Deep Dive into Air Barrier Development & Implementation

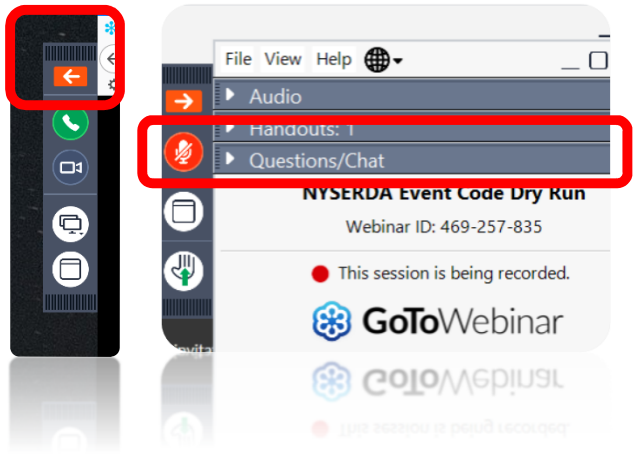
All attendees have been placed on mute.

Use the Question Section on the webinar control panel to ask a question at anytime during the presentation.

Q&A will take place at the end of each segment.

Webinar will be recorded and sent.

Webinar Overview



Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

Our services include:

- Energy Conservation and Management
- Sustainability Consulting
- Green Building Certification
- Accessibility Consulting

We have over 125 staff across three office locations:
New York, NY | Washington, DC | Norwalk, CT

For more information, visit
www.swinter.com

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This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA or any material of construction or any method or manner of handling, using, distributing or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation

Upon Completion of Module

You will receive the following items via email:

- AIA Certificate of completion-can also be used for:
  - PHI Credits
  - NYS PE CEUs
- PDF of final presentation
- Link to the webinar recording

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

Provider #: J827

CONTINUING EDUCATION AIA

CERTIFICATE OF COMPLETION

THIS CERTIFICATE IS TO CERTIFY THAT
Katie Zoppo

PARTICIPATED IN
Module 1: Overview of PH/Net Zero Building Concepts, Techniques and Benefits

COURSE NUMBER
M1OOPHNZBCTAB

ON
February 11th, 2020

LOCATION
New Paltz, NY

EARNING
4 AIA CES Learning Unit/HSW

Lois B. Arena, PE
Director, Passive House Services
Steven Winter Associates, Inc.

Steven Winter Associates, Inc.
61 Washington Street
Norwalk, CT 06854
203.857.0200
Larena@swinter.com

Learning Objectives

Understand why air tight facades are important for high performance buildings

Explain the steps to designing and constructing an air tight and moisture tight building

Identify air barriers and explain why a continuous air barrier is critical to high performance buildings

List 3 products and construction techniques utilized in high performance buildings

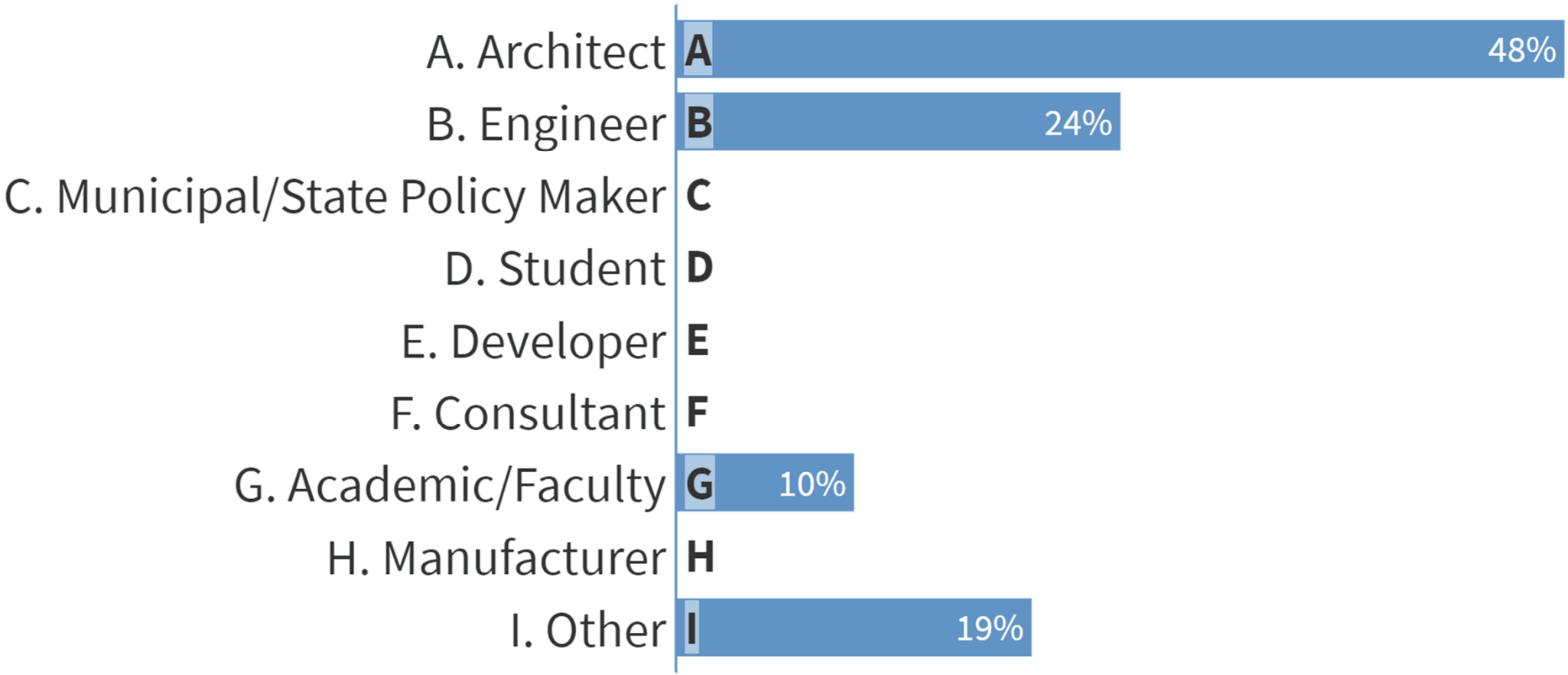
Overview of Presentation

15 min break
~10:00 AM

1. Air Flow in Buildings
2. Planning During Design
3. Air Barrier Approaches
4. Retrofit Air Barrier Approaches
5. Construction Phase QA/QC
6. Mock Ups
7. Case Studies
8. Final Blower Door Test Planning

15 min break
~11:30 AM

What is your profession?



What is the one thing you were hoping to learn about today?

Coykendall Science Building

Why we are here: **Directive 1B-2**

- 2018 Chancellor calls for all new buildings to be zero-net-carbon & deep energy retrofits for existing buildings
- 2018 SUCF issued Directive 1B-2
  - Purpose: define and identify goals for Net Zero Carbon (NZC) new buildings and Deep Energy Retrofits (DER) of existing buildings.
  - Function: outlines the project target goals and provides direction for project designs.
  - Metrics: Site Energy as the measure of performance and energy consumption.

Why we are here: **Directive 1B-2**

- Design and construct highly energy efficient buildings which significantly reduce energy consumed below an energy code standard for new buildings or energy usage for an existing building.
- In the case of insufficient project funding, the design goal will be to design the building as NZC “capable” where: the design achieves the energy use intensity (EUI) limit using HVAC equipment and systems that can be electrically powered from renewable energy sources.

New Building Performance goals:
Site Energy Use Intensity (EUI) limits

Classroom building	50 kBTU/ft2/year
Office building	50 kBTU/ft2/year
Laboratory building	150 kBTU/ft2/year
Residence Hall	32 kBTU/ft2/year

Directive 1B2 **Trainings**

- **Module 1:** Overview of PH and Net Zero
- **Module 2:** Construction Methods and High-Performance Products and Details
- **Module 3:** Air Barrier Development & Implementation
- **Module 4:** Net Zero HVAC Strategies and Controls + DHW
- **Module 5**: Construction Documents and Bidding
- **Module 6**: Deep Energy Retrofits
- **Module 7**: Refrigerant Management in Design, Construction, and Operations
- **Module 8**: Construction Manager/Subcontractor/Tradesperson Training

Airtightness

Planning during design and the integrated design approach

Training for contractors and subs

Inspections and testing

Why Air Seal?

- Comfort
- Efficiency
- Moisture
- Indoor air quality (IAQ)

Air Flow in Buildings

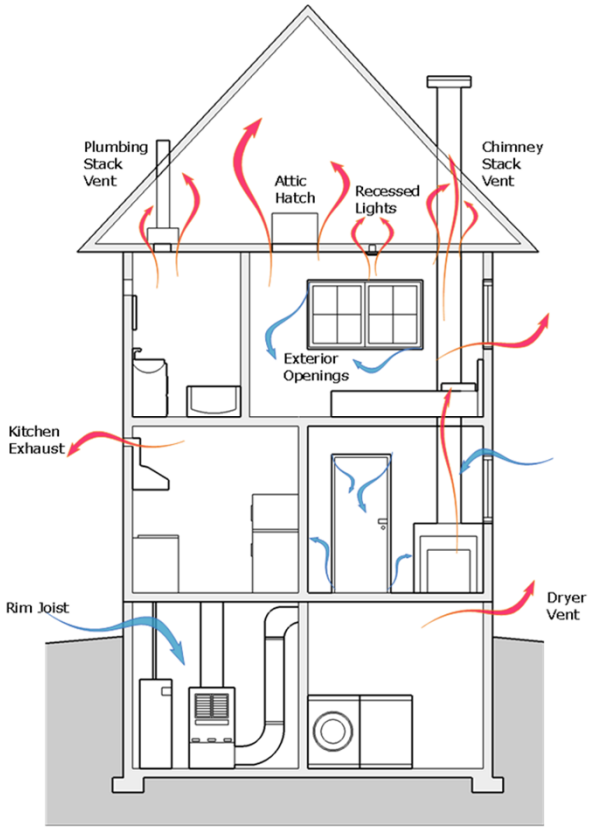
Air Flow in Buildings

Infiltration: air movement into the building

Occurs in areas of negative pressure inside the building

Exfiltration: air movement out of the building

Occurs in areas of positive pressure inside the building

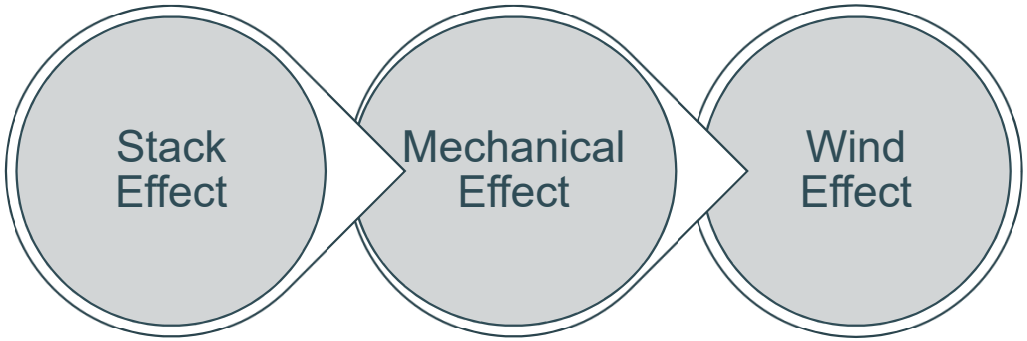


Exfiltration
Air Leakage from Inside to Outside

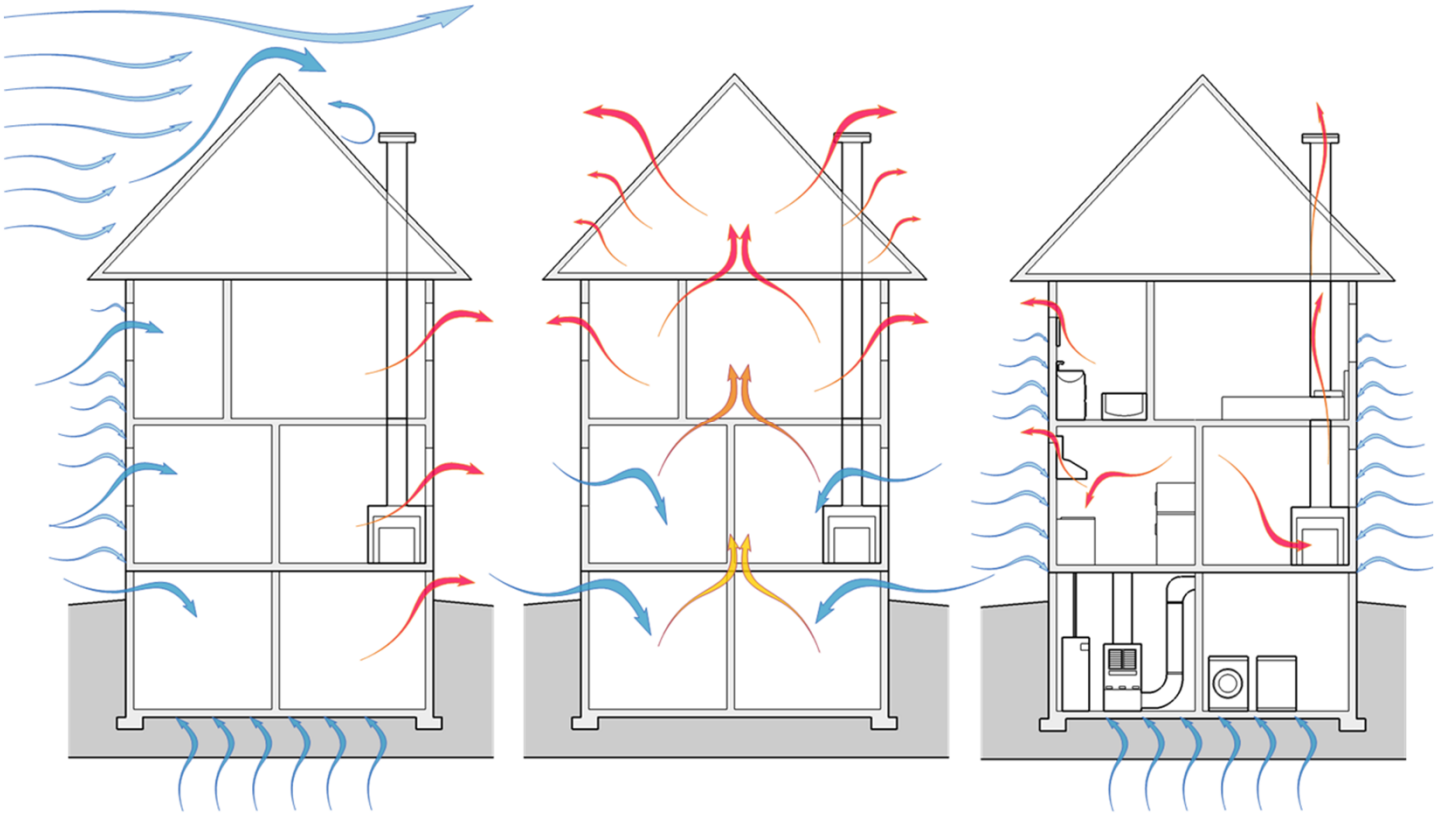
Infiltration
Air Leakage from Outside to Inside

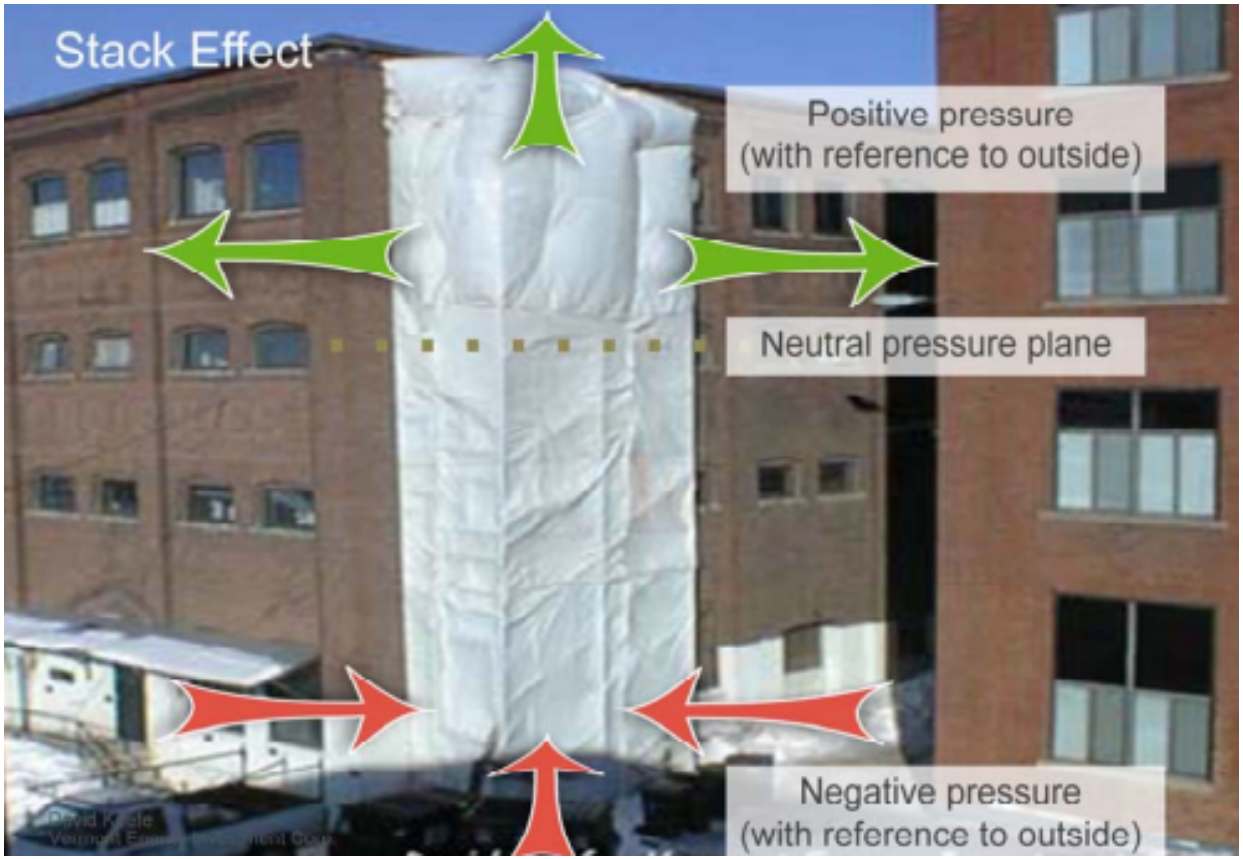
Air Flow in Buildings

3 Main Driving Forces



Air Flow in Buildings





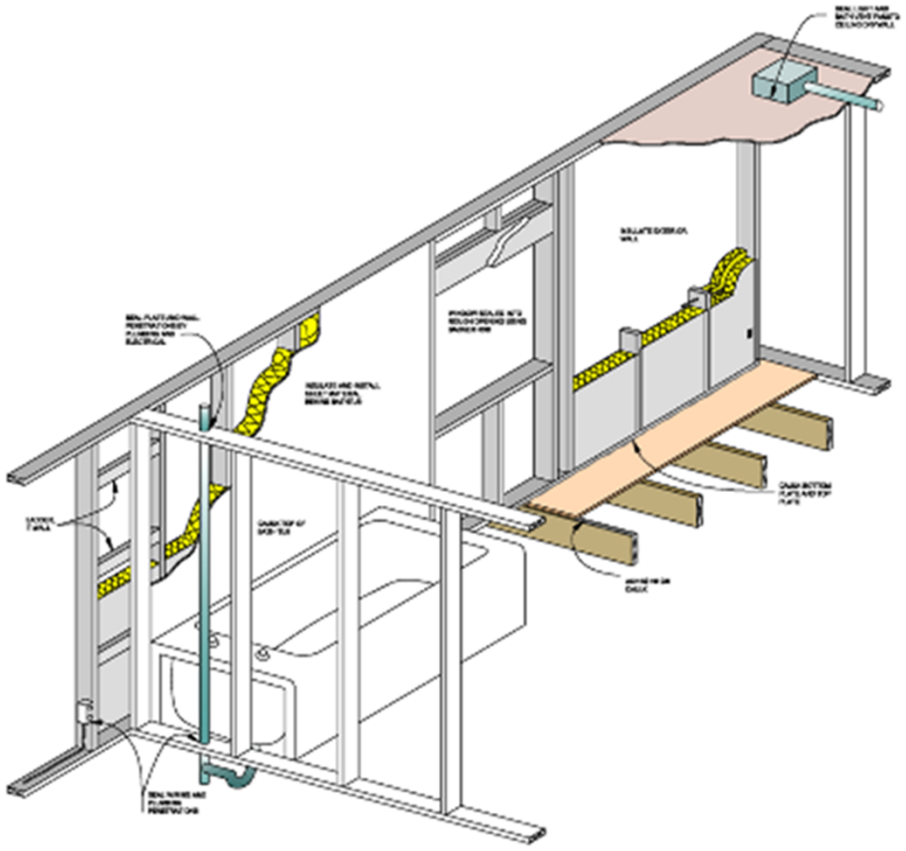
Stack Effect

Air Sealing Priorities

- Stop the Stack Effect!!
- Resolve the biggest holes first
- Top of the building is typically first priority
- Base of the building is next
- Center of the building after that

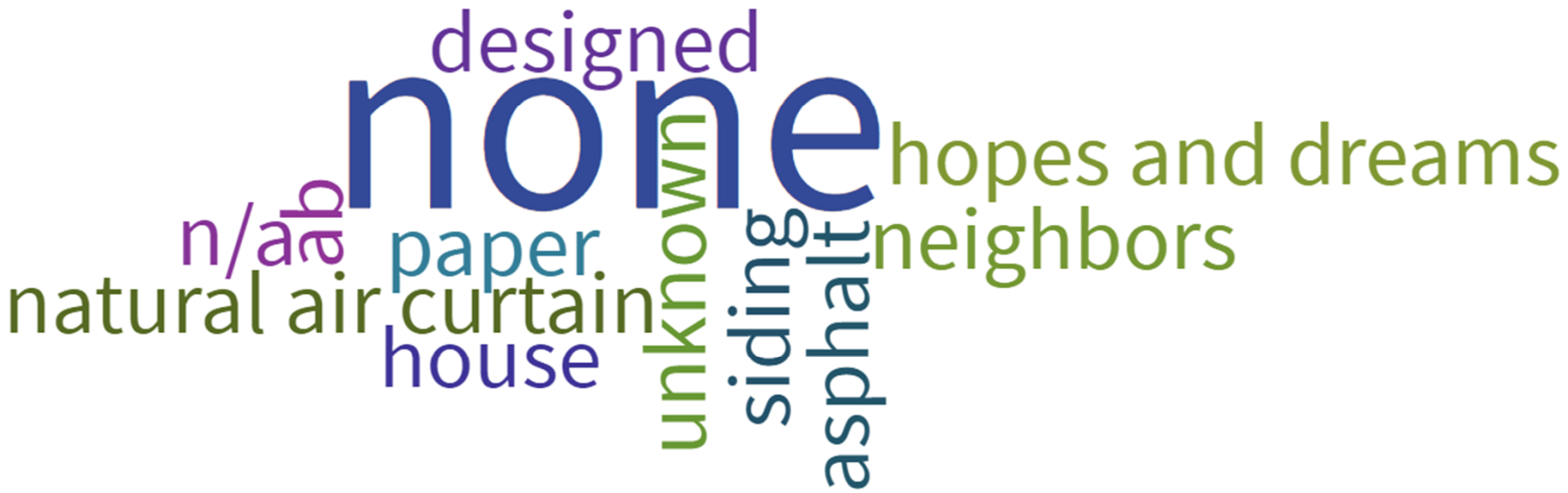
Air Barriers

- 90% of Moisture transport is (was) by air-movement, not diffusion
- Insulation is ineffective without air-sealing
- Leakage primarily at edges, corners, joints and penetrations, transitions, and terminations

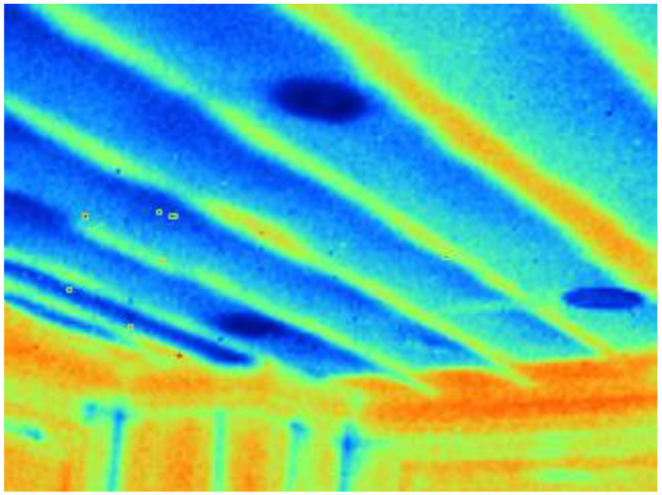


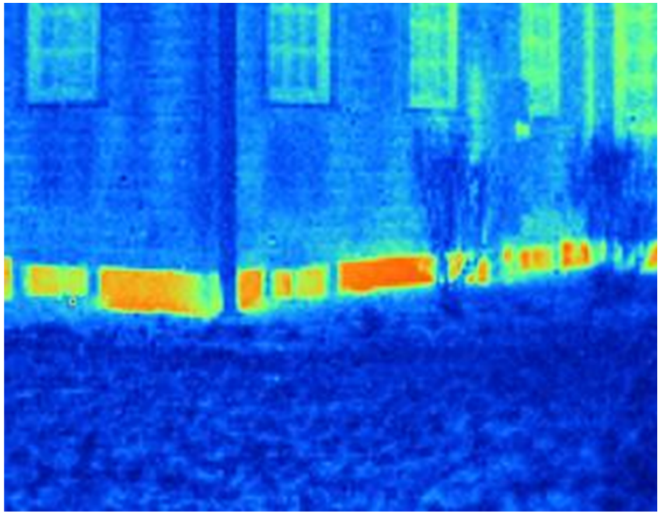
Find the Air Barrier

What is the air barrier?



Find the Air Barrier

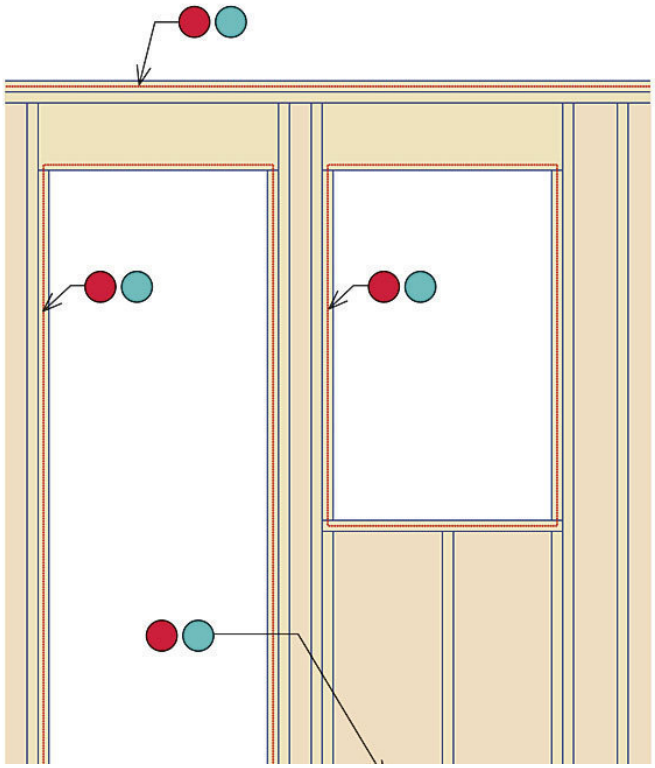


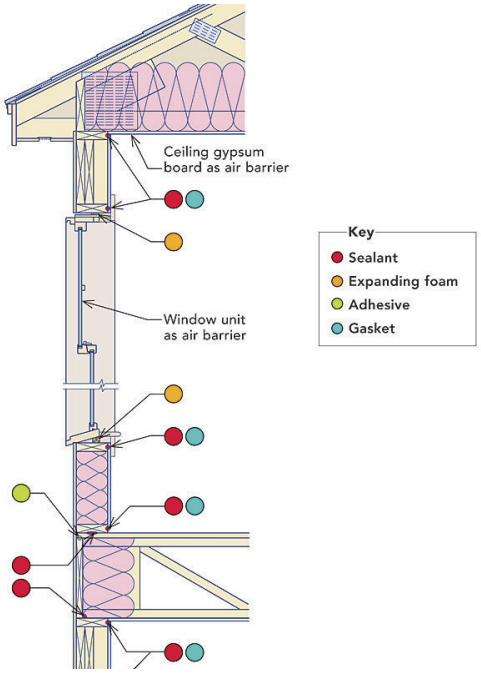


Finding and Measuring Leaks

Caulking your way to Air-tight?

Air Tight Drywall and Interior Membrane





Air-Barrier Placement and Material

How Tight Do You Want To Get?

JOE MUNROE / SAINT MARY'S COLLEGE OF CALIF./P

2021 IECC Residential Code
- 3.0 ACH50
- 0.3 CFM50/ft2 (individual dwelling)

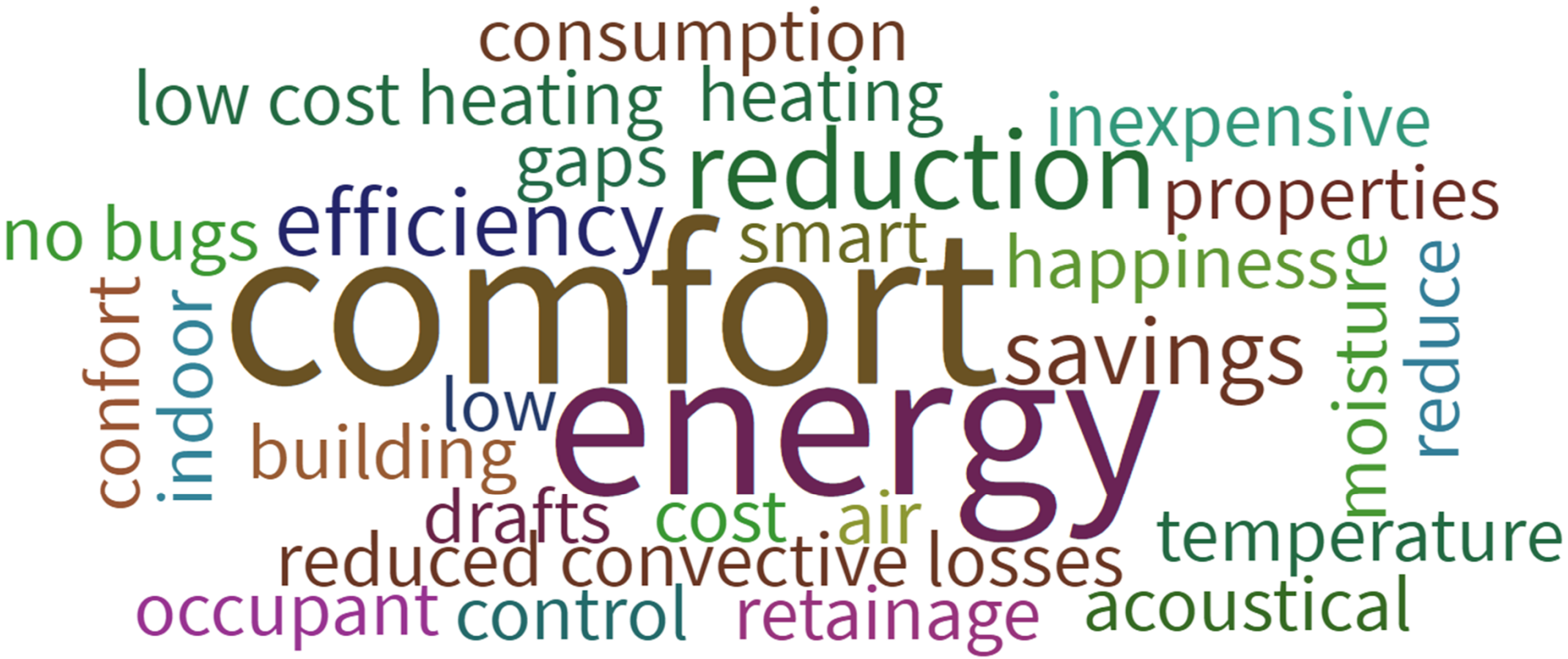
2021 IECC Commercial Code
- 0.3 CFM50/ft2 (individual dwelling)
- 0.4 CFM75/ft2 (whole-building)

Passive House
- 0.6 ACH50

Air Tightness

- Requirement: < 0.6 ACH@50
- What does this mean?
  - @50 refers to 50 pascals pressure difference between indoors and out during a blower door test, ≈ 20mph wind on all sides of house
  - 0.6 ACH@50 ≈ 5 times tighter than Code requirements

Name some benefits of air barriers.



Define Air-Barrier

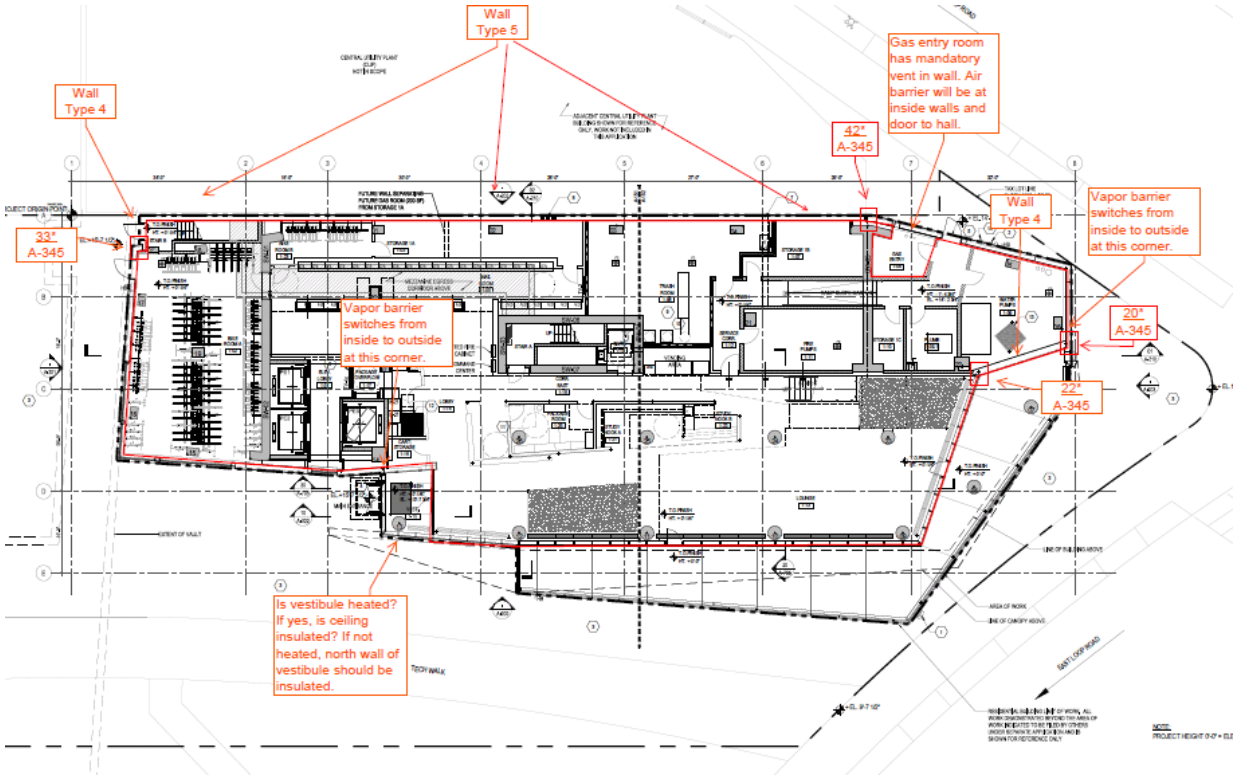
Redline around entire perimeter indicating air-sealed surface

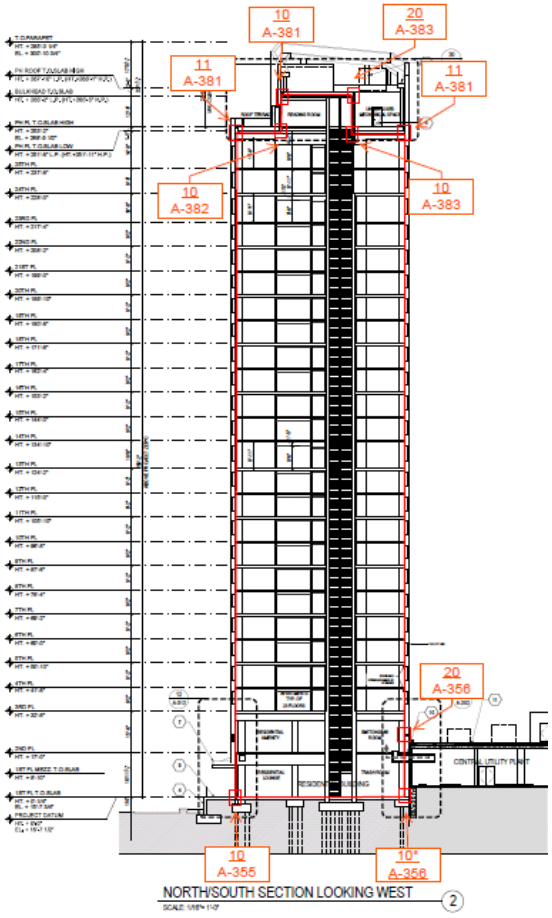
Both in plan view and in section

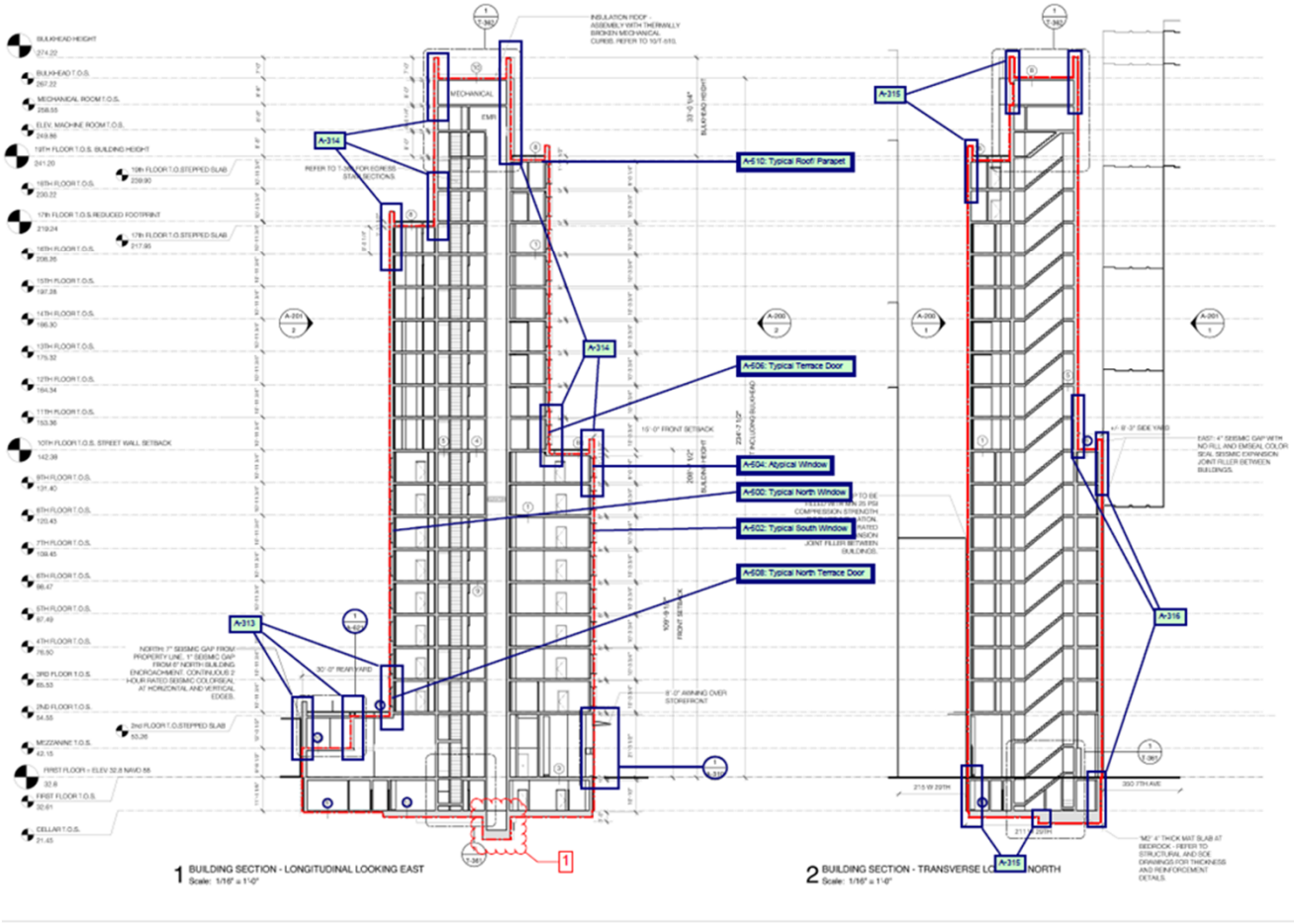
Circle all unique transition points – corners, changes in components, cantilevers, wall/roof, slab/wall, etc.

Key to details for how all these transitions will be air sealed.

