# AIR BARRIERS AND COMMISSIONING

## Owner and Developer Perspective

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## OVERVIEW

- Developer/Owner Perspective
  - Value of Air Barrier and Commissioning?
    - Costs of Tight Air Barriers
    - Challenges of Air Barrier Design and Installation
      - HVAC, Structural, Quality Control
    - Challenges of Measurement and Testing
  - Experience with Whole Building Pressurization

# What I Develop: Midrise Wood-frame Apartments

SITKA APARTMENTS - 2005

RAMONA APARTMENTS - 2011

# Value of Air Barriers and Commissioning

- I'm a big fan of both
  - Started Ramona design with 8 massing models, then studied 12 options for air/moisture/thermal barriers (opaque wall R-value, energy use), then modeled whole wall R-value with 3 different windows
  - Use an envelope consultant/building scientist
  - Extensive water/air testing – mock-up, in place
  - Energy modeling and track actual energy use
  - Blower door tests on apartments, whole building pressurization on Ramona

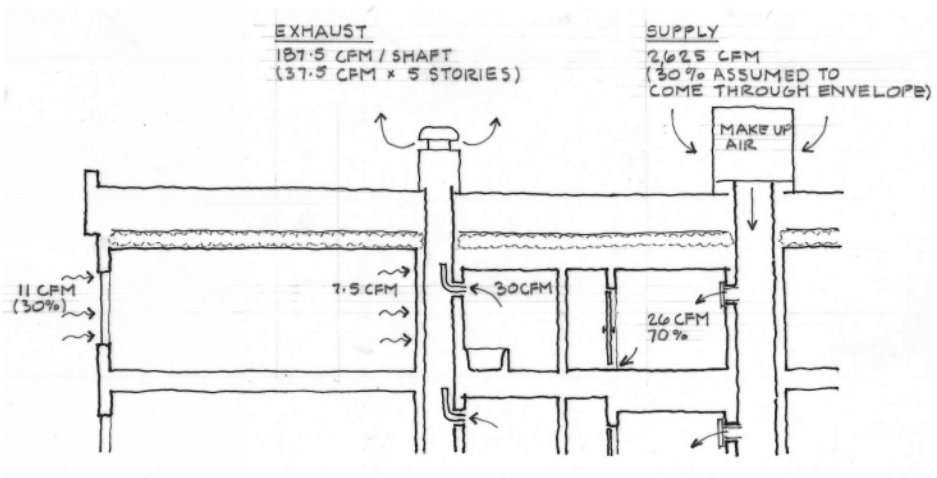
## Barriers for Developers

- For many developers
  - No $ payback from extra cost unless
    - Intending to hold long-term and
    - Building owner pays for heat and air conditioning
  - Costs could include
    - Costs of barrier design and installation
    - Related costs from changes in HVAC
    - Possible increases in operating costs
    - Risks of failures

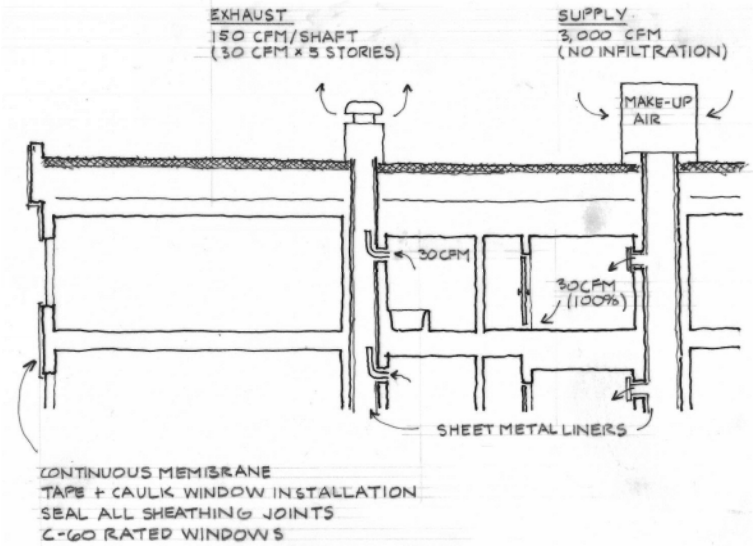
## COSTS OF TIGHT AIR BARRIERS

- Sitka - with tight air barrier
  - Added construction costs
    - Sealed joints
    - Sheet metal lining for supply and exhaust shafts (to reduce leakage)
    - Separate HVAC for laundry
  - 14% higher utility costs for make-up air (3,000 CFM vs. 2,625 CFM after reminding mechanical engineer after air-tightness)

