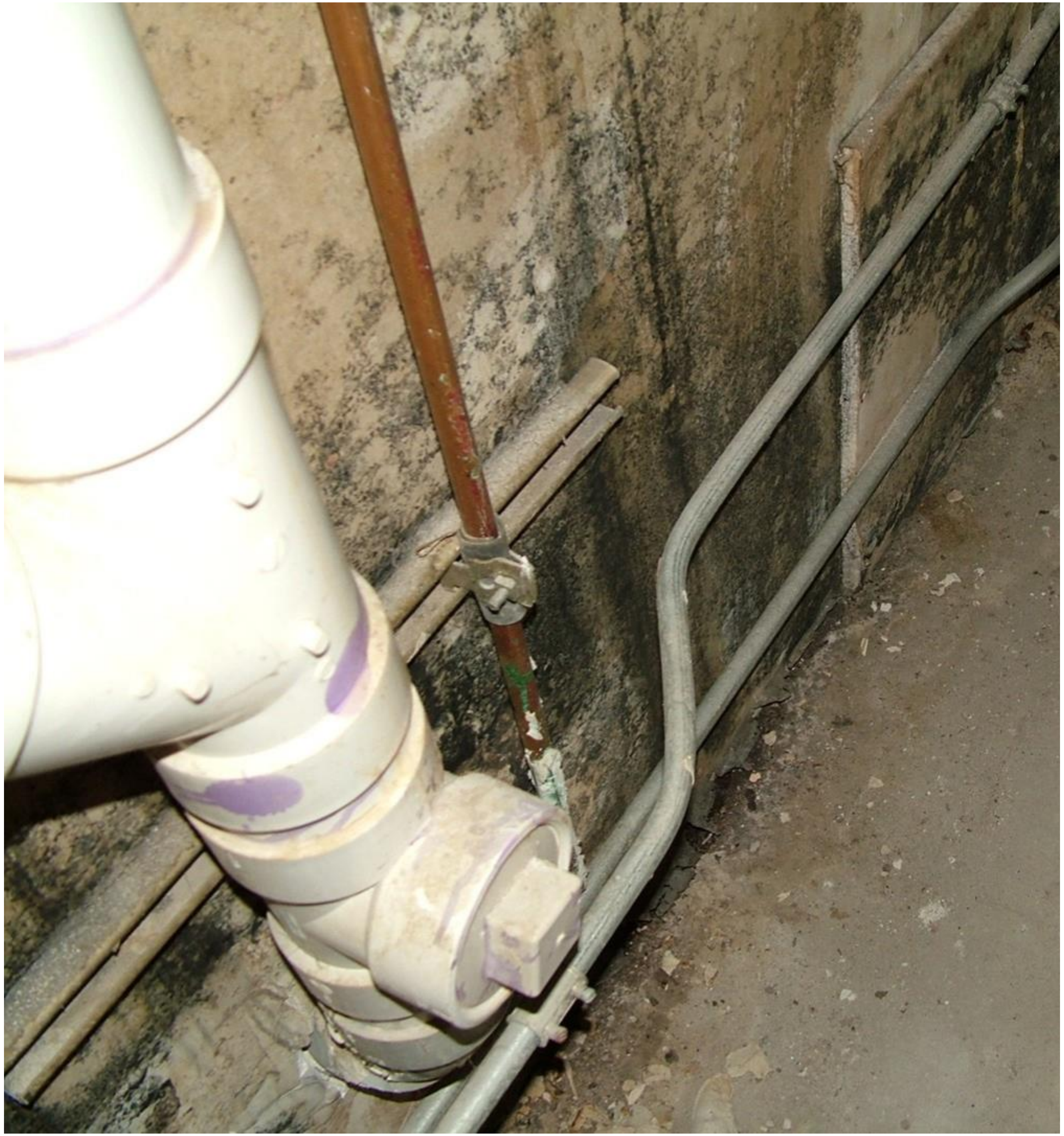
The Problem

- If no one complains….
- Out of sight……

………..Out of mind.



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The Problem

- Results in:
  - Tenant Complaints
  - Loss of productivity
  - Some health effects for some people
  - Contents Damage
  - Building Damage
  - Loss of Revenue
  - Loss of a good reputation
  - Legal Liability

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The Problem

- Moisture can also enter through many types of defects:
  - Roof leaks
  - Wall leaks such as brick veneer, openings, other cladding systems
  - Cracks in joints at windows, doors, flashings
  - Plumbing system leaks, both in supply and waste piping systems
  - Spills and other tenant activities such as cleaning
  - <u>Water vapor infiltration via unintentional air leaks through exterior envelope components</u>

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The Problem

- Water, and in particular unintended water vapor entry via air movement into a building is greatly exacerbated by a difference in air pressure between the inside and outside portions of a leaky building envelope.
- Air leaks can contribute far more moisture to the interior of a building than can occur by diffusion through various building materials.

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At times, Owners just give up and decide to demolish their buildings rather than repair them.

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The Assignment

- A frustrated Owner, Tenant or Facility Manager
- Owner concerned or panicked
- Occupants highly dissatisfied or upset
- May be in the middle of a renovation project
- May have finished a renovation project in the last year or so
- Have already hired multiple consultants
- May have performed environment testing
- Insurance or attorneys may already be involved

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The Signs – Key Locations Inside the Occupied Spaces Include:

- At inside corners at the base of a wall and corner of the room
- Behind furniture that is up against an outside wall
- At or near a ceiling supply register where conditioned air is supplied into the room
- On stored paper materials
- Behind framed artwork and posters
- Inside closets or storage rooms where little air circulation occurs
- Behind wall coverings where various colored stains bleed through and are visible inside the room

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In spaces with high relative humidity look for paper products that are wrinkled: artwork, photos, copier paper, magazines and books.

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In spaces with high relative humidity look for surface rust on office furniture and drywall corner beads.

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Vinyl wall coverings will act as a vapor barrier and will trap moisture.

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Vinyl wall coverings will act as a vapor barrier and will trap moisture.

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Example of mold development inside an insulated wall assembly with mold development on the inside of the stud cavity as well as on the outside of the drywall finish where it occurred behind vinyl wall coverings.

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The Approach

- Define the problem
- Make a plan and explain it to your client
- Collect all your data
- Redefine or add to the list of problems if necessary
- DON’T jump to conclusions – this can be deadly
- Analyze the data and surmise causes
- Collect more data if necessary
- Test final conclusions with the available data
- Propose recommendations
- Select best recommendations(s)

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The Approach

- Forensic Study Game Plan
- State the problem in a written Scope Statement
- Review files (available plans, specifications, prior reports, etc.)
- Interview staff
- Collect data – Site visit(s), testing…..
- Work methodically
- Make list of hypotheses
- Test their validity
- Make conclusions based on the outcome of the facts

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The Approach

Use the right tools

- Flashlight
- Sharp and pokey things
- Camera – for “the shot”
- Dual mode moisture meter
- Thermal imaging equipment
- Hygrometer - For temperature and RH
- Hand held smoke generator or smoke pencil
- Micromanometer
- Means of access
- Digital recorder

The Background

- Building was constructed in the late 1980's
- 2 story public office building
- 75,000 square feet
- Structural steel frame with LGMF walls with
    - Interior painted gypsum wall board
    - Fiberglass wall insulation with kraft facing
    - Paper faced gypsum sheathing
    - Felt paper weather barrier
    - Masonry cavity
    - Brick or split face CMU cladding

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The Background

- Large open attic with wood roof trusses, wood sheathing, and architectural standing seam metal roofing
- Interior finishes include
  - Painted gypsum wall board
  - Suspended acoustical ceiling tile with a return air plenum above
- HVAC system includes 17 VAV boxes with hot and cold water coils
- Separate outside air fans (4 each) supplying ducted outside air to each VAV box
- Separate building exhaust fans (6 each) for utility spaces, bathrooms, etc.