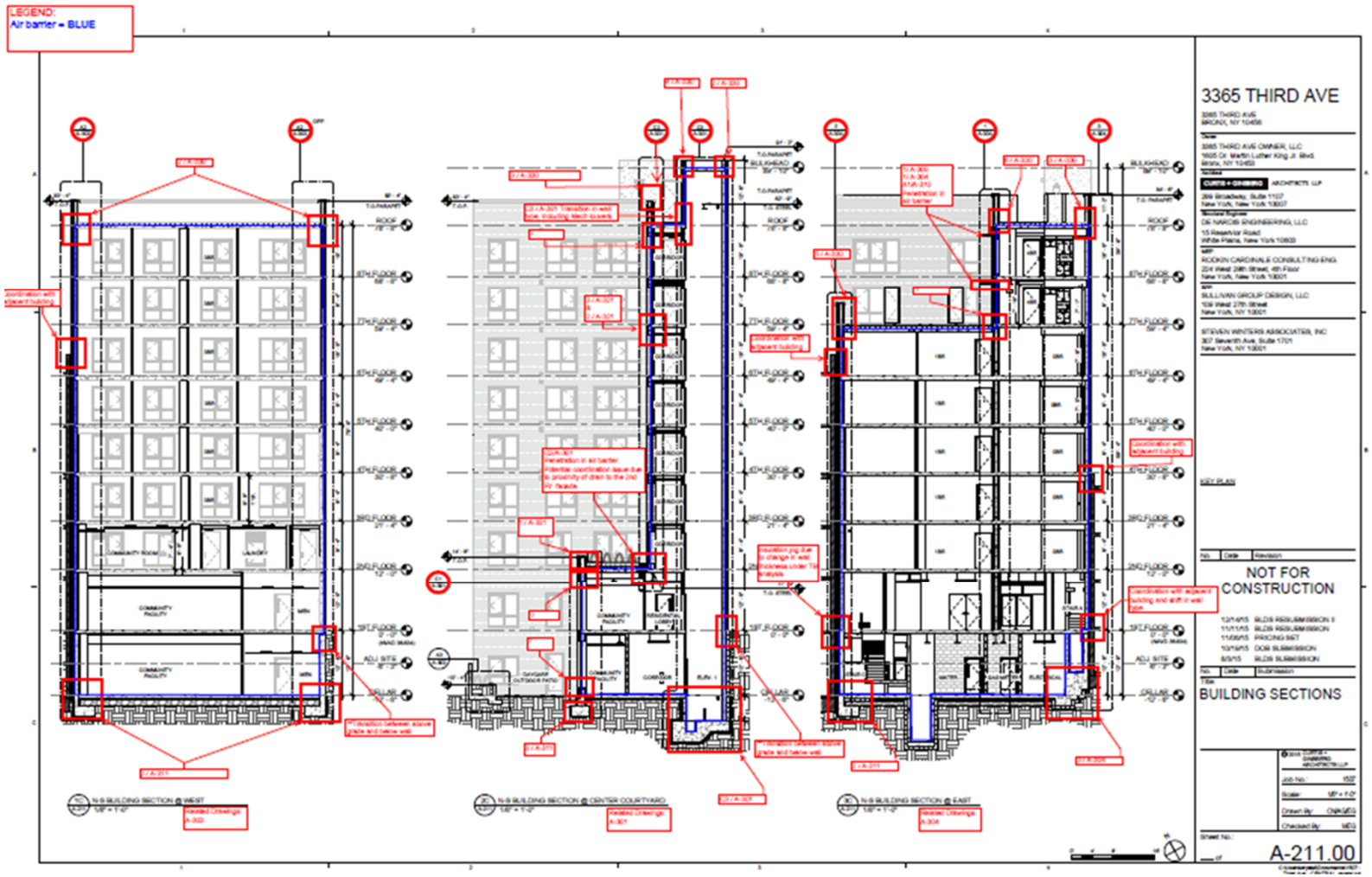
Define Air-Barrier



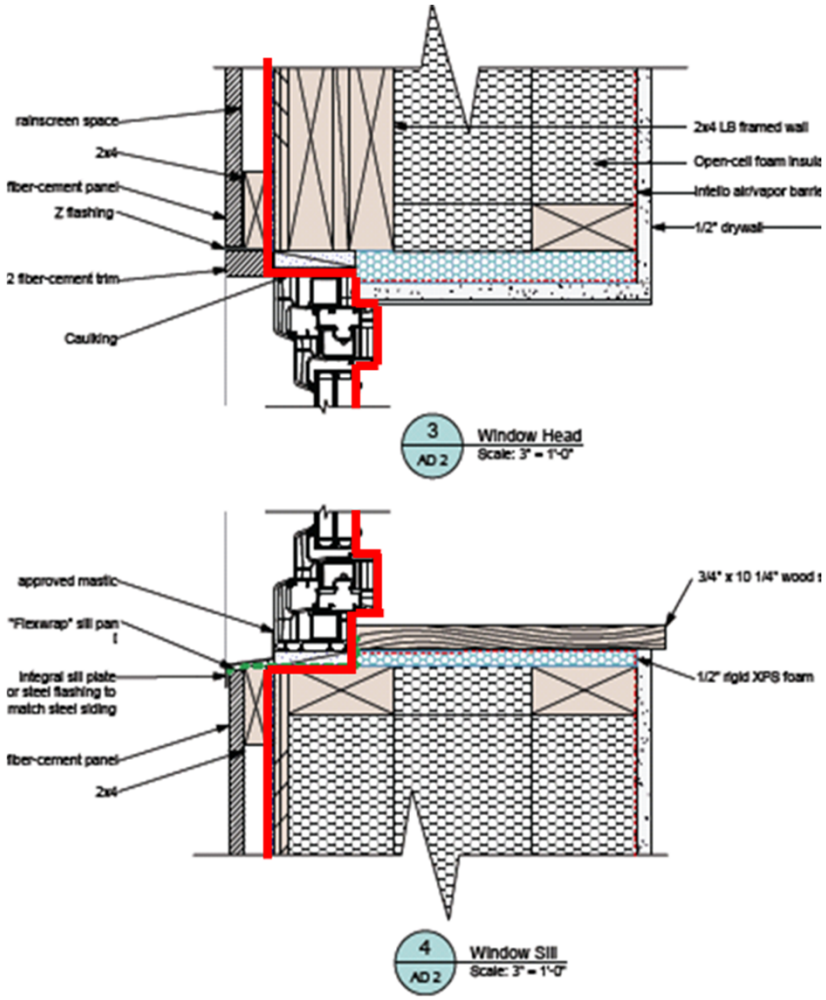




Define
Air Barrier



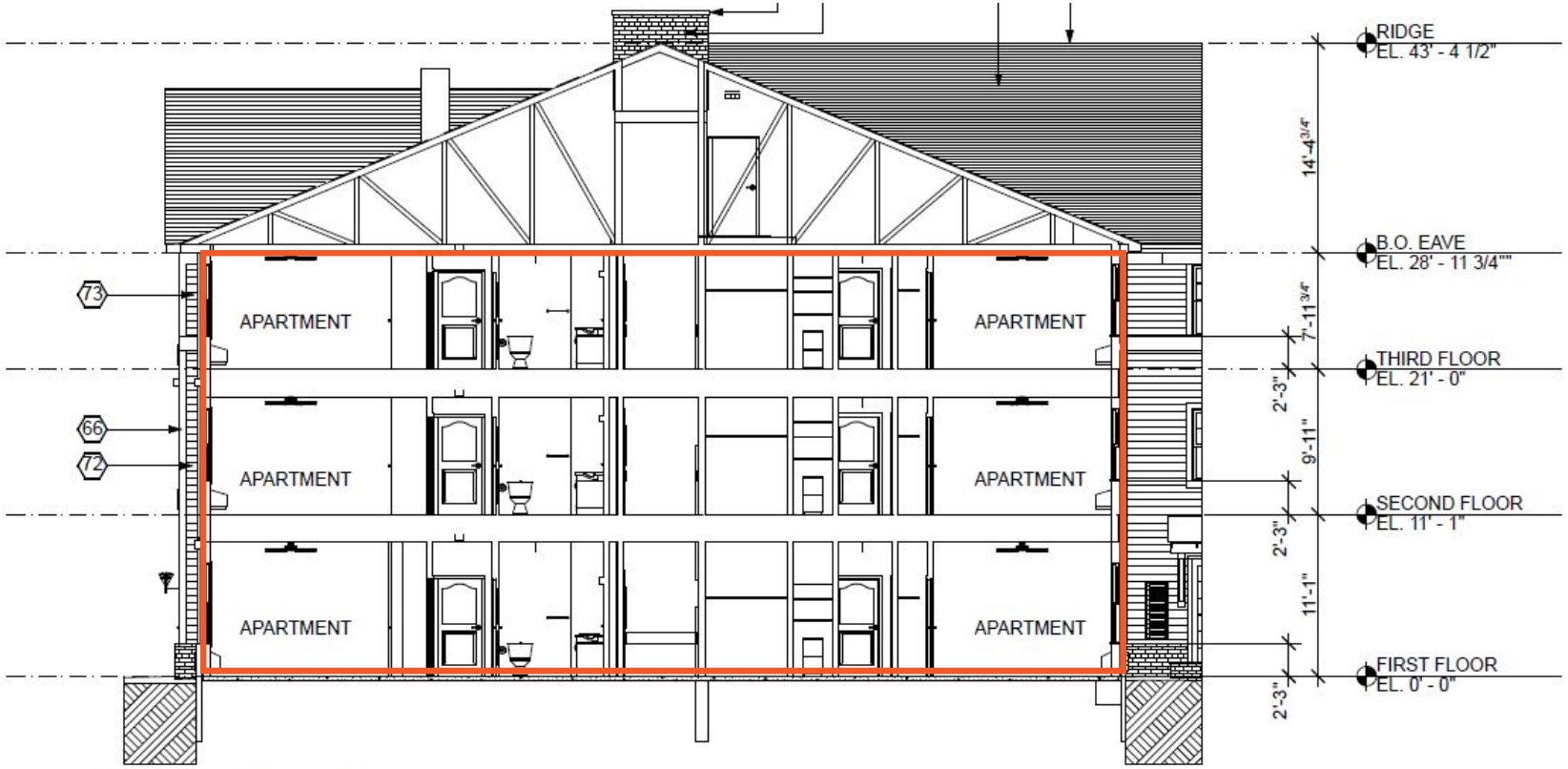
Define
Air Barrier



Define Air Barrier

- Redline around entire perimeter indicating air sealed surface
- Both in plan view and in section
- Circle all transition points – corners, changes in components, cantilevers, wall/roof, slab/wall, etc.
- Provide details for how all these transitions will be air sealed

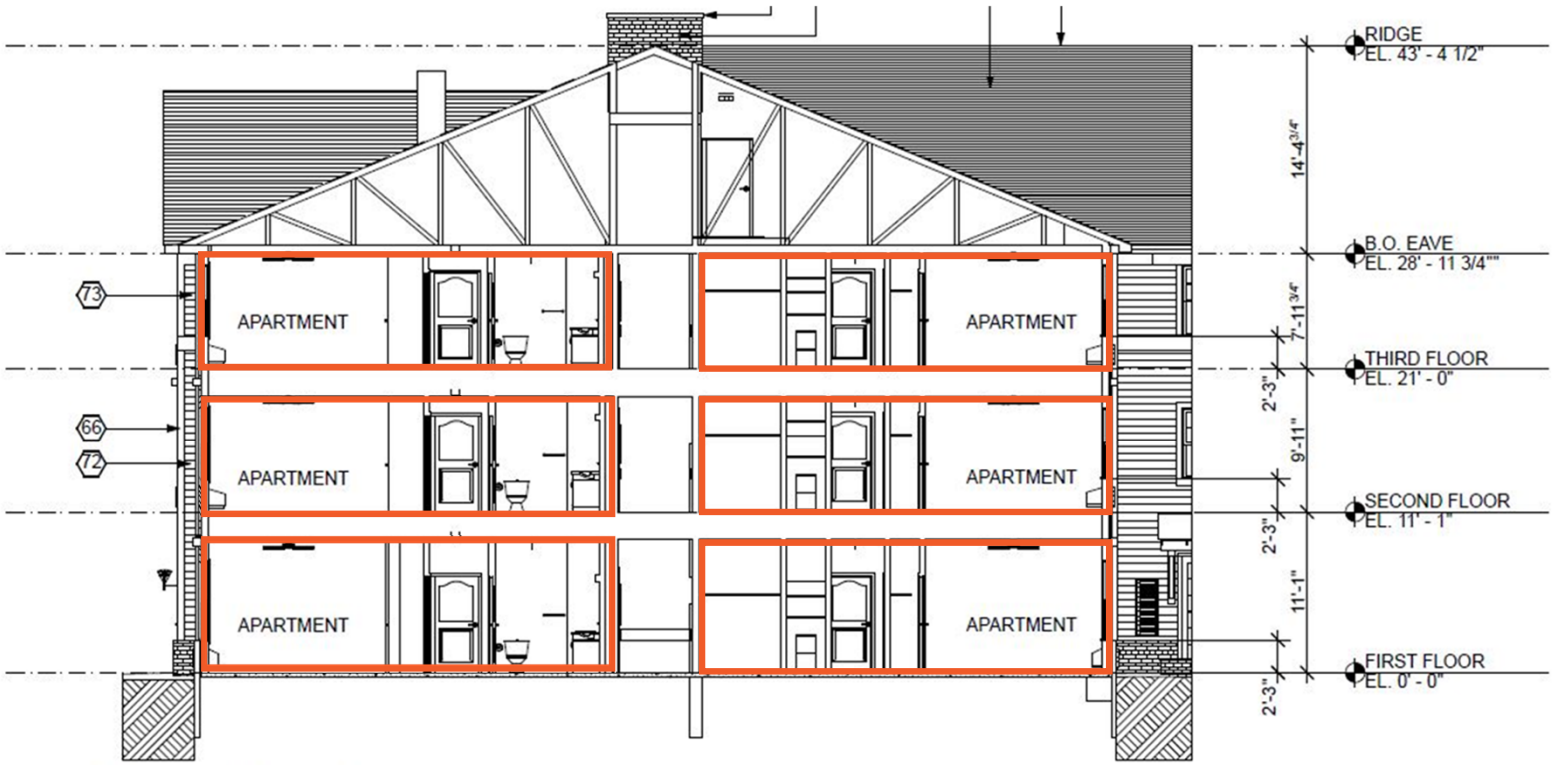
Whole Building Barrier



1 Typical Wing Section

1/8" = 1'-0"

Compartmentalization



1 Typical Wing Section

1/8" = 1'-0"

Air Barrier Materials

- Building materials that are designed and constructed to provide the principal plane of airtightness through an environmental separator, which has an **air permeance rate no greater than 0.02 L/(s•m²) (0.004 cfm/ft²) at a pressure difference of 75 Pa when tested in accordance with ASTM E 2178.**

Air Barrier Accessories

- Products designated to maintain air tightness between air barrier materials, assemblies and components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, nails/washers, ties, clips, staples, strapping, primers) and which has **an air permeance rate no greater than 0.02 L/(s•m²) at a pressure difference of 75 Pa when tested in accordance with ASTM E 2178.**
- Air barrier components are used to connect and seal air barrier materials and/or air barrier assemblies together.

Air Barrier Components

- **Air barrier components** – Pre-manufactured elements such as windows, doors and service elements that are installed in the environmental separator and sealed by air barrier accessories
- Must have an air leakage rate no greater than **0.20L/(s•m²)** at a pressure difference of 75 Pa when tested in accordance with ASTM E 2357.

Air Barrier Assemblies

- Combinations of air barrier materials and air barrier accessories that are designated and designed within the environmental boundary to act as a continuous barrier to the movement of air through the environmental boundary
- Must have an air leakage rate no greater than **0.20 L/(s•m²)** at a pressure difference of 75 Pa when tested in accordance with ASTM E 2357.

Air Barrier Systems (Enclosure)

- Combinations of air barrier assemblies and air barrier components, connected by air barrier accessories, that are designed to provide a continuous barrier to the movement of air through an environmental separator, which has an **air leakage rate no greater than 2.0 L/(s•m²) at a pressure difference of 75 Pa** when tested in accordance with ASTM E 779.

Common Air Barrier Materials

- Gypsum Wall Board
- Plywood
- Concrete
- Housewrap products
- 6 Mil poly (unpeforated)
- Roll form Water Resistive Barriers
- Fluid Applied WRBs
- Foil-faced Polyisocyanurate
- Extruded Polystyrene (XPS)
- Closed Cell SPF
- “Smart” Vapor-retarders

House Wrap

Gypsum Sheathing

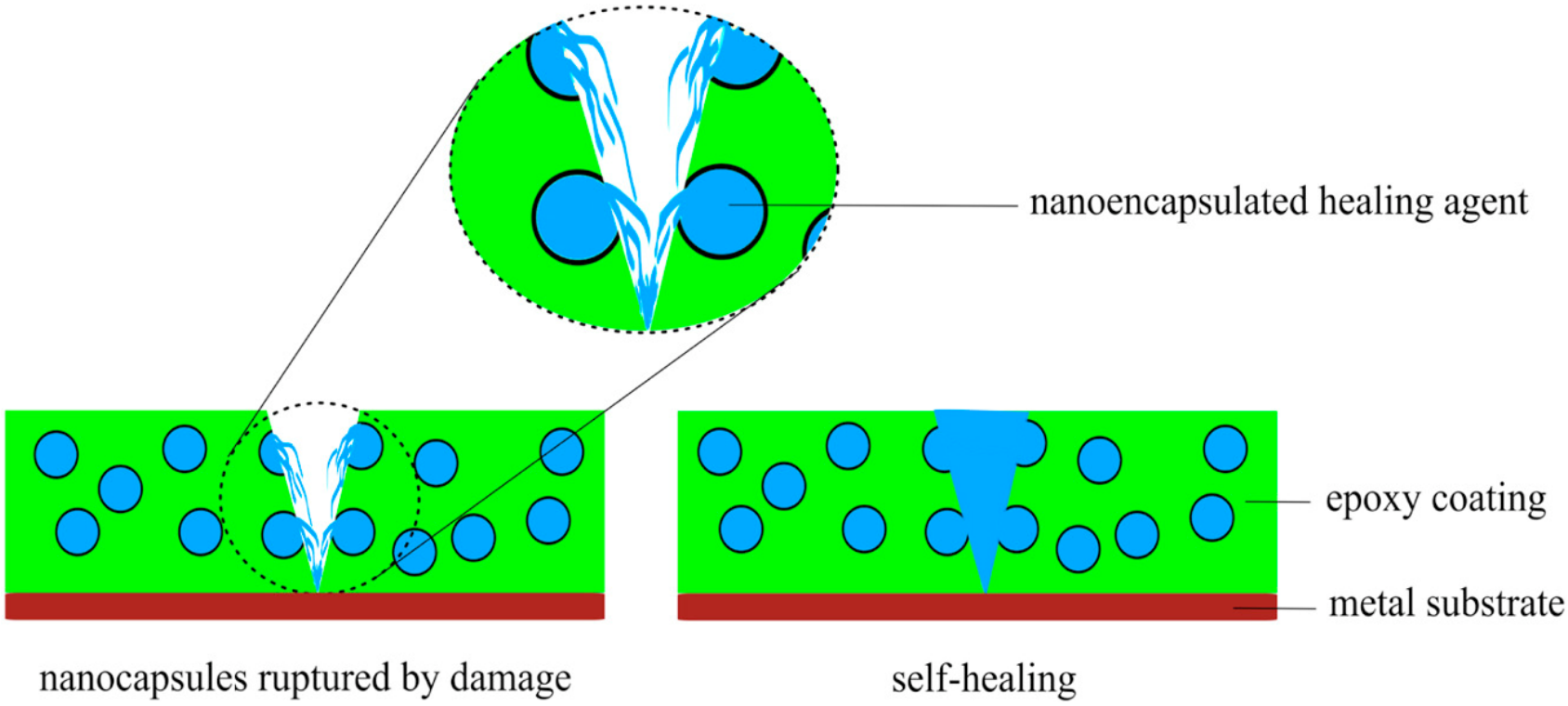
Proprietary Air Barrier Materials

Plywood as an Air Barrier

Self-Adhered Air-Barriers and WRBs

Fluid Applied Air-Barriers and WRBs

Self Healing Membranes

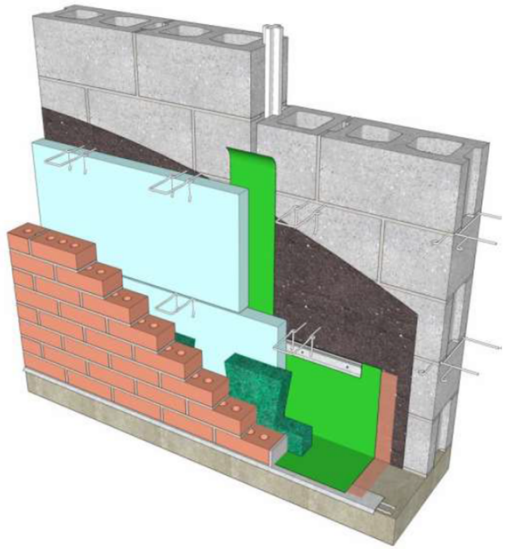


Closed-cell Spray Polyurethane Foam (ccSPF)

Polyisocyanurate

- R-6.5/inch
- Air and vapor impermeable if faced (other facers available)
- Can serve as air-barrier and water-resistive barrier
- Common above-deck roof insulation

Extruded Polystyrene (XPS)



- Can be effective WRB; joints critical
- Monolithic material with no facer
- Material is very water tolerant (below grade uses)
- R-5 per inch (5.4/inch available)
- Class II VR (thickness dependent)

Interior Membranes

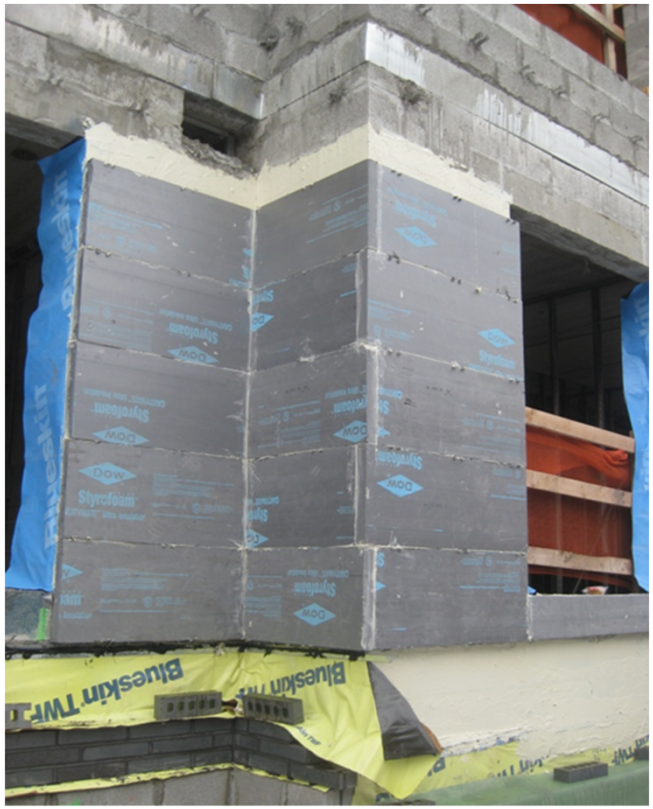
Compartmentilazation

Execute Air Barrier Correctly

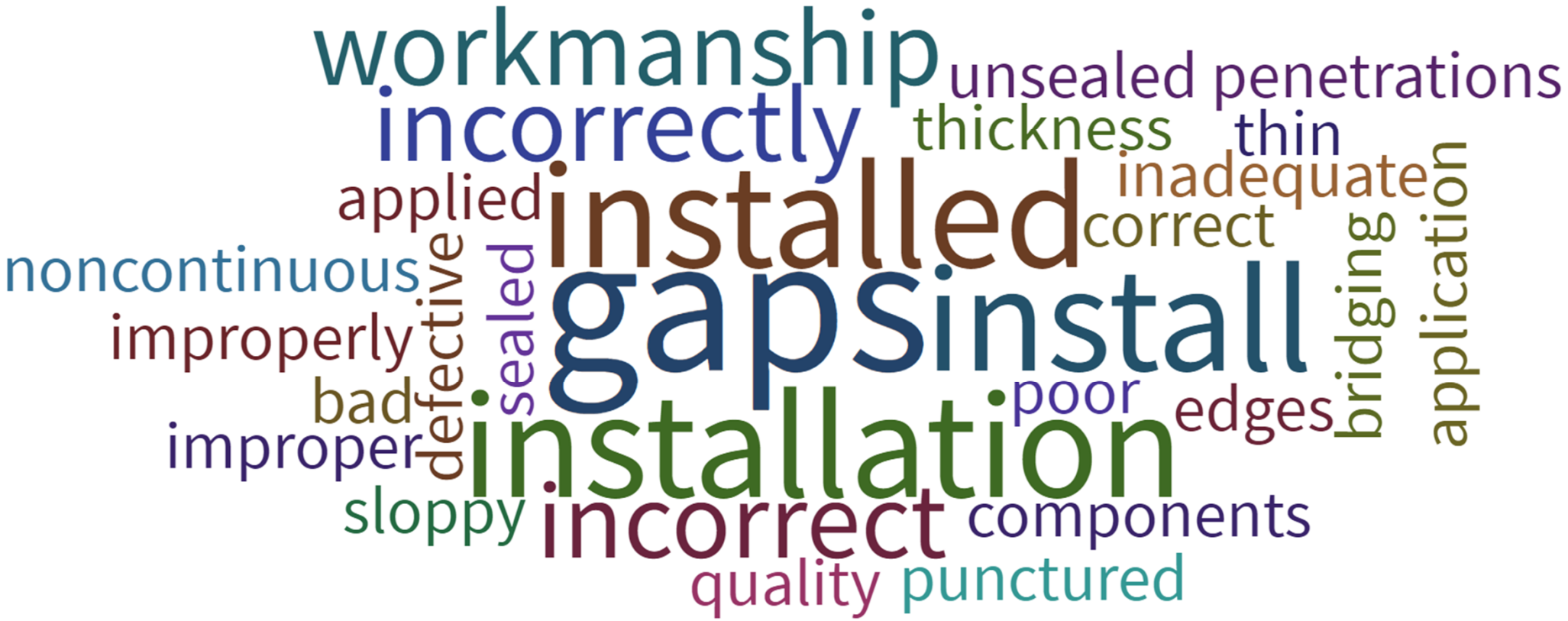
Thermal Boundary and Air Barrier Integration

- The two boundaries work together to manage Energy, Moisture, and Increase Durability
  - Energy Control = C02 and $$$ Saved
  - Moisture Control = building durability
  - Comfort Control = happy occupants
- To Function Properly Must be:
  - Continuous (no gaps)
  - Aligned with each other

Aligned Thermal Boundary and Air Barrier



Name a common reason air barriers are ineffective.



Questions?

15 Minute Break

Planning during design and the integrated design approach

Air-Barrier Review

Light Gauge Steel Back-up

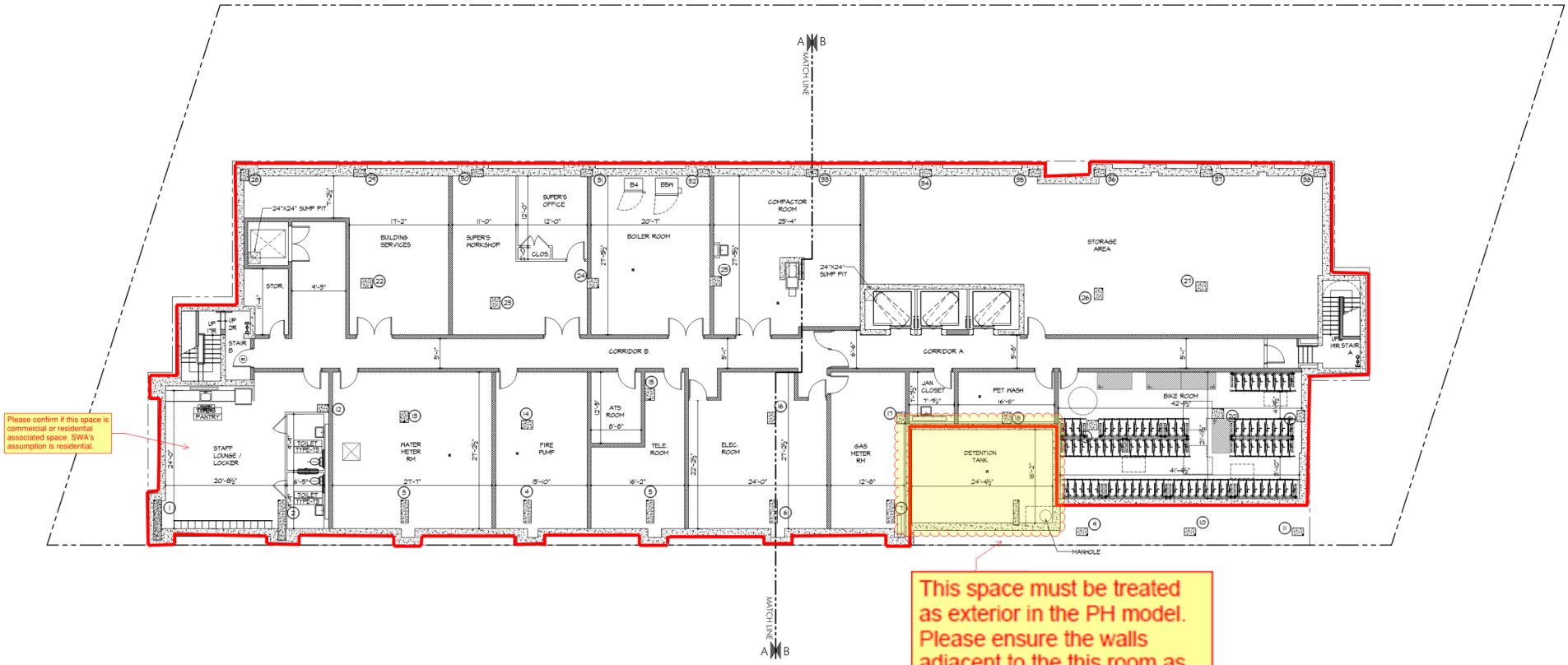
fxcollarborative / MHG Architects

La Central Building C: Air Barrier Review - 50% CD
Steven Winter Associates, Inc.
January 29, 2019

PH Air Barrier Review Key

- Continuous air tight layer
- Air barrier detail - **must be provided**
- Air barrier detail - already provided
- SWA plan review comment

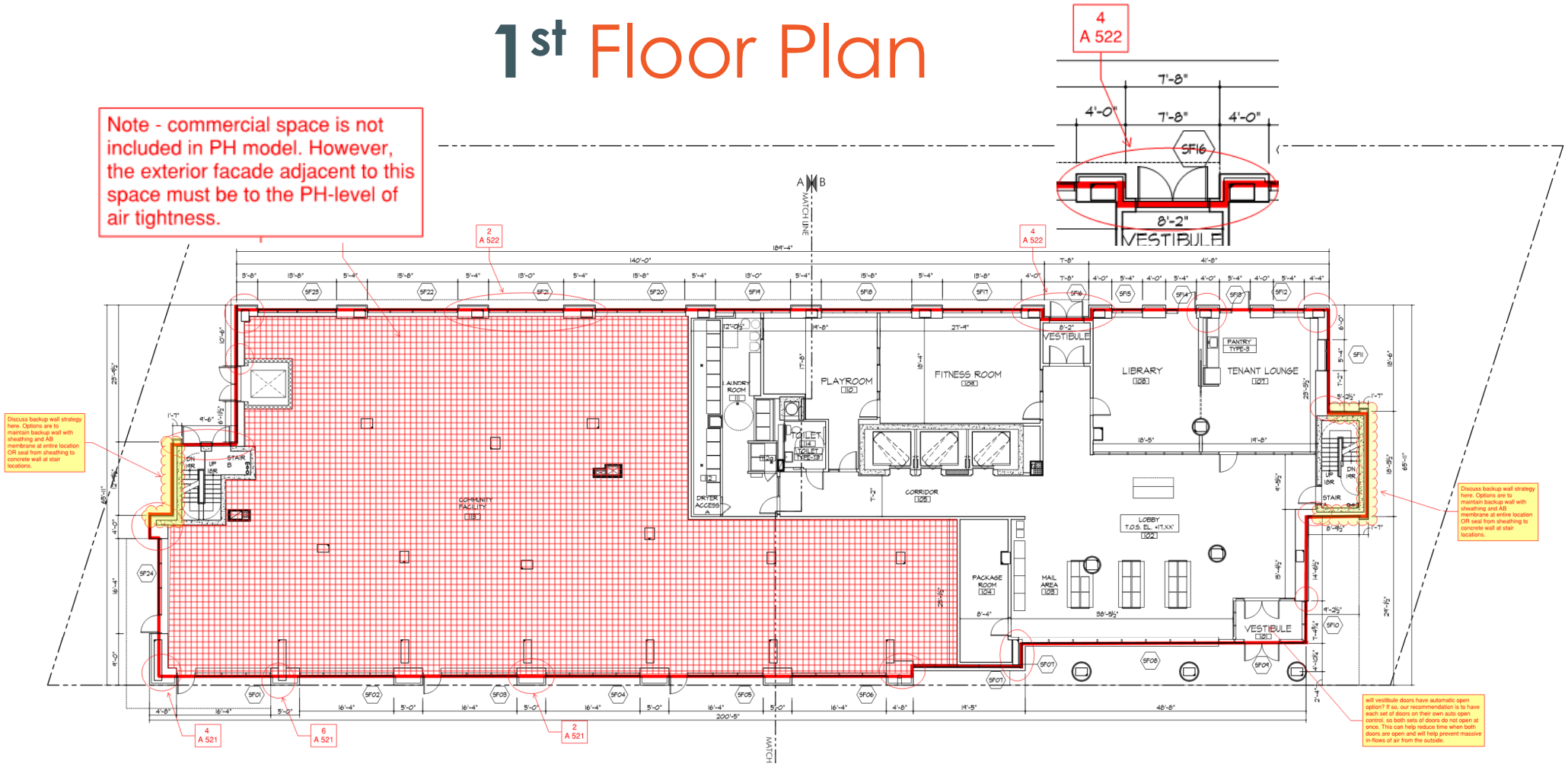
Foundation/Basement Plan



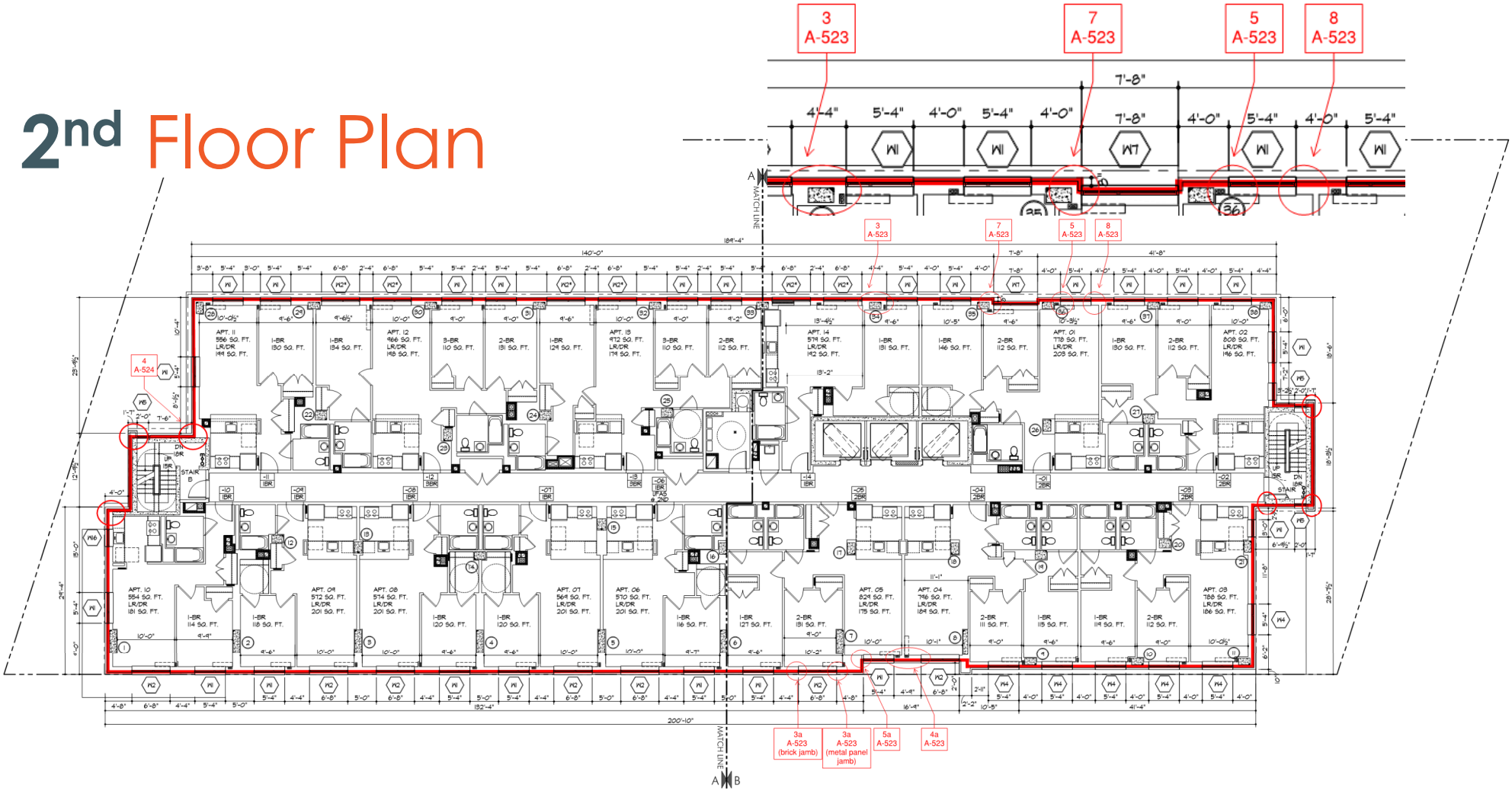
Please confirm if this space is commercial or residential associated space. SWA's assumption is residential.

This space must be treated as exterior in the PH model. Please ensure the walls adjacent to the this room as well as the underside of the detention tank ceiling are insulated to at least R-10.