## ENVELOPE INFILTRATION – TYPICAL
### Cheap for owner, expensive for tenants




## ENVELOPE INFILTRATION – SITKA
### Added heating/cooling for owner, lower for tenants

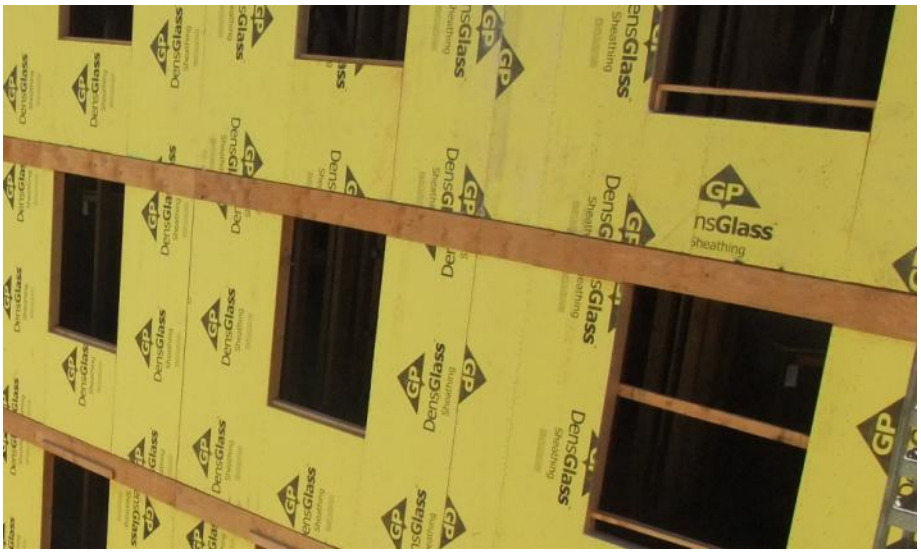


## CHALLENGES – In the field

- Sitka used sealed joints on exterior gypsum
- Ramona used taped Tyvek
  - Sealed all horizontal joints, assumed vertical joints fell on studs and were relatively tight
  - Framer used pre-fabricated walls,
    - Came out in 12' lengths with sheathing installed
    - Saved costs and time, but
      - Left a large gap every 12' on wall

## Sitka – Sealed joints on gypsum

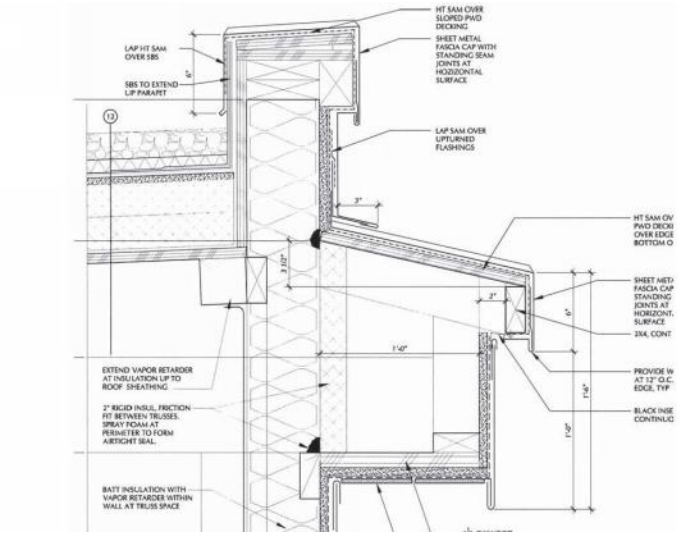
## RAMONA
## Vertical joints with gaps




## CHALLENGES – from the design team

- Ramona cornice construction detail changed by design team
  - Had cornice built as part of roof truss instead of framing it onto wall
  - Improved structural attachment, but
    - Required venting cornice
    - Air barrier had to make transition from outside of sheathing to inside of framing
    - Became impossible to get tight seal

# Ramona Cornice




# Ramona Cornice

## Ramona Cornice

## CHALLENGES - Quality control

- Ramona air barrier design relied on Tyvek being airtight
  - Installers left loose ends flapping in wind, potentially tearing at staples
  - Masons had to cut Tyvek to install brick ledgers
    - Ledgers didn't arrive
    - Left massive slices in Tyvek in courtyard on windiest day of the year

# Tyvek Installation

# Tyvek Installation

## CHALLENGES - Products

- Patio Doors
  - Selected the best we could, but had extensive and repeated failures in water and air testing, both on mock-up and in field testing
- Window wrap material
  - At contractor's suggestion, upgraded to higher quality wrapping material
  - Found out after all cladding was installed that we got a bad run and had potential delamination

## MEASUREMENT CHALLENGES

- What are we measuring?
  - Air barrier tightness or whole building tightness
- Ramona original plan for HVAC was to "compartmentalize" each apartment
  - Horizontal ducting of intake and exhaust
  - No connection to hall, no shared shafts
- Concerns about air-tightness
  - Multiple penetrations
  - Backdraft potential