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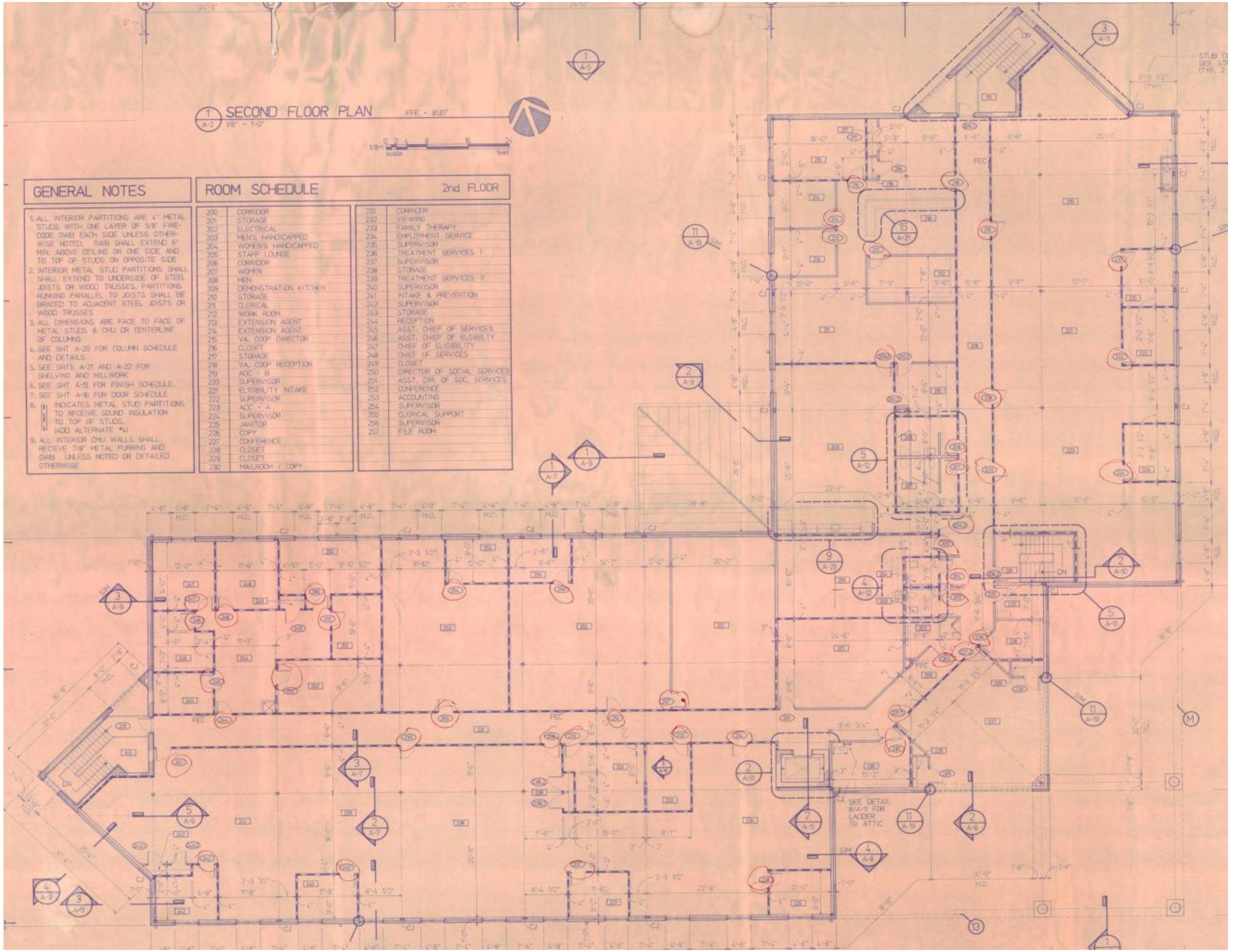
Typical Floor Plate for the subject case study