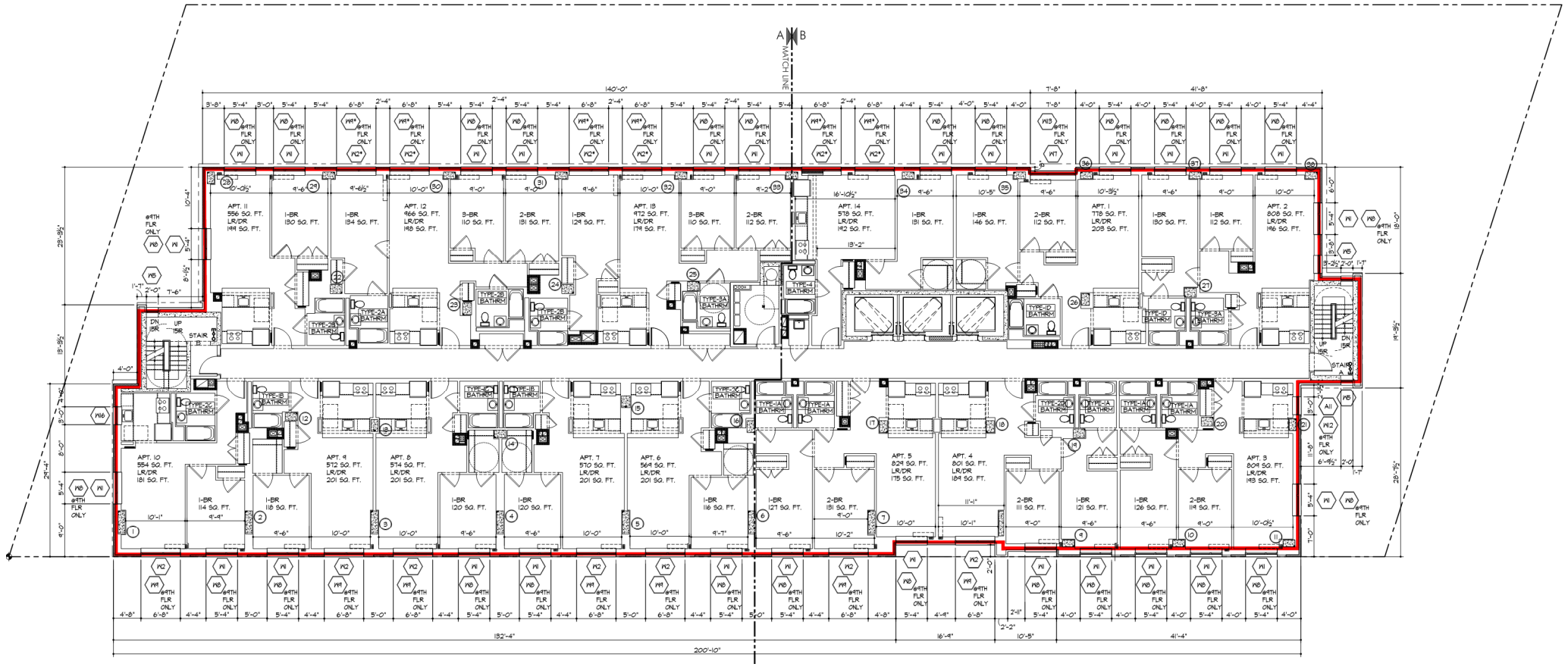
1st Floor Plan



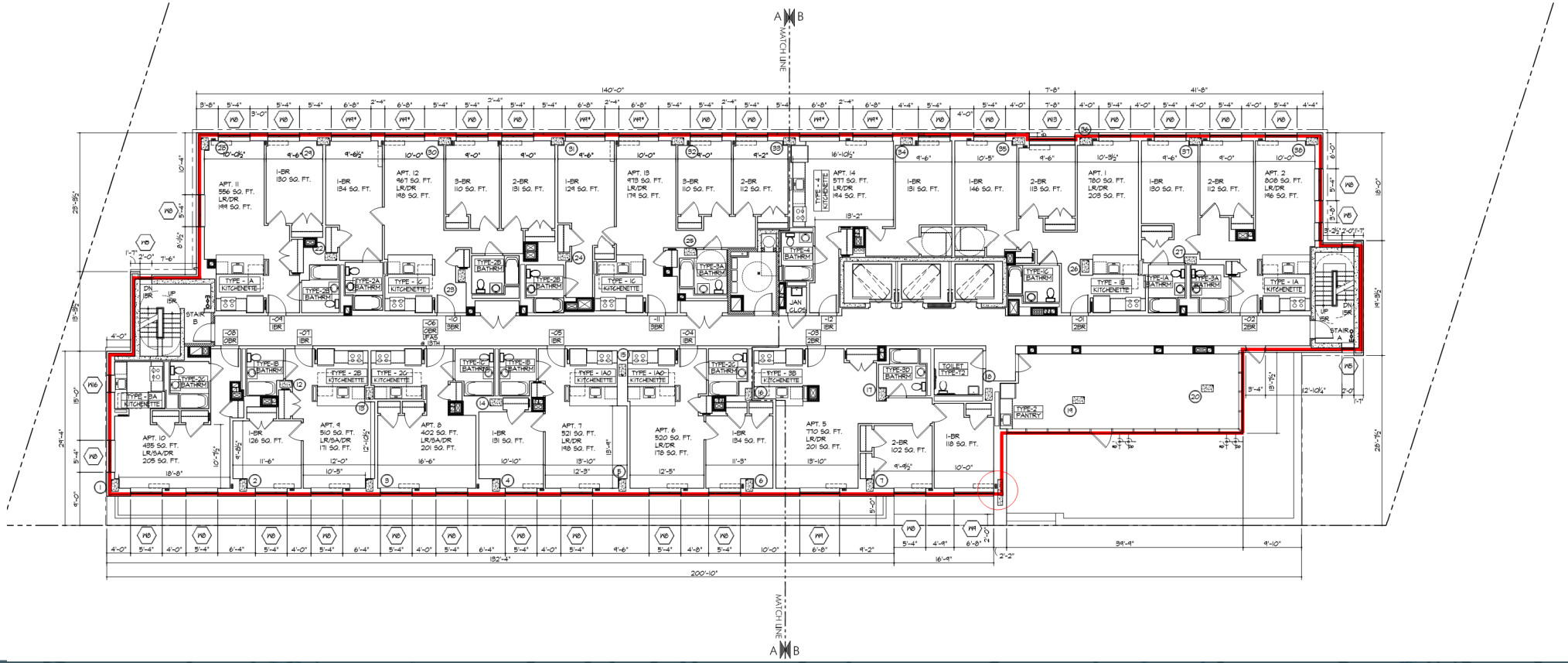
2nd Floor Plan



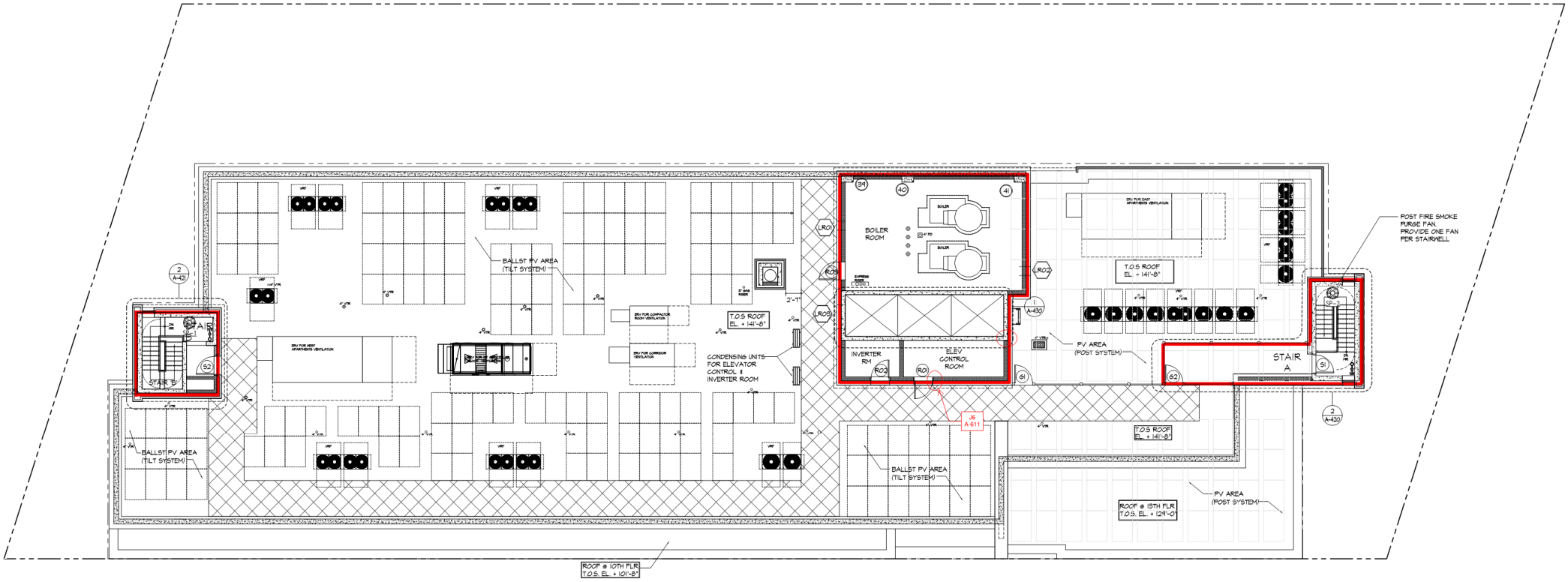
Floors 3-9 Floor Plan



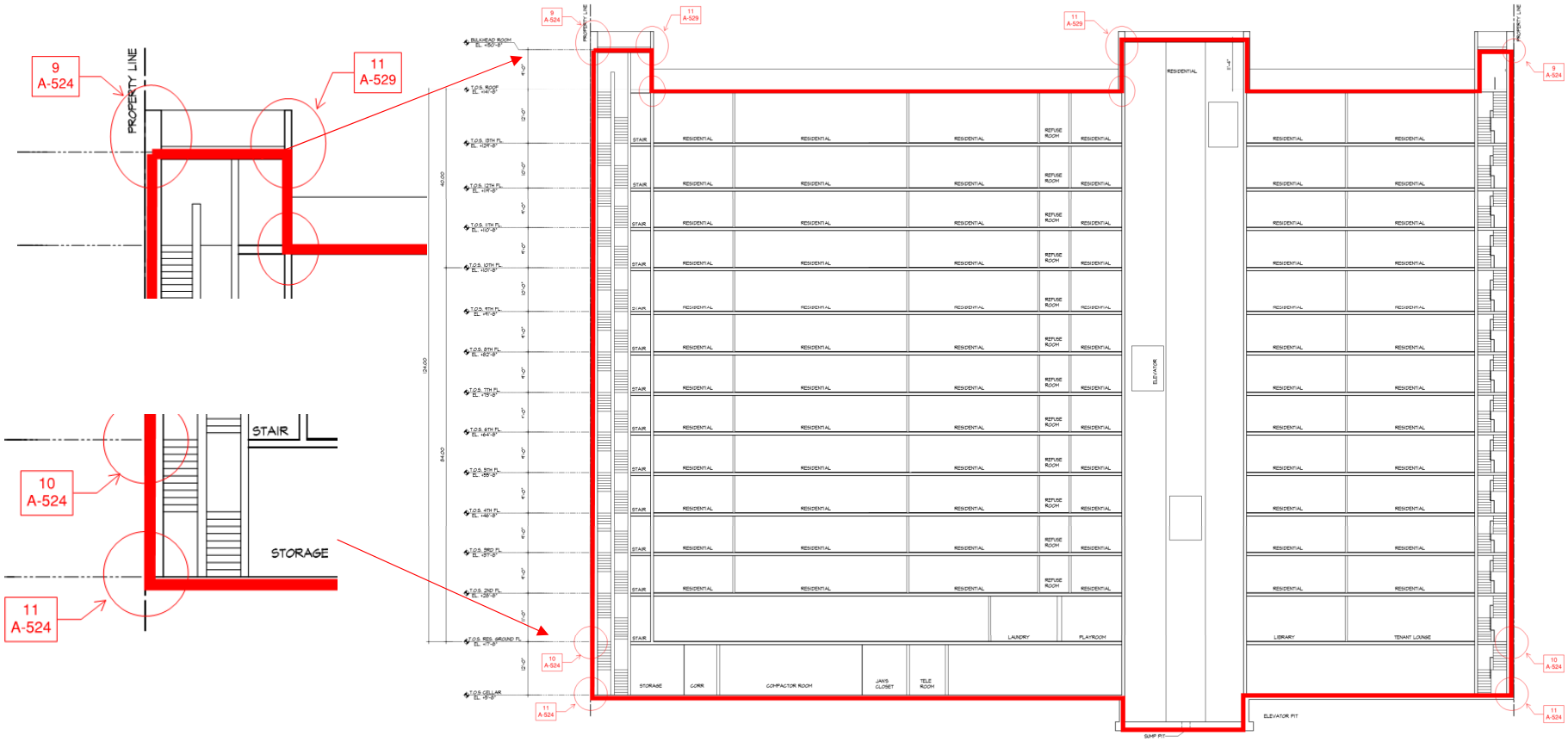
13th Floor

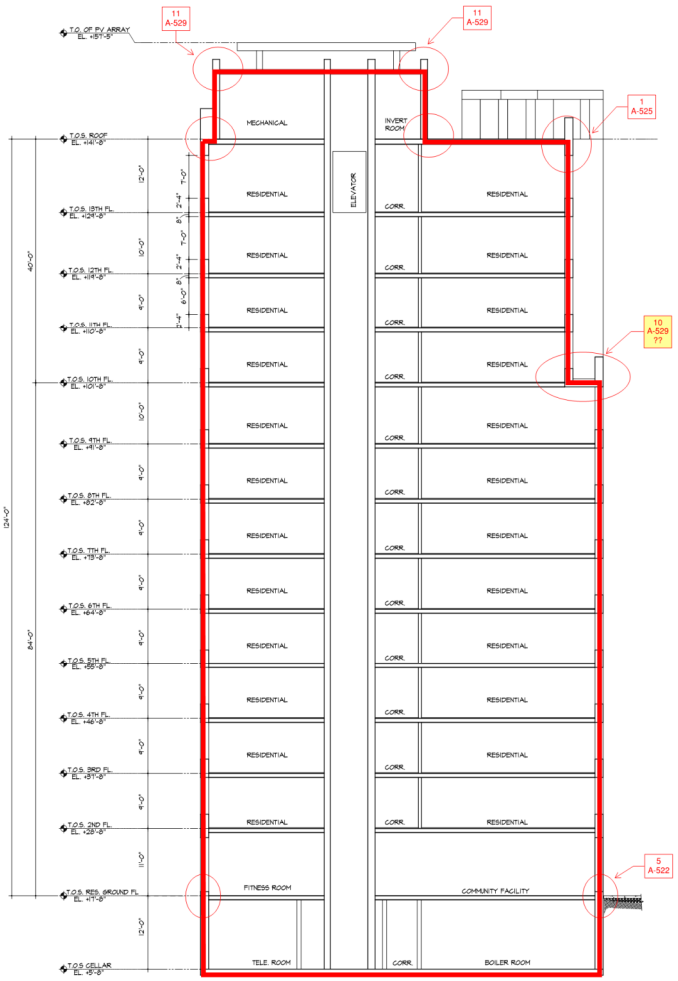

A B
MATCH LINE
140'-0"
41'-8"
APT. 11
556 SQ. FT.
LR/DR
199 SQ. FT.
1-BR
130 SQ. FT.
1-BR
134 SQ. FT.
APT. 12
967 SQ. FT.
LR/DR
188 SQ. FT.
3-BR
110 SQ. FT.
2-BR
131 SQ. FT.
1-BR
129 SQ. FT.
APT. 13
673 SQ. FT.
LR/DR
174 SQ. FT.
3-BR
110 SQ. FT.
2-BR
112 SQ. FT.
APT. 14
577 SQ. FT.
LR/DR
184 SQ. FT.
1-BR
131 SQ. FT.
1-BR
146 SQ. FT.
2-BR
113 SQ. FT.
APT. 1
780 SQ. FT.
LR/DR
208 SQ. FT.
1-BR
130 SQ. FT.
2-BR
112 SQ. FT.
APT. 2
808 SQ. FT.
LR/DR
196 SQ. FT.
APT. 10
485 SQ. FT.
LR/SA/DR
205 SQ. FT.
1-BR
126 SQ. FT.
APT. 9
510 SQ. FT.
LR/SA/DR
171 SQ. FT.
APT. 8
402 SQ. FT.
LR/SA/DR
201 SQ. FT.
1-BR
131 SQ. FT.
APT. 7
521 SQ. FT.
LR/DR
198 SQ. FT.
APT. 6
520 SQ. FT.
LR/DR
178 SQ. FT.
1-BR
134 SQ. FT.
APT. 5
770 SQ. FT.
LR/DR
201 SQ. FT.
2-BR
102 SQ. FT.
1-BR
118 SQ. FT.
TYPE-2
PANTRY
132'-4"
200'-10"
MATCH LINE
A B

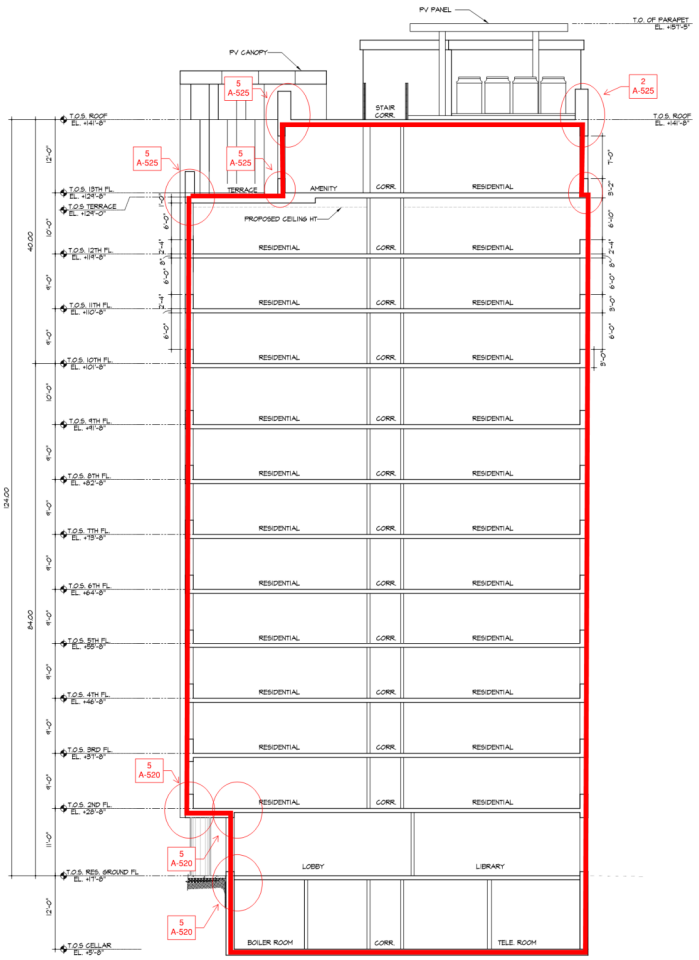
Roof Plan


BOILER ROOM
INVERTER RM
ELEV CONTROL ROOM
BALLST PV AREA (TILT SYSTEM)
T.O.S ROOF EL. + 141'-8"
CONDENSING UNITS FOR ELEVATOR CONTROL & INVERTER ROOM
PV AREA (POST SYSTEM)
POST FIRE SMOKE PURGE FAN. PROVIDE ONE FAN PER STAIRWELL
STAIR A
STAIR B
ROOF @ 10TH FLR T.O.S. EL. + 101'-8"
ROOF @ 13TH FLR T.O.S. EL. + 129'-0"

