AXIOM BUILDERS

WBALT
What are we testing?

Dan Gronross
Axiom Builders

Agenda

The air barrier and WBALT

Code Requirements

Installation

Standard Operating Procedure

Results

Common Issues, Lessons Learned

Introduction | AXIOM BUILDERS

Axiom Builders is a construction partner for many major developers and is active in both residential and commercial construction.

We currently have over 12 million square feet under construction in Vancouver, Victoria, Calgary, and Seattle.

Introduction: Dan Gronross

15+ years in Building Envelope Consulting

2.5 years in the GC World

Program Director for BCBEC

Completed the BCIT Construction of Mass Timber Structures course in 2023

Embodied Carbon, VEC, CoR, UBC

Completed 70.3 and Full Ironman in 2023

AXIOM BUILDERS


If we just built
buildings better.

The Air Barrier