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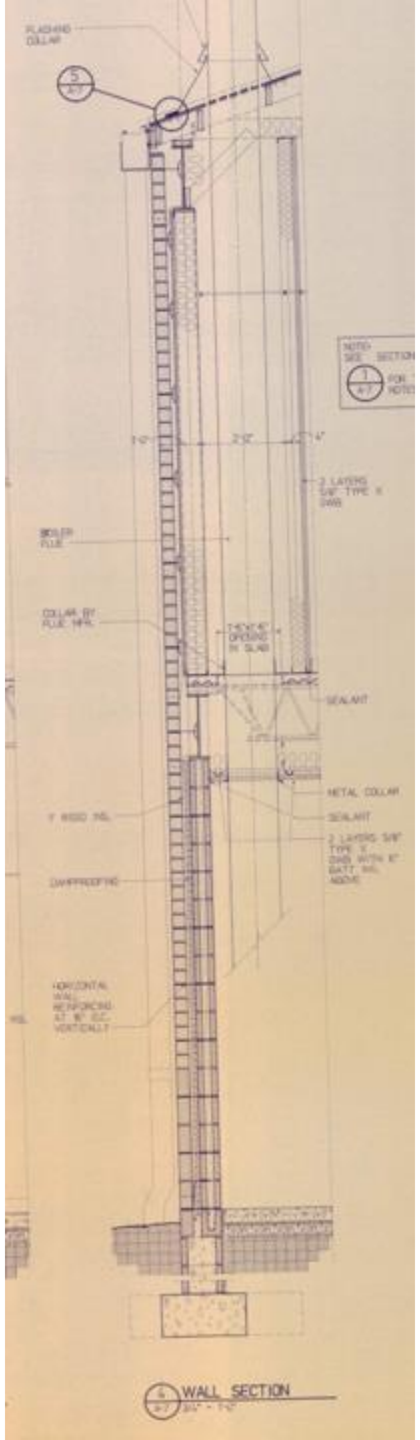
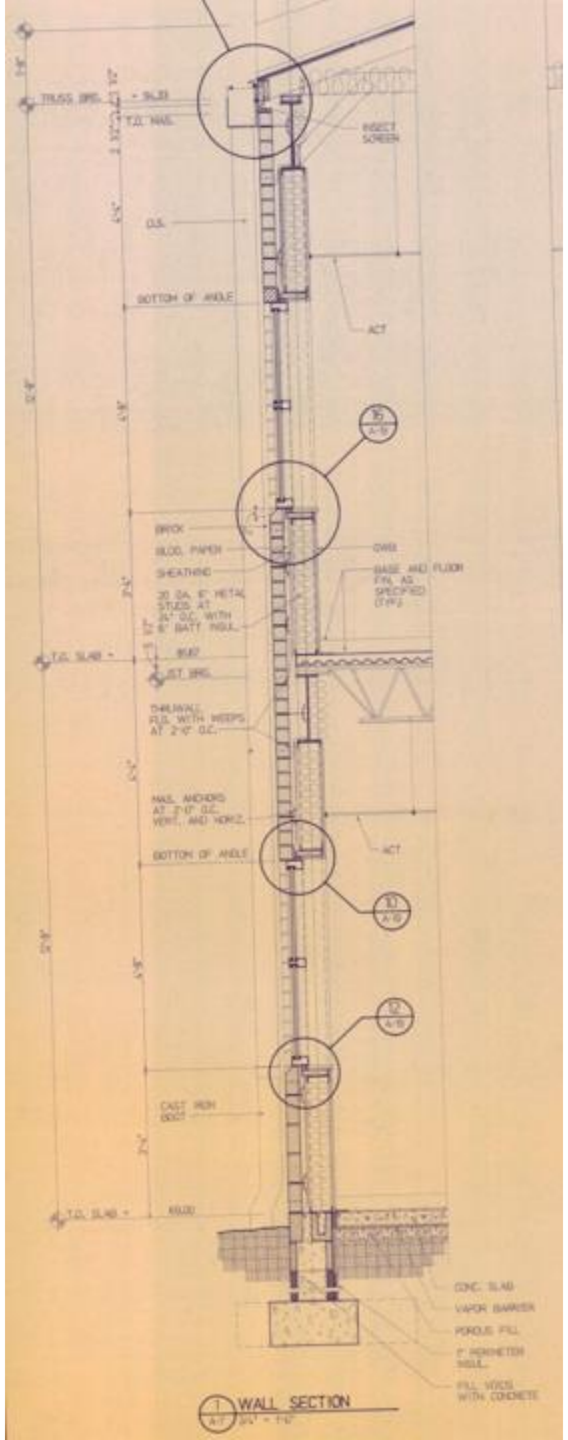
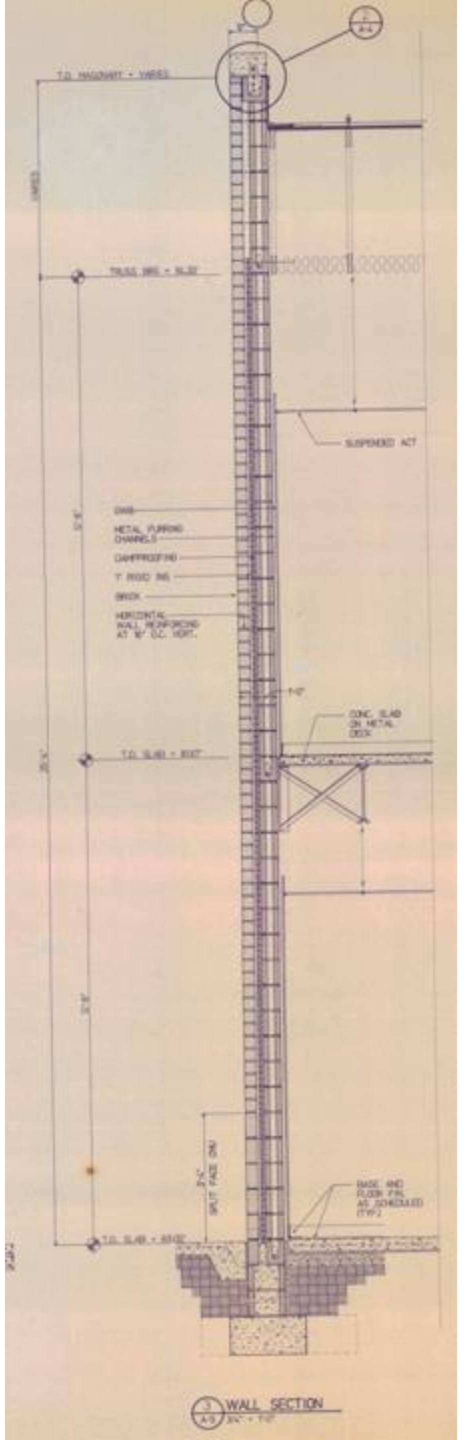
Building
Wall
Sections
Plan







Evidence

Lack of maintenance, leaking downspouts, poor grading and plant growth on the walls are contributing building failure and increased moisture in the masonry cavity.

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Evidence

Open penetrations in the exterior envelope are never a good thing.

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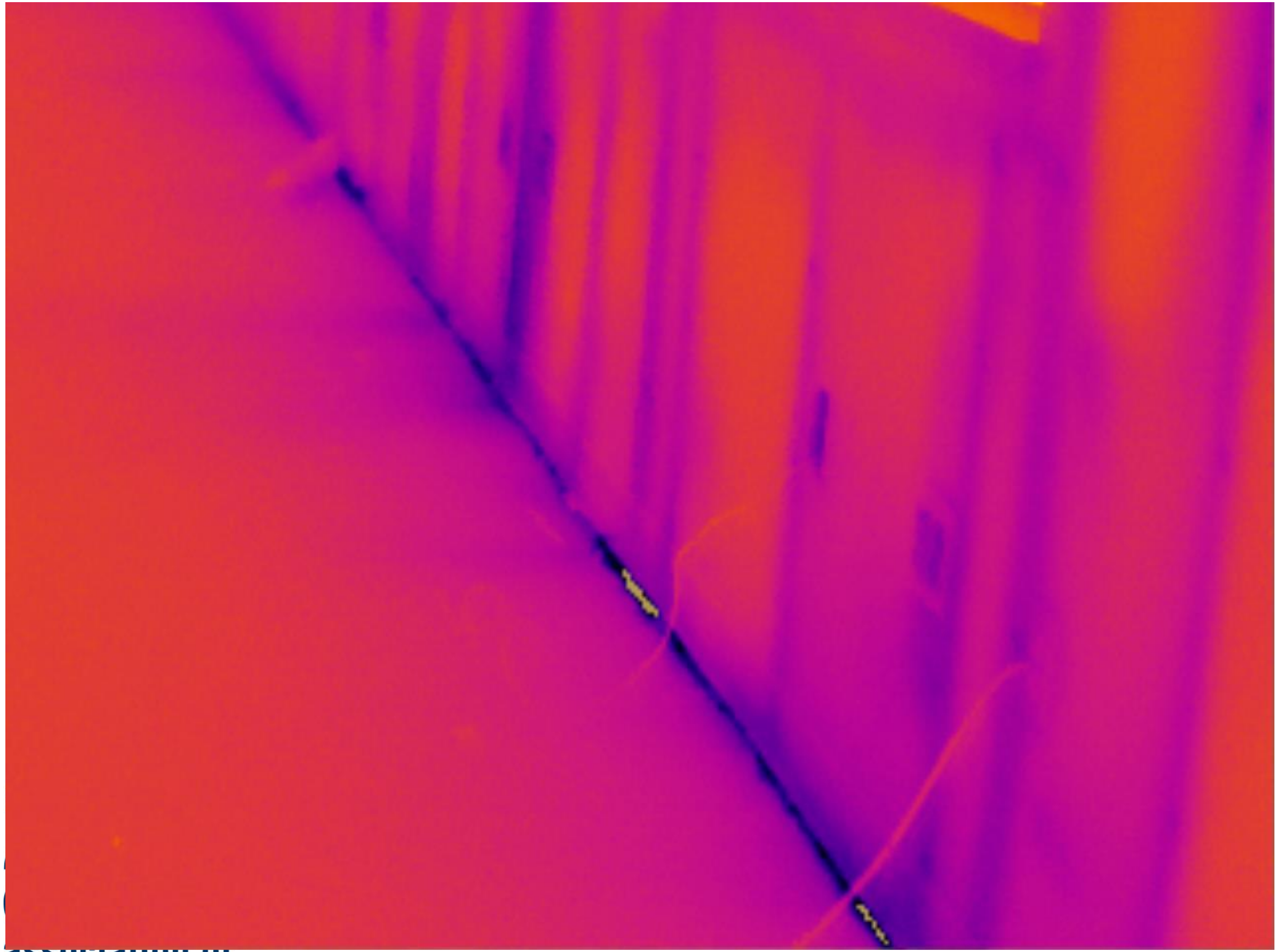
Evidence

Look for dirt and dust staining (not mold) accumulation on the glass batt insulation and at other places.