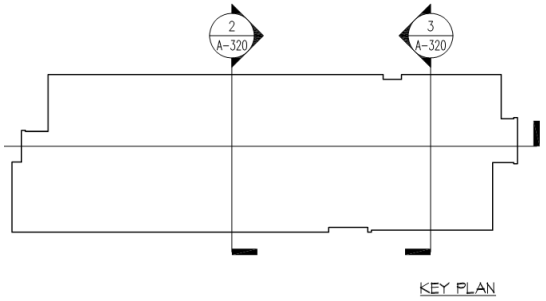
Transverse Section



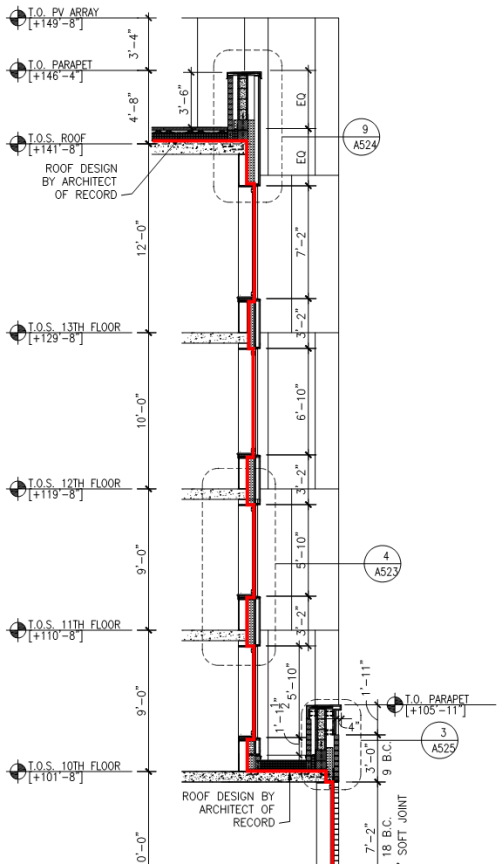


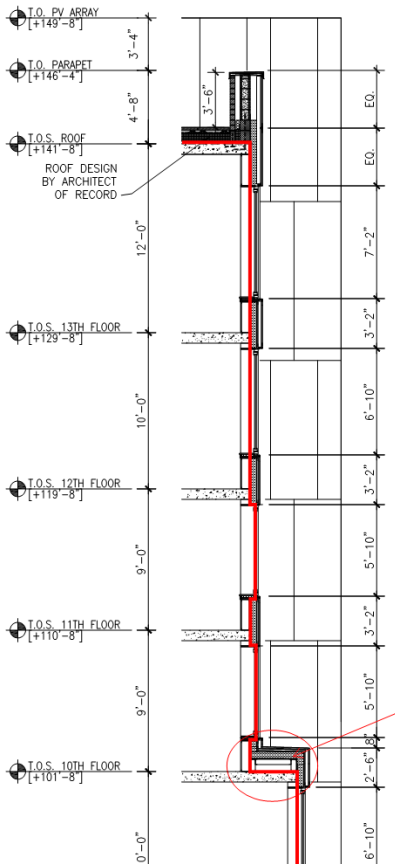


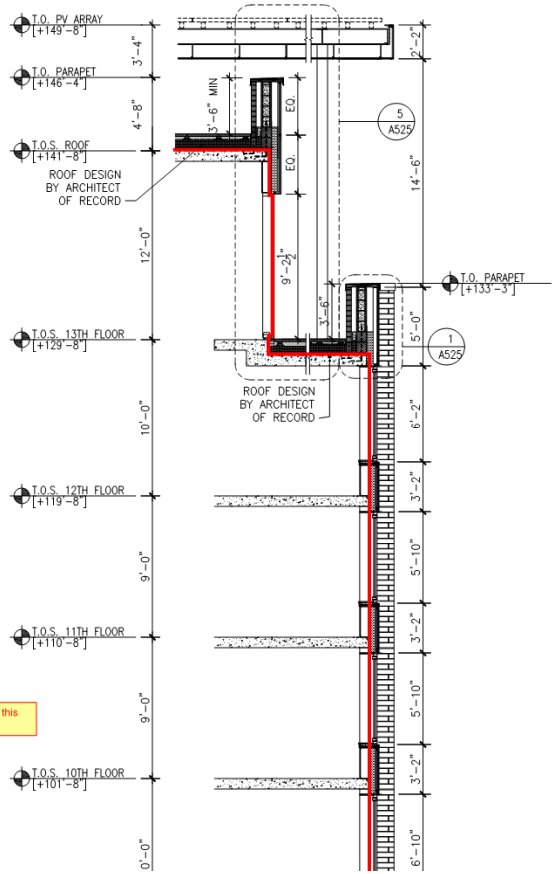
Cross Sections

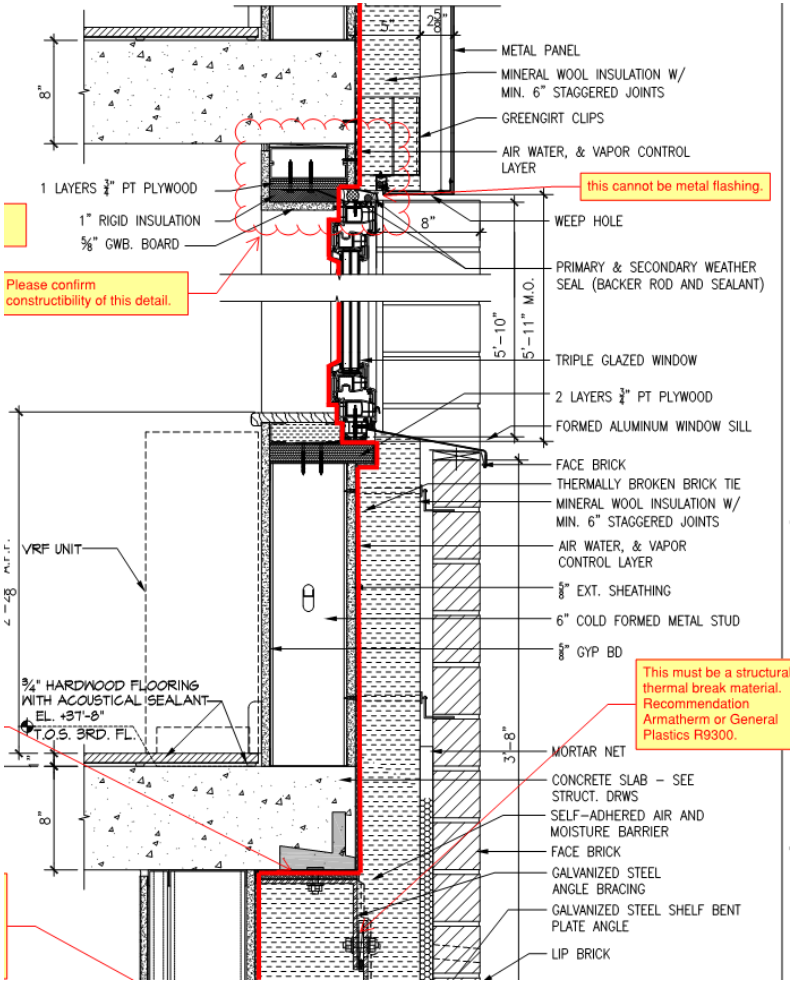


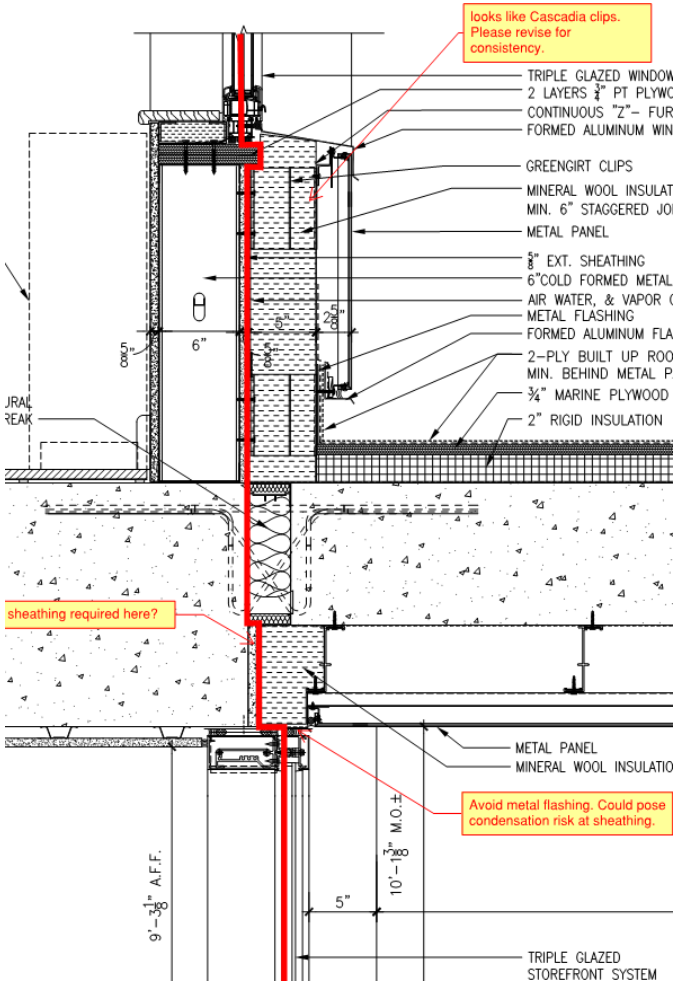
Wall Sections



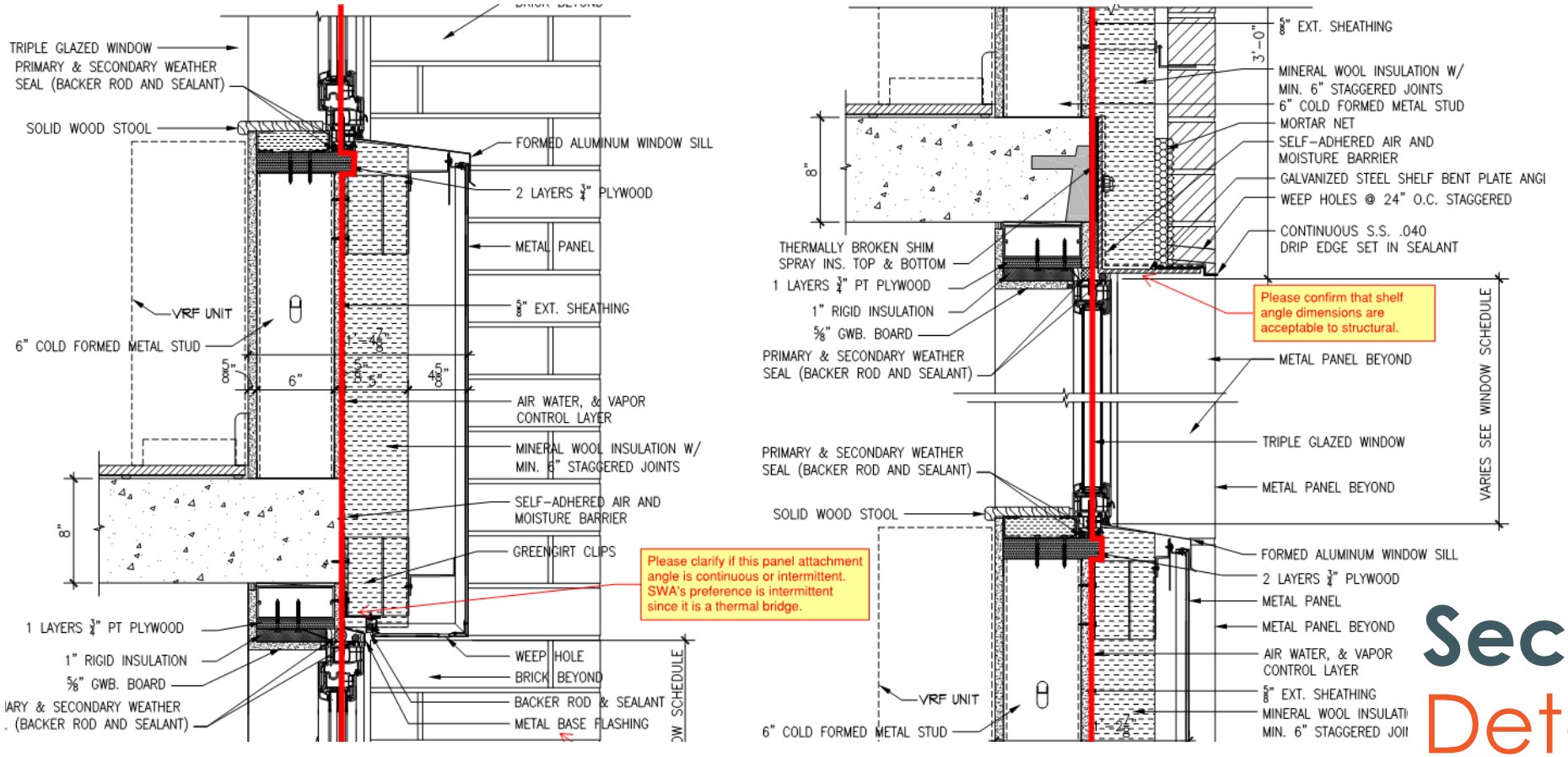






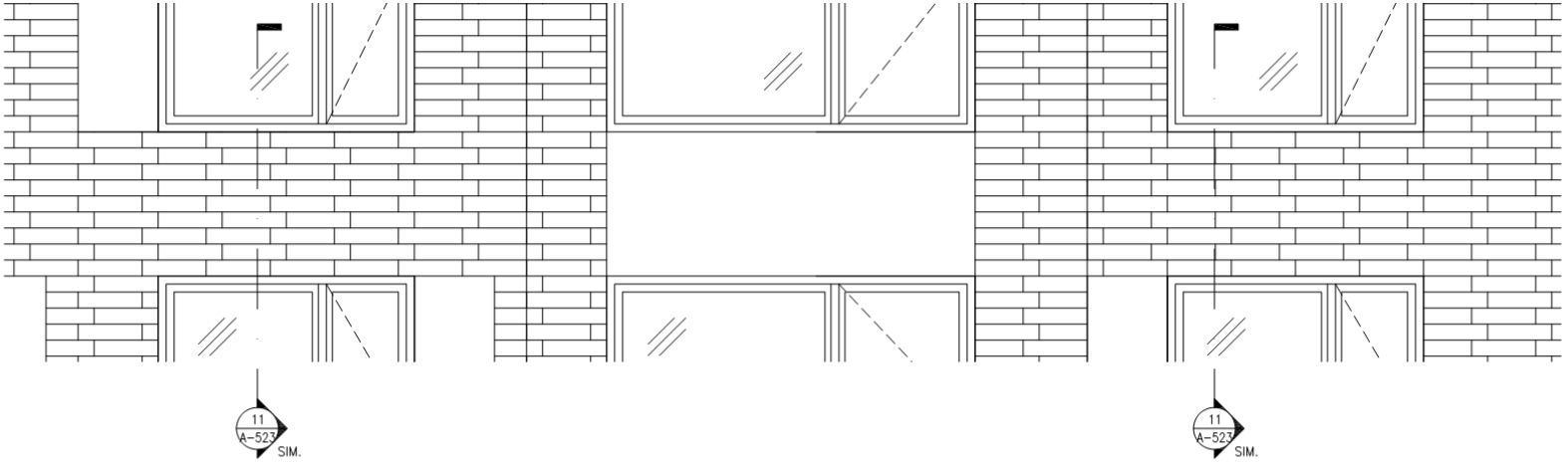


Section Details

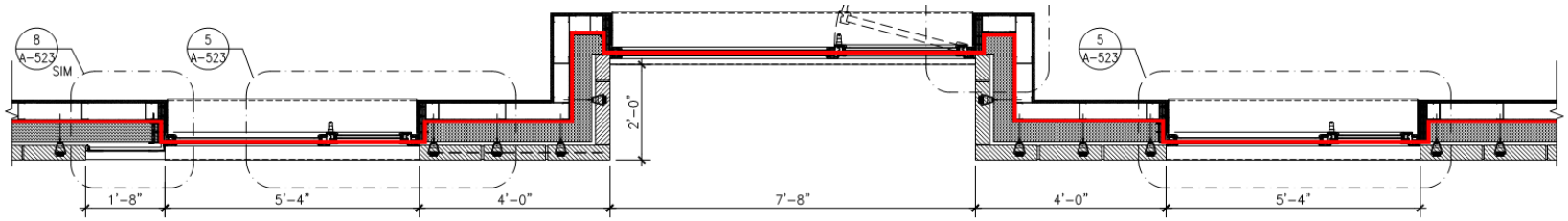


Section Details

Plan Details

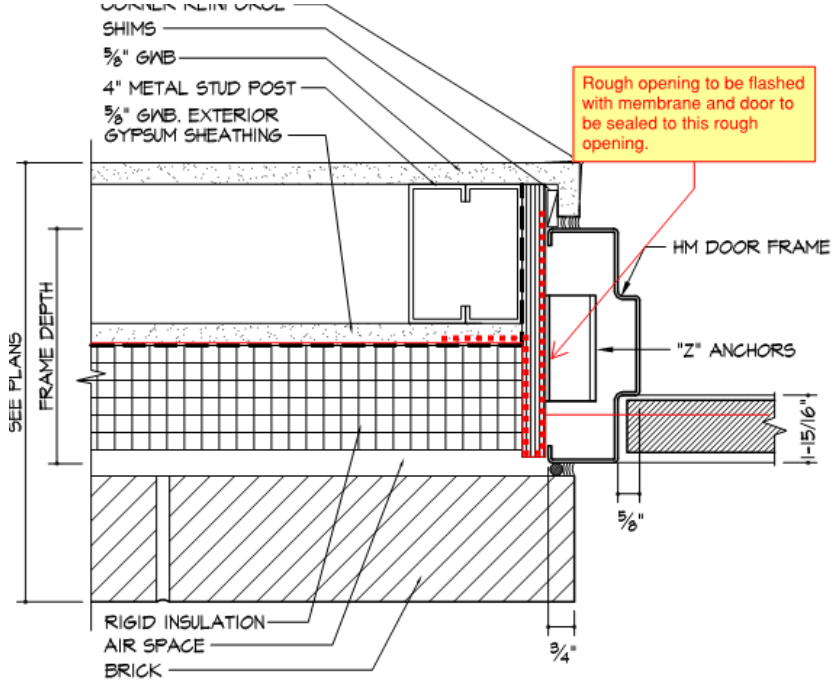


1 ENLARGED ELEVATION @ COURTYARD
SCALE: 1/2" = 1'-0"

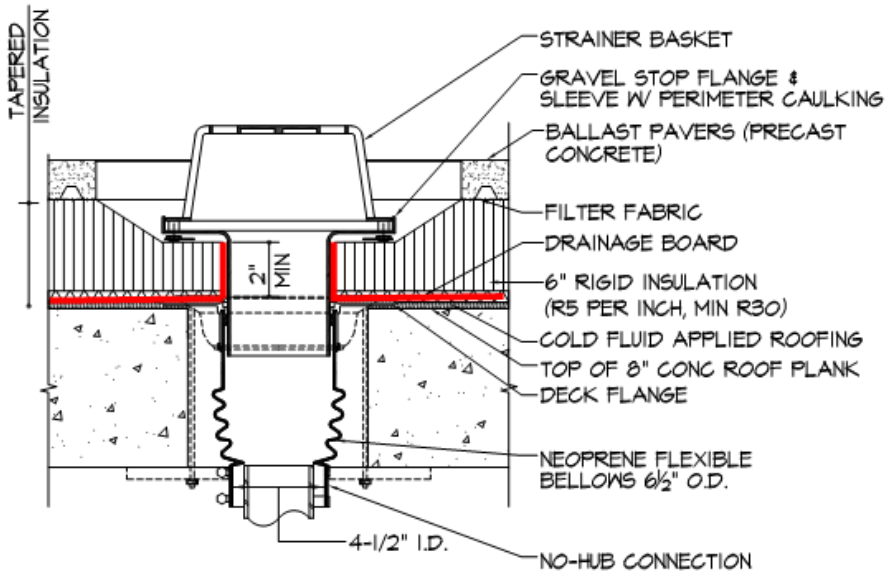


2 PLAN DETAIL @ COURTYARD
SCALE: 1/2" = 1'-0"

Misc. Details

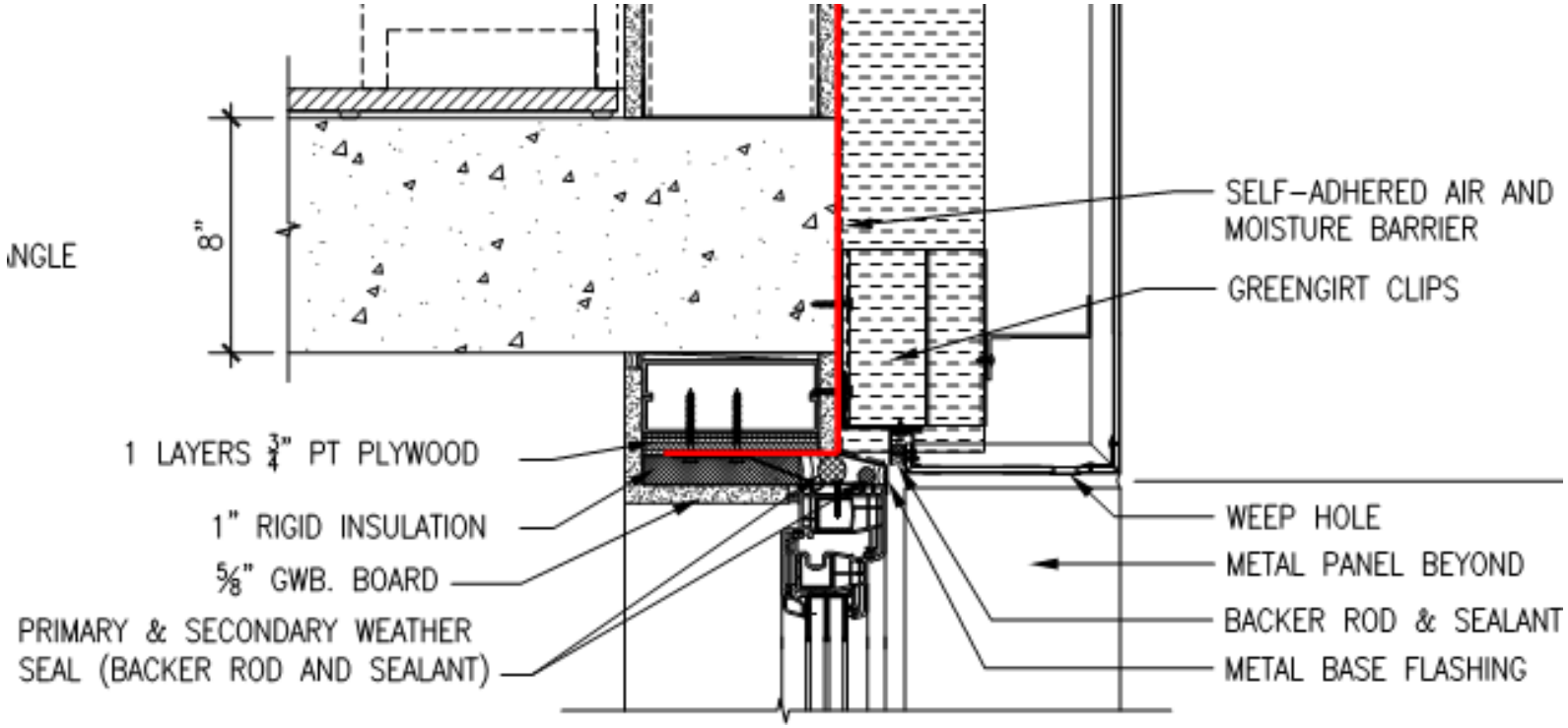


J4 JAMB FOR H5 @ EXTERIOR DOOR

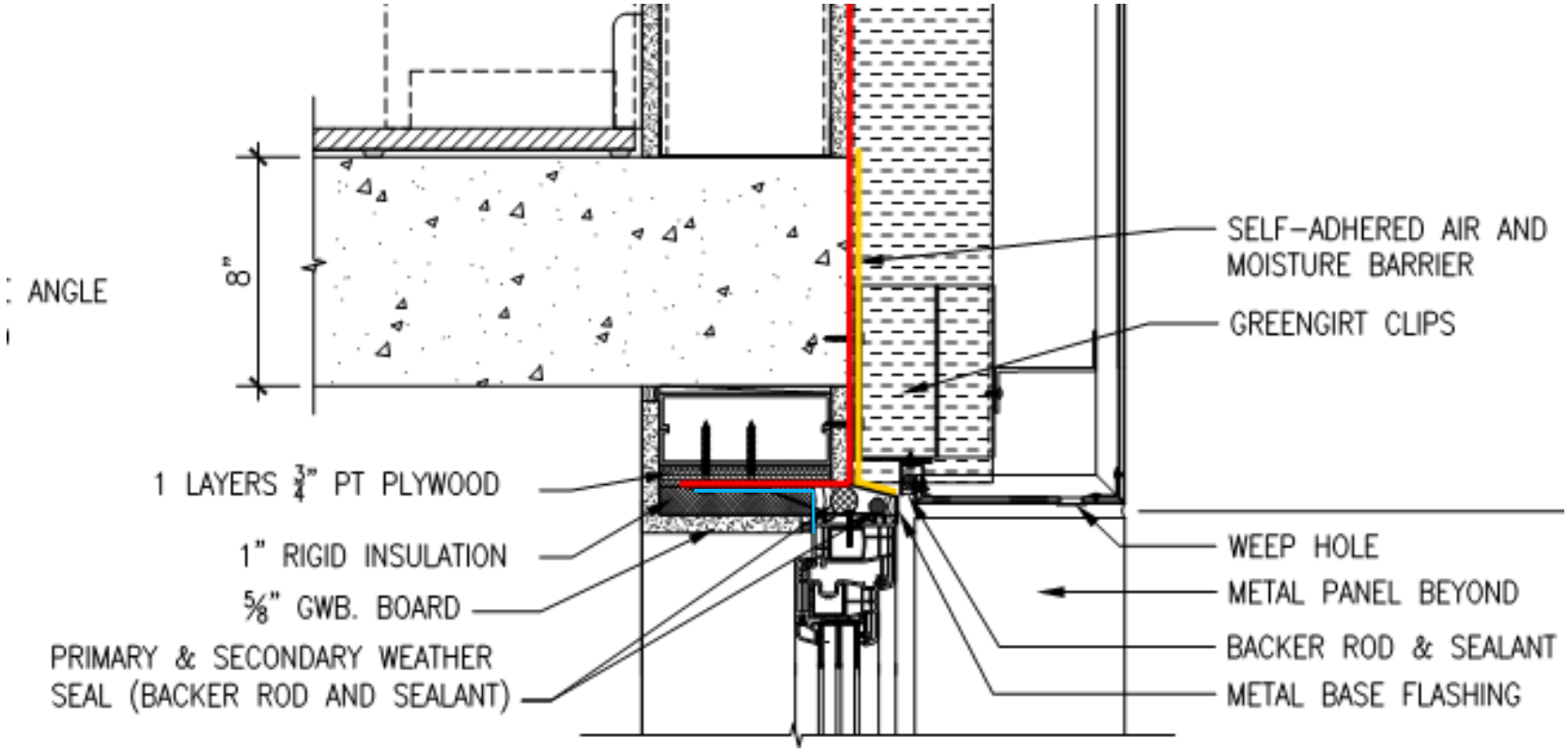


2 ROOF DRAIN DETAIL
1-1/2" = 1'-0"

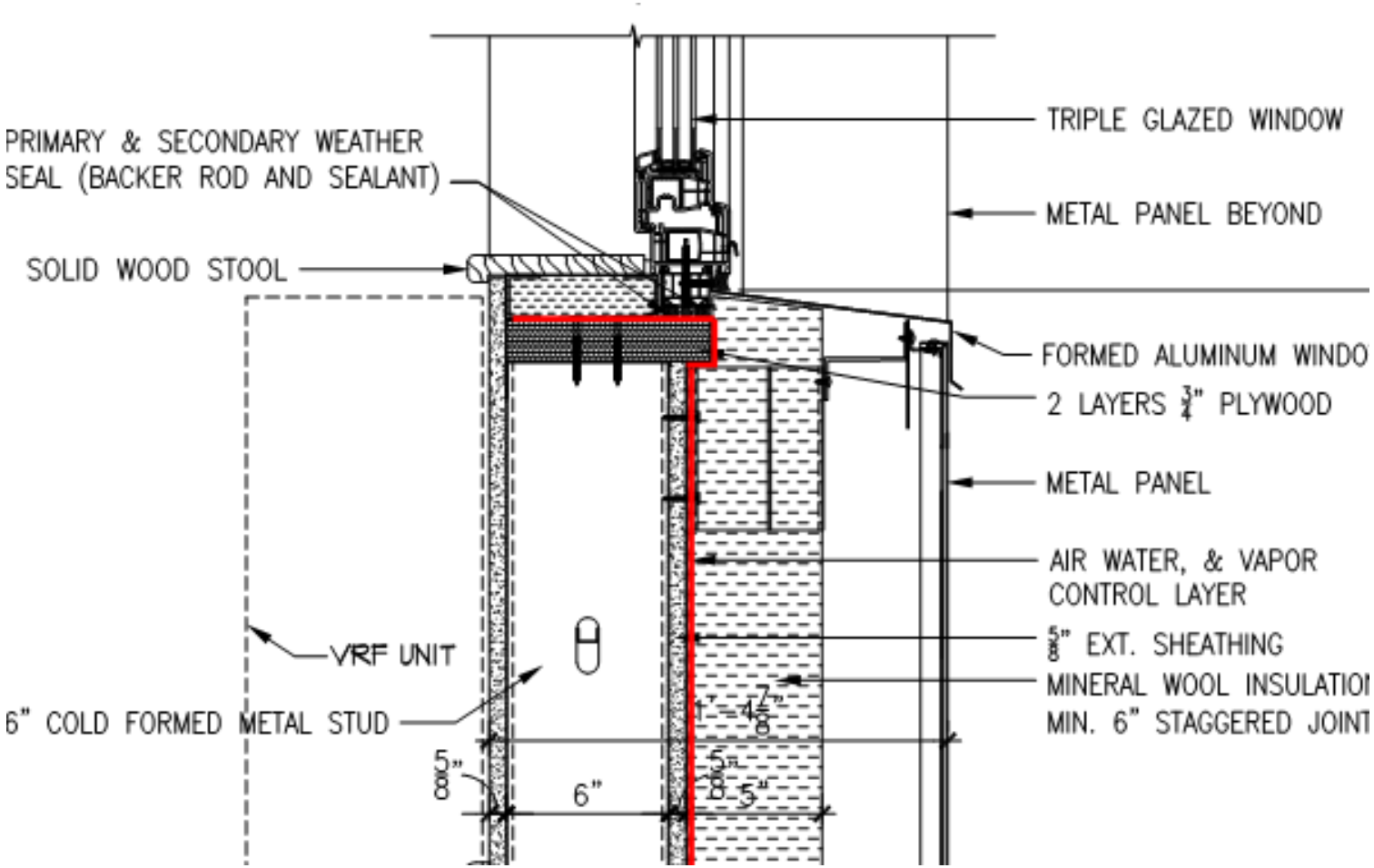
Window Details



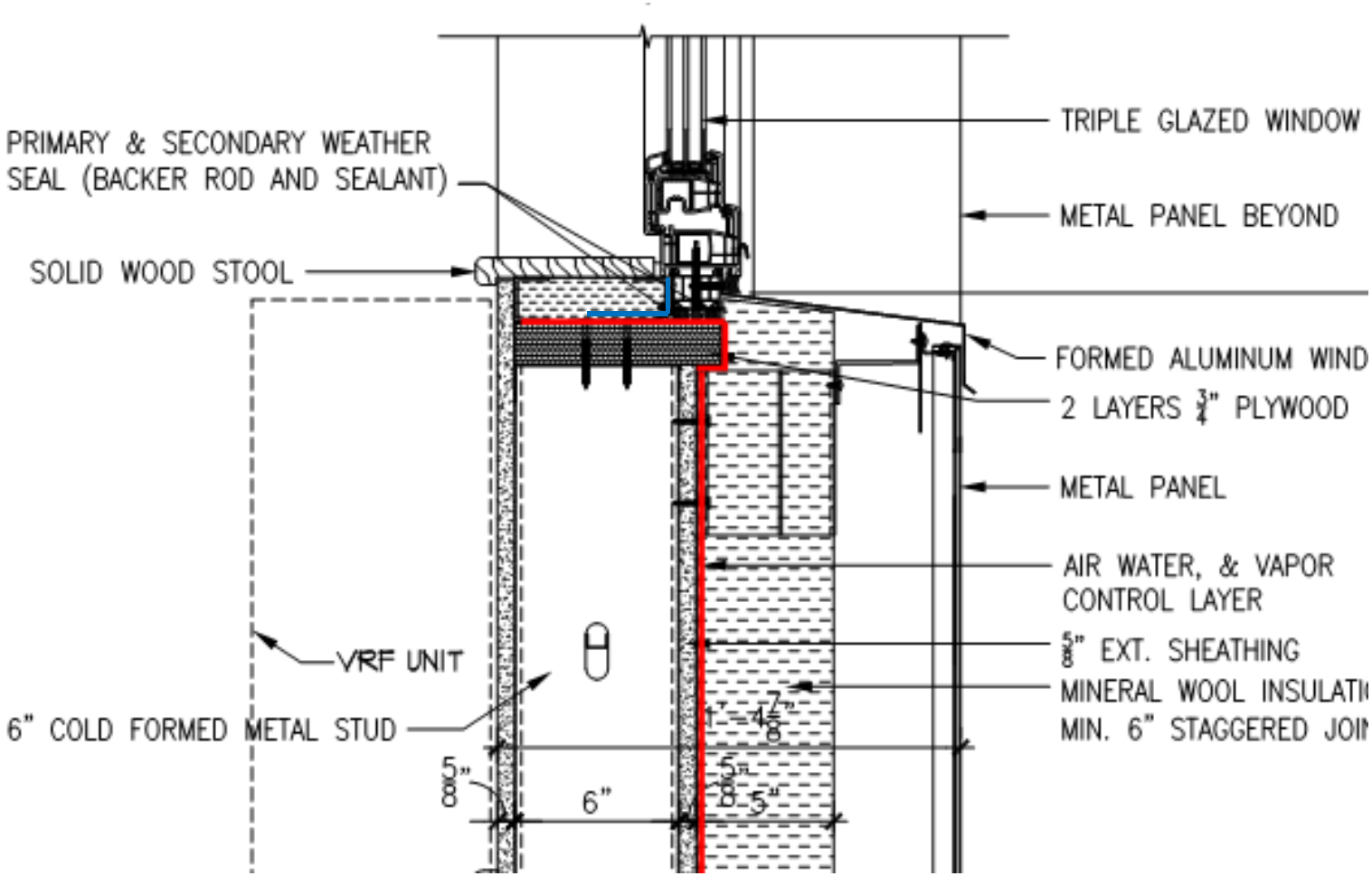
Window Details



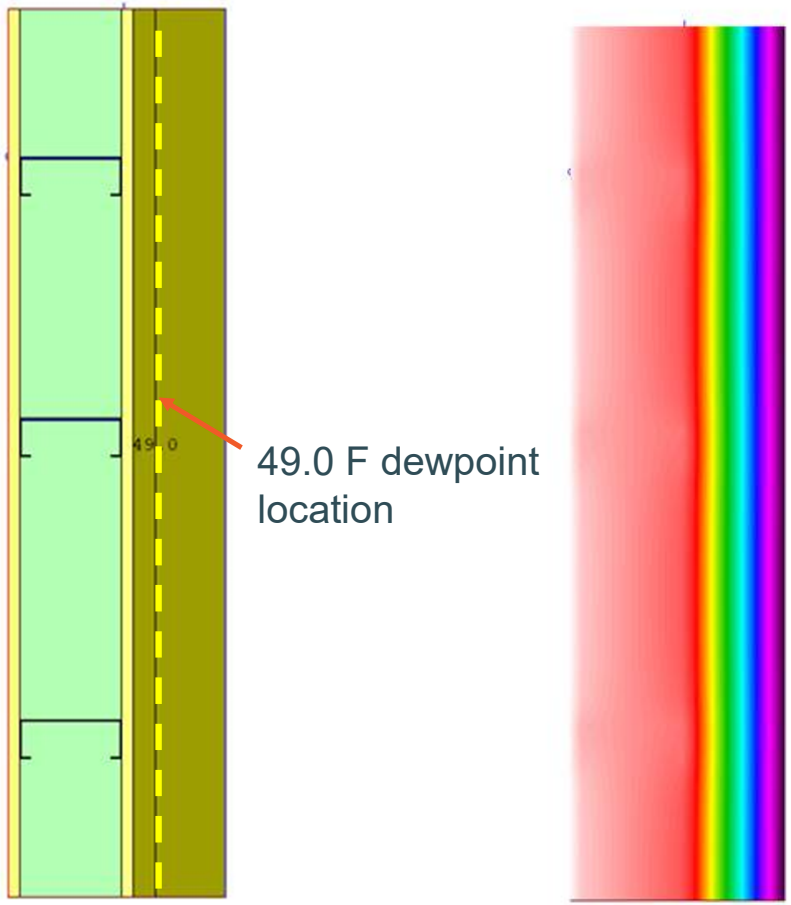
Window Details



Window Details



THERM
Analysis



Air Barrier Review

CMU Back-up

Steven Winter Associates, Inc.
January 29, 2019

PH Air Barrier Review Key

Continuous air tight layer

X
A-xxx

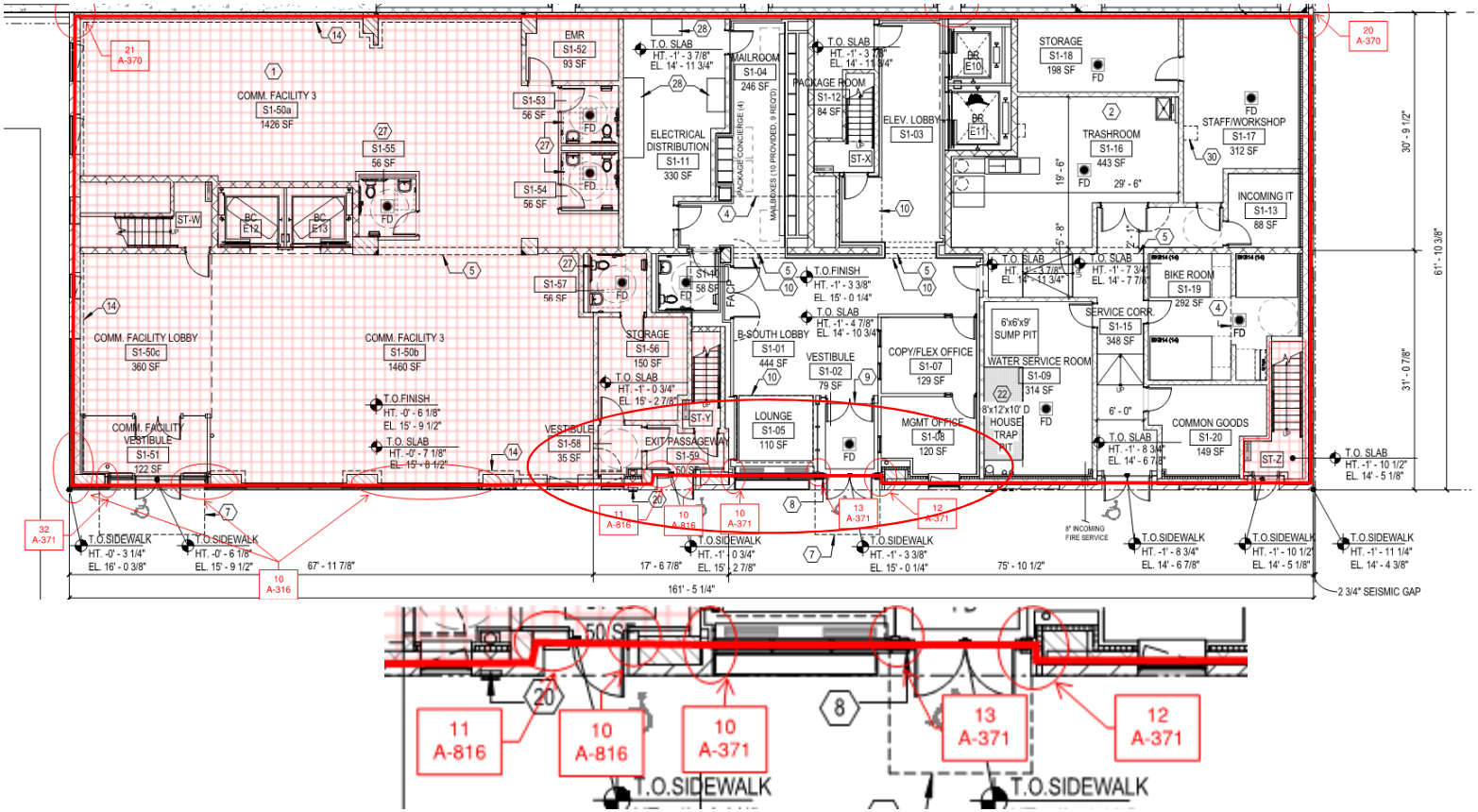
Air barrier detail - **must be provided**

Air barrier detail - already provided

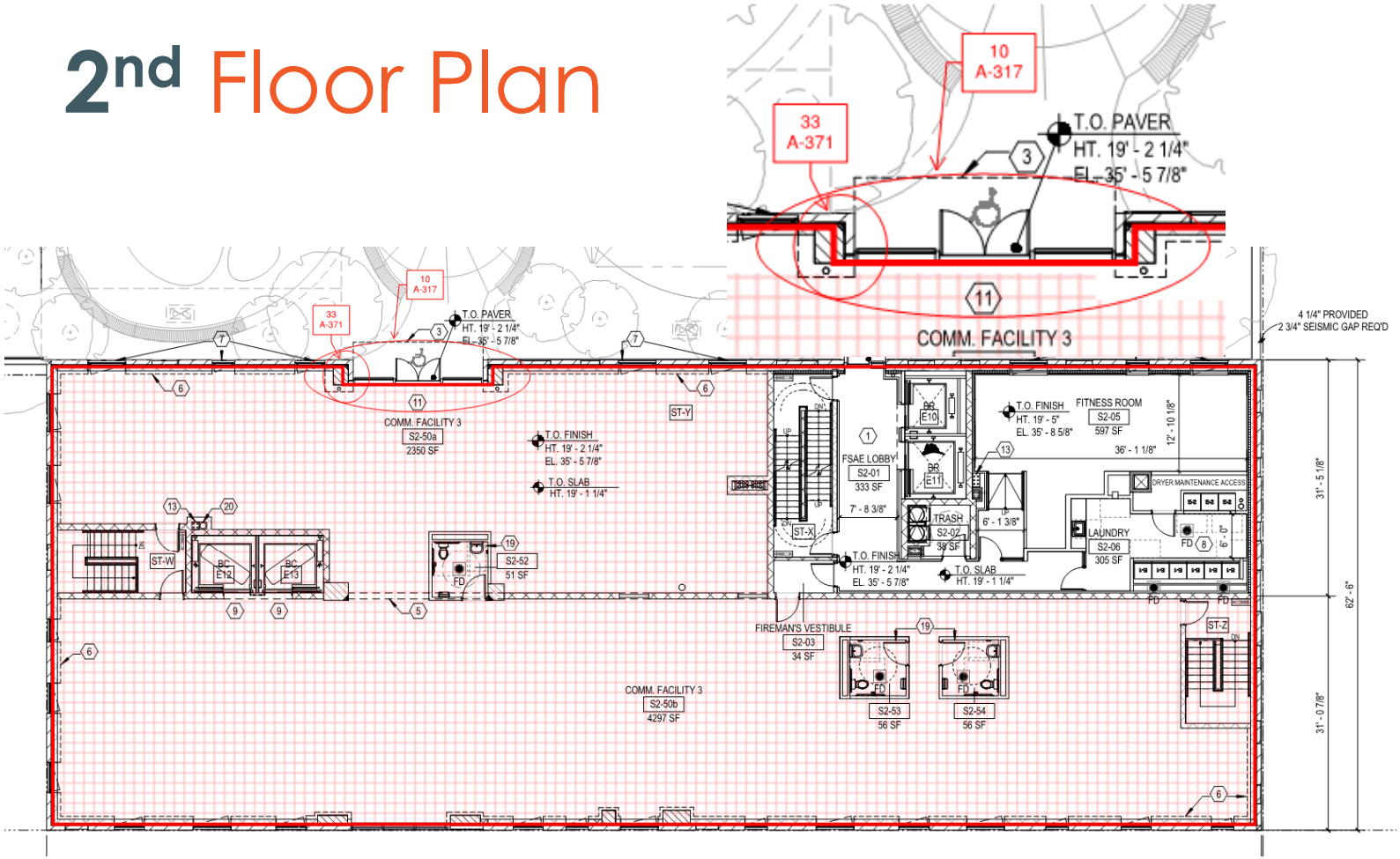
xx

SWA plan review comment

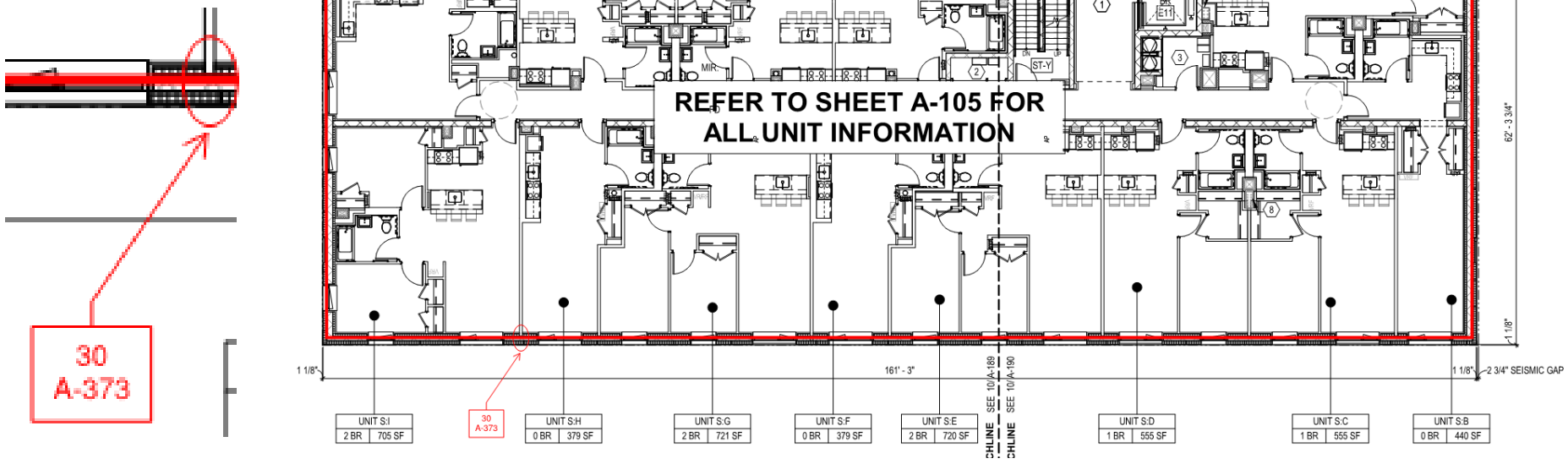
1st Floor Plan (slab-on-grade)



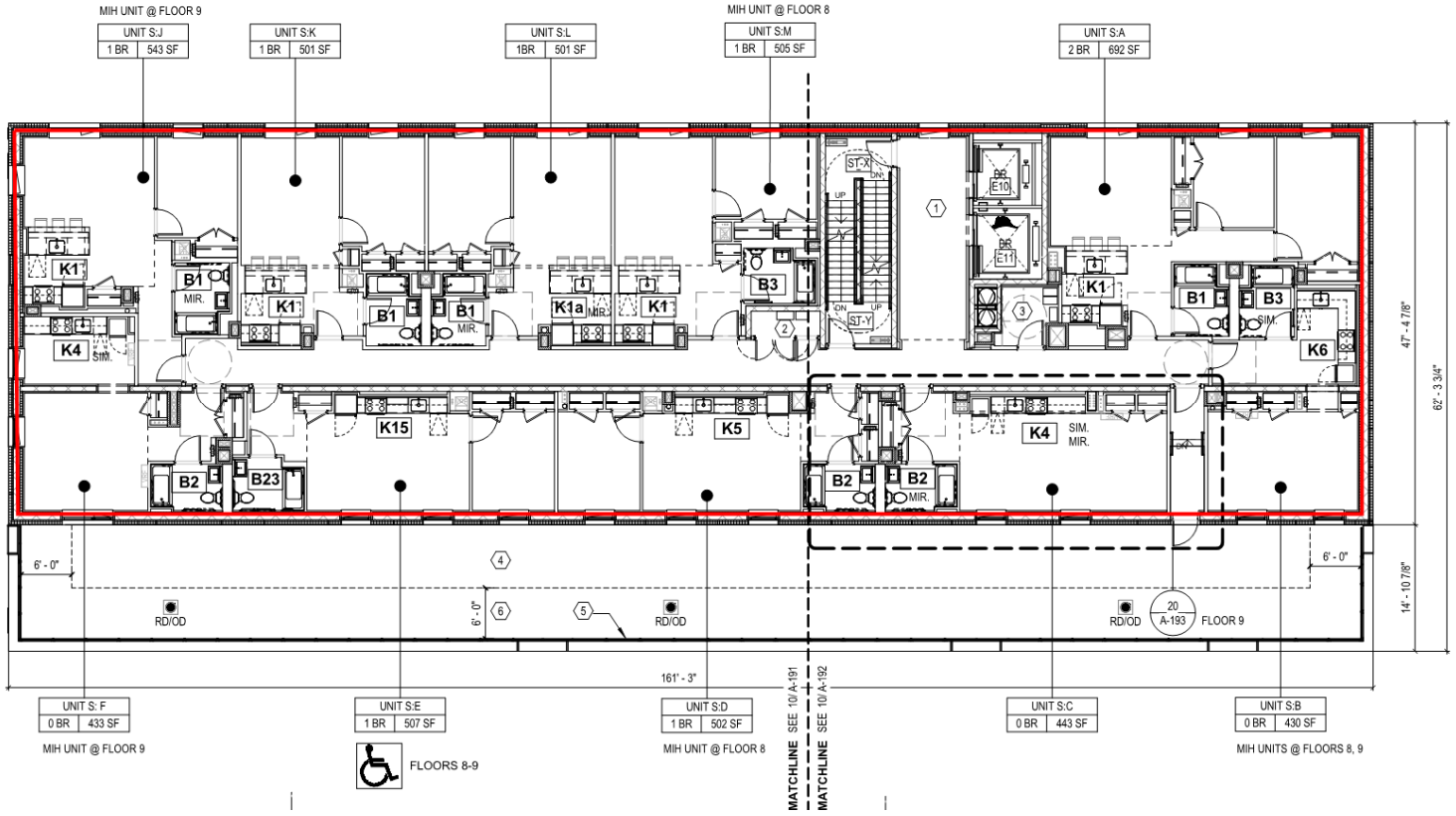
2nd Floor Plan



3rd & 4th Floor Plan

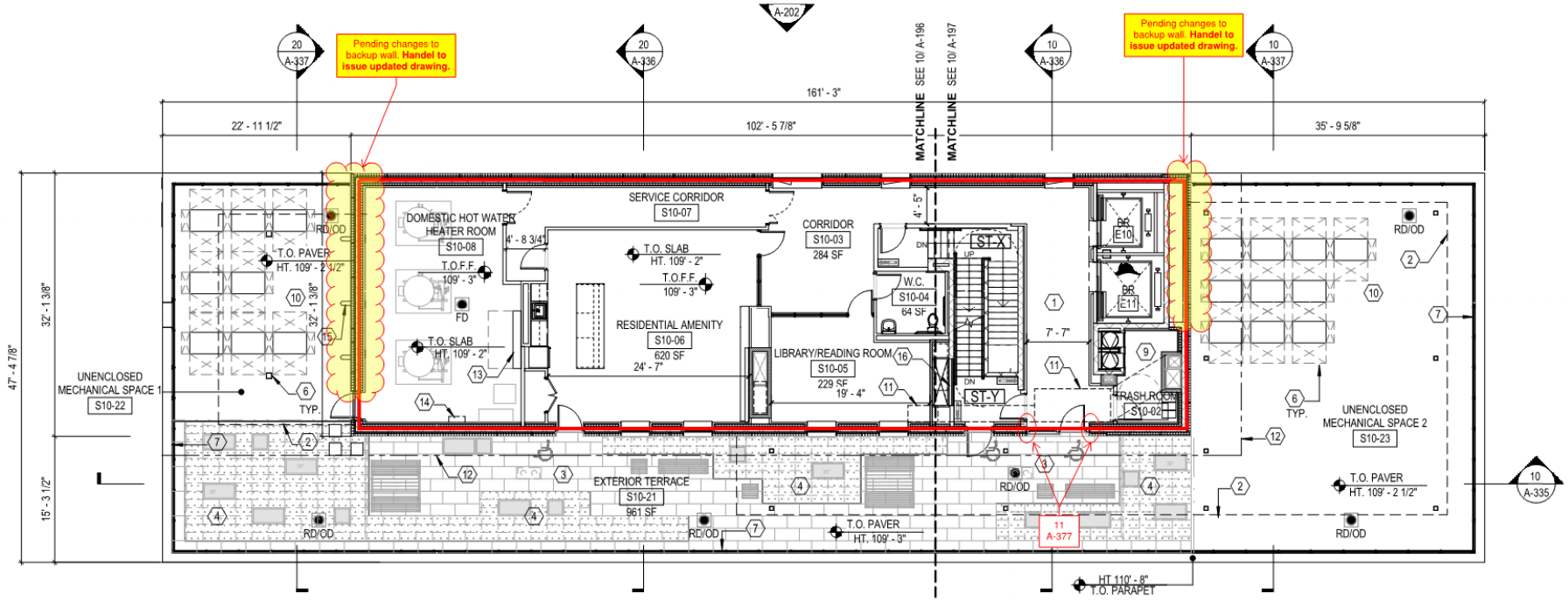


8th & 9th Floor Plan



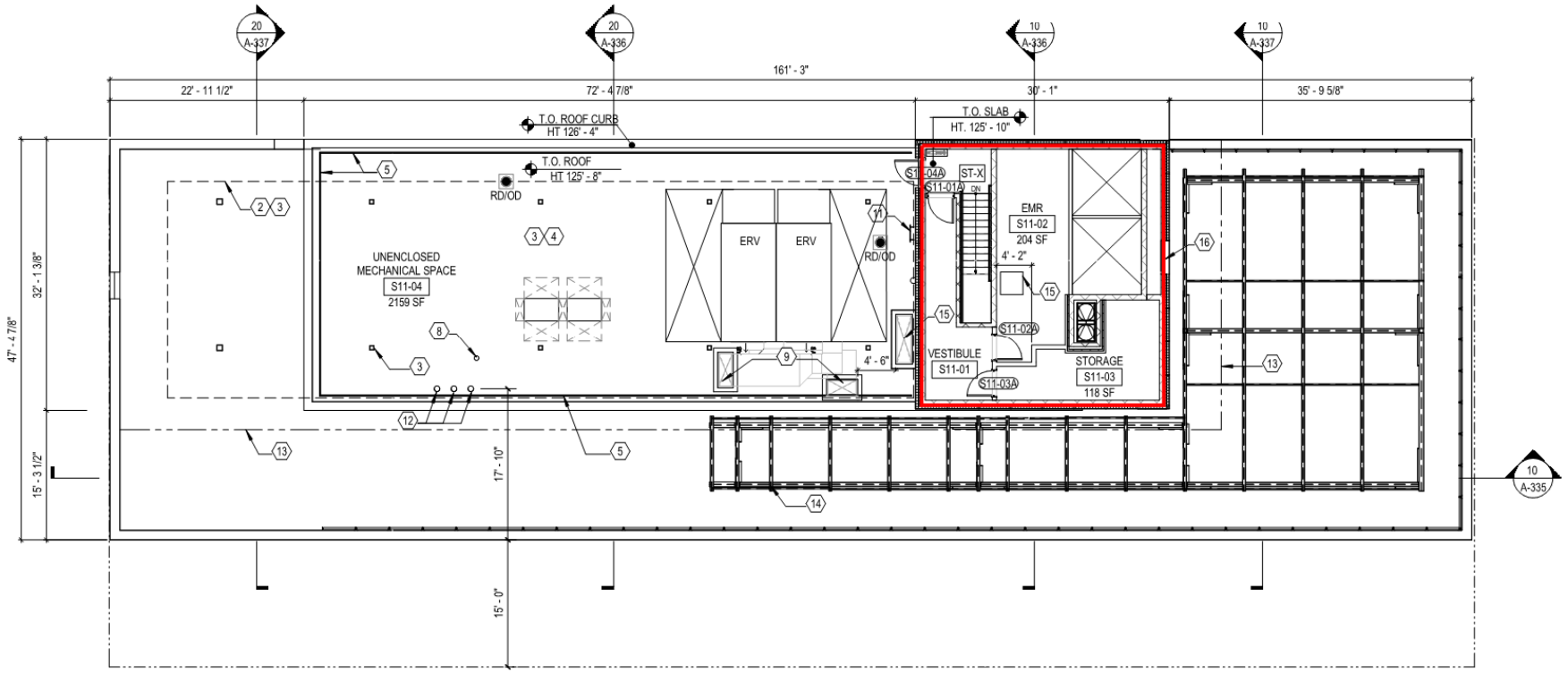
10th Floor Plan

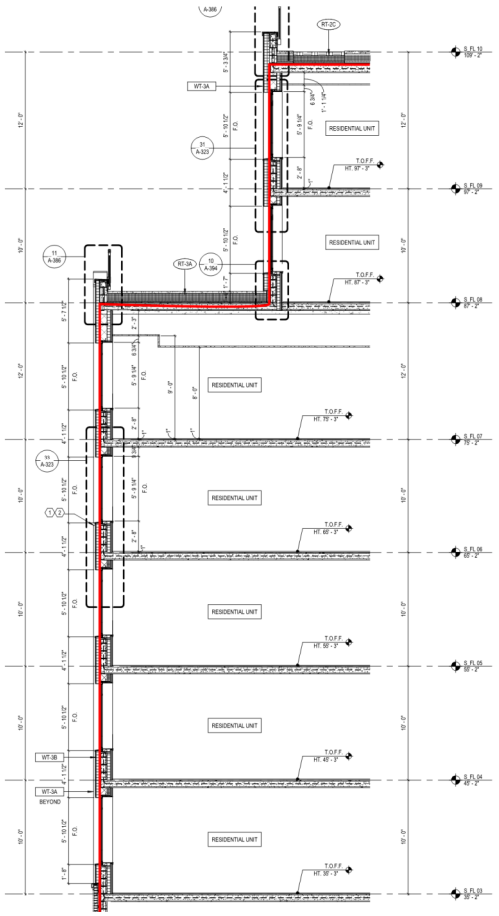
Refer to A-391 and A-392 for roof penetration details.

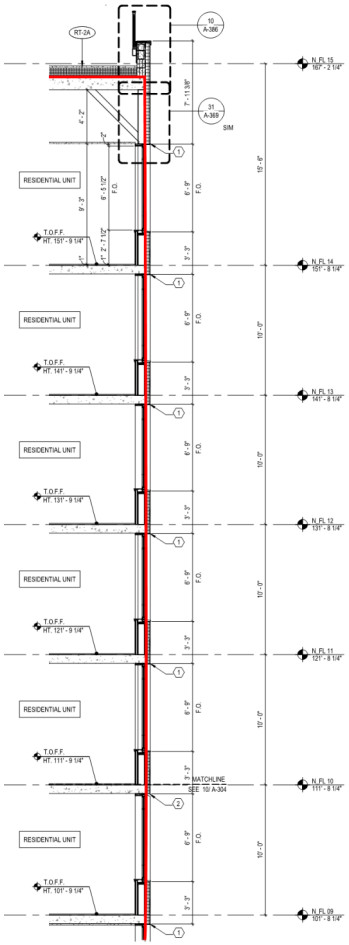


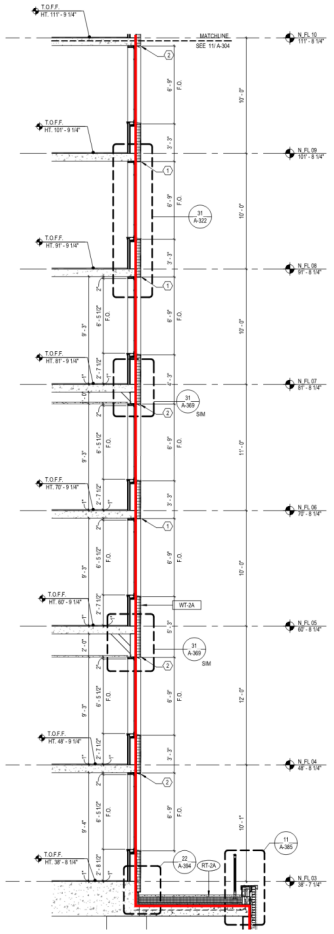
Bulkhead/Roof Plan

Refer to A-391 and A-392 for roof penetration details.