## MEASUREMENT CHALLENGES

- Blower door test results
  - Sitka - 0.166 ACH (incl. one high outlier)
  - Ramona – 0.1406 ACH
- 15% better with taped Tyvek instead of sealed gypsum

## Controlling for other variables

- Was improvement a result of taped Tyvek or a result of other Ramona differences?
  - Smaller and better windows
  - Improved window wrap/installation
  - Better patio doors (after multiple adjustments)
  - Double layer of sheetrock with staggered joints
  - Minimal # of electrical boxes on exterior walls
  - Putty pads and gaskets at electrical/CATV boxes

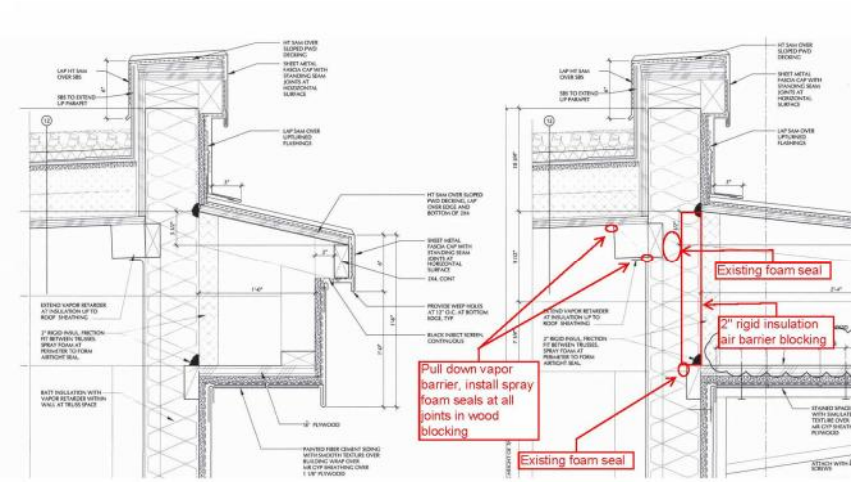
# WHOLE BUILDING PRESSURIZATION
## Unexpected Benefits

- Thought it would only help for next building
- Pressurization and thermal imaging (building heated to 23° - or 74° - for 2 days)
  - Found and corrected cornice leaks (thermal imaging and smoke pencils)
  - Found casements that needed adjustment
  - Added vestibule at elevator in garage
  - Added weather-stripping to secondary exterior doors (e.g. door from hallway to loading dock)

# WHOLE-BUILDING PRESSURIZATION
## Thermal Imaging

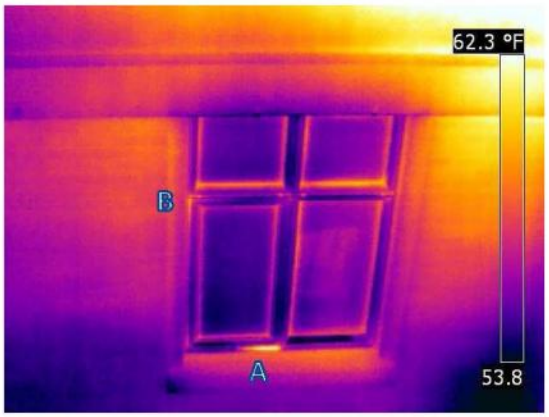
**Friday, March 4th 4:20 PM 55 degrees F**
**South Wall of Courtyard**
Air leakage is visible at the roof to wall connection (A). It is not unusual to see air leakage at such intersections, especially at inside and outside building corners, as air barrier construction is difficult where the building geometry is complex. The brick ledger (B), is also visible as a clear thermal bridge, conducting heat through the building frame to the exterior. It is typical for brick ledgers to conduct heat unless thermally isolated from the building frame. Note the heat signature at the outside edge of the soffit (C). The roof-to-wall intersection is the likely source of this warm air leakage.

# WHOLE BUILDING PRESSURIZATION
## Cornice Detail Adjustments




# WHOLE BUILDING PRESSURIZATION
## Casement windows

**Saturday, March 5th 3:23 PM 68 degrees F**
**North Wall of Courtyard, Sixth Floor**
*Positively Pressurized*
Air leakage is visible at the lower right corner of the operable casement sash (A), while additional minor air leakage is also evident at the top left corner of the operable sash (B). Although this window system features three gaskets, it is evident that insufficient compression of the gasket is the cause of air leakage at the operable unit. The window manufacturer has indicated that simple adjustments can be effected to improve the gasket compression for better air tightness.



## WHOLE BUILDING PRESSURIZATION
## Added vestibule at elevators in garage

## CONCLUSIONS

- In my experience….
  - Air barrier is important component of energy reduction and resident comfort
  - Requires integration with HVAC
  - Requires constant vigilance throughout design, construction, submittals, etc.
  - Need clearer goals about testing, need to isolate other variables in design

# THANK YOU