This occurs due to unintended air infiltration at a sheathing joint in the wall sheathing where the insulation acts as a filter collecting and trapping dirt and dust particles.



Evidence

Thermal imaging can be useful in determining air flow at building envelope corners.

In this case, cold outside air is infiltrating into the occupied space at the floor/wall intersection.

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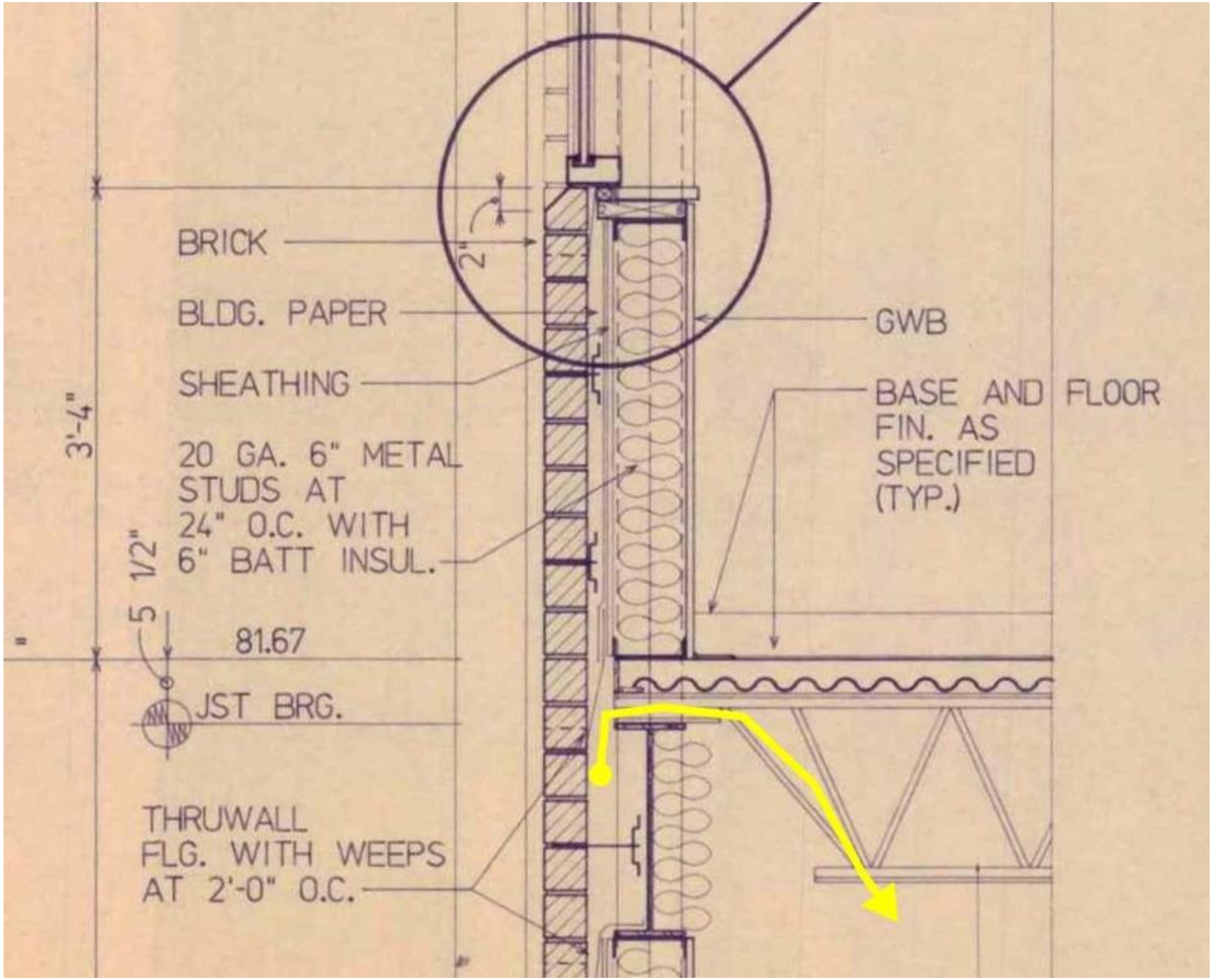
Evidence

Depicting the detailing of the exterior wall weather barrier and other building elements and the bearing condition for the second-floor structural steel bar joists and floor slab. Note opportunities for easy air transfer between the masonry cladding cavity and the above ceiling return air plenum.



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Evidence

Second Floor structural system at slab perimeter, bar joists, metal form deck and concrete topping slab.

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As-built condition where second floor joist bears on exterior structural steel perimeter beam providing an annular slot around the entire perimeter of the building which is open to the masonry cladding cavity. Smoke pencil used to verify unintended air infiltration at this location.

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Evidence

Direct view of the masonry cavity (back side of brick cladding visible from interior plenum space) between the second-floor steel form deck and structural steel framing.

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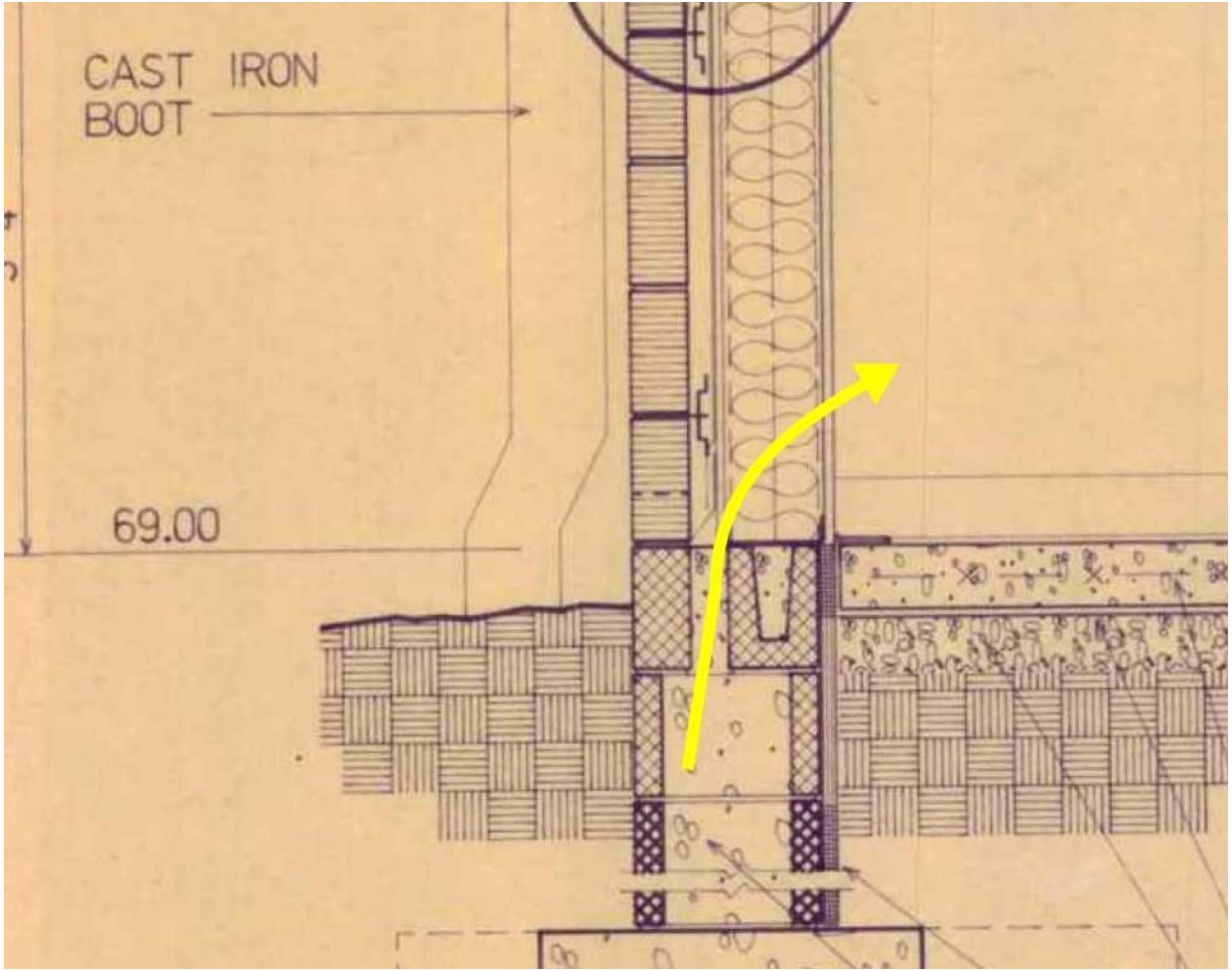
Evidence