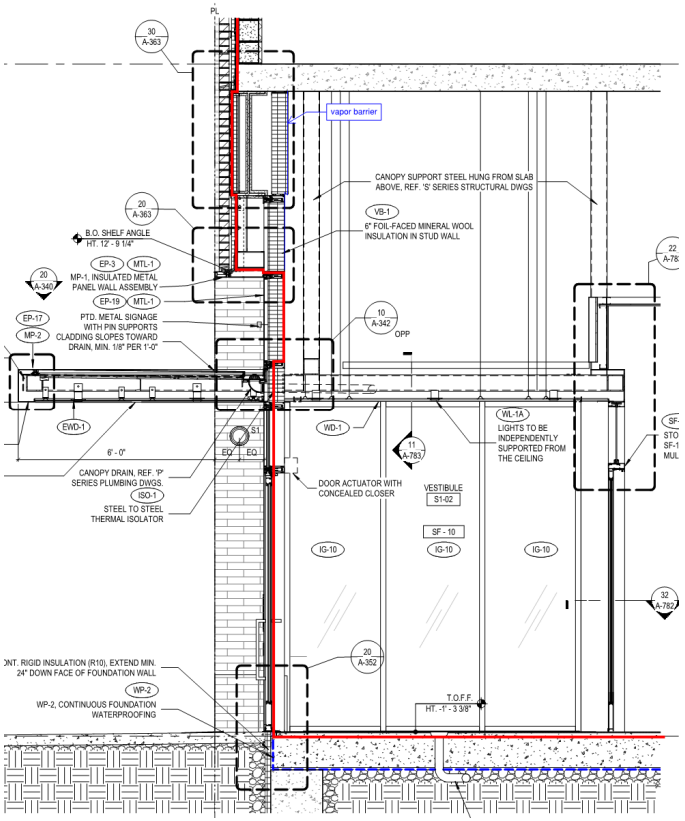


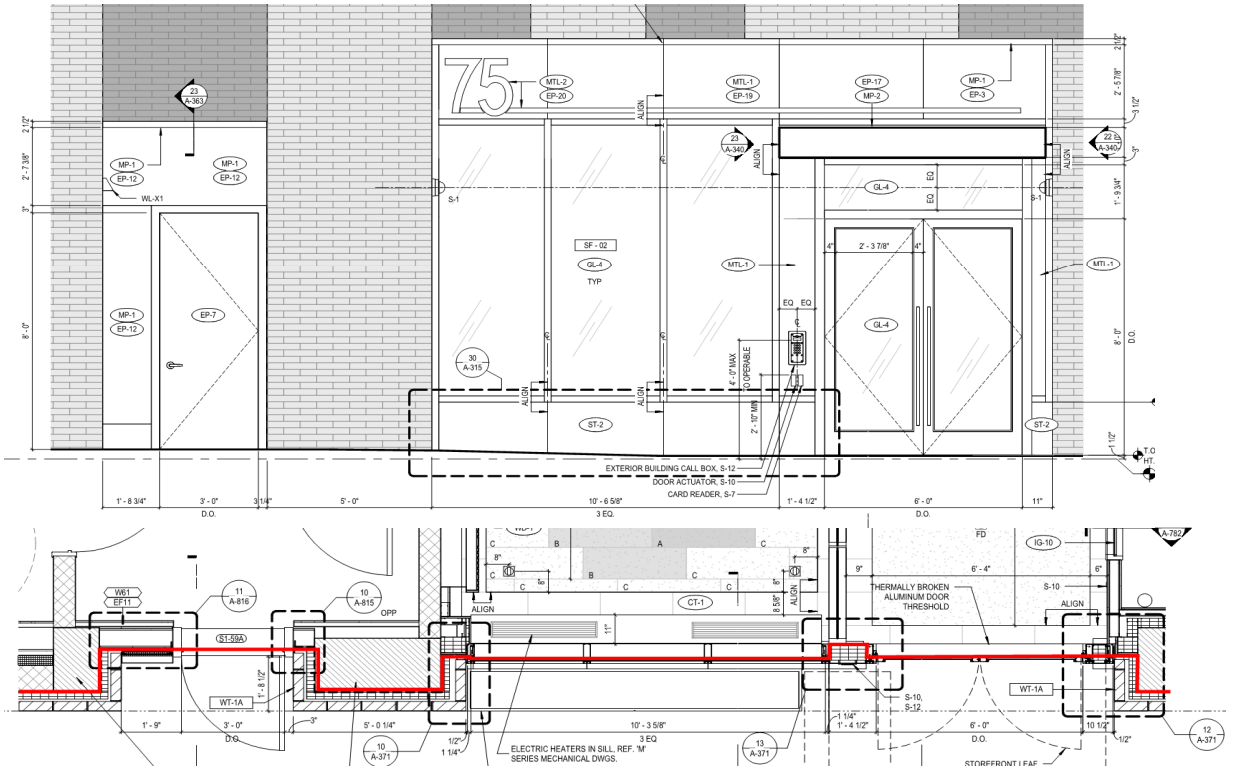


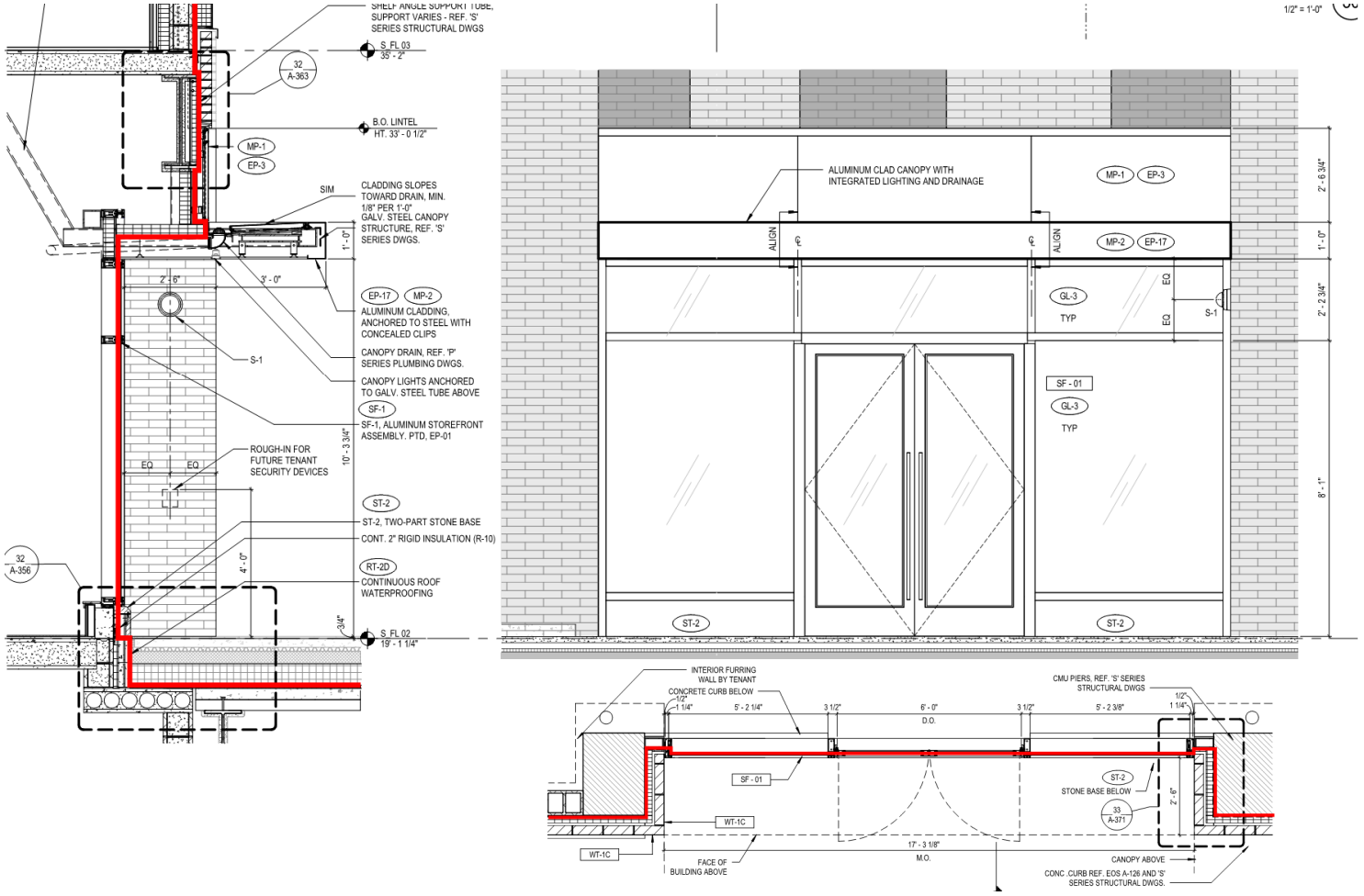


Wall Sections

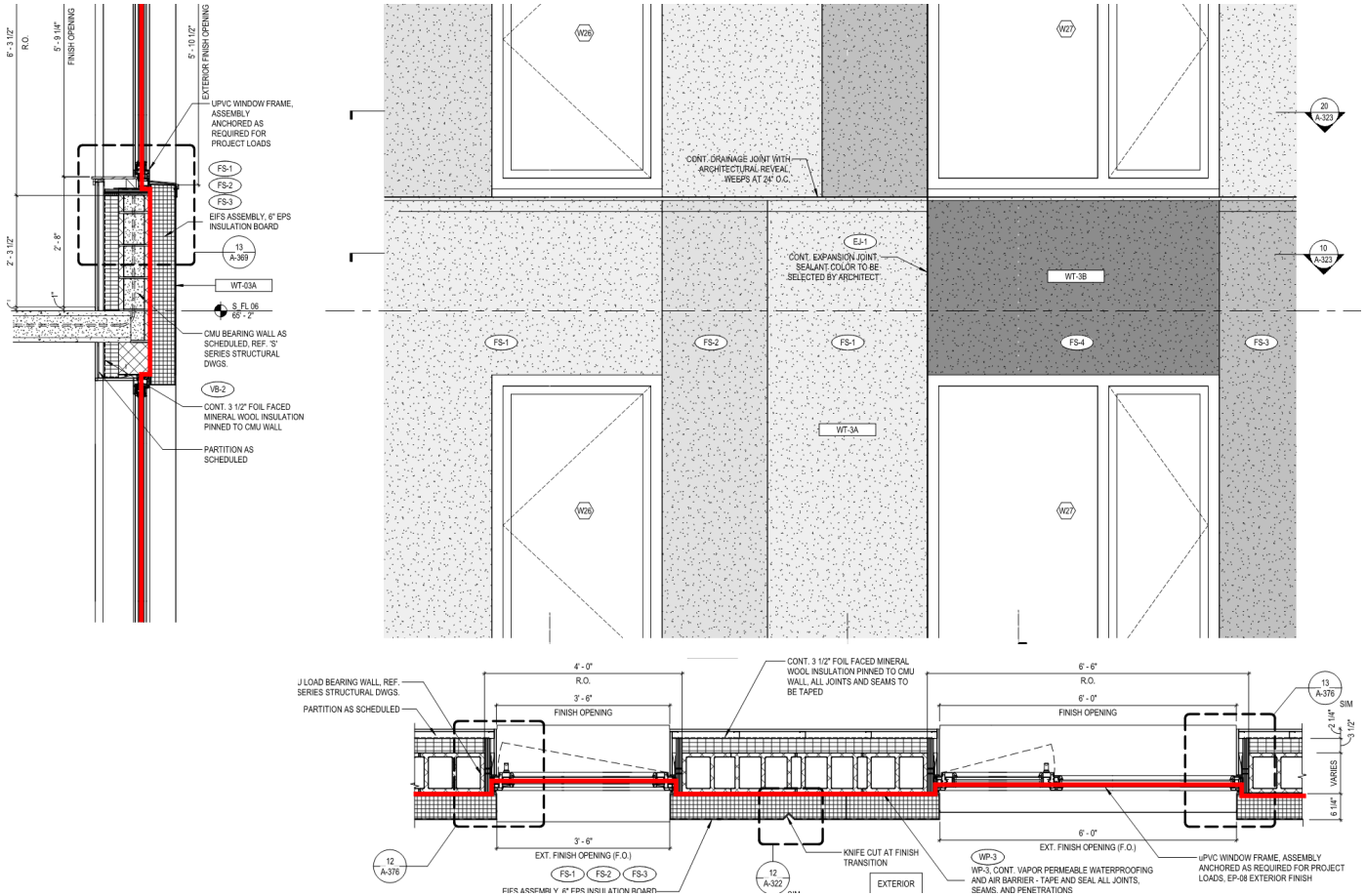
Detail Sections





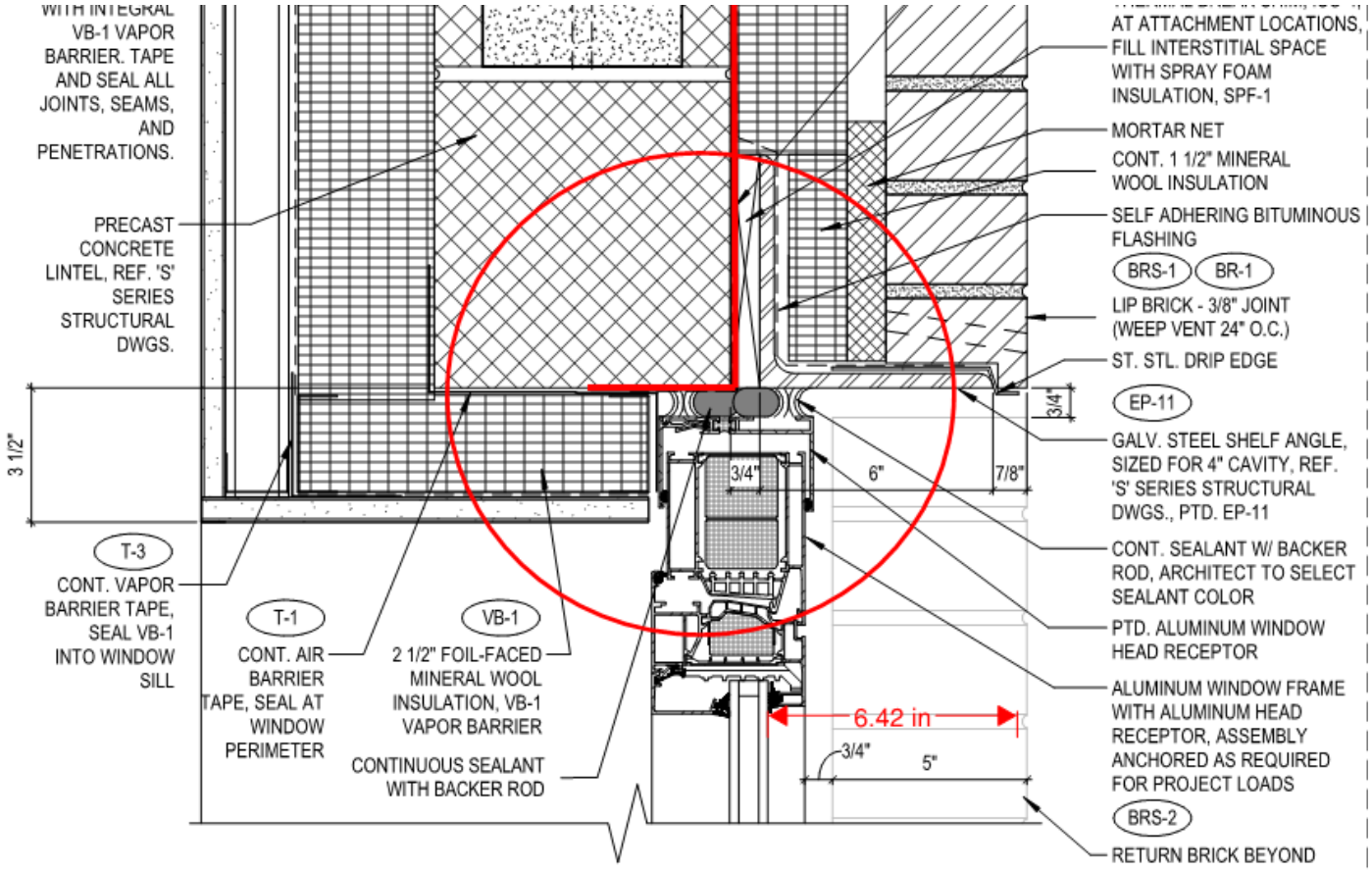


Detail
Sections

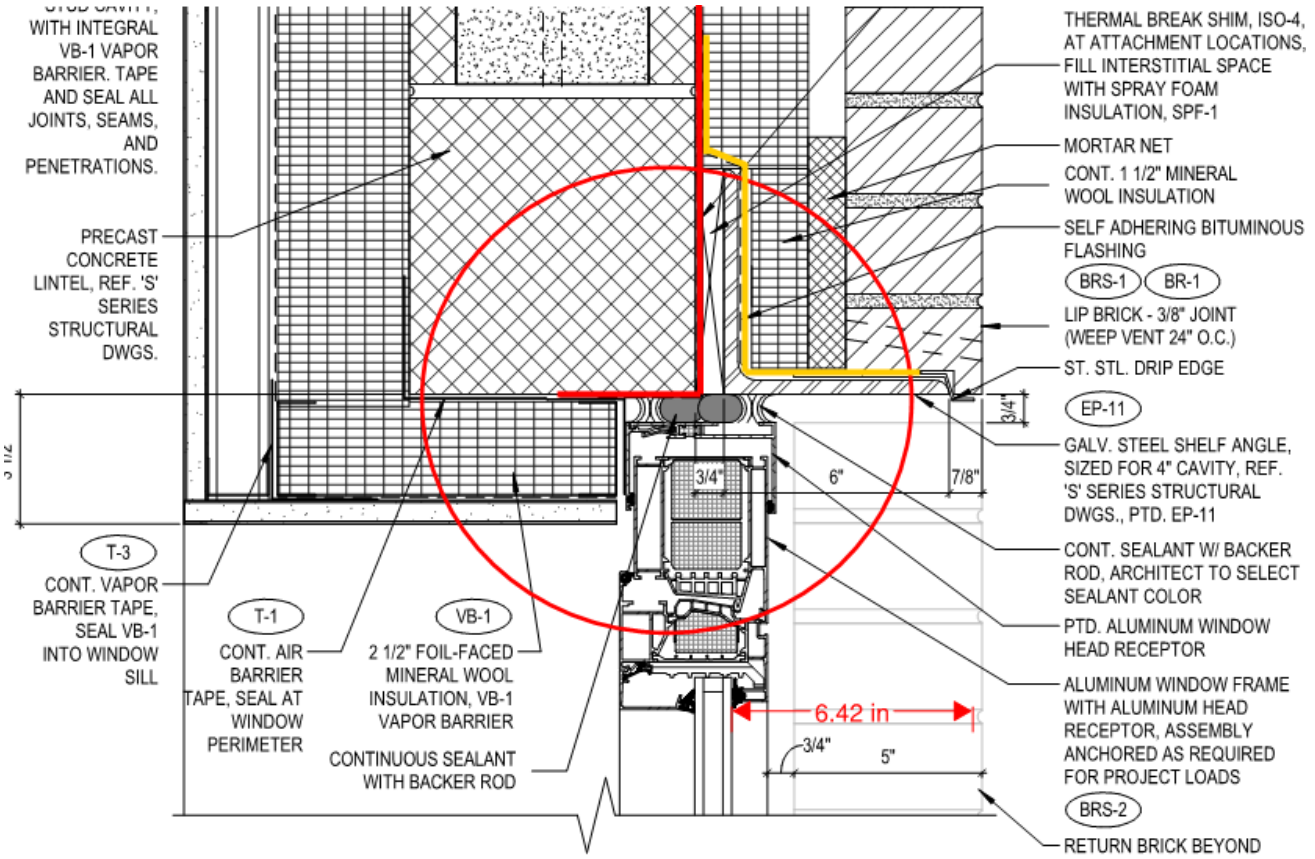


Detail
Sections

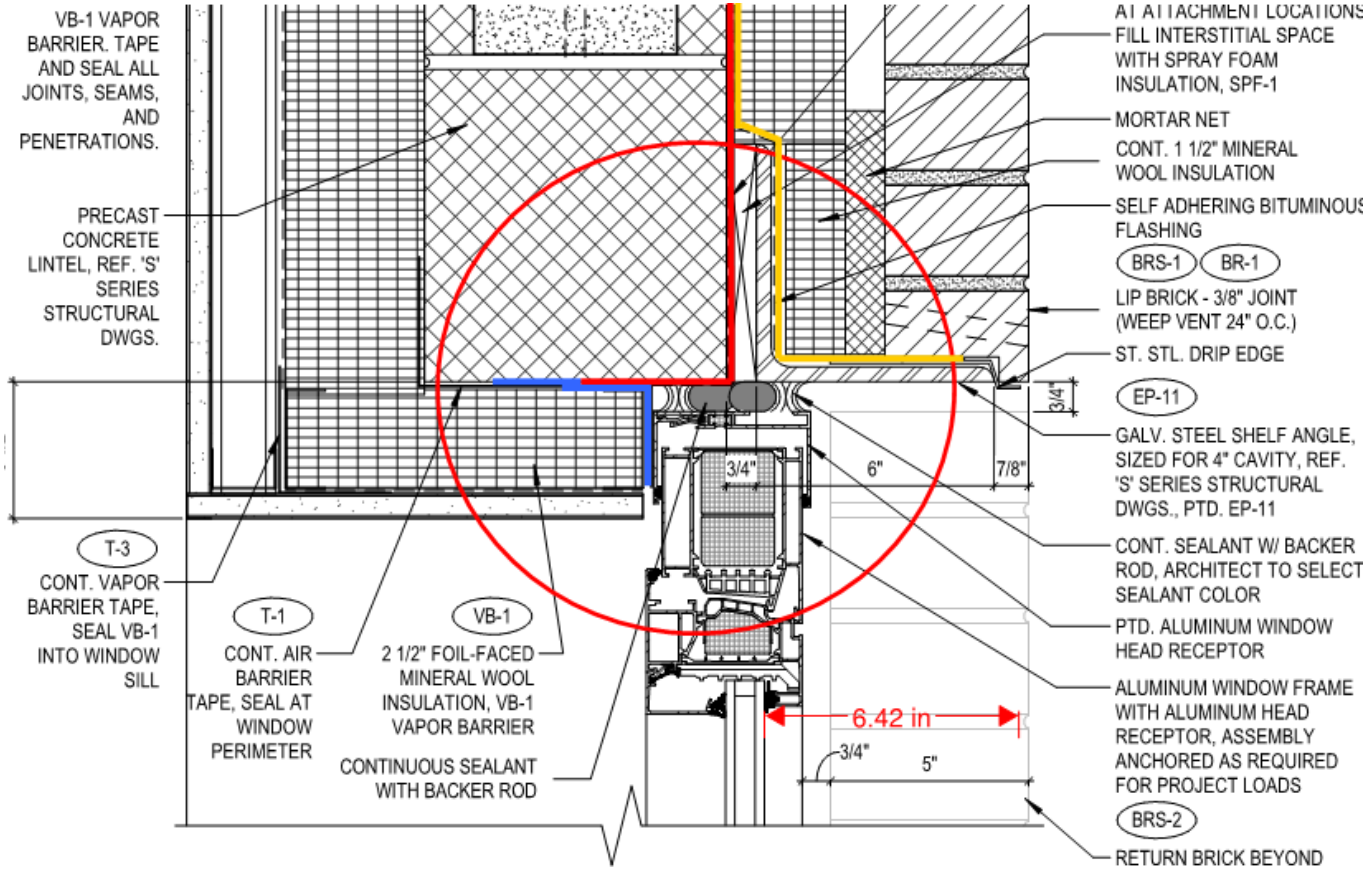
Typical Window Head @ Brick Veneer



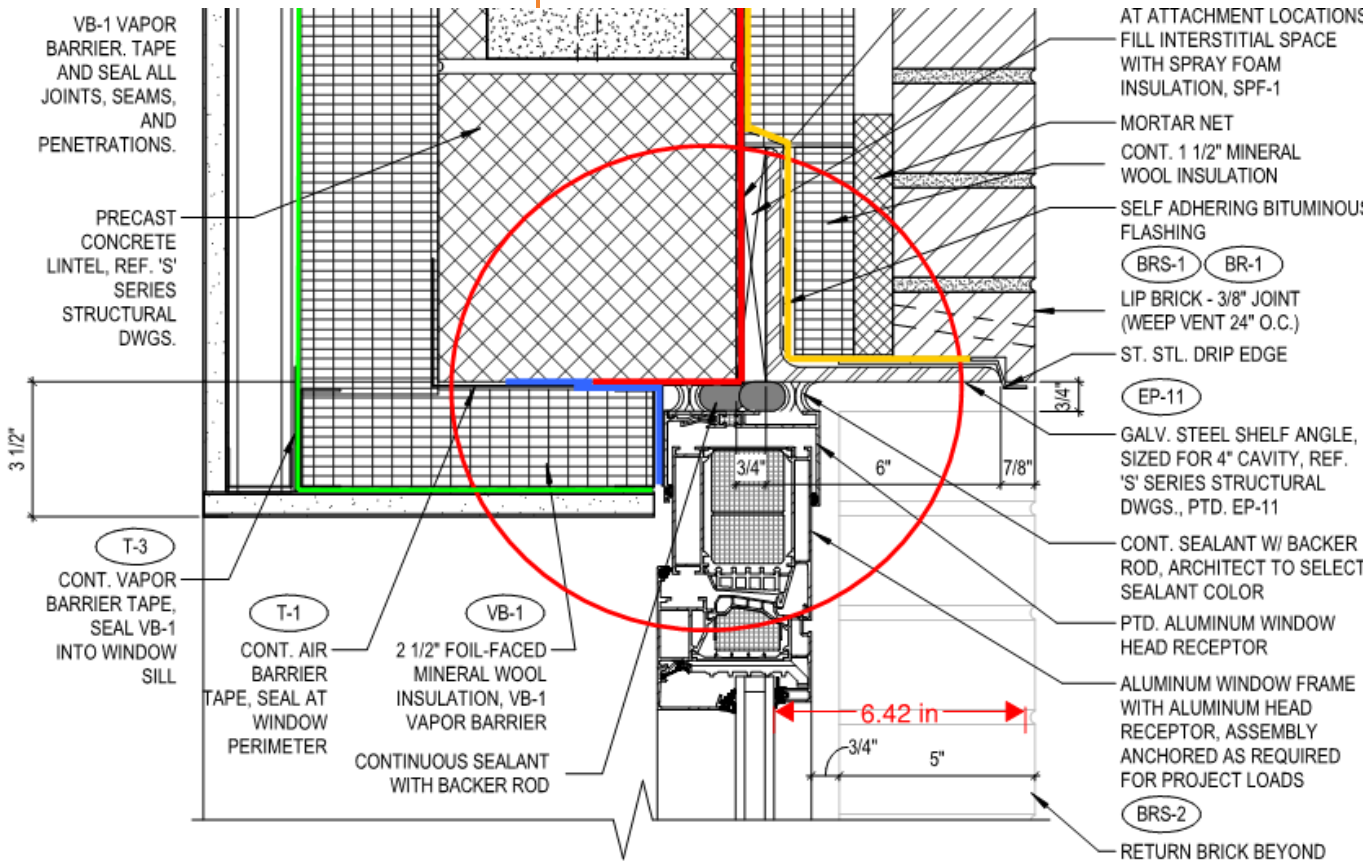
Typical Window Head @ Brick Veneer



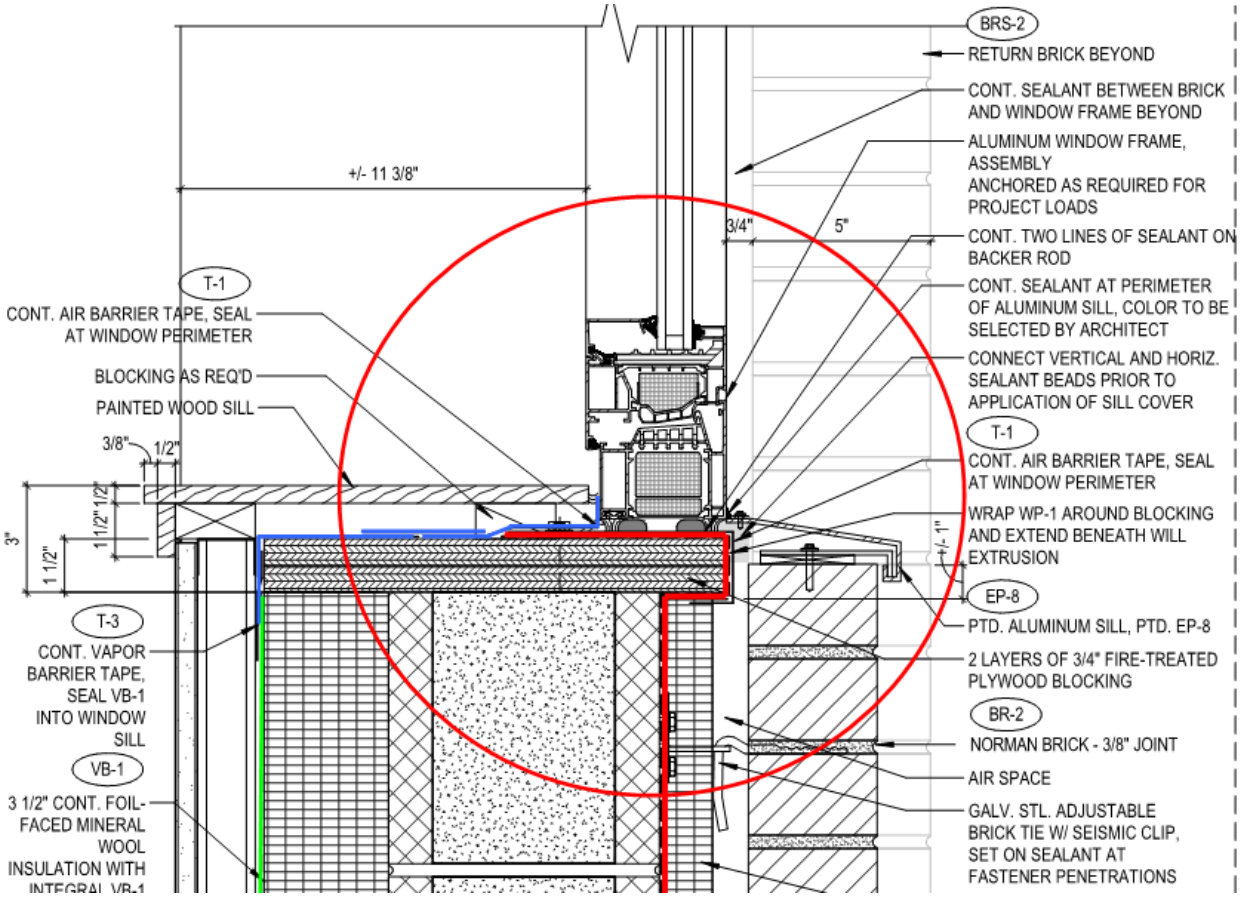
Typical Window Head @ Brick Veneer



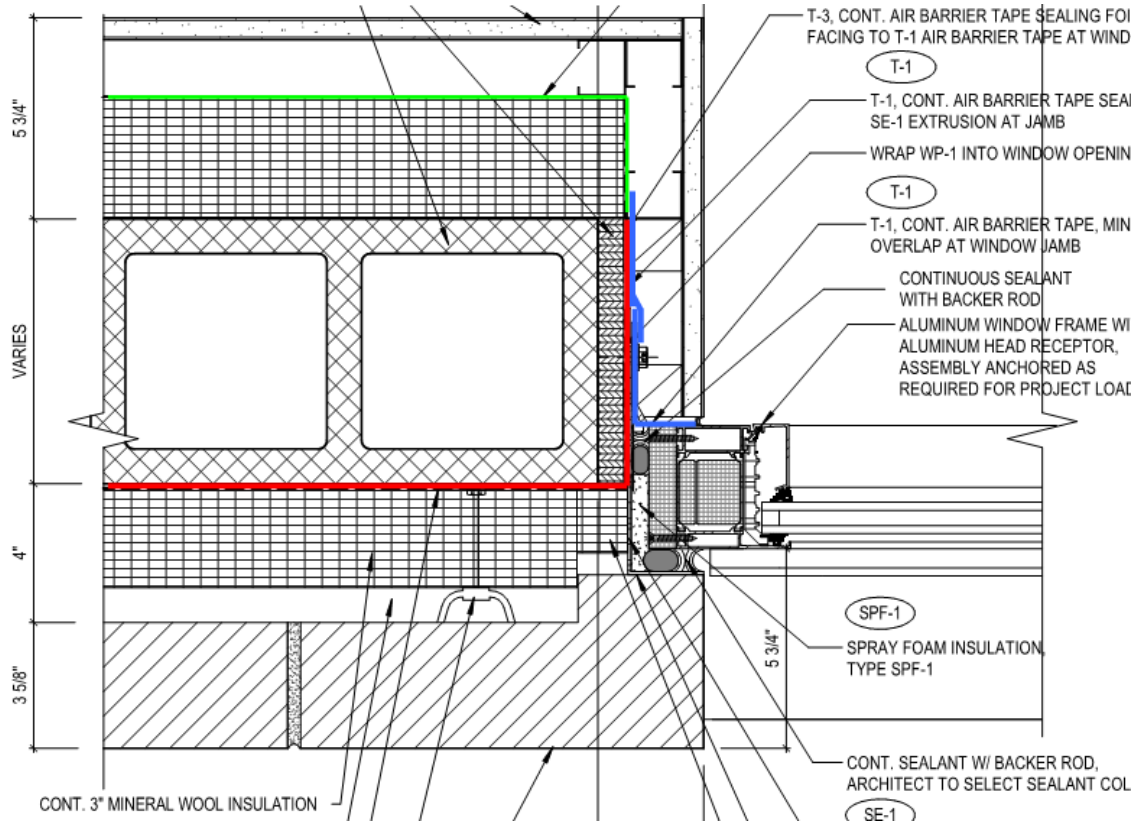
Typical Window Head @ Brick Veneer

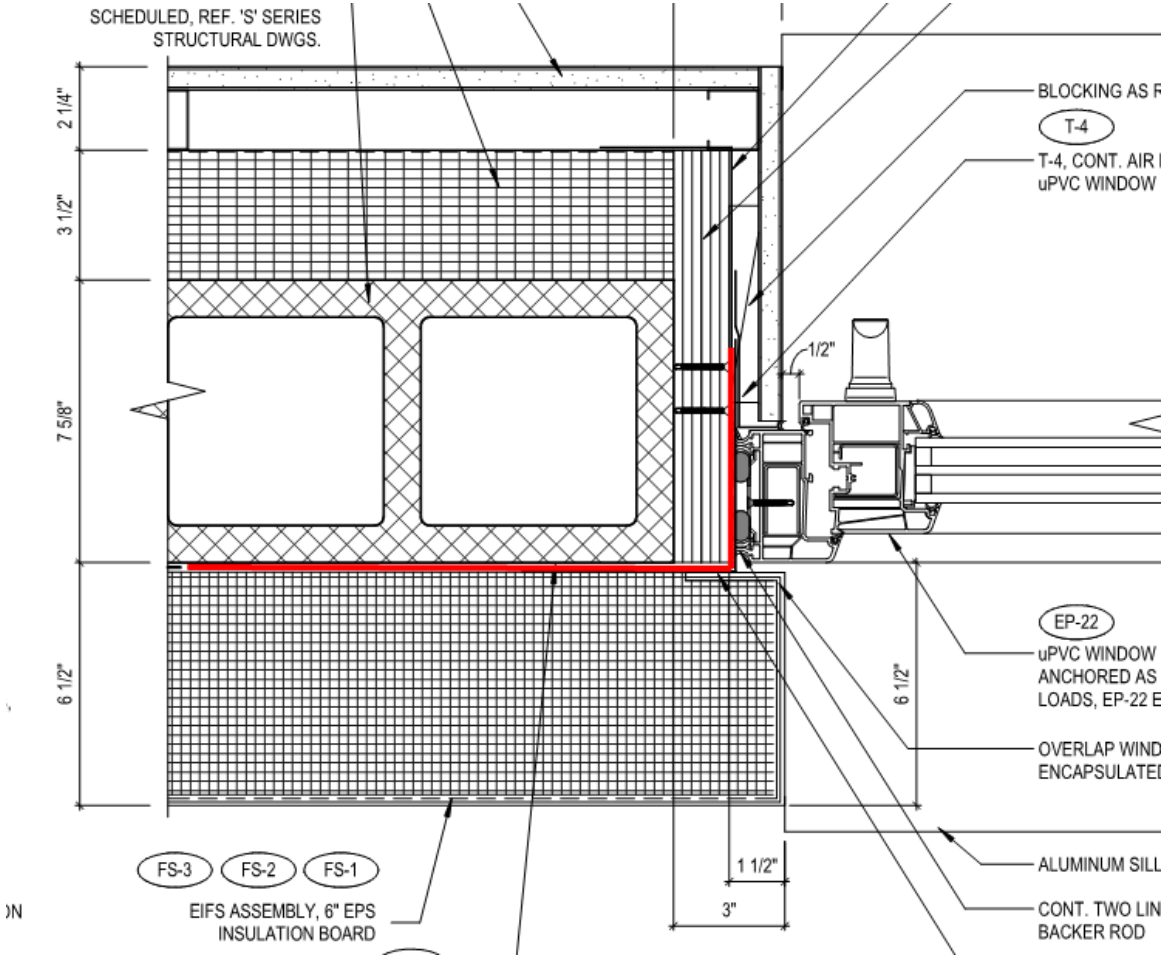


Typical Window Sill @ Brick Veneer

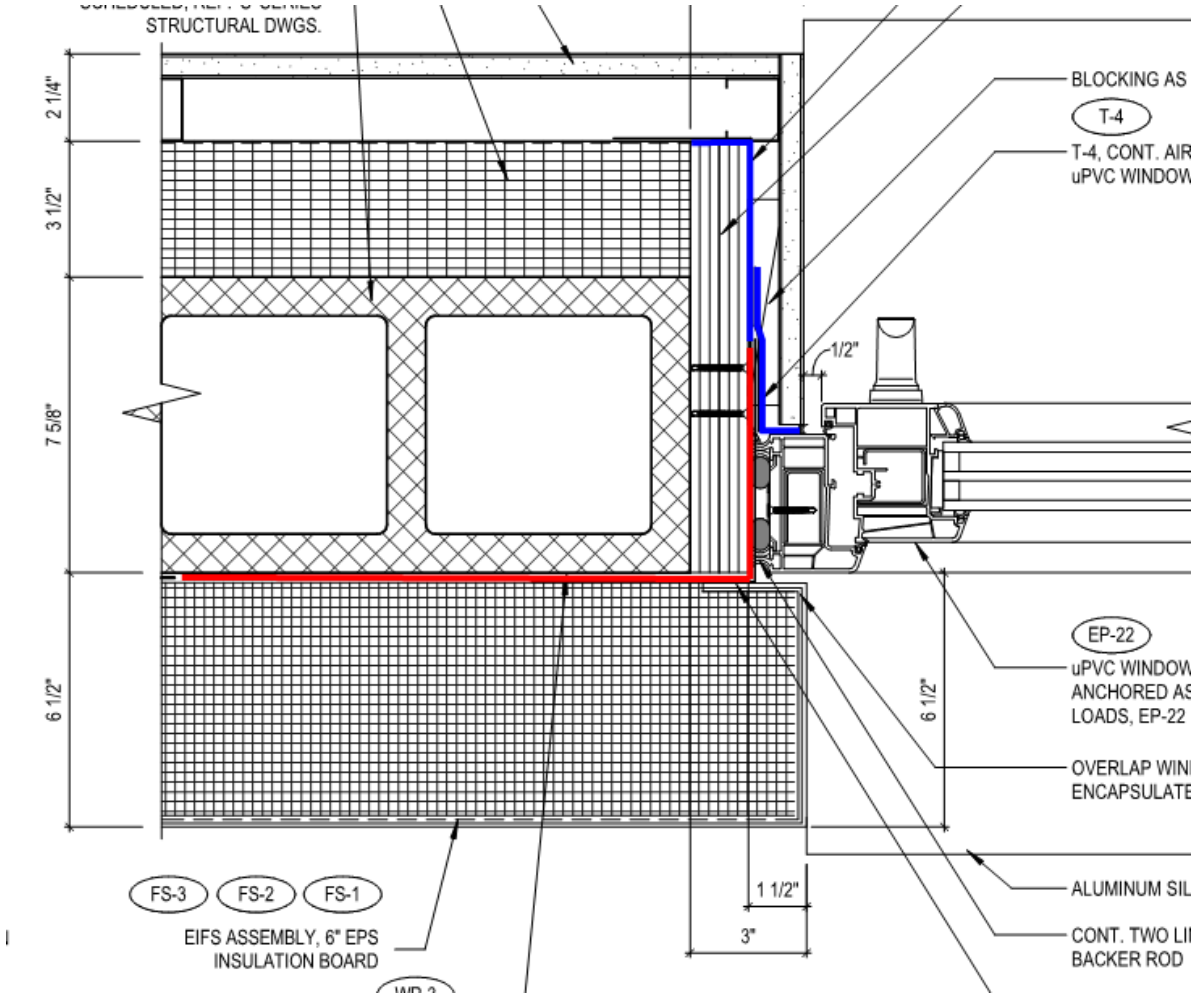


Typical Window Jamb @ Brick Veneer

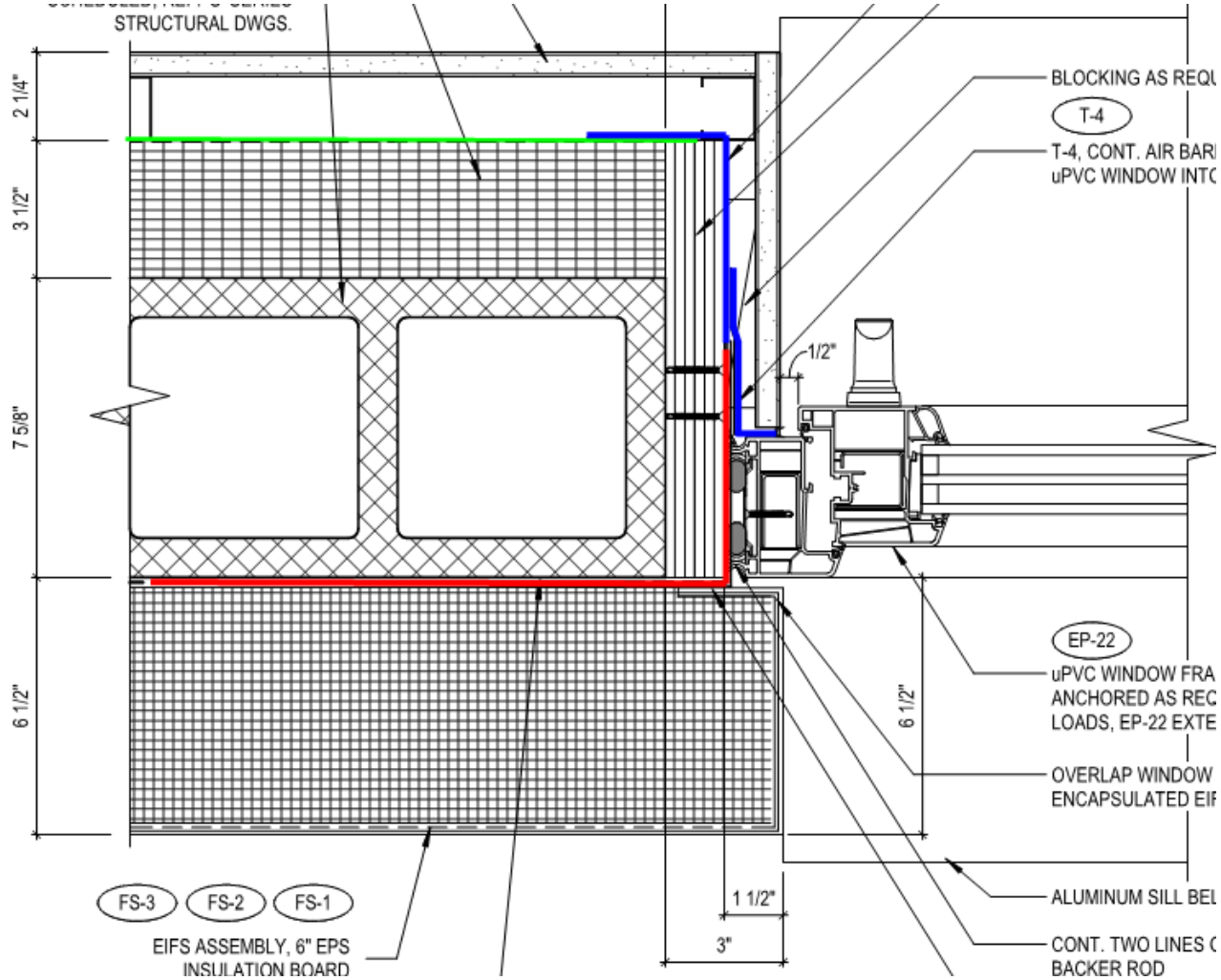




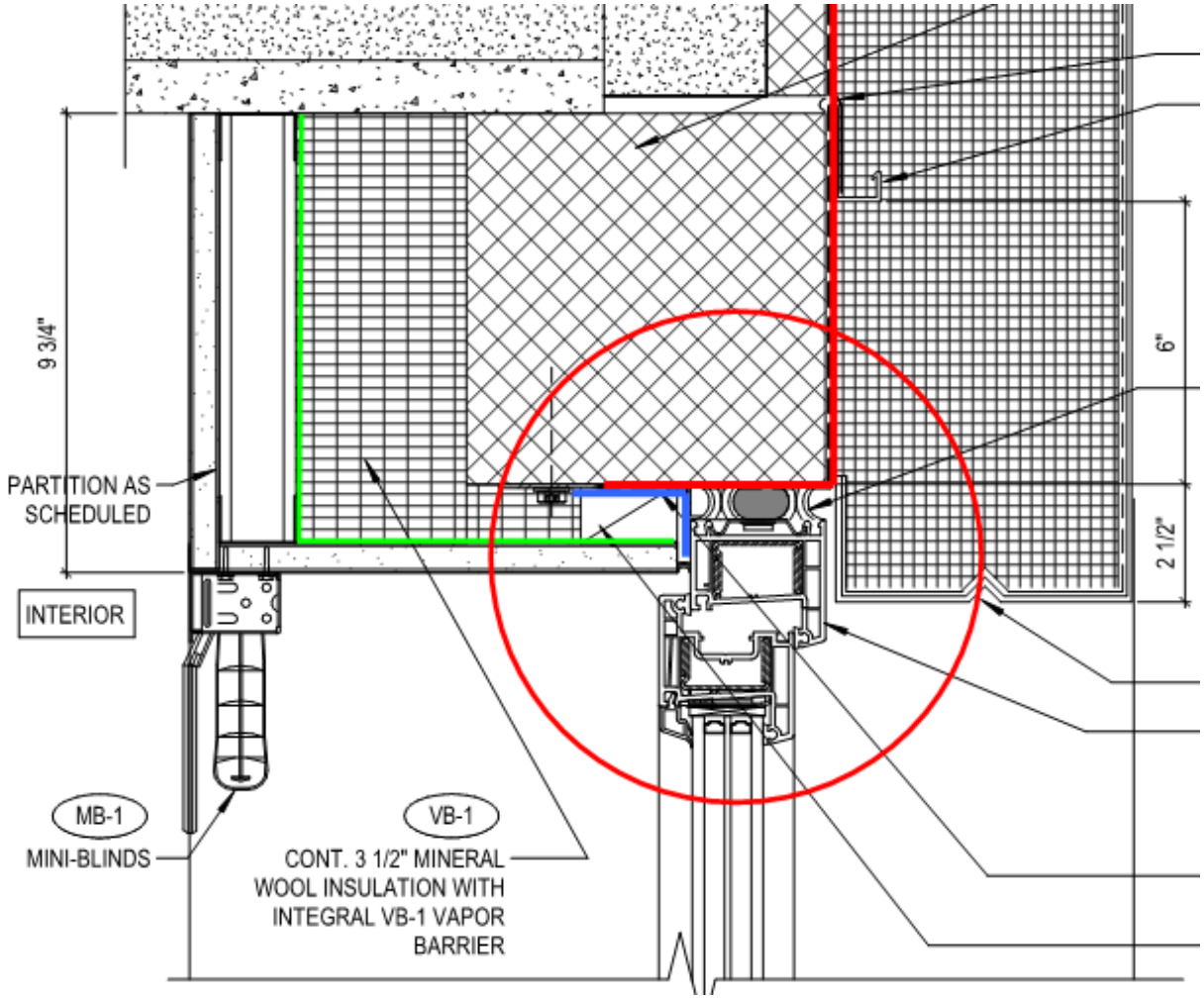
Typical Window Jamb @ EIFS



Typical Window Jamb @ EIFS

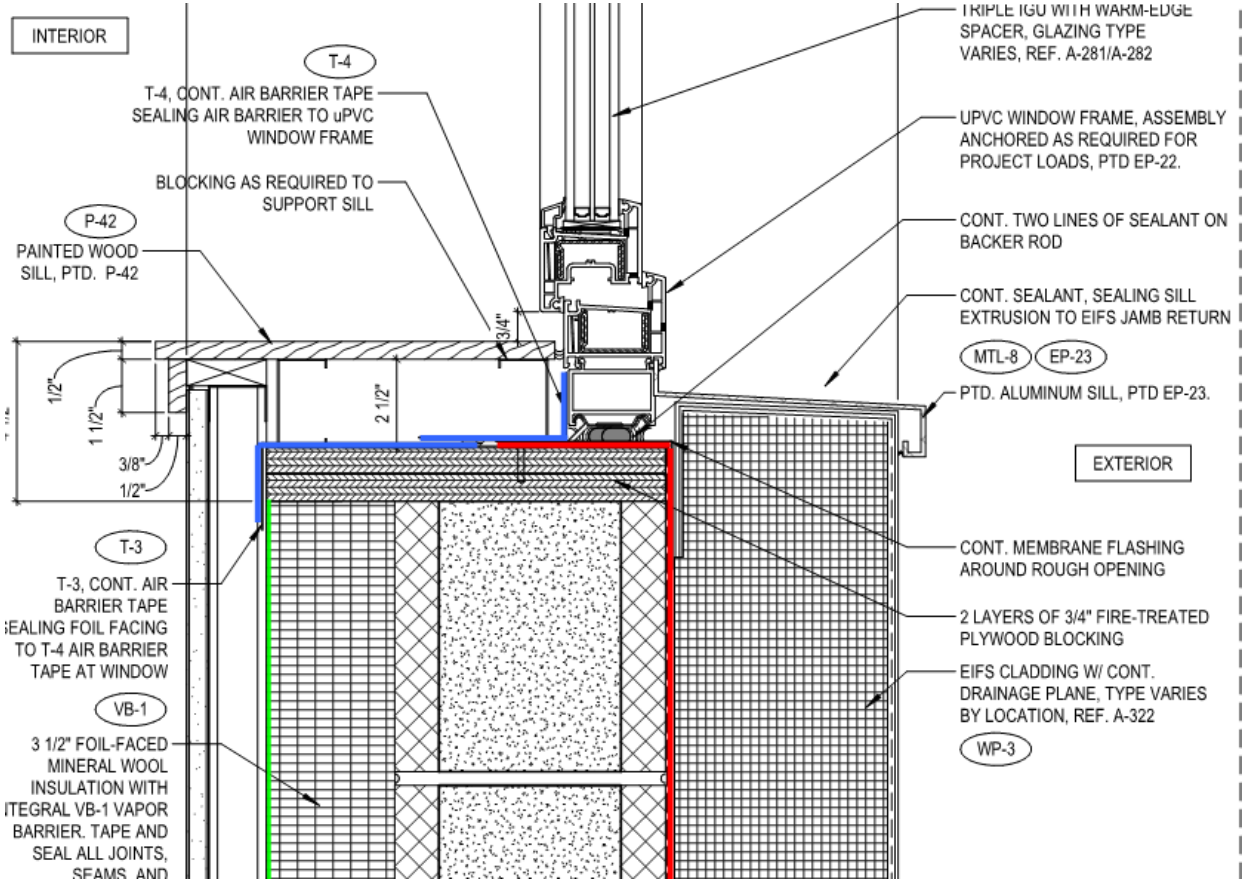


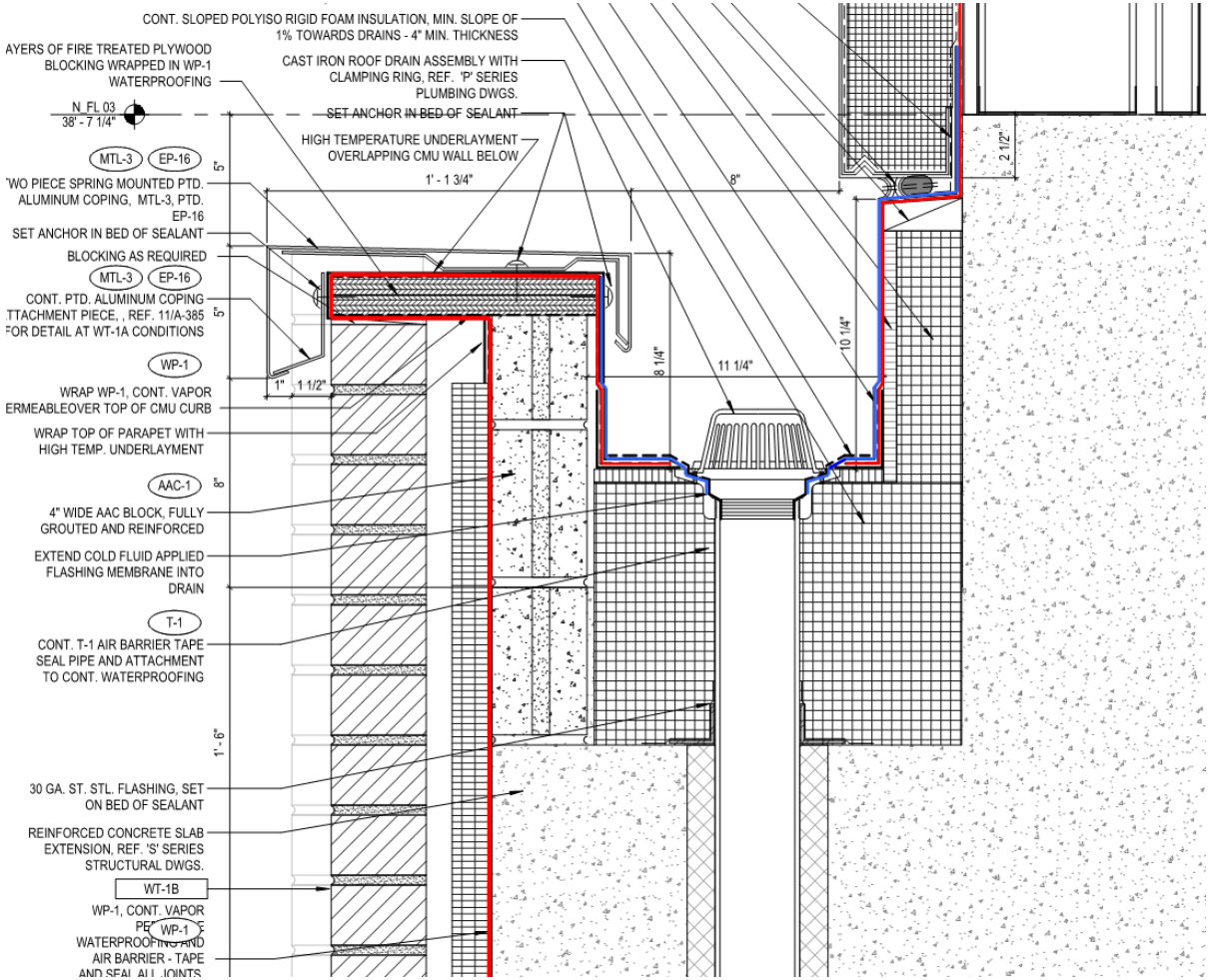
Typical Window Jamb @ EIFS



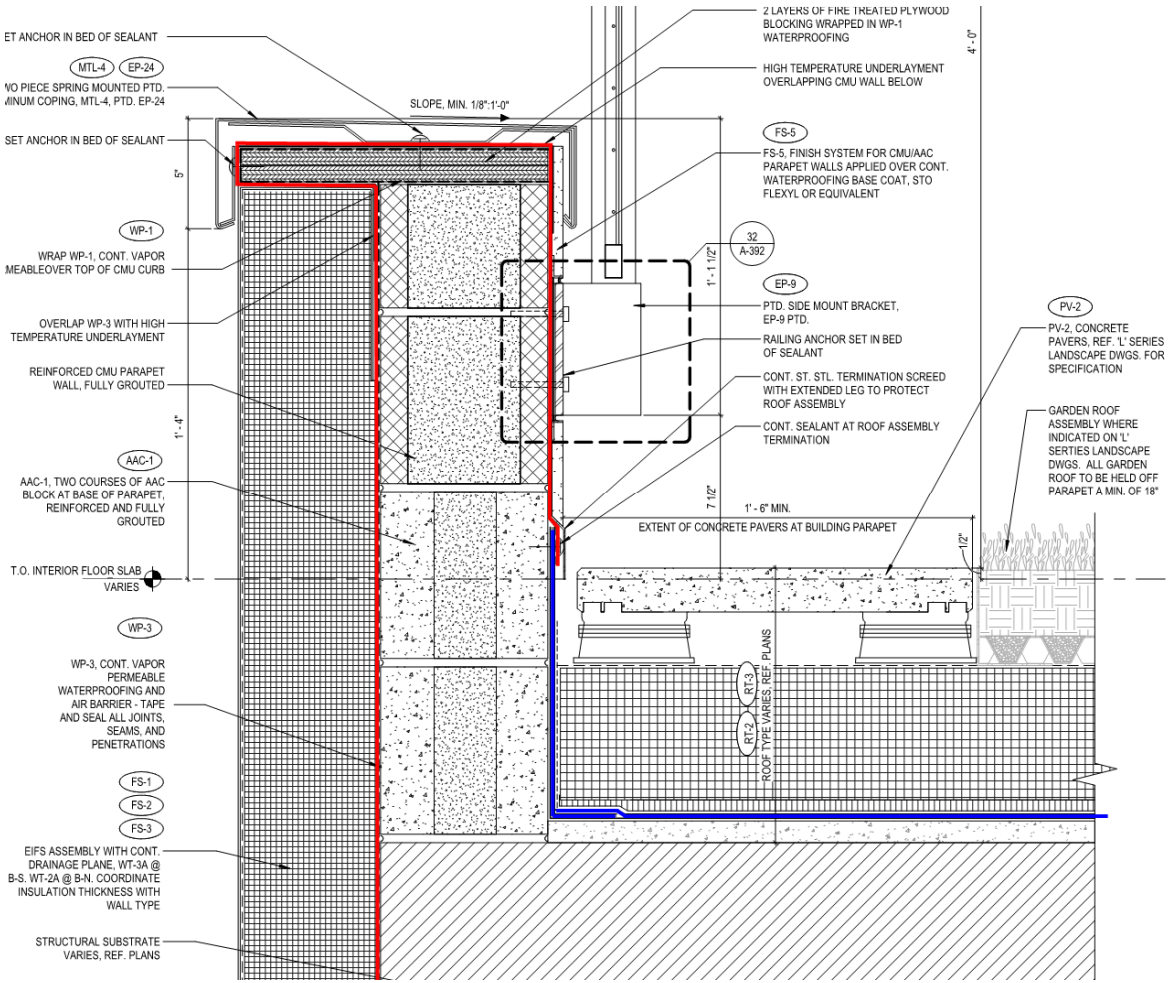
Typical Window Head @ EIFS

Typical Window Sill @ EIFS





Parapet / Roof Details



Parapet / Roof Details

Name required attributes for high performance wall assemblies.