Base of wall detail that does not provide for good separation between the always damp or wet ground condition and the base of the wall studs and gypsum sheathing.



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Evidence

Where mold development and water damage is occurring inside the stud cavity on the paper faced sheathing.

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Evidence

Typical condition of the backside of a completed masonry cladding (facing the cavity). Note poorly executed head joints. Often daylight is visible. In our experience this is a common occurrence in masonry cladding construction.

Evidence

Installed weather resistant barrier (building felt) has become brittle, is easily damaged and disintegrates on contact.

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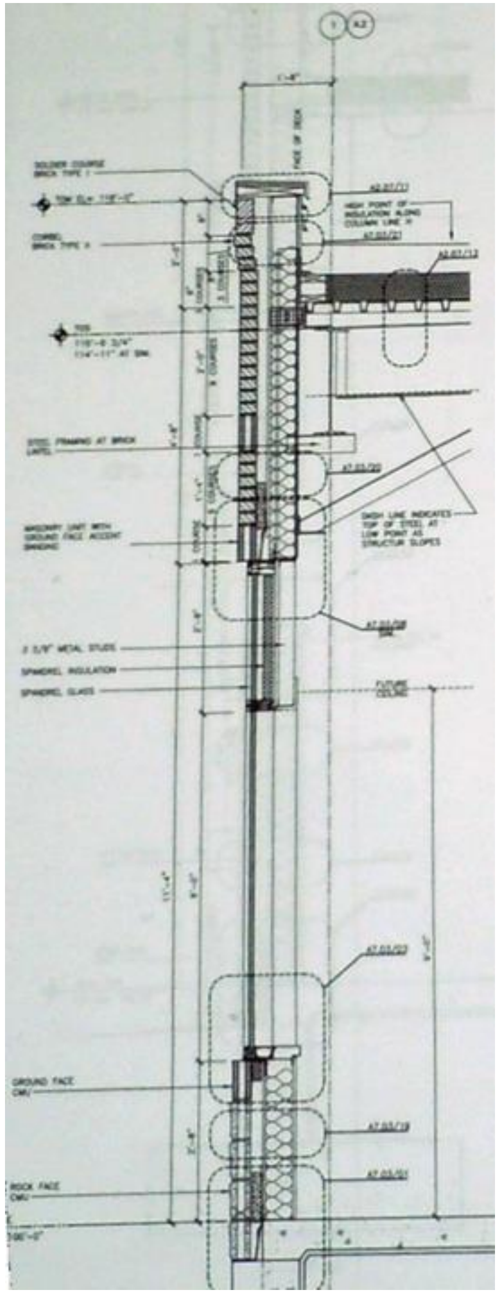

Base of Wall Detail

A very common detail doesn’t perform as you might expect.