Questions?

Air Barrier Approaches

TEAM

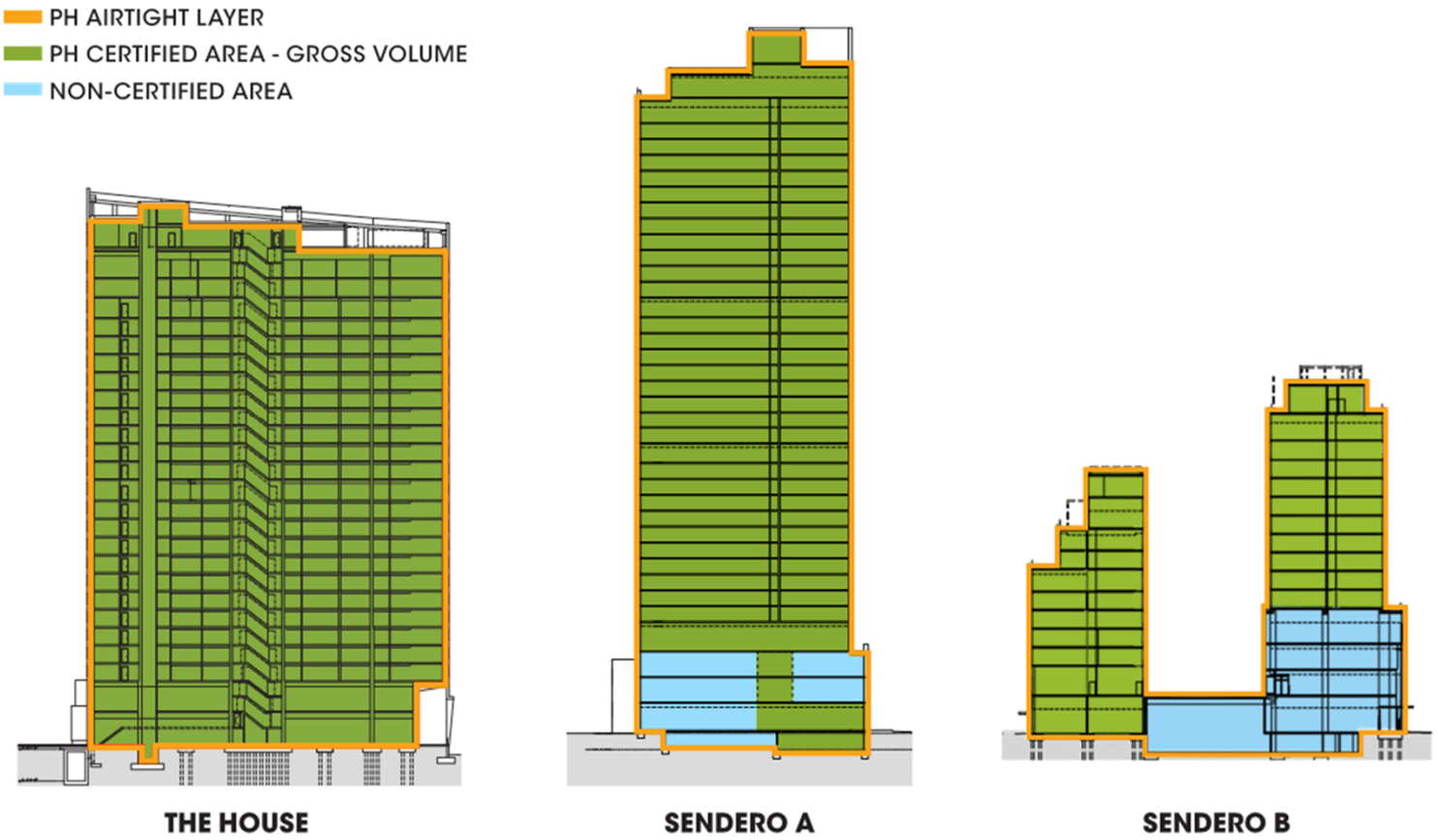
Cornell University | Hudson Companies | Related Companies
Handel Architects | Steven Winter Associates | Buro Happold
Vidaris | Monadnock Construction

TEAM

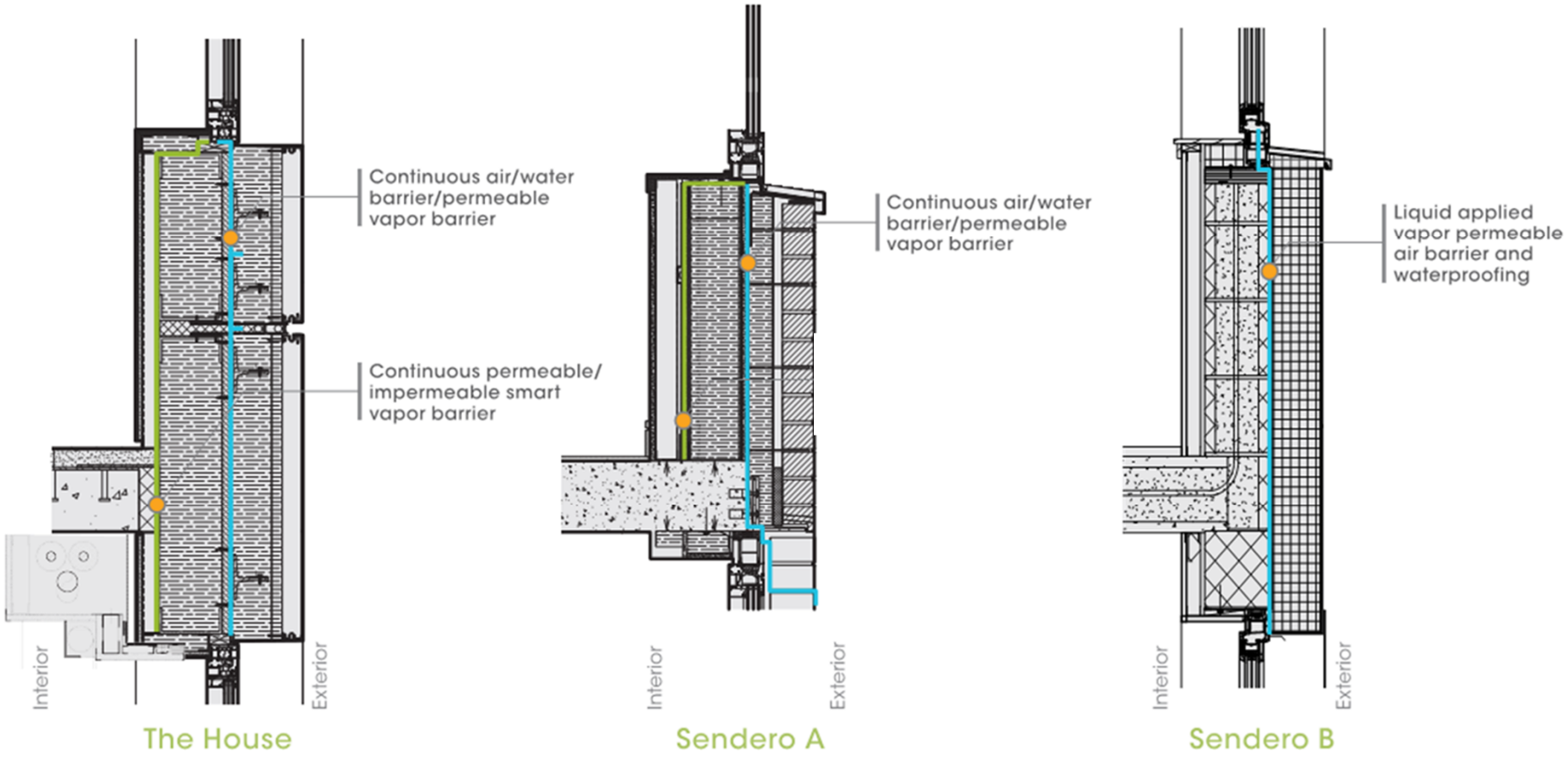
Jonathan Rose Companies | L+M Development Partners | Acacia Network | Handel Architects | Steven Winter Associates
Cosentini | DeSimone Consulting Engineers | Vidaris

Comparing Three Different Projects

Exterior Wall Comparison: Air-Tightness



Exterior Wall Comparison: Air Tightness



PROJECT SUMMARY

- 26 stories
- 352 units
- Lobby, fitness room, laundry, lounge, party room
- Split system VRF for heating and cooling
- Centralized ventilation using 2 Rooftop ERV's
- Gas fired boilers for domestic hot water
- 272,500 GSF, 198,338 SF TFA - the largest residential Passive House building
- 270' to roof, 285' to top of wrap

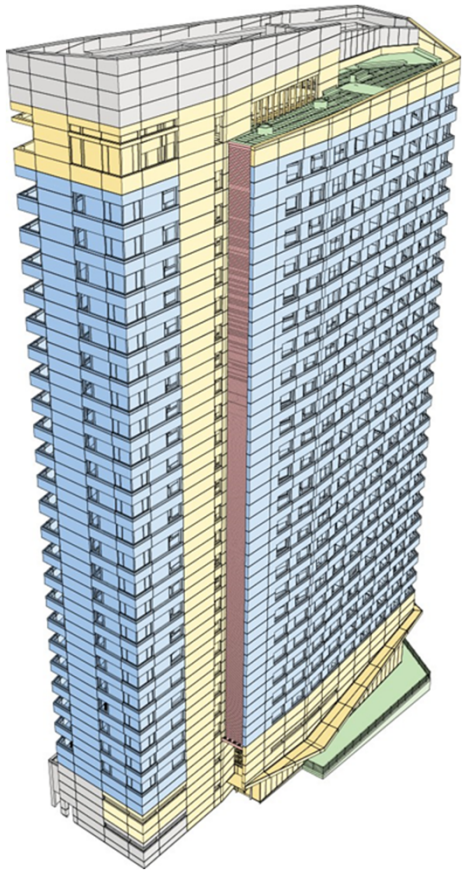
USERS

Graduate Students

PhD Candidates

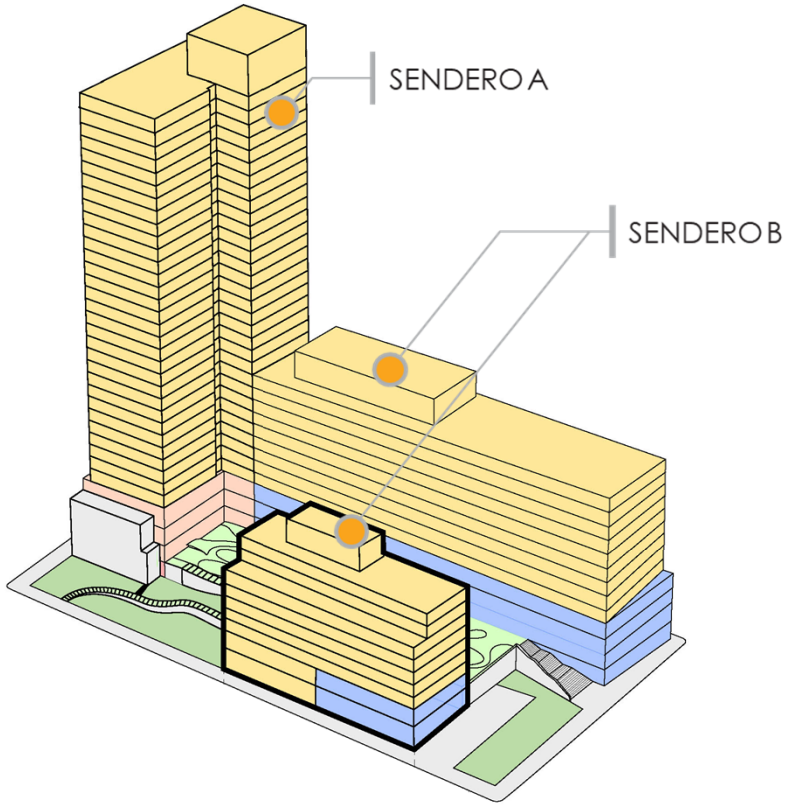
Post Doctoral

Faculty



The House
Project Summary

Sendero Project Summary



PROJECT SUMMARY

- A: 37 stories, B: 15/9 stories
- 698 units total
- Residential amenities: lounges, fitness rooms, study rooms, roof decks
- Split system VRF for heating and cooling
- Centralized ventilation with Rooftop ERV's
- Gas Fired boilers for domestic hot water
- 650,000 GFA Residential, 249,332 SF TFA (Bldg A), 152,333 SF TFA (Bldg B North), 55,076 SF TFA (Bldg B South)
- 150,000 GFA Community Facility Spaces: High School and Supportive Services

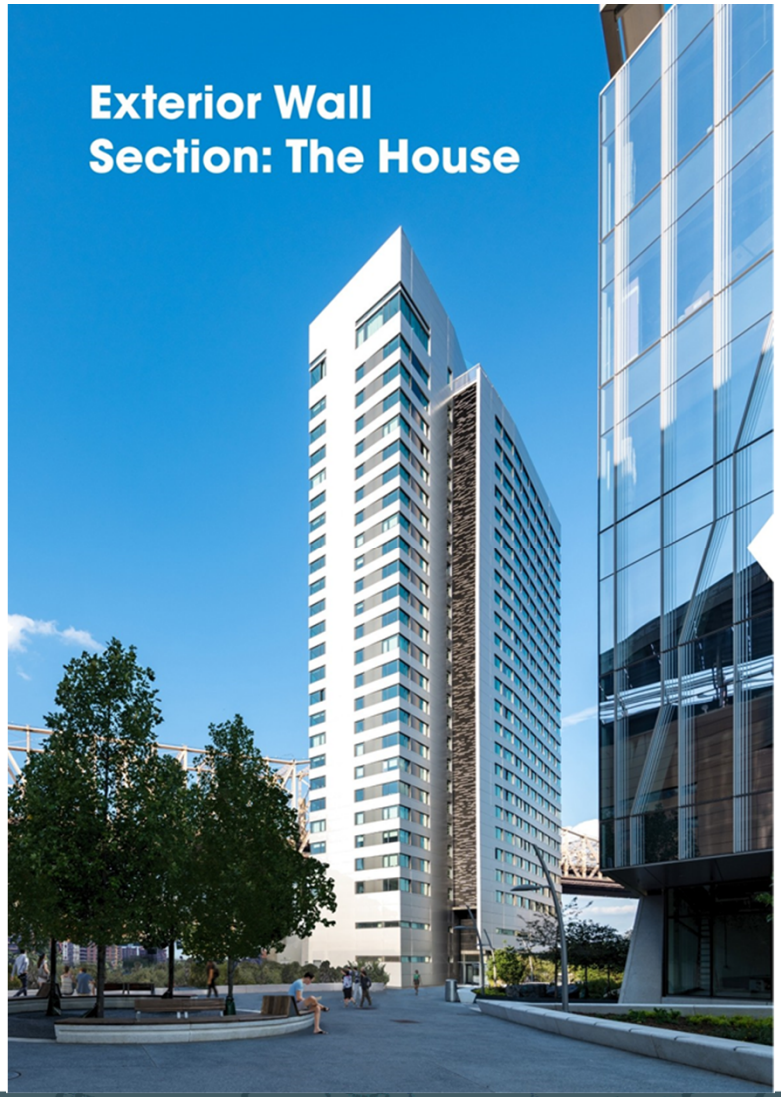
USERS

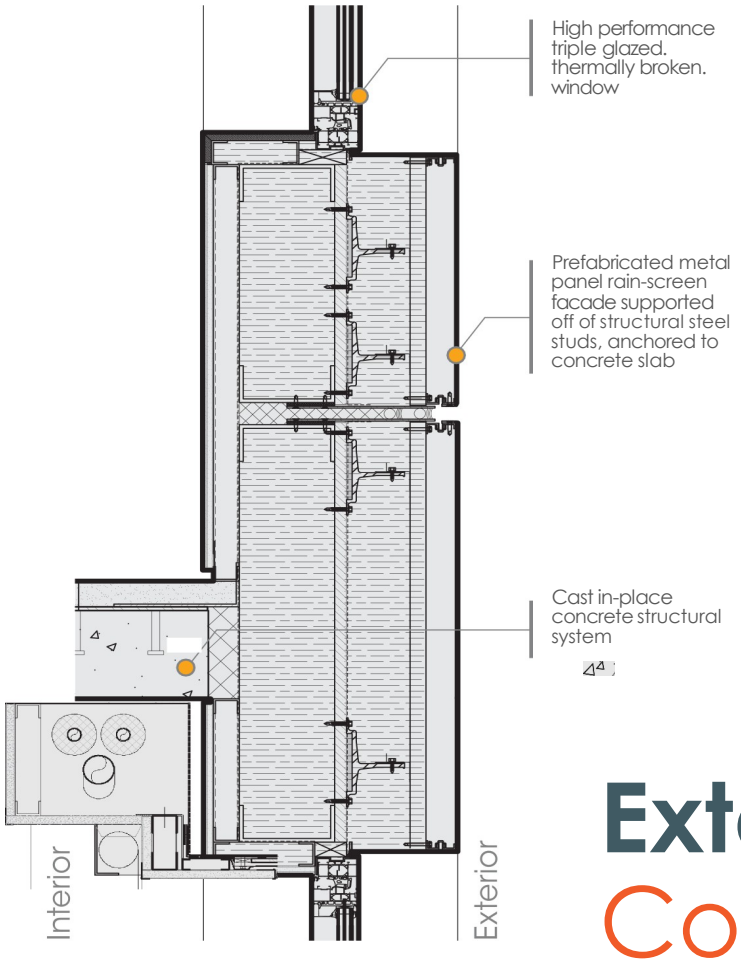

High Shool Students


Residents

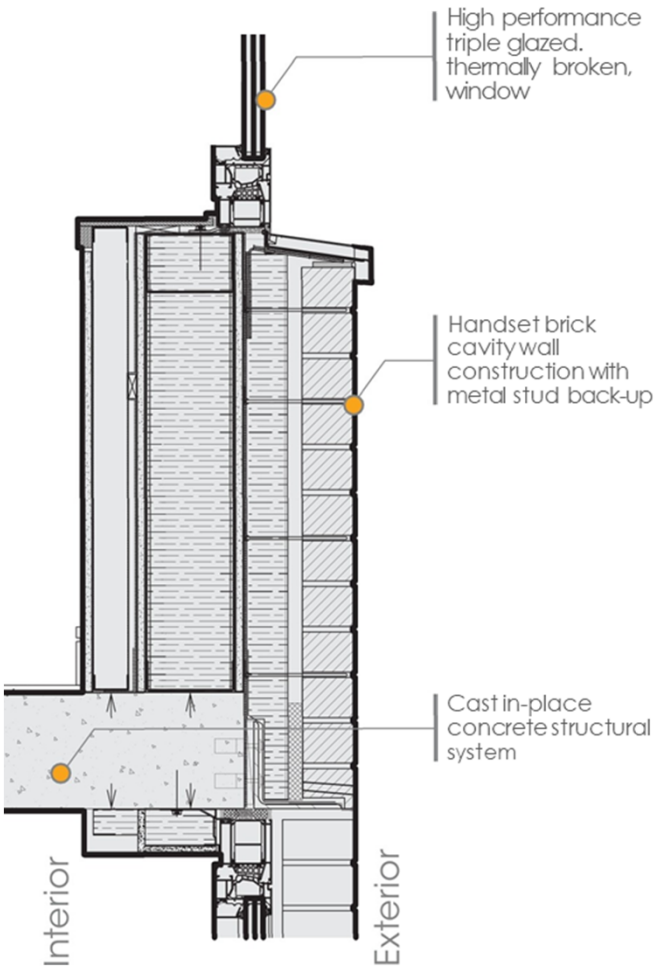

Seniors


Health Clinic Users

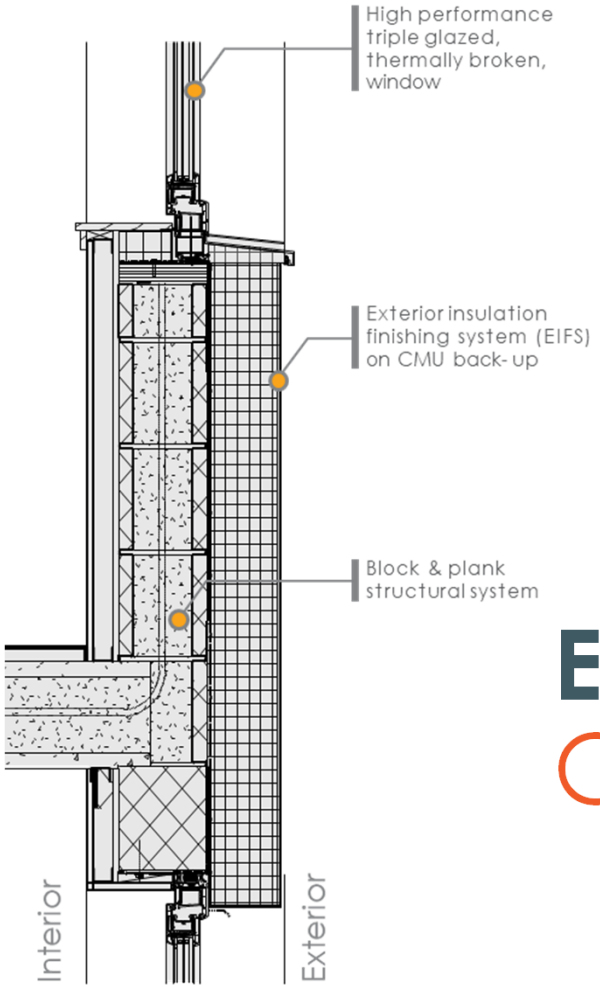




Exterior Wall Comparison

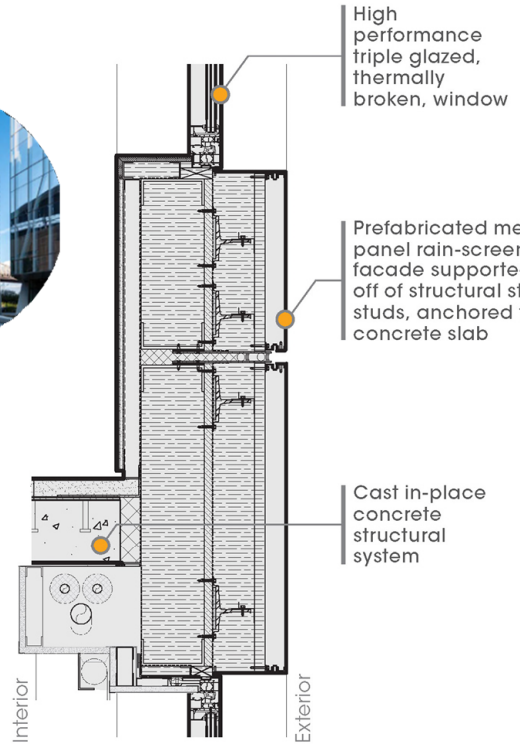


Exterior Wall Comparison



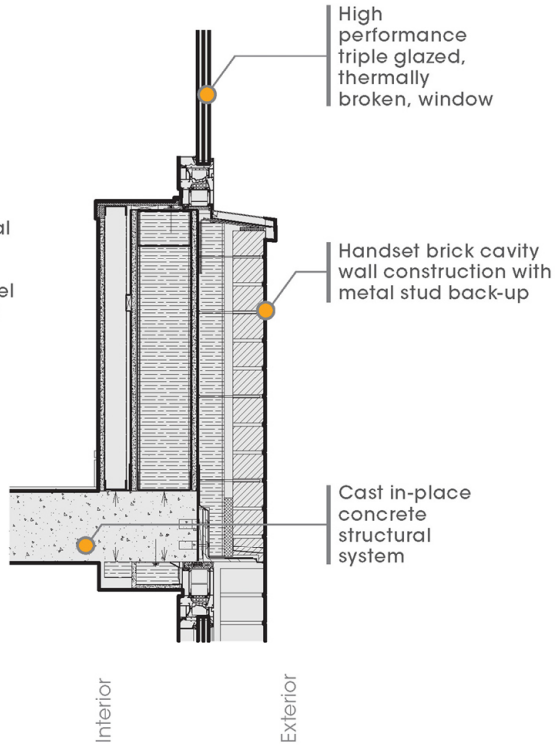
Exterior Wall Condition

Exterior Wall Section Comparison



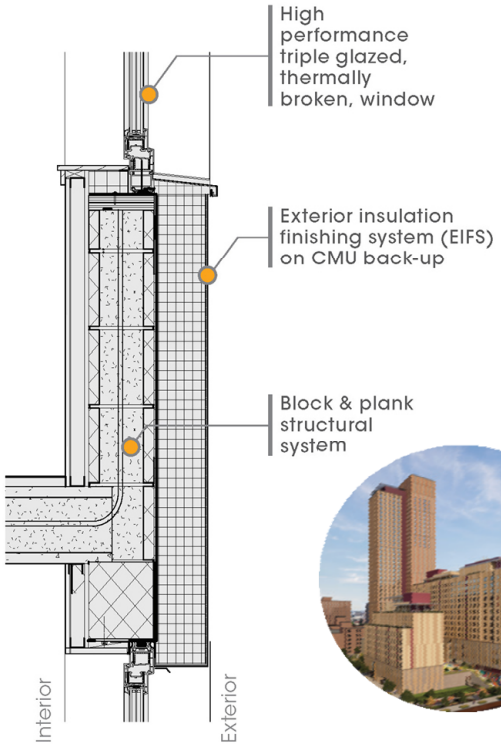
The House

R-38



Sendero Verde Bldg. A

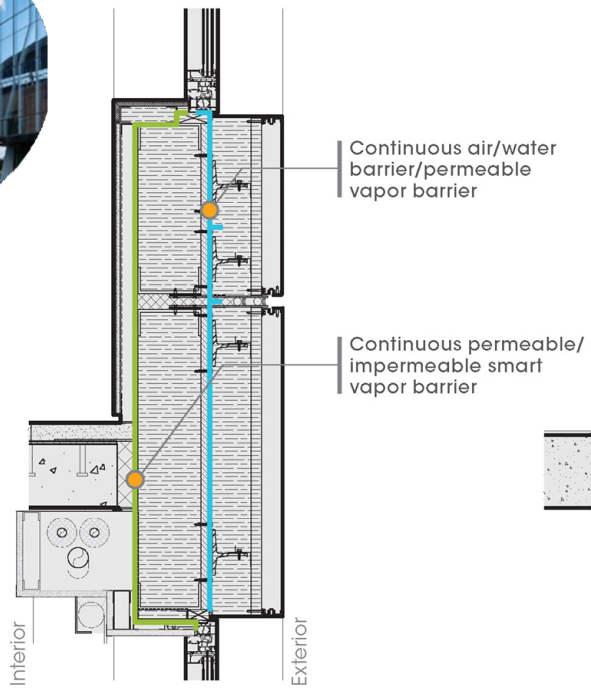
R-38



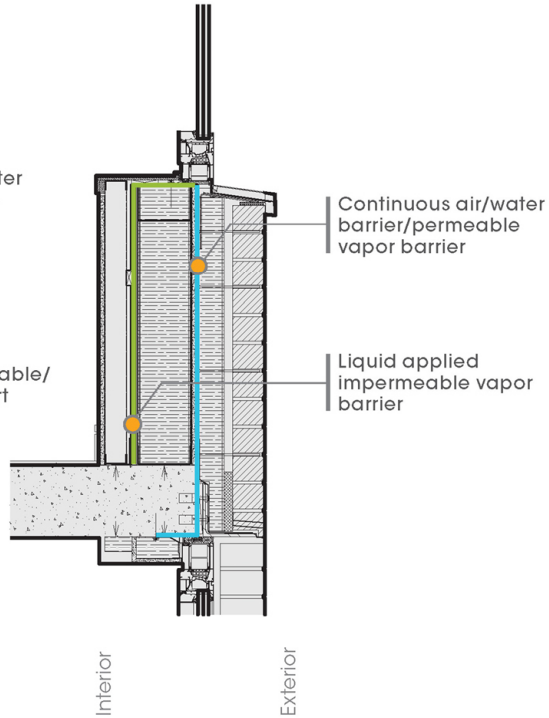
Sendero Verde Bldg. B

R-25

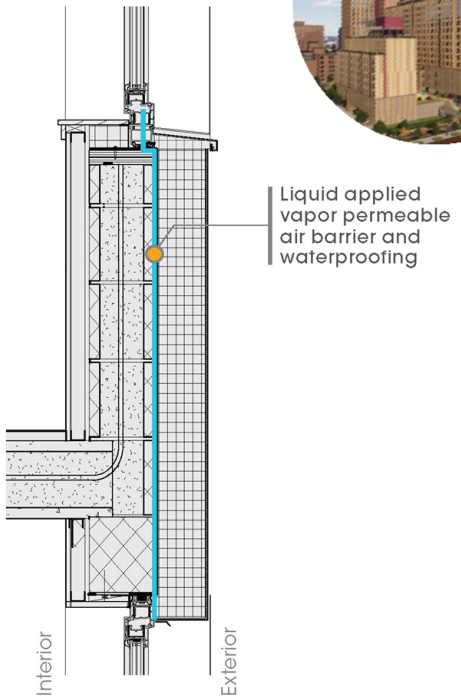
Exterior Wall Section Comparison



The House

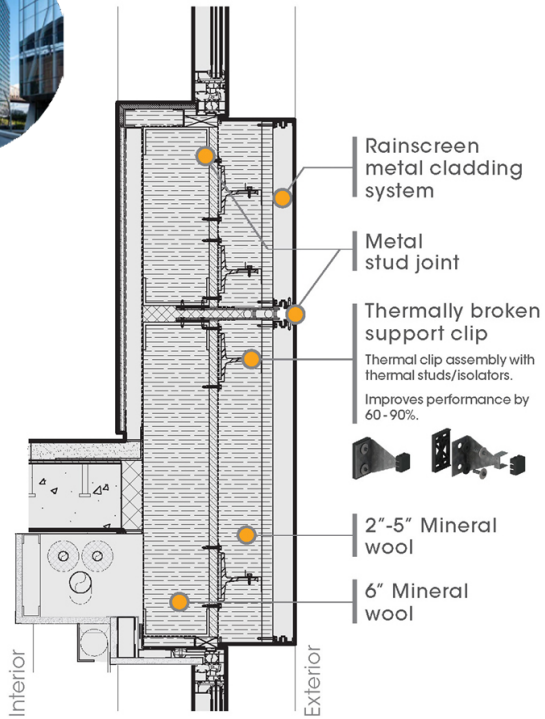


Sendero Verde Bldg. A

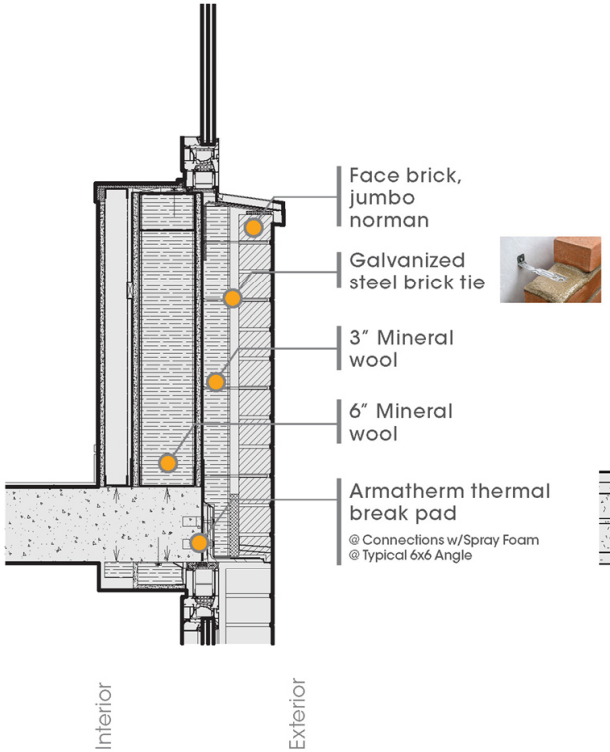


Sendero Verde Bldg. B

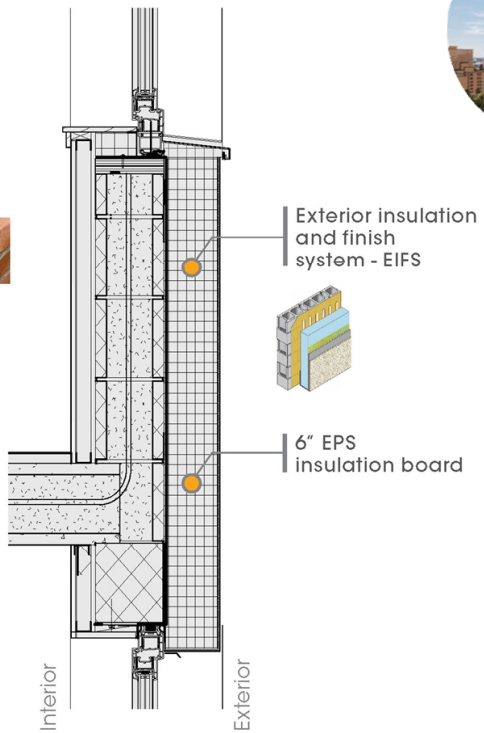
Exterior Wall Section Comparison



The House
R Value: R-19

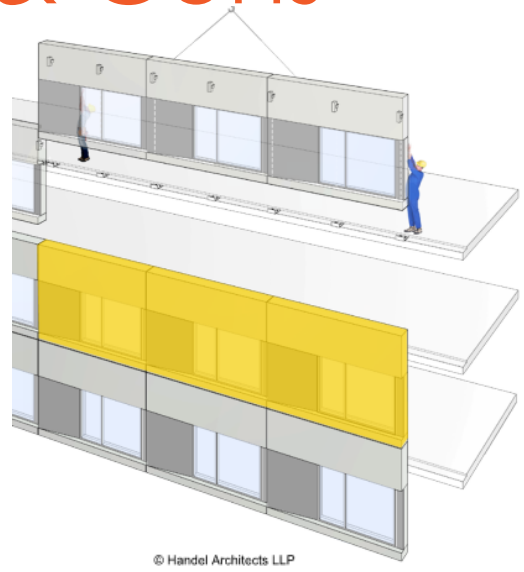


Sendero A
R Value: R-24



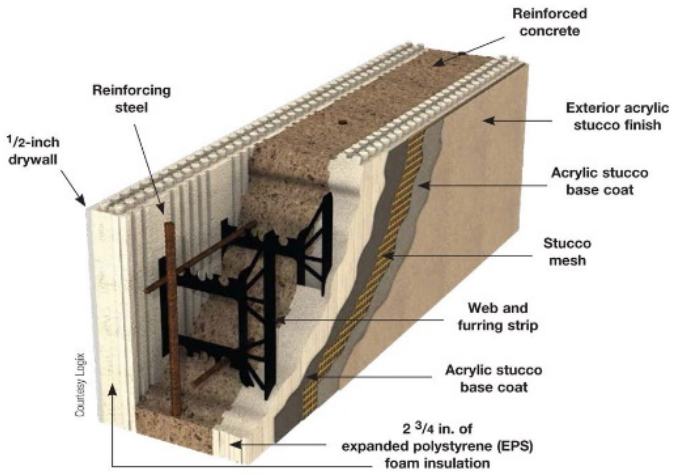
Sendero B
R Value: R-25

Thermal Performance / Air Barrier Pros & Cons



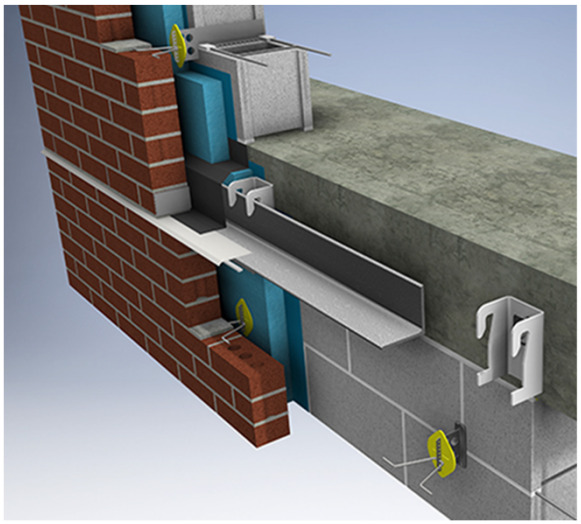
Prefabricated Panels

Fabricated Stud Frame Wall panel offset with water vapor barrier installed with window



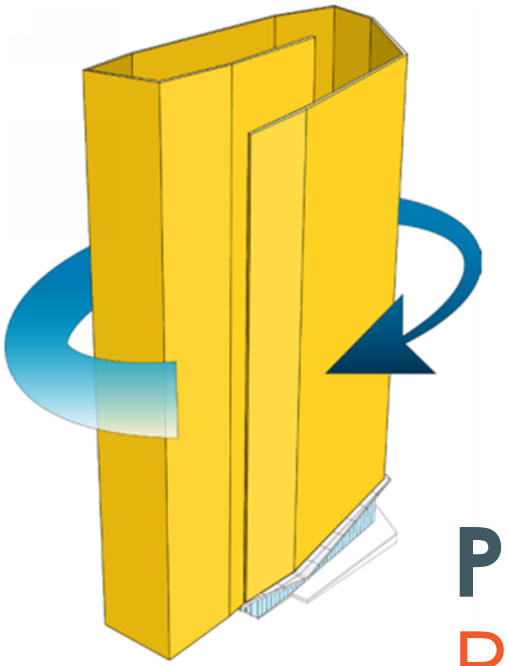
Insulated Concrete Form

Stay in place concrete form with integral straps for attachment



CMU

Concrete masonry wall with rigid insulation



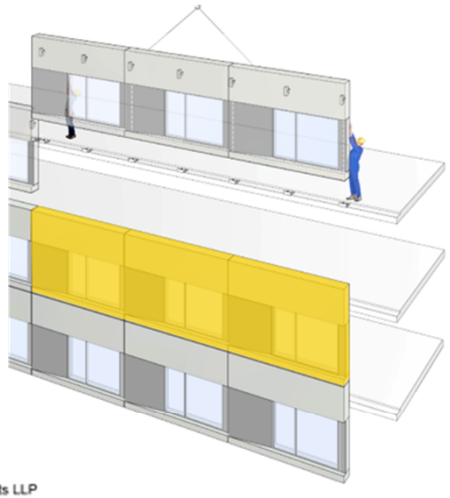
Prefabricated Panels Thermal Performance