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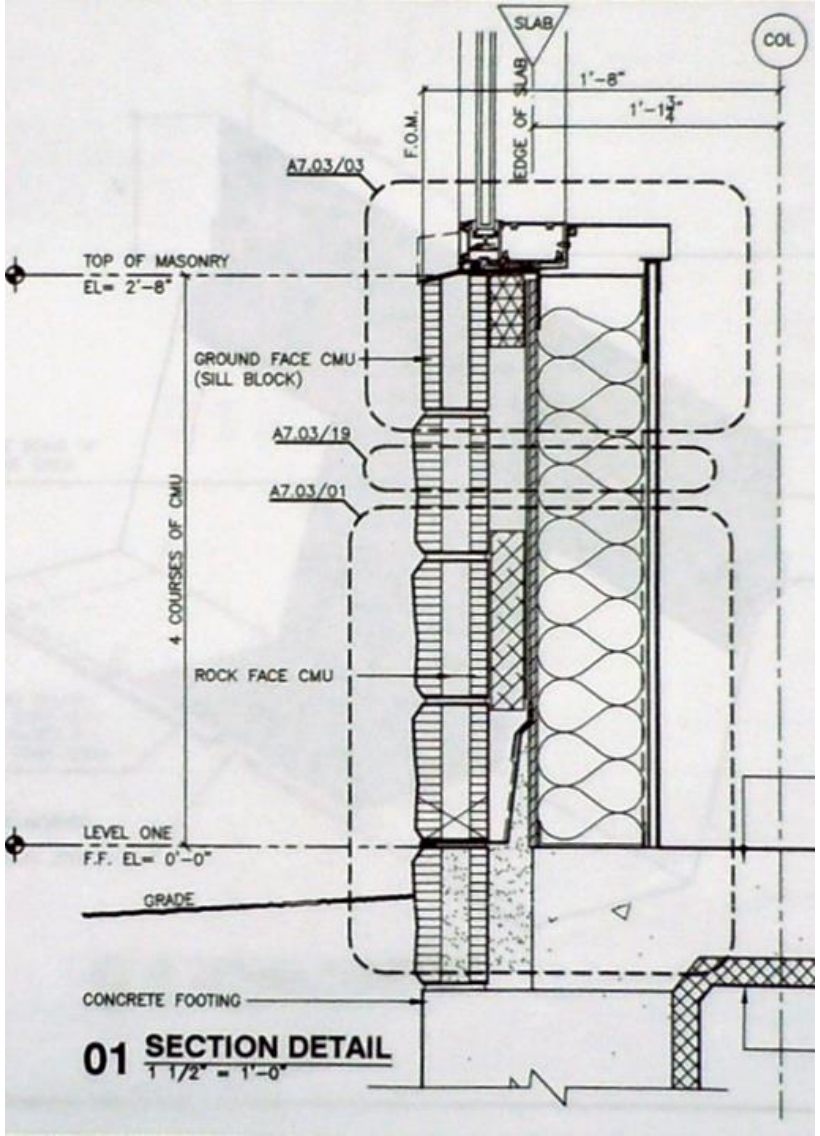
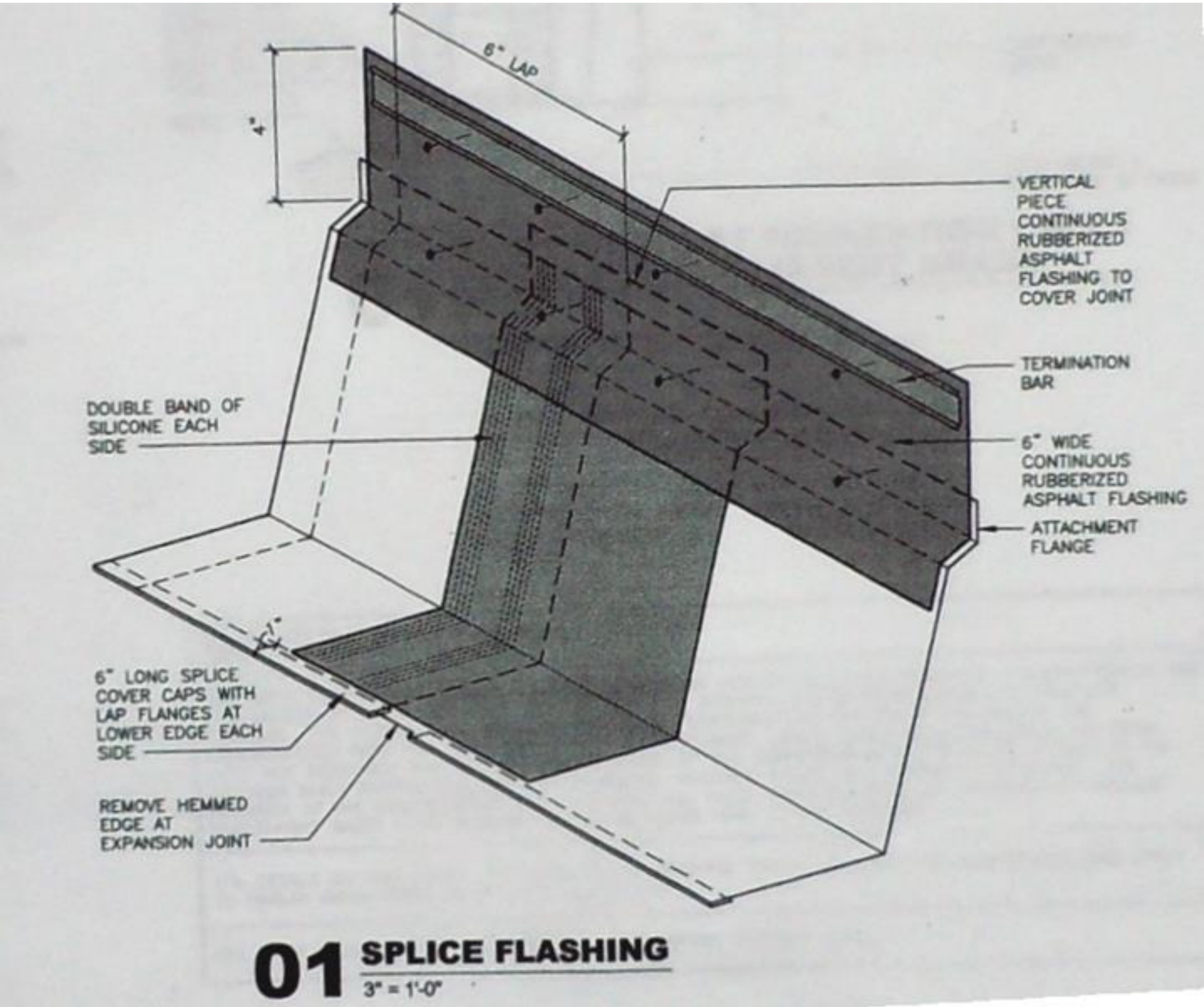


Base of Wall Detail

The best plans and details don't always perform as you might expect.



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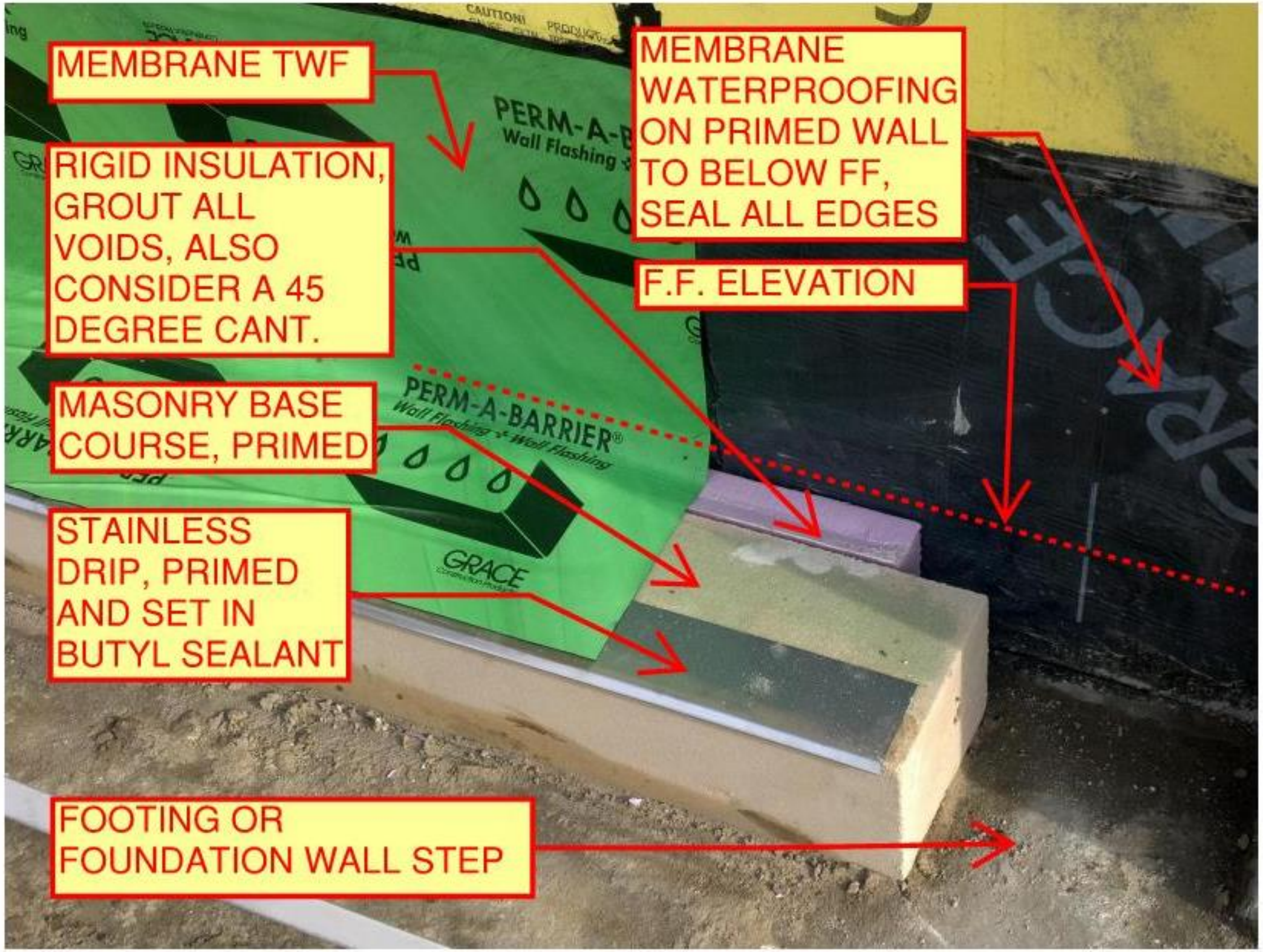
BEST PRACTICE