Prefab Panels Air-barrier and Sealing

BEFORE PANEL SUPPORTS SEALED

AFTER PANEL SUPPORTS SEALED

Prefab Panels Pros and Cons



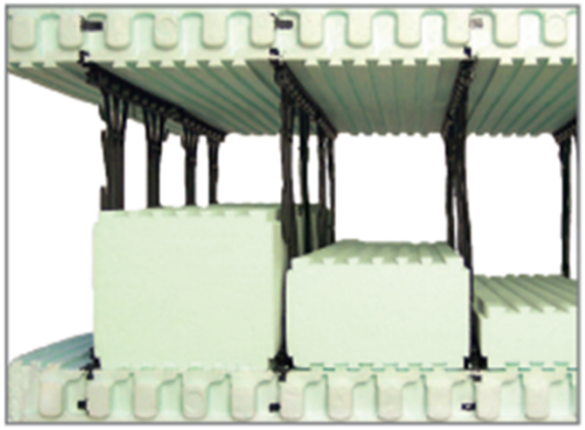
Pros

- Speed of construction
- Quality control in the factory
- Can be extremely efficient and air tight

Cons

- Cost
- Coordination and design assistance needed very early on
- Logistics/shipping to site
- Ability to perform air leakage testing on site/sequencing
- Detailing at panel edges is crucial

ICF Thermal Performance



2- 5/8” EPS each side + thermal mass of concrete for effective R-24.1
Additional insert at 2” increments up to R-48

ICF Air Barrier and Sealing

Integral cast insulated jamb are cleanest tightest detail

Avoid Panel Joint at Opening, which allow water/air infiltration

Min. Thermal bridge of Brick Angle

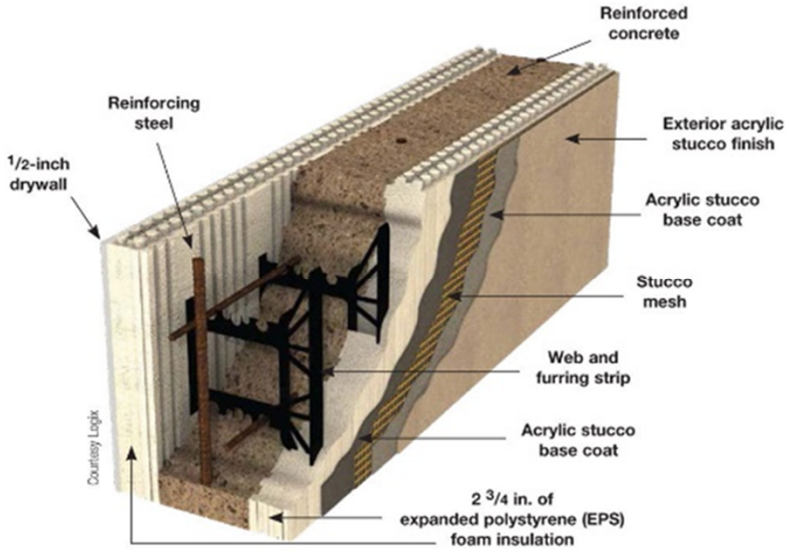
Coordination of Min. Penetration Sleeve

Provide reinforcement at floor edge to prevent gaps

ICF Air Barrier and Sealing

Joint of ICF allow air pathway. Gyp bd finish adds to the air tightness

ICF Pros and Cons



Pros

- Reduces Trades/More done with one system
- Watertight Quickly
- Greater Design Flexibility
- Great Sound Isolation (OITC 41 to 65)
- Energy Efficiency System with high R-value and integrated air barrier

Cons

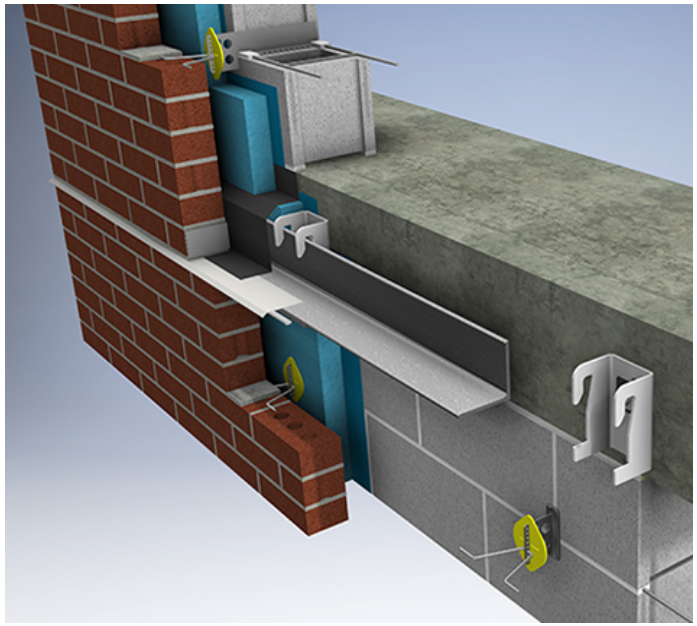
- Unfamiliar construction technology and limited sub contractor
- Implementation crucial to maintain vapor/air barrier continuity

CMU Back-up Thermal Performance

Structural Thermal Break at Individual ERV opening

Exterior continuous rigid insulation + Thermal mass of grouted masonry

CMU Back up Pros and Cons



Pros

- Ease and knowledge of construction method

Cons

- Need more diligence on air tightness
- May require more structural thermal break for façade elements

Aerated Autoclaved Concrete

R-1.2 per inch (varies)
Compressive Strength up to 1200 psi

Exterior Cladding Options - EIFS

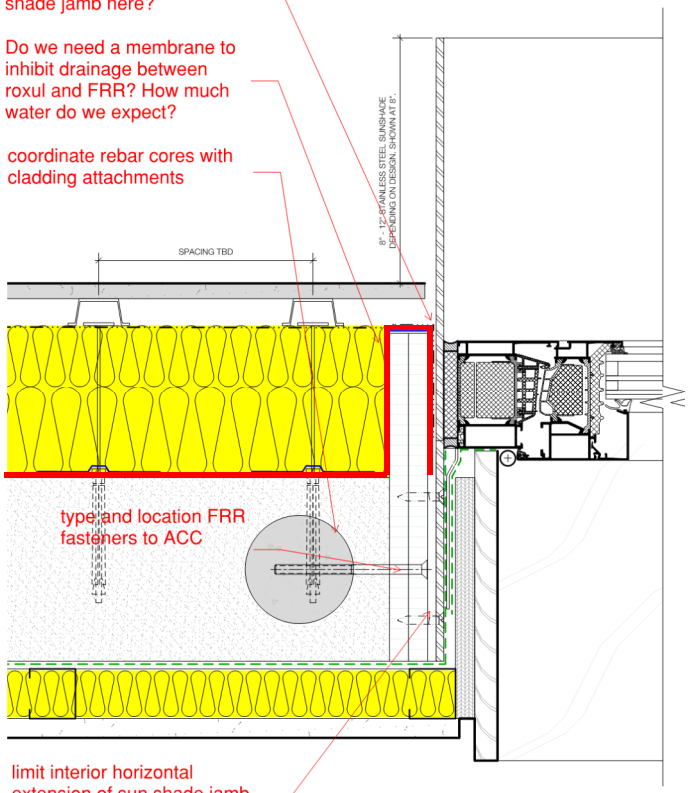
Exterior Cladding Options – Rainscreen

Detail Head and Jamb Mark Ups

How to prevent drainage between membrane and shade jamb here?

Do we need a membrane to inhibit drainage between roxul and FRR? How much water do we expect?

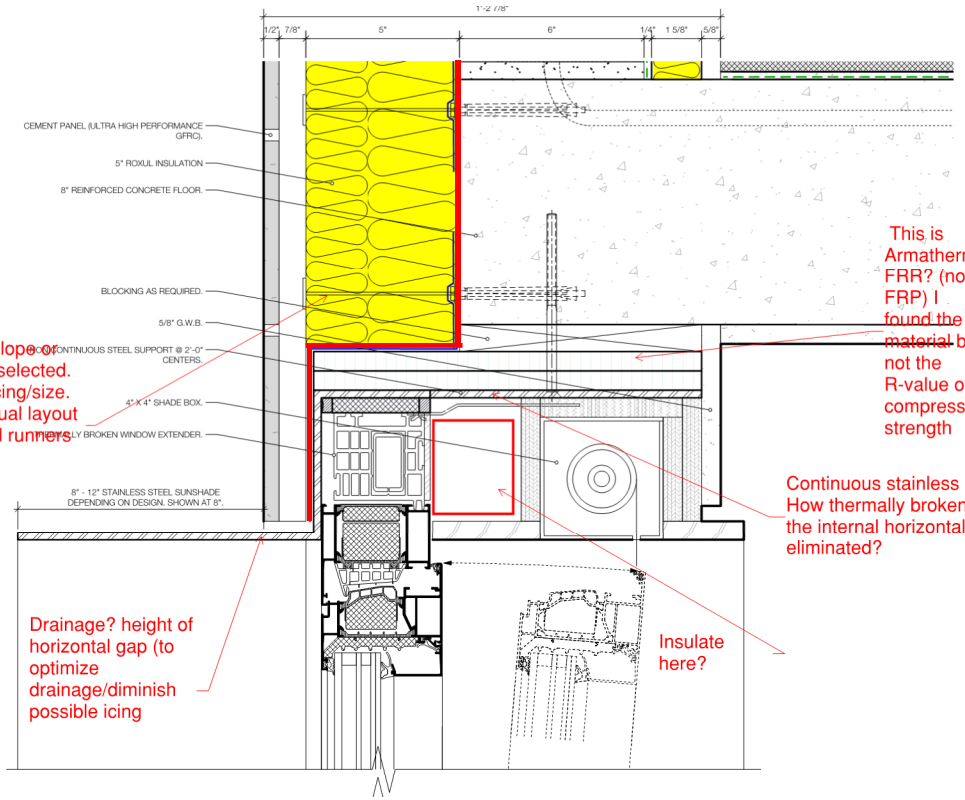
coordinate rebar cores with cladding attachments



type and location FRR fasteners to ACC

limit interior horizontal extension of sun shade jamb (thermal bridge)

Show with N-velope or Knight clips as selected. Determine spacing/size. Create conceptual layout of Zee clips and runners



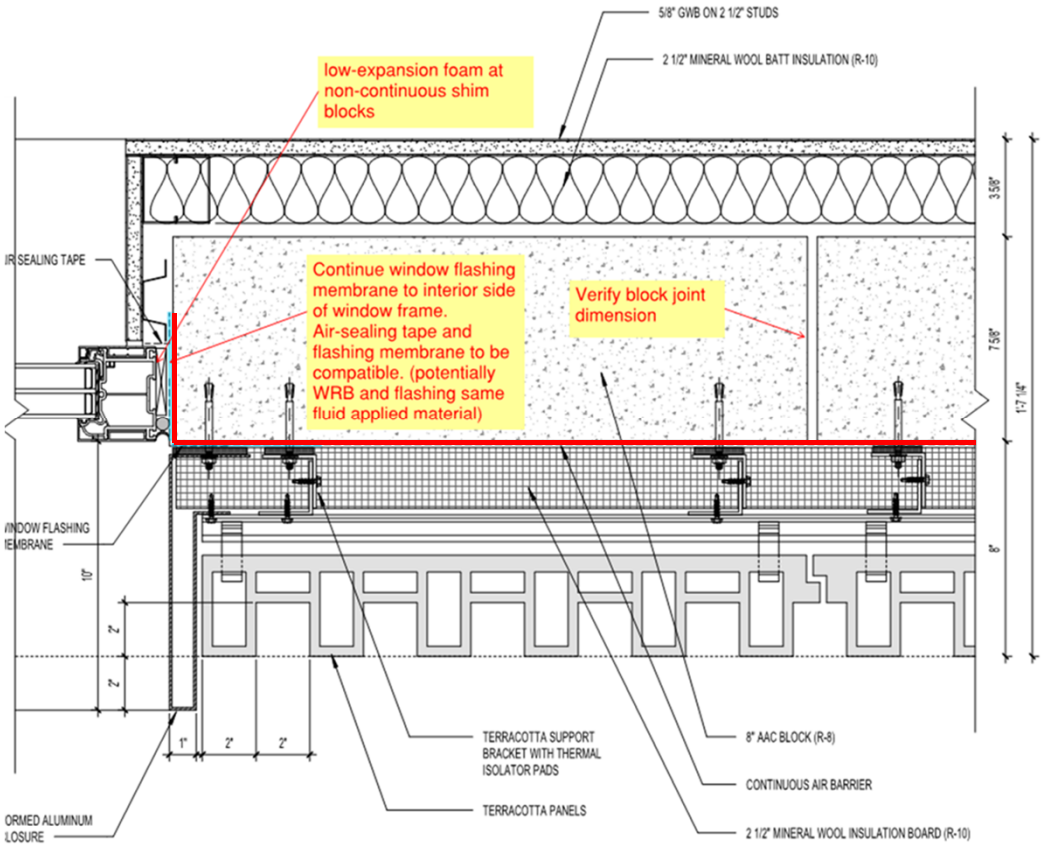
This is Armatherm FRR? (not FRP) I found the material but not the R-value of compressive strength

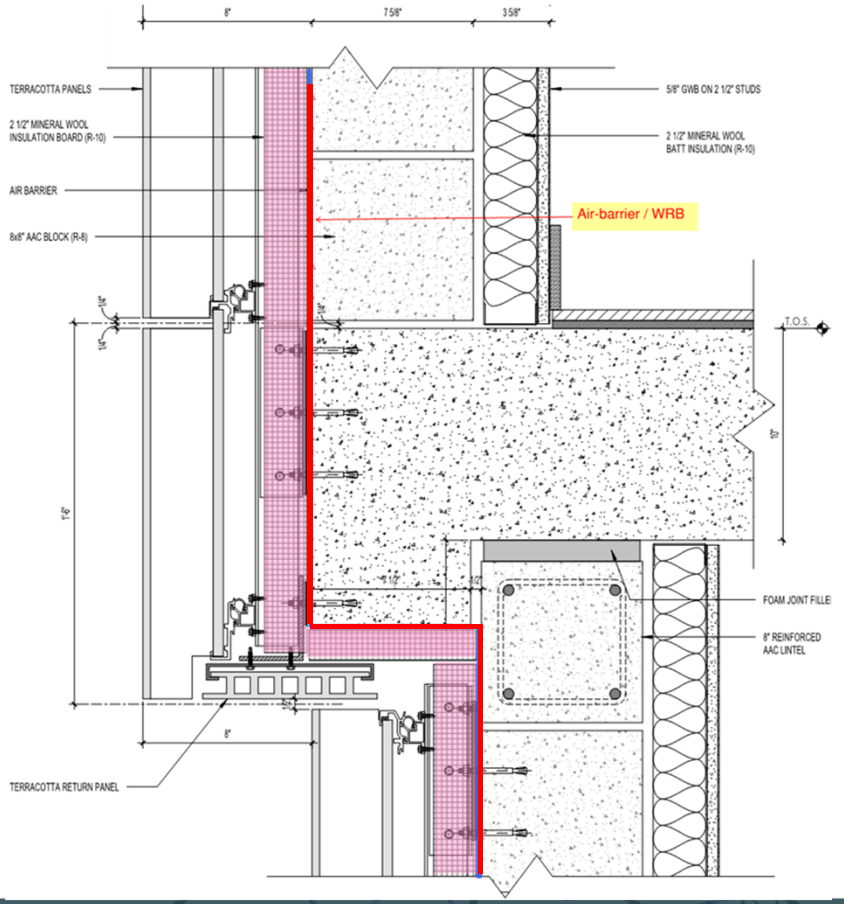
Continuous stainless steel? How thermally broken? Can the internal horizontal leg be eliminated?

Drainage? height of horizontal gap (to optimize drainage/diminish possible icing

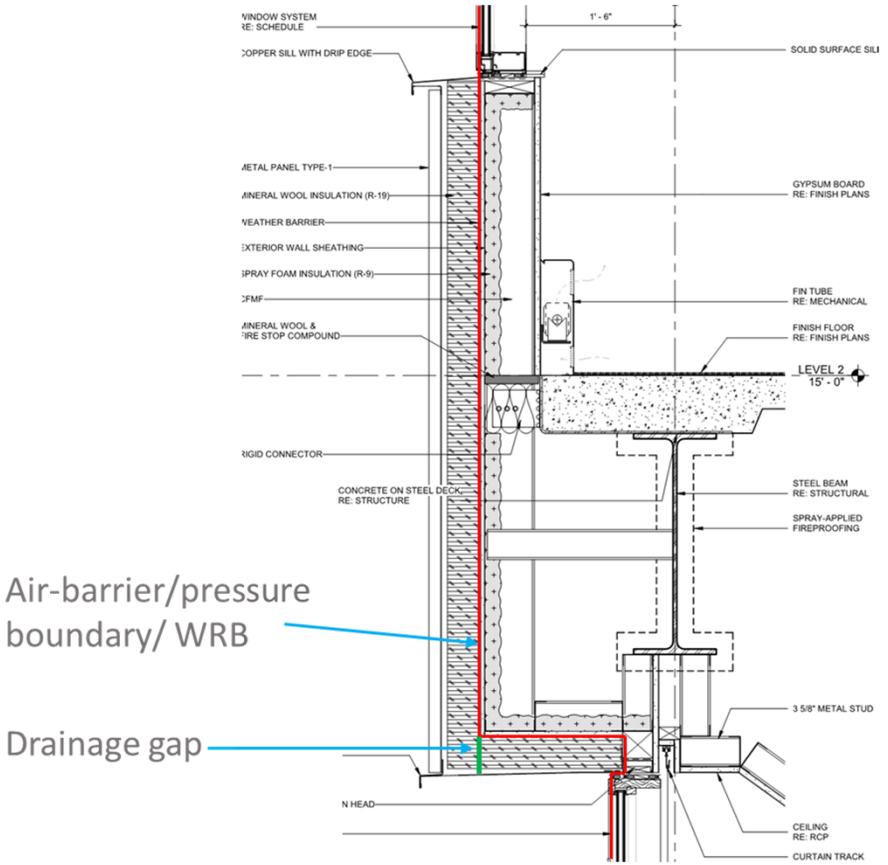
Insulate here?

Aerated Autoclaved Concrete (AAC)

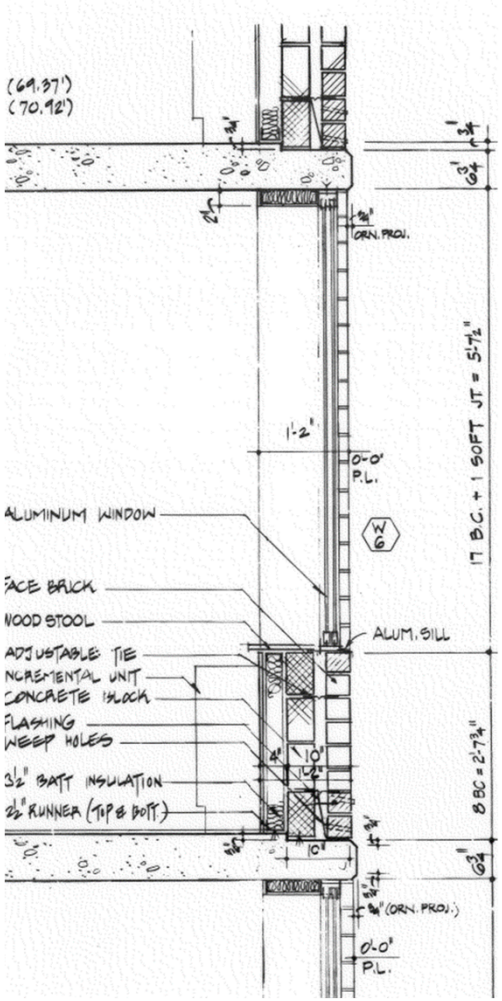




New Construction: Rain Screen

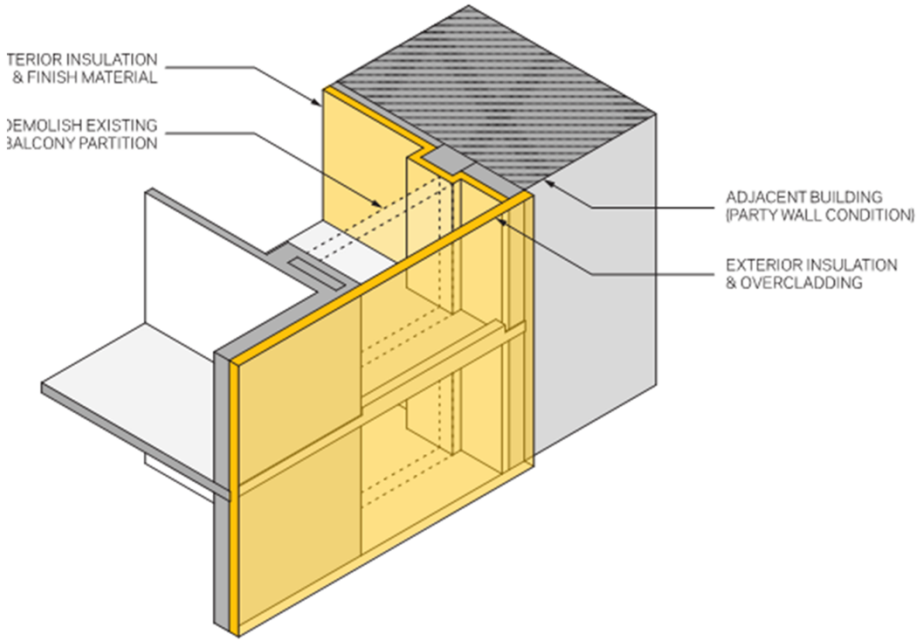


Retrofit Air Barriers Solutions

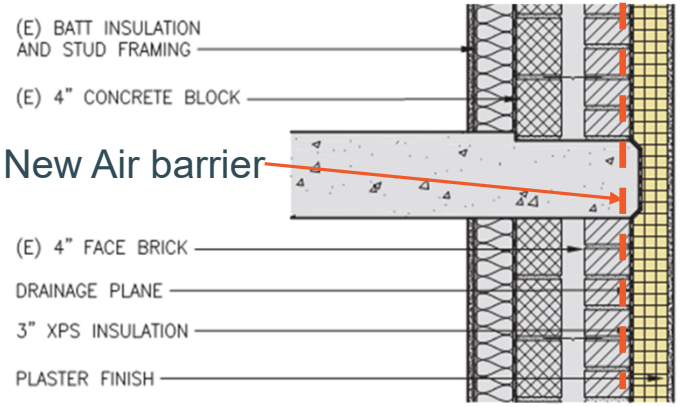


Over-Cladding Solutions

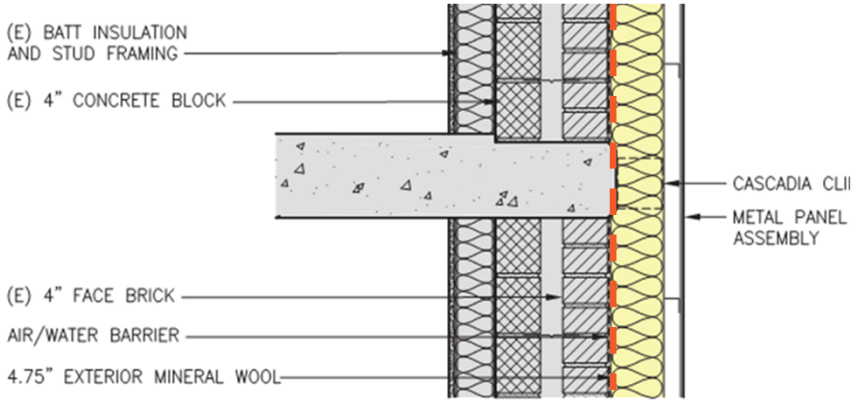
Over-Cladding
Solutions



ECM-C-EW-05: Balcony Enclosure Diagram

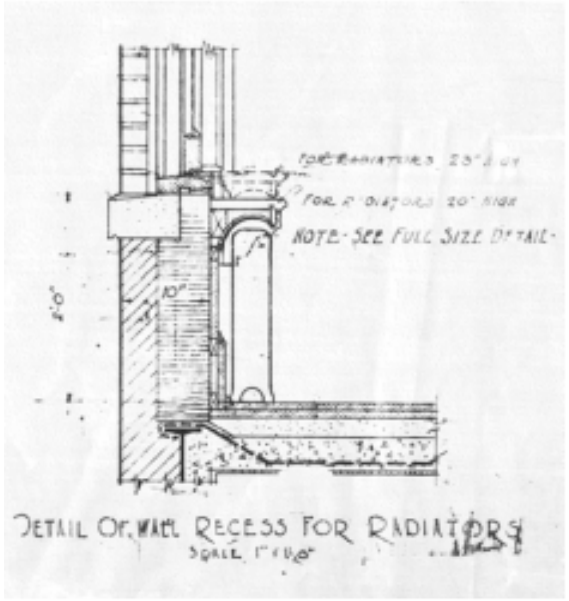


EIFS Over-cladding



Rain-Screen Over-cladding

EnerPHit Study: Rubin Hall - Interior Insulation Proposed



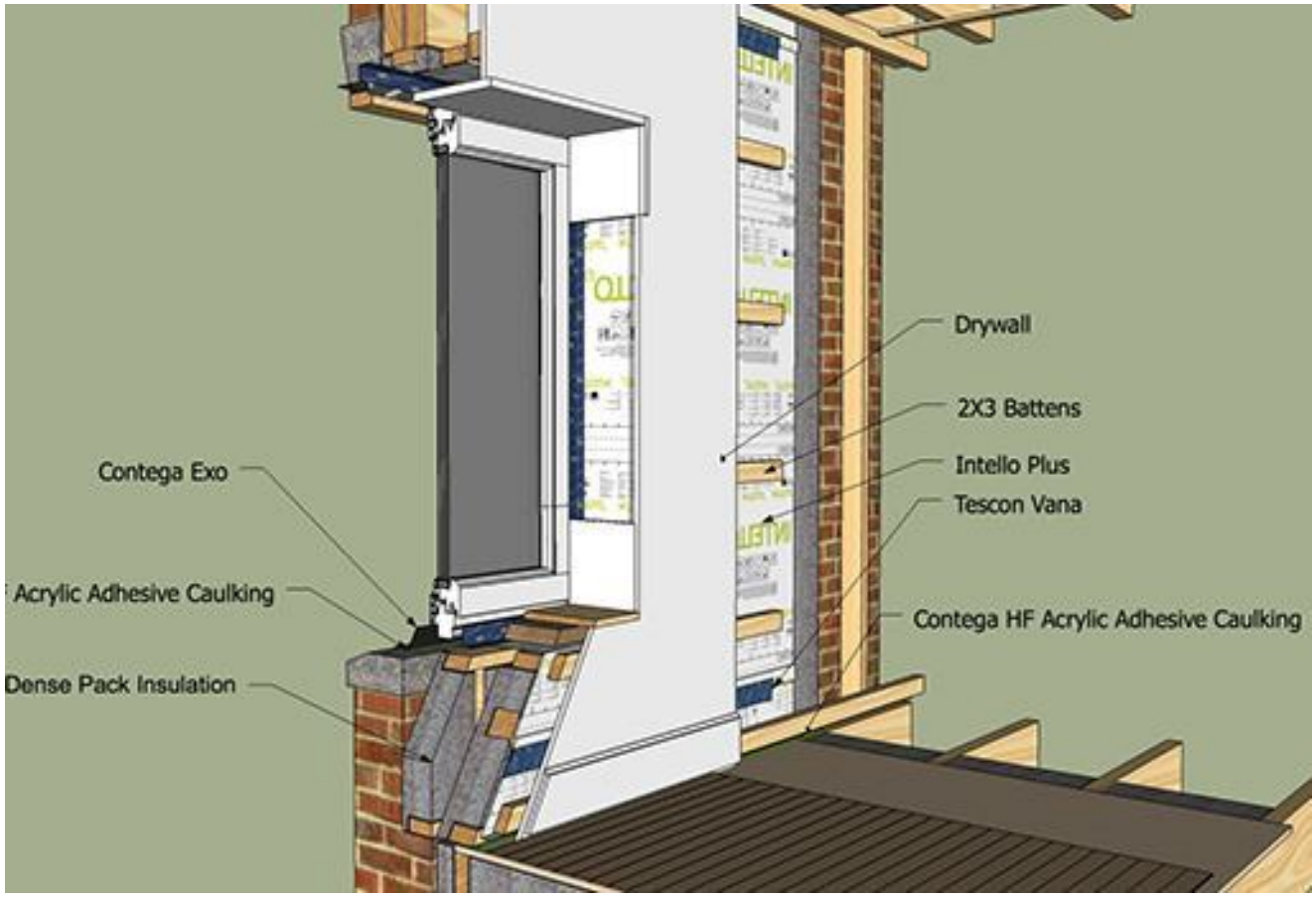
WALL SECTION DETAIL DATED 1948

- Rubin Hall – 1925 Historic Building
- Uninsulated Walls: 4” face brick + 8” Terracotta
- Metal, Single Pane Windows

RH: Wall Assembly Recommendations

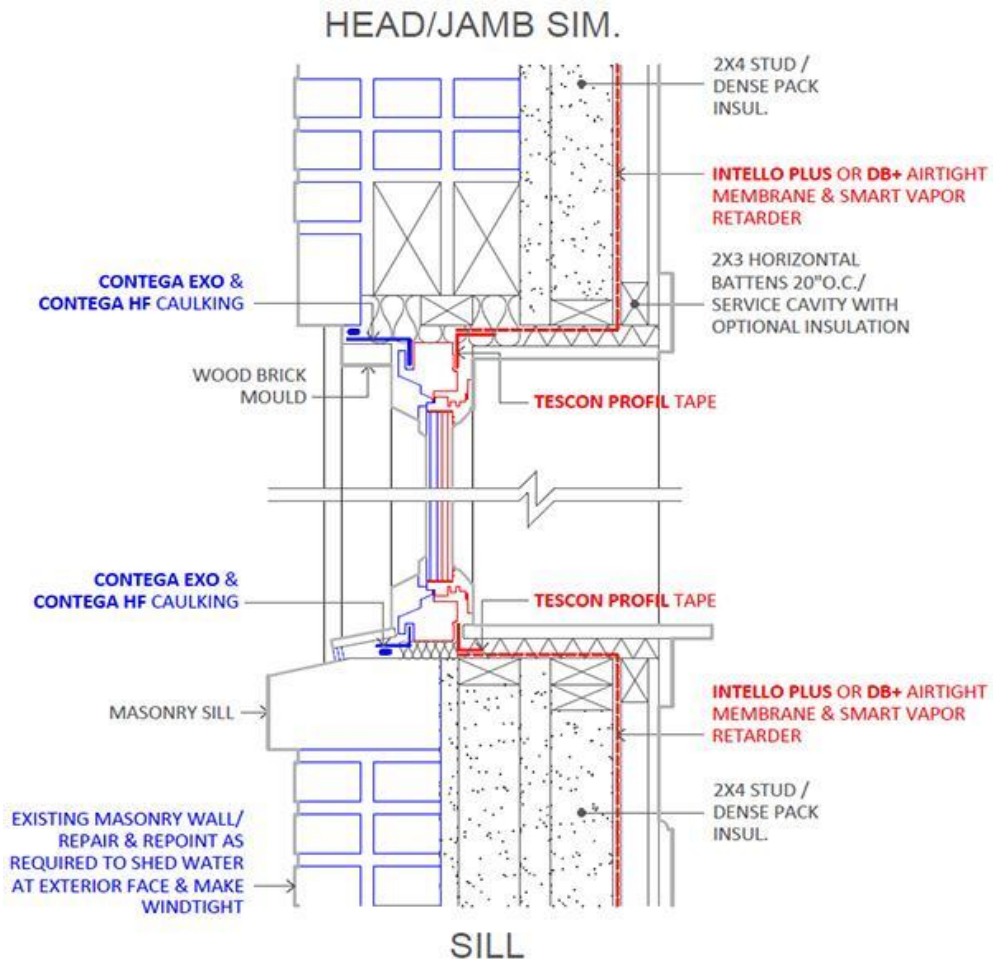
	1.5” Polyiso +2.5” Mineral Wool	**2.5” Closed Cell**
Benefits	Provides interior continuous insulation, air-barrier and dewpoint control layer. R-10 without additional mineral wool	Provides interior continuous insulation, air-barrier and dewpoint control layer. Thinner wall assembly. Even coverage is easily achieved
Issues	Thicker wall assembly - 4.5" and loss of square footage Install quality is important Can be labor intensive	Objections to spray foam and off gassing. Cost of material is higher, but labor to install may not be.

Air Barrier Retrofit Masonry Const.



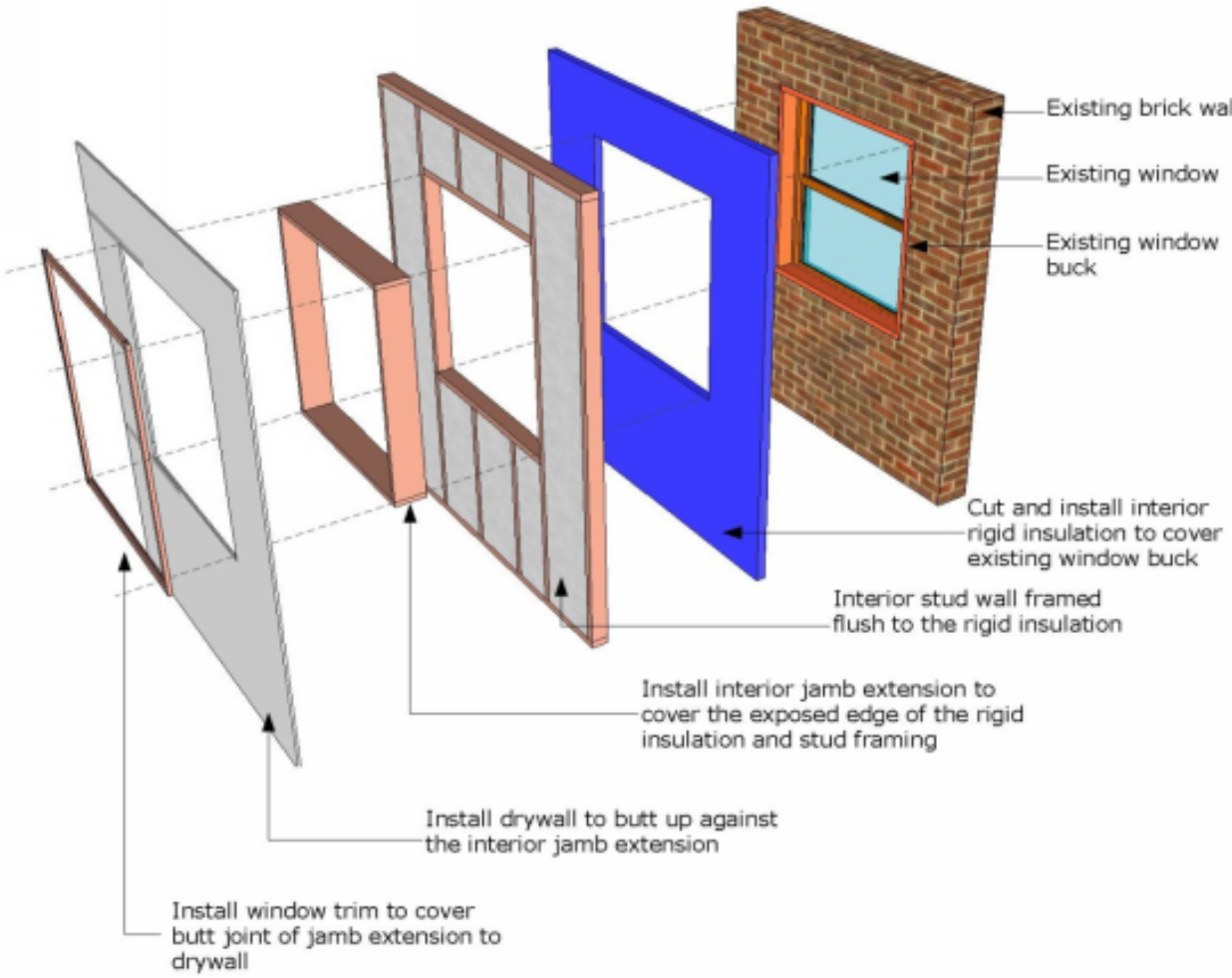
Drawing courtesy 475 High Performance Building Materials

Air Barrier Retrofit Masonry Const.

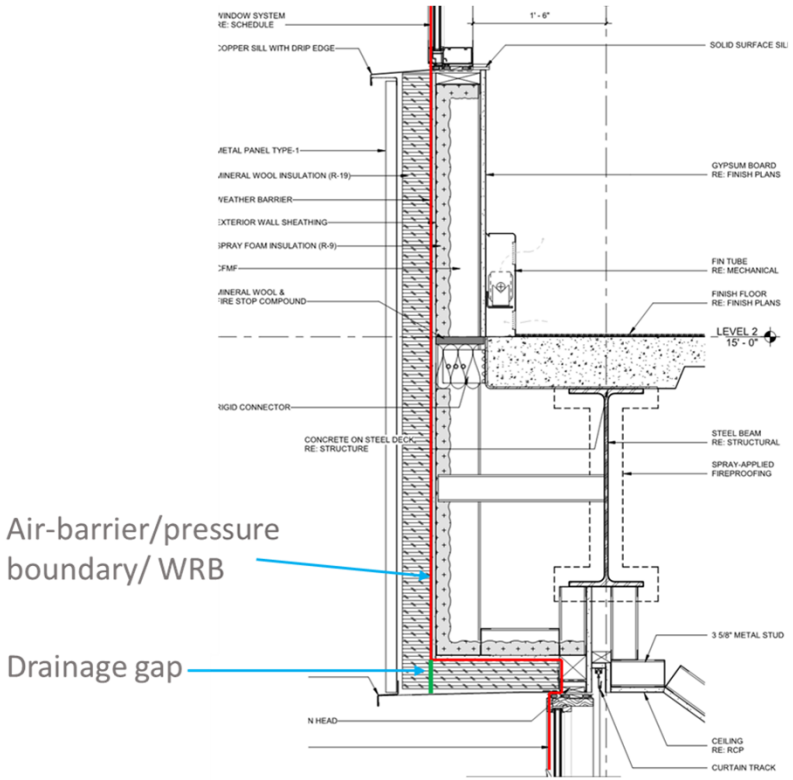


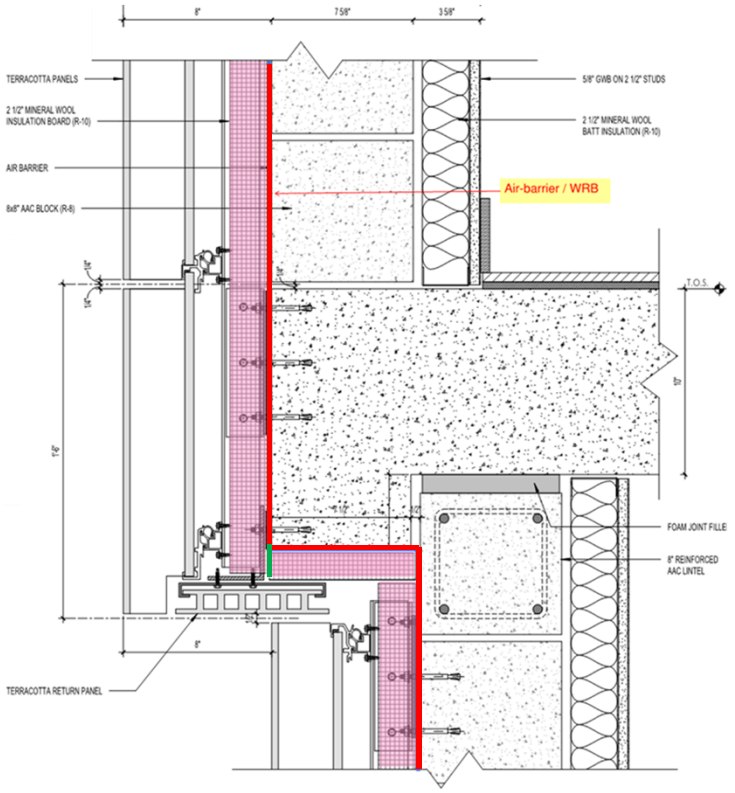
Drawing courtesy 475 High Performance Building Materials

Interior Rigid Insulation



WRBs Must Be Drainable

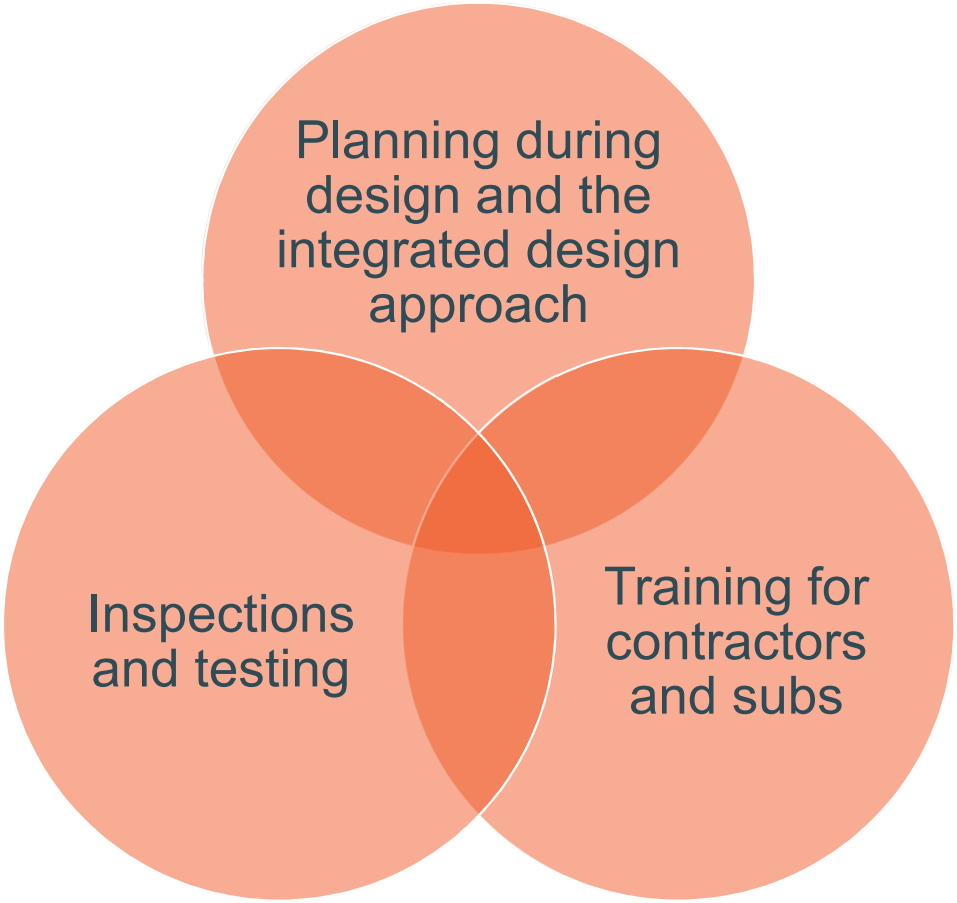




Questions?