BASE of WALL DETAIL, SLAB on GRADE



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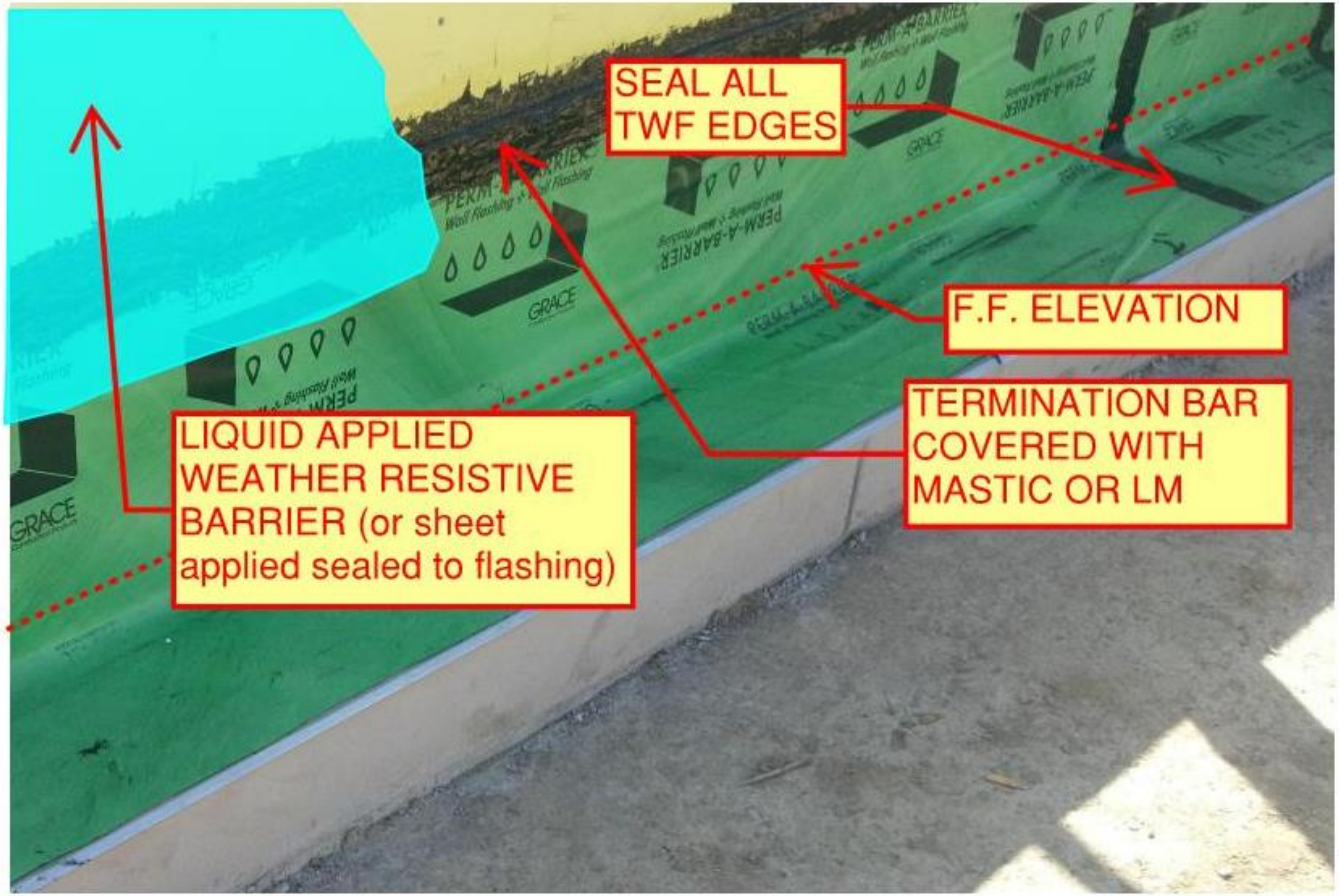
BEST PRACTICE



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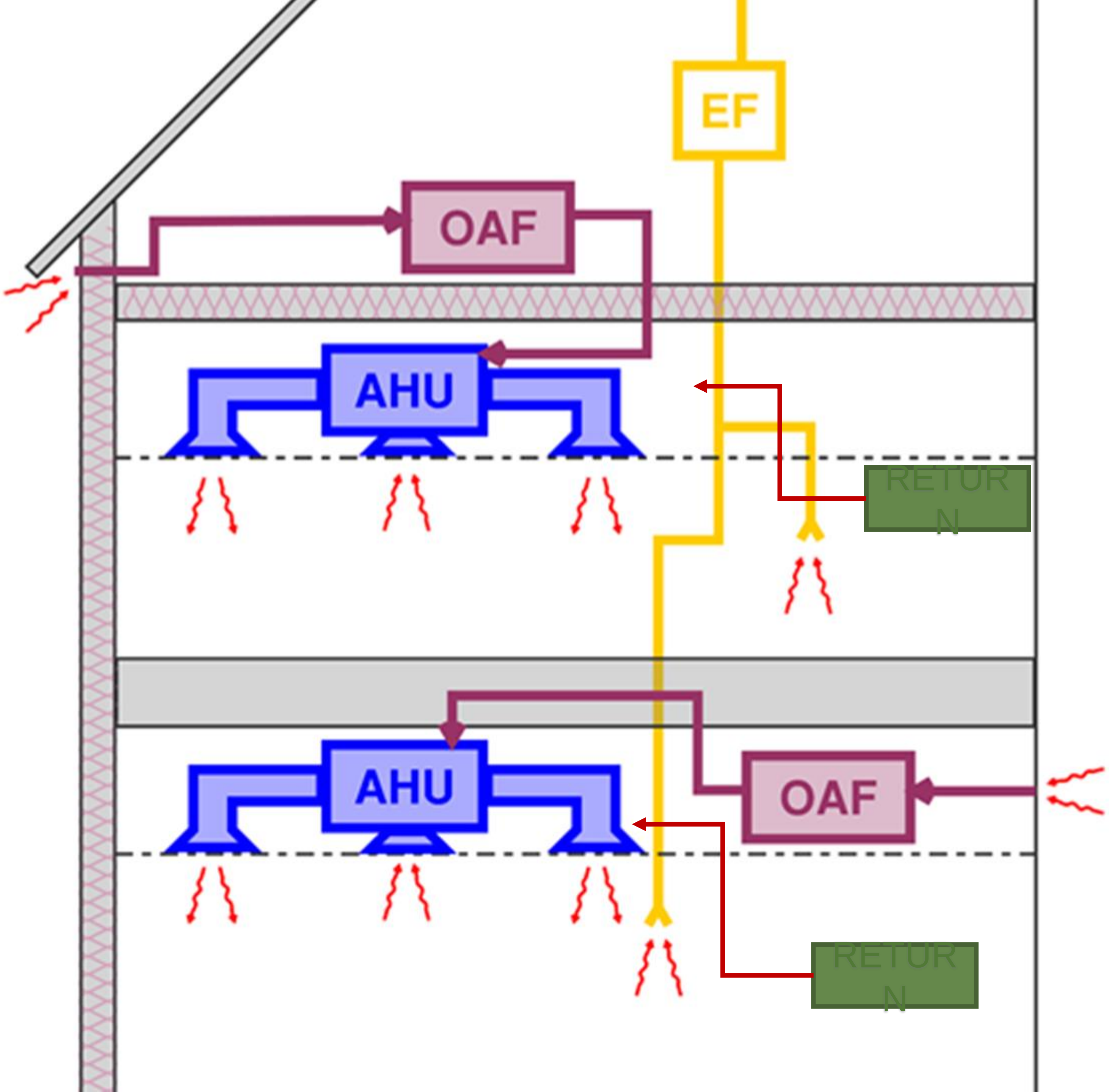
Schematic diagram depicting where intentional air flow across the building envelope occurs including the introduction of outside air (Outside Air Fan) and building exhaust (Exhaust Fan).