15 Minute Break

Construction Phase QA/QC



Airtightness

Contractor Buy-In

- General contractor and subcontractor buy-in is critical to project success
- All trades have an impact on project results and may require a mind shift on performance testing
- Passive House Tradesperson training mandatory for key personnel
- GC needs at least two people who will be dedicated to PH scope and coordination

Contractor Buy-In

- Ensure GC & trades fully understand what is included in respective work scope
- Discuss expectations with whole project team during bidding
- Ask questions, dispel myths

Verification for Large Projects

- Foundations
  - Abutting neighbor(s)
  - Staging of foundation
  - Under slab / stem walls
- Above Grade Walls
  - Wall construction type: CMU, wood framed, etc.
  - Sequencing for hoistways, upper vs. lower floors
- Roof
  - Thermal breaks and roof membrane penetrations
  - Bulkheads, louvers & dampers

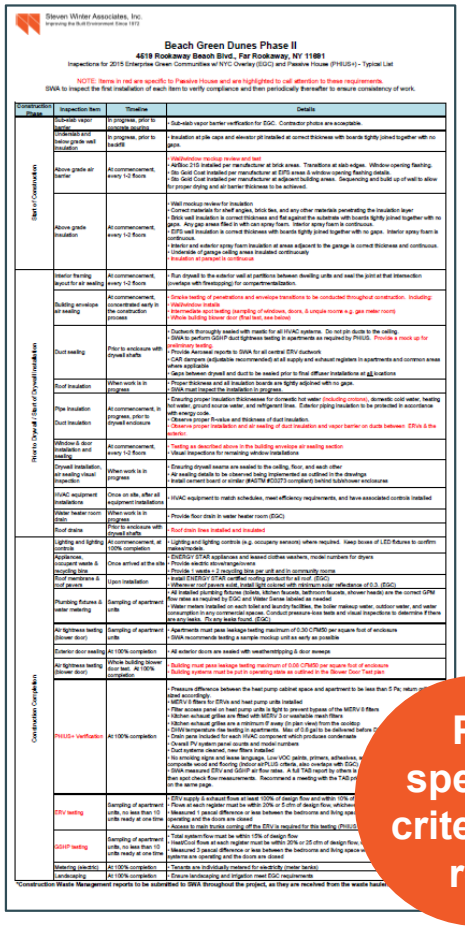
Verification for Large Projects

- MEP
  - In unit heat/cool duct testing
  - Ventilation
  - TAB process
  - Pipe insulation
  - Lighting wattages & controls

Start of Construction

Prior to Drywall / Start of Drywall Installation

Construction Completion



Steven Winter Associates, Inc.

Beach Green Dunes Phase II

4619 Rookaway Beach Blvd., Far Rookaway, NY 11691

Inspections for 2015 Enterprise Green Communities w/ NYC Overlay (EGC) and Passive House (PHIUS+) - Typical List

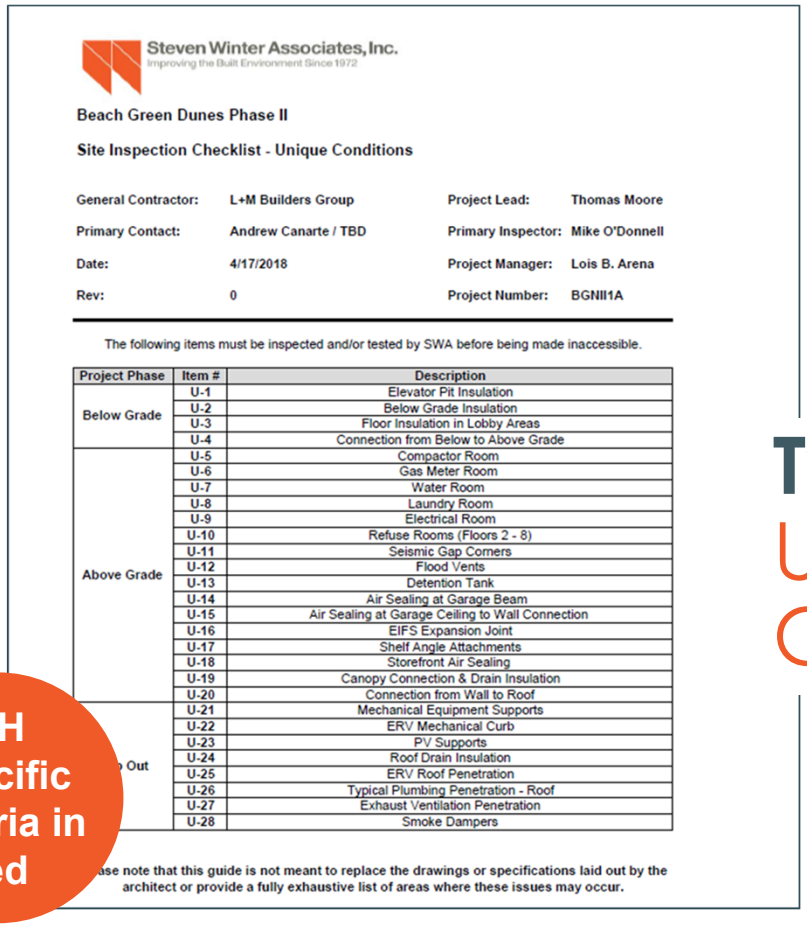
NOTE: Items in red are specific to Passive House and are highlighted to call attention to these requirements.

SWA to inspect the first installation of each item to verify compliance and then periodically thereafter to ensure consistency of work.

Construction Phase	Inspection Item	Timeline	Details
Start of Construction	SOG+slab vapor barrier	In progress, prior to concrete pouring	- Sub-slab vapor barrier verification for EGC. Contractor photos are acceptable.
	Underslab and below grade wall insulation	In progress, prior to backfill	- Insulation at pile caps and elevator pit installed at correct thickness with boards tightly joined together with no gaps.
	Above grade air barrier	At commencement, every 1-2 floors	- Wall/window mockup review and test - AdBloc 21G installed per manufacturer at brick areas. Transitions at slab edges. Window opening flashing. - Blu Gold Coat installed per manufacturer at EIFS areas & window opening flashing details. - Blu Gold Coat installed per manufacturer at adjacent building areas. Sequencing and build up of wall to allow for proper drying and air barrier thickness to be achieved.
	Above-grade insulation	At commencement, every 1-2 floors	- Wall mockup review for insulation - Correct materials for shelf angles, brick ties, and any other materials penetrating the insulation layer - Brick wall insulation is correct thickness and flat against the substrate with boards tightly joined together with no gaps. Any gap areas filled in with can spray foam. Interior spray foam is continuous. - EIFS wall insulation is correct thickness with boards tightly joined together with no gaps. Interior spray foam is continuous. - Interior and exterior spray foam insulation at areas adjacent to the garage is correct thickness and continuous. - Underside of garage ceiling areas insulated continuously - Insulation at parapet is continuous
Prior to Drywall / Start of Drywall Installation	Interior framing layout for air sealing	At commencement, every 1-2 floors	- Run drywall to the exterior wall at partitions between dwelling units and seal the joint at that intersection (overlaps with firestopping) for compartmentalization.
	Building envelope air sealing	At commencement, concentrated early in the construction process	- Smoke testing of penetrations and envelope transitions to be conducted throughout construction. Including: - Slab/window details - Intermediate spot testing (sampling of windows, doors, & unique rooms e.g. gas meter room) - Whole building blower door (final test, see below)
	Duct sealing	Prior to enclosure with drywall shafts	- Ductwork thoroughly sealed with mastic for all HVAC systems. Do not pin ducts to the ceiling. - SWA to perform GSHP duct tightness testing in apartments as required by PHIUS. Provide a mock up for preliminary testing. - Provide Aeroseal reports to SWA for all central ERV ductwork - CAR: dampers (adjustable recommended) at all supply and exhaust registers in apartments and common areas where applicable - Gaps between drywall and duct to be sealed prior to final diffuser installations at all locations
	Roof insulation	When work is in progress	- Proper thickness and all insulation boards are tightly adjoined with no gaps. - SWA must inspect the installation in progress.
	Pipe insulation Duct insulation	At commencement, in progress, prior to drywall enclosure	- Ensuring proper insulation thicknesses for domestic hot water (including controls), domestic cold water, heating hot water, ground source water, and refrigerant lines. Exterior piping insulation to be protected in accordance with energy code. - Observe proper R-value and thickness of duct insulation. - Observe proper installation and air sealing of duct insulation and vapor barrier on ducts between ERVs & the exterior.
	Window & door installation and sealing	At commencement, every 1-2 floors	- Testing as described above in the building envelope air sealing section - Visual inspections for remaining window installations
	Drywall installation, air sealing visual inspection	When work is in progress	- Ensuring drywall seams are sealed to the ceiling, floor, and each other - Air sealing details to be observed being implemented as outlined in the drawings - Install cement board or similar (AASTM #33073-compliant) behind tub/shower enclosure
	HVAC equipment installations	Once on site, after all equipment installations	- HVAC equipment to match schedules, meet efficiency requirements, and have associated controls installed
	Water heater room drain	When work is in progress	- Provide floor drain in water heater room (EGC)
	Roof drains	Prior to enclosure with drywall shafts	- Roof drain lines installed and insulated
Construction Completion	Lighting and lighting controls	At commencement, at 100% completion	- Lighting and lighting controls (e.g. occupancy sensors) where required. Keep boxes of LED fixtures to confirm makes/models.
	Appliances, occupant waste & recycling bins	Once arrived at the site	- ENERGY STAR appliances and leased clothes washers, model numbers for dryers - Provide electric stove/range/ovens - Provide 1 waste + 2 recycling bins per unit and in community rooms
	Roof membrane & roof pavers	Upon installation	- Install ENERGY STAR certified roofing product for all roof. (EGC) - Where roof pavers exist, install light colored with minimum solar reflectance of 0.3. (EGC)
	Plumbing fixtures & water metering	Sampling of apartment units	- All installed plumbing fixtures (toilets, kitchen faucets, bathroom faucets, shower heads) are the correct GPM flow rates as required by EGC and Water Sense labeled as needed. - Water meters installed on each toilet and laundry facilities, the boiler makeup water, outdoor water, and water consumption in any commercial spaces. Conduct pressure-loss tests and visual inspections to determine if there are any leaks. Fix any leaks found. (EGC)
	Air tightness testing (blower door)	Sampling of apartment units	- Apartments must pass leakage testing maximum of 0.30 CFM50 per square foot of enclosure - SWA recommends testing a sample mockup unit as early as possible
	Exterior door sealing	At 100% completion	- All exterior doors are sealed with weatherstripping & door sweeps
	Air tightness testing (blower door)	Whole building blower door test. At 100% completion	- Building must pass leakage testing maximum of 0.06 CFM50 per square foot of enclosure - Building systems must be put in operating state as outlined in the Blower Door Test plan
	PHIUS+ Verification	At 100% completion	- Pressure difference between the heat pump cabinet space and apartment to be less than 5 Pa; return [illegible] sized accordingly - MERV 8 filters for ERVs and heat pump units installed - Filter access panel on heat pump units is tight to prevent bypass of the MERV 8 filters - Kitchen exhaust grilles are fitted with MERV 3 or washable mesh filters - Kitchen exhaust grilles are a minimum 8" away (in plan view) from the cooktop - DHW temperature rise testing in apartments. Max of 0.6 gal/s to be delivered before [illegible] - Drain pans included for each HVAC component which produces condensate - Overall PV system panel counts and model numbers - Duct systems cleaned, new filters installed - No smoking signs and lease language, Low VOC paints, primers, adhesives, [illegible] composite wood and flooring (indoor airPLUS criteria, also overlaps with EGC) - SWA measured ERV and GSHP air flow rates. A full TAB report by others is [illegible] then spot check flow measurements. Recommend a meeting with the TAB [illegible] on the same page.
	ERV testing	Sampling of apartment units, no less than 10 units ready at one time	- ERV supply & exhaust flows at least 100% of design flow and within 10% of [illegible] - Flows at each register must be within 20% or 5 cfm of design flow, whichever [illegible] - Measured 1 pascal difference or less between the bedrooms and living spaces when [illegible] operating and the doors are closed - Access to main trunks coming off the ERV's is required for this testing (PHIUS)
	GSHP testing	Sampling of apartment units, no less than 10 units ready at one time	- Total system flow must be within 15% of design flow - Heat/Cool flows at each register must be within 20% or 25 cfm of design flow, [illegible] - Measured 3 pascal difference or less between the bedrooms and living spaces when [illegible] systems are operating and the doors are closed
	Metering (electric)	At 100% completion	- Tenants are individually metered for electricity (meter banks)
	Landscaping	At 100% completion	- Ensure landscaping and irrigation meet EGC requirements

*Construction Waste Management reports to be submitted to SWA throughout the project, as they are received from the waste hauler.

PH specific criteria in red



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Improving the Built Environment Since 1972

Beach Green Dunes Phase II

Site Inspection Checklist - Unique Conditions

General Contractor:	L+M Builders Group	Project Lead:	Thomas Moore
Primary Contact:	Andrew Canarte / TBD	Primary Inspector:	Mike O'Donnell
Date:	4/17/2018	Project Manager:	Lois B. Arena
Rev:	0	Project Number:	BGNII1A

The following items must be inspected and/or tested by SWA before being made inaccessible.

Project Phase	Item #	Description
Below Grade	U-1	Elevator Pit Insulation
	U-2	Below Grade Insulation
	U-3	Floor Insulation in Lobby Areas
	U-4	Connection from Below to Above Grade
Above Grade	U-5	Compactor Room
	U-6	Gas Meter Room
	U-7	Water Room
	U-8	Laundry Room
	U-9	Electrical Room
	U-10	Refuse Rooms (Floors 2 - 8)
	U-11	Seismic Gap Corners
	U-12	Flood Vents
	U-13	Detention Tank
	U-14	Air Sealing at Garage Beam
	U-15	Air Sealing at Garage Ceiling to Wall Connection
	U-16	EIFS Expansion Joint
	U-17	Shelf Angle Attachments
	U-18	Storefront Air Sealing
	U-19	Canopy Connection & Drain Insulation
	U-20	Connection from Wall to Roof
Out	U-21	Mechanical Equipment Supports
	U-22	ERV Mechanical Curb
	U-23	PV Supports
	U-24	Roof Drain Insulation
	U-25	ERV Roof Penetration
	U-26	Typical Plumbing Penetration - Roof
	U-27	Exhaust Ventilation Penetration
	U-28	Smoke Dampers

...se note that this guide is not meant to replace the drawings or specifications laid out by the architect or provide a fully exhaustive list of areas where these issues may occur.

Typical & Unique Checklists

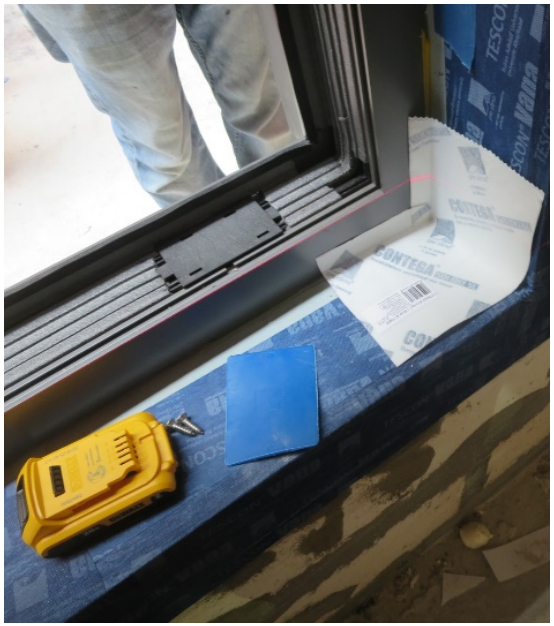
Testing Tools and Protocols

- Window mockup testing
- Interim guarded blower door testing
- Interim whole building test if schedule and sequencing allows
- Envelope compartmentalization and window testing
- Unique component testing
- Whole building blower door test

Mock Ups

Purpose-Built Assembly, Off-site / On-site, or First Install

Mock ups



Complete Assembly including Windows

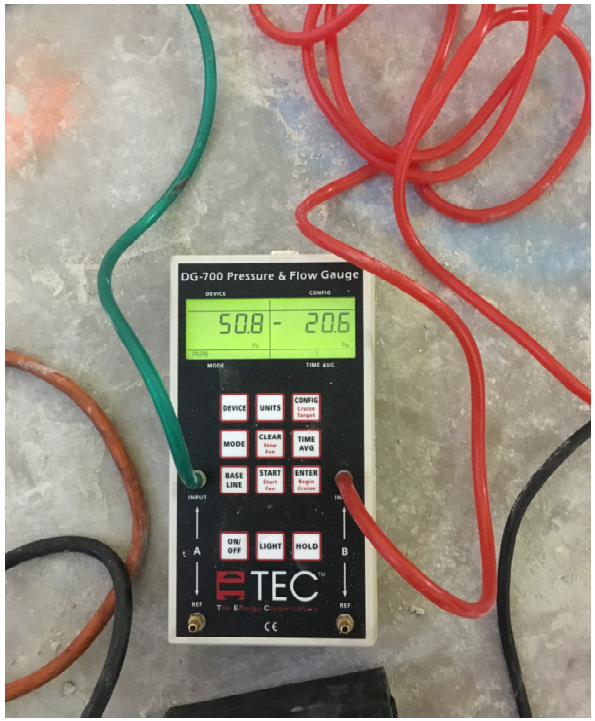
Repeat the Successful Steps Every Time

Repeat the Successful Steps Every Time

Interim Testing

- Window mockup testing
- Envelope and window testing
- Unique component testing
- Guarded blower door testing
- Whole building blower door test

Testing Interior-Side Air-barrier



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WHOLE BUILDING INFILTRATION TESTING PLAN
TO DETERMINE COMPLIANCE WITH PHIUS+ AIRTIGHTNESS REQUIREMENTS
AT BEACH GREEN DUNES PHASE II
45-19 ROCKAWAY BEACH BLVD., QUEENS, NY 11691
REV 1

APRIL 17, 2018
UPDATED 10/16/2019

Blower Door Test Plan

Whole-Building Blower Door Testing

Whole-Building Blower Door Testing

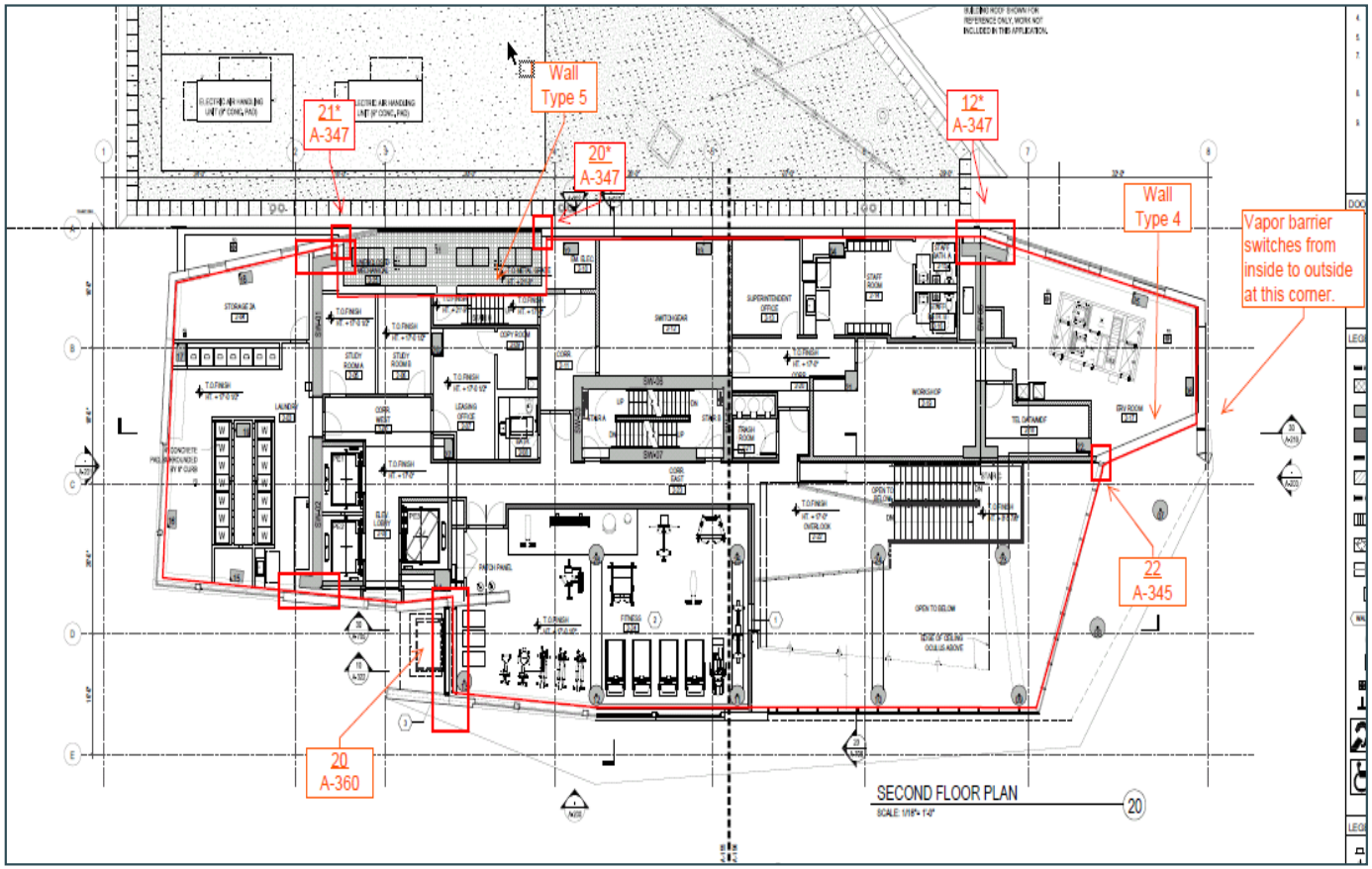
Who needs to be involved to insure that the air barrier is installed correctly?

Questions?

Case Studies

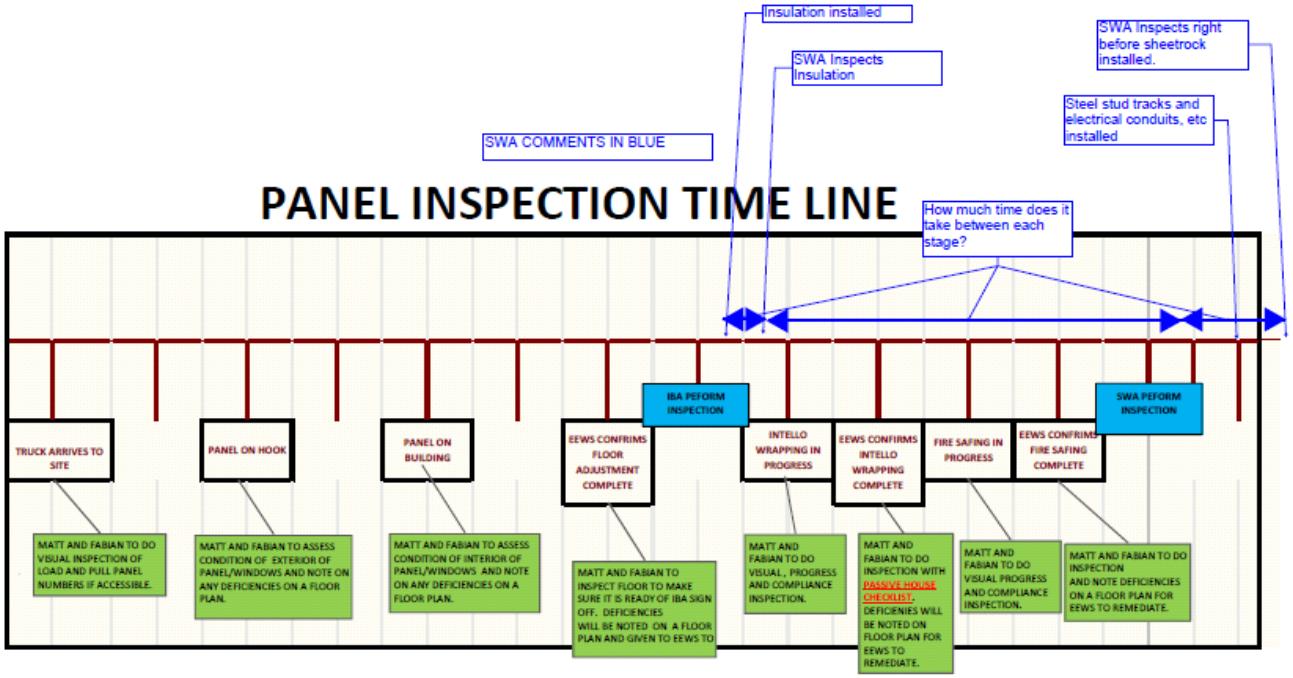
The House at Cornell Tech

- 352 units, student housing
- Roosevelt Island, NY
- Panelized wall system



Redline Plan & Section – Air Barrier Review

Identify Sequencing & Timing of Inspections

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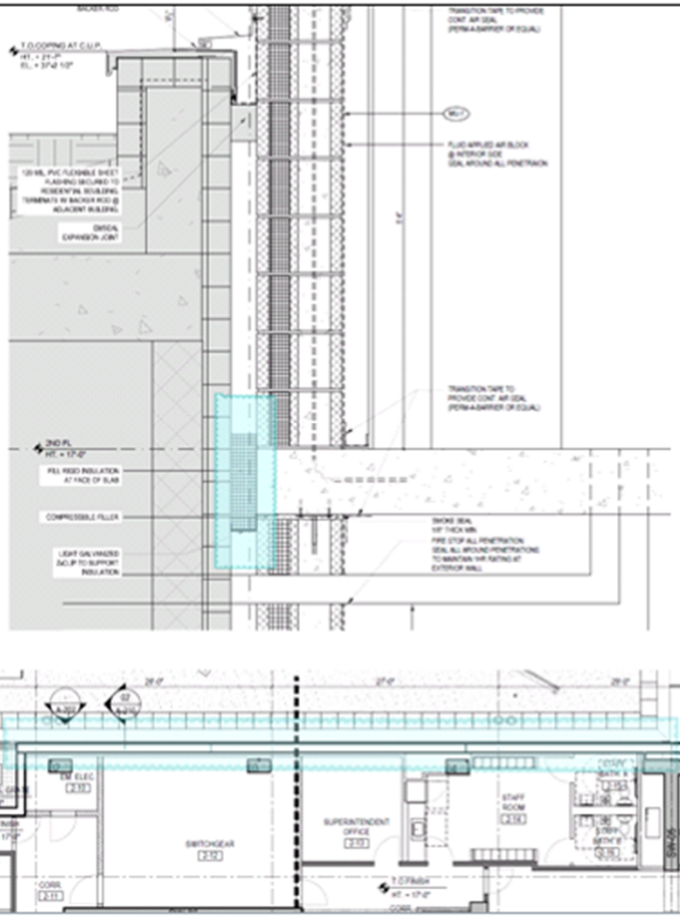
Wall Panels

Item #	Description	Image
	2nd Floor Slab Edge Insulation: Refer to architectural details 20 A-356. Detail 20 shows 4" thick nsulation at the slab edge between the CUP and the Residential Tower extending 2" above and below the slab (highlighted area in detail at right). This conditions exits at the area highlighted on the plan to the right.	

Site Visit Reports

Issues Log

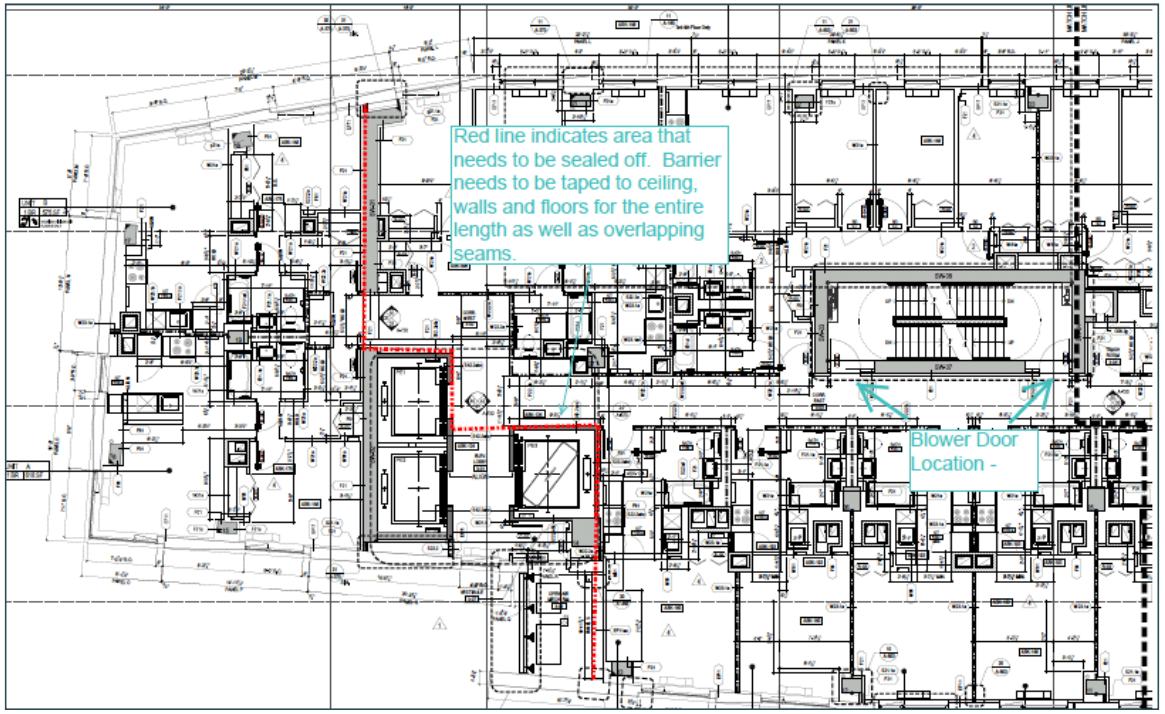
Issues Log - 1/25/2017

SVR #	SVR Item	Issue Type	Location	Issue	Found by	Date Found	Action Required	Responsible Party	Reinspection Required?	Actions Taken/Updates	Date Verified/ updated	Open/ Closed
7	1	ENV	7th Floor	**Panel Insulation at Joints:** Insulation at the panel joints was found to be around 6 inches deep. Shop drawings indicate 9". (EEWS Shop Drawings Sheet 501, Detail 1, second image right). SWA notified Monadnock of the issue. Monadnock followed up with a photo on 5/11/16 and informed SWA that EEWS will continue to install insulation at 9 inch depth. All panels below the six floor will need to be inspected for insufficient insulation and corrected if needed via exterior scaffolding when exterior caulk is applied.	SWA	5/10/16	Photo documentation using a measuring device will be required to verify PH compliance. SWA & EEWS to agree on frequency of photos and method of depth verification.	Eastern	Y	On 9/22/16, Eastern issued photos of joint insulation being installed along two swing stage areas (Rig 3 Drop 2 and Rig 3 Drop 4). SWA will continue keeping track of Eastern's progress.		Ongoing
24	2	ENV	2nd Floor	Gap at the corner of storage room and condenser porch located behind the column is not air sealed at this time. Neither is the connection of Intesana to block. SWA to inspect when complete.	SWA	8/9/16	Monadnock to send photos of the area to SWA.	Monadnock	N			Open
42	3	HVAC	All Floors	**Damaged Ductwork Covers:** SWA observed numerous instances of damaged ductwork opening covers damaged or loose throughout the first and second floors. SWA believes a significant amount of dust has likely accumulated in the ductwork. The project is now at risk of losing a LEED point needed for LEED Platinum certification.	SWA	11/21/16	Monadnock to make sure that all ductwork openings have been covered on floors 1, 2, 15-25. Monadnock to issue written confirmation to SWA once this work has been complete. SWA to spot check these areas in its next visit.	SWA	Y	On 11/30/16, SWA observed that much of previously noted loose and damaged ductwork opening covers were repaired. Issues still persist on the various floors. SWA performed spot checks on floors 1, 2, 15-25 and found issues in all floors. On 12/1/16, Monadnock emailed SWA notifying that floors 1,2, and 15-25 had been reinspected and damaged ductwork covers had been repaired. On 12/12/16, SWA observed issues on floors 1, 2, and 17.		Open
n/a	n/a	ENV	2nd Floor	**Insulation under 2nd floor condensor porch ballast** was covered before SWA could inspect. Images showing insulation depth and coverage must be provided.	SWA	5/24/16	Monadnock possesses photo documentation that shows depth and coverage. Provide images to SWA.	Monadnock	N	On 7/28/2016, Monadnock sent photos showing depth of insulation at condensor porch ballast.	7/28/2016	Closed
n/a	n/a	ENV	26th & 27th Floor	**Roof deck insulation inside AHU curb** was covered before SWA could inspect. Images showing insulation depth and coverage must be provided.	SWA	5/1/16	Monadnock possesses photo documentation that shows depth and coverage. Provide images to	Monadnock	N	On 10/1/2016, SWA received photos from Monadnock showing blurry tape measurements of insulation at the AHU curbs. On 10/24/2016, SWA	10/24/2016	Closed

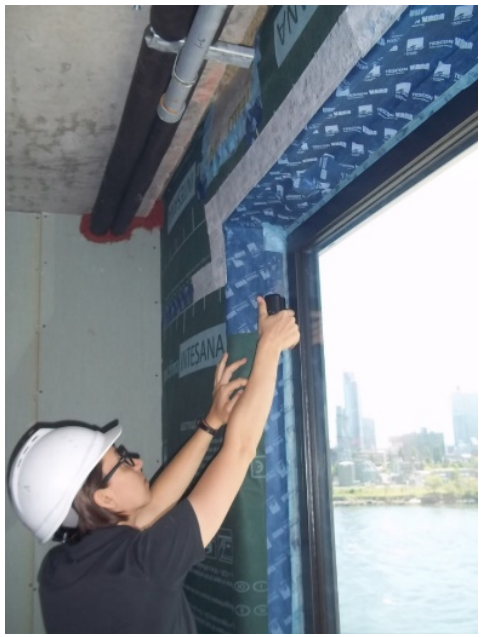
Interim Testing

- Original plan – no whole floor testing
- Revised plan – guarded testing on 4th, 5th and 6th floors
- Window & Door Leakage
- Façade Leakage
- Compartmentalization

Guarded Test & Temporary Barriers



Guarded Test = Blower Doors on 3 Floors



Other Tests

- Condenser porch doors
- Trash chute rooms / doors

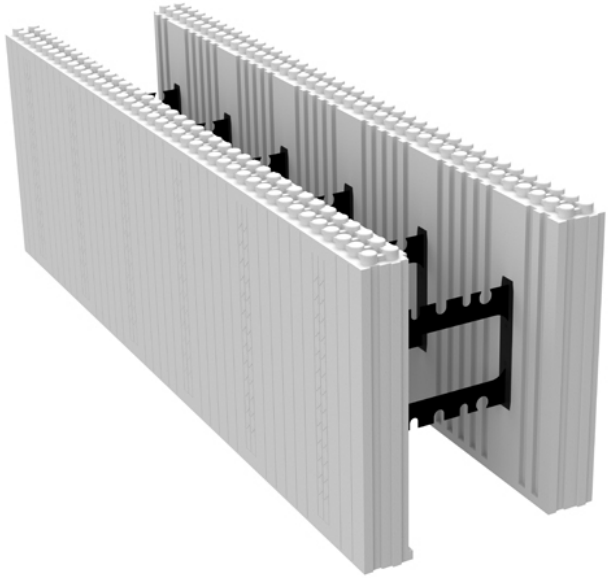
Results

- 6/3/2017 - blower door test completed
  - 0.13 ACH50 (more than 4x less than 0.6)
- ERVs commissioning completed
- 8/1/2017 - students moved in
- *10/17/2017 - PH Certification received!!!*

Beach Green North

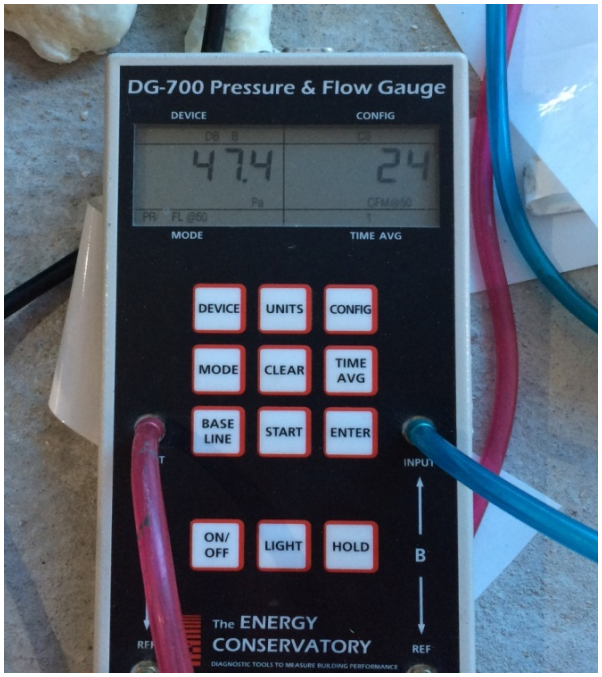
- 101 units, affordable housing
- Far Rockaway, NY
- Insulated concrete forms (ICF)

Wall Inspections



- ICF doesn't require as many inspections for insulation and air barrier

1st Window Mock-up Test



2nd Window Mock-up Test

ICF Potential Issues (similar project)

ICF Potential Issues (similar project)

Results

- AeroBarrier by Aeroseal was utilized
- 6/24/2017 - envelope leakage test performed but couldn't finish, Building Department shut down site for working on Saturday
- 7/6/2017 - infiltration test for energy model passed!!
- ERV testing & commissioning completed
- *4/4/2018 - PHIUS Certification received!!!*

Final Blower Door Test Planning

Blower Door Test Conditions

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

WHOLE BUILDING INFILTRATION TESTING PLAN
TO DETERMINE COMPLIANCE WITH PHIUS+ AIRTIGHTNESS REQUIREMENTS
AT SAINT JOHN NEUMANN

MAY 8, 2017
UPDATED JUNE 22, 2017

Key: HVAC Contractor; Plumber; GC / Builder

Intentional Opening	Test Setting	Notes
Windows, doors, skylights in the building enclosure	Closed and latched	
Doors and operable windows inside the test enclosure	Open	Use stairways to connect all zones of the building
Fire dampers	Remain as found	
Dryer doors	Closed and latched	
Gas meter room	Door to gas meter room closed and weather stripped	
Waste handling system	Trash chute termination at roof taped off. Door to trash rooms closed.	
ERVs (apartments)	Fan off, any dampers closed. Ducts to the outside sealed inside the ERV cabinet in each apartment.	Ventilation is continuous, so can remain taped off
Motorized dampers: ERV-4 (cellar)	Fan off, dampers closed. Taped off from the exterior	Ventilation is continuous, so dampers closed and sealed off
Motorized dampers: ERV-5 (1st floor)	Fan off, dampers closed. Taped off from the exterior	Ventilation is continuous, so dampers closed and sealed off
Motorized dampers: ERV-2A (1st floor)	Fan off, dampers closed. Taped off from the exterior	Ventilation is continuous, so dampers closed and sealed off
Motorized damper: Laundry Room (2nd floor)	Fan off, dampers closed. Taped off from the exterior	Untaped for Method A test
Motorized damper: ERV-2 (2nd floor)	Fan off, dampers closed. Taped off from the exterior	Ventilation is continuous, so dampers closed and sealed
Motorized dampers: EMR (1st floor), Stair A, Star B, Elevator, Boiler Room (roof)	Taped off from the exterior	Untaped for Method A test

Whole Building Test Logistics

- Enough fans, cruise manometers, frames, shrouds, tubing, CAT5 cabling, people?
- Is building access limited to avoid people opening and closing doors, windows, etc.?
- Thorough walkthrough the day prior to test date to confirm prep has taken place?
- GC and appropriate subs on site to help with building prep and issues that come up on the test day?
- Saturday work permits active?

Central ERVs and Blower Door

- Need to seal off ERVs for the test
- Wrap rooftop ERVs and/or seal exterior intake and exhaust louver ports

Individual ERVs and Blower Door


- Typically can't reach all vents to seal from outside
- Tape off both outdoor connection ports inside every ERV
- Some ERV's can't be sealed inside the cabinets

Recommendations for Success

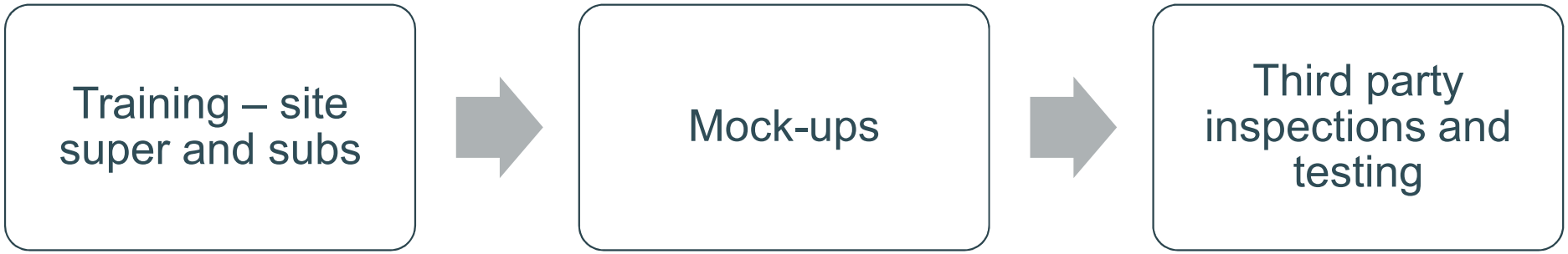
Do This

- **Insist on**
  - Training for construction staff
  - Mockups & don't stop until the window mockup passes
  - Interim blower door testing
- **Advanced Planning**
  - Typical and Unique checklists
  - Blower door testing plan
- **Quality Control**
  - Typical details readily available on site for all subs
  - Communication between GC and PH verifier
  - Panelized construction, if applicable

Do NOT Do This

- **Be wary**
  - Assume if the GC has done a PH / Net-Zero project that the second will automatically pass
  - Keep going without passing the window mockup
  - Depend on subs understanding contract docs without communication
  - Allow the GC to exclude meeting PH requirements from the contract
- Ignore your PH Consultant!!!!!

Construction Process and Quality Assurances



Summary

- Thermal insulation slows heat flows and drying
- Moisture management is **critical!** Understand it.
- Understand dew-points and condensation control
- Understand vapor retarders and their placements
- Air barriers must be complete and continuous
- Insulation is ineffective without air barriers

Summary Continued

- The air barrier must be planned and delineated
- Reduce thermal bridges
- Specify grade I Insulation
- The code will not save you
- Multiple viable insulation / air-barrier options for all circumstances.
- Consider the issues to make informed selections

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- **Module 5**: Contracting for Passive House: Construction Documents and Bidding
- **Module 6**: Deep Energy Retrofits: Strategies for Gut Rehab or Full Occupancy Retrofits
- **Module 7**: Beyond Hydrofluorocarbons (HFCs): Refrigerant Management in Design, Construction, and Operations
- **Module 8**: Construction Manager/Subcontractor/Tradesperson Training: Classroom and Field Training

Register here: https://www.newpaltz.edu/sustainability/view-programs-and-progress/zero-net-carbon-training/workshop-schedule-registration--details/

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Resources

- www.airbarrier.org