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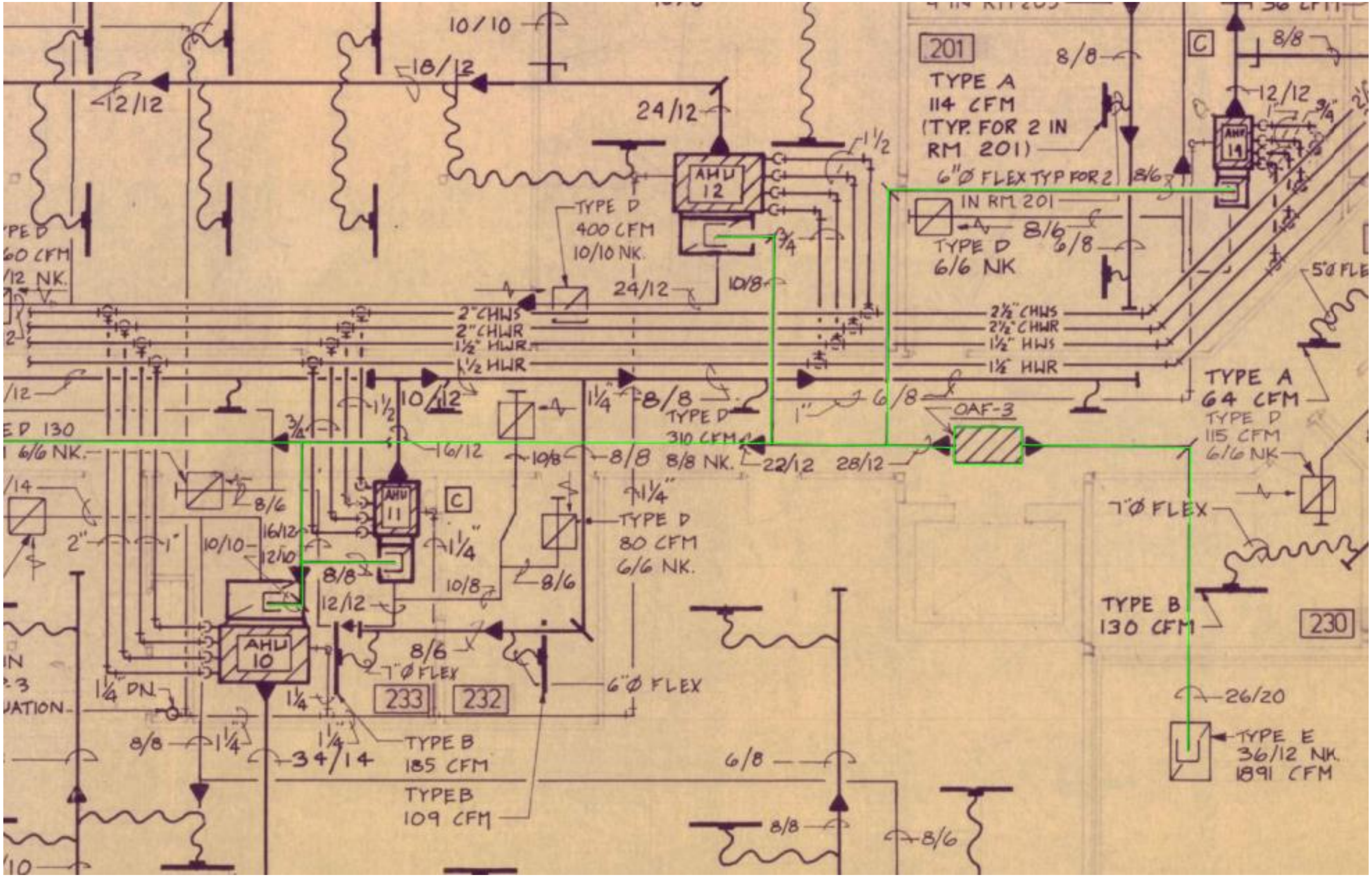
Mechanical Plan



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Evidence

No, the dirt, dust and mold is not coming out of the supply registers.

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Evidence

Use smoke at receptacles to check for infiltration or exfiltration

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Evidence

HVAC overflow pan condensate drains

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Evidence

One of four outside air fans installed in the attic space providing ducted outside air directly to the 17 air handler units throughout the building. This unit was inoperable.

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Evidence

A common condition where the attic is missing thermal insulation creating an open condition to the return air plenum below.

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Evidence

- The 4 outside air fans (OAFs) were not operable and had not been run for years. Staff didn't know they existed.
- Construction details called for a perimeter wide flange structural beam to support the second floor, but the design detail allowed for an open annular space around the entire perimeter of the building's second floor directly to a return air plenum
- Poor detailing and construction at the base of wall detail creating an open vapor path from the below grade foundation wall to the building's interior
- The attic was open to the second floor plenum

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Conclusions – Take Aways

- A poorly air-sealed building envelope is a recipe for potential issues.
- A negatively pressurized building is a recipe for potential issues.
- Both of the above and you have a disaster in the making.
- The negative building pressure results in:
  - Unintended outside air infiltration
  - Elevated interior relative humidity during the cooling season
  - It is probable that a poorly sealed air-envelope by itself in this instance would not lead to building failure if the building was pressurized.

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Conclusions – Take Aways

- A poorly air-sealed building envelope results in high energy costs due to unintended air exfiltration or infiltration either due to HVAC system or wind.
- Keep in mind that buildings perform and fail differently in different climate zones. Another study would show very different results if the building were located in a different climate zone.
- An entire niche industry is developing whose purpose is air sealing existing buildings with building envelopes that leak air.

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Conclusions – Take Aways

- In our case study it would be relatively easy to seal up the annular space at the perimeter second-floor steel bearing line because the open masonry cavity is relatively easy to access from inside and above the lay-in ceiling tiles.

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Conclusions – Take Aways

- Likewise, the attic area could be separated from the second-floor ceiling plenum space by installing either a sheet air barrier or gypsum drywall air barrier to the bottom of the attic trusses. This modification is more intrusive as it will require removal and reinstallation of the suspended ceiling system; however, it is a feasible approach.

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Conclusions – Take Aways

- Furthermore, a more reliable method to pressurize the building with outside air while also ensuring that air is conditioned before introduction into the interior environment could be to install a dedicated outdoor air system (DOAS). Such a system would not have to rely on the air handler cooling coils to dehumidify the air before it is introduced into the building.

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THANK YOU!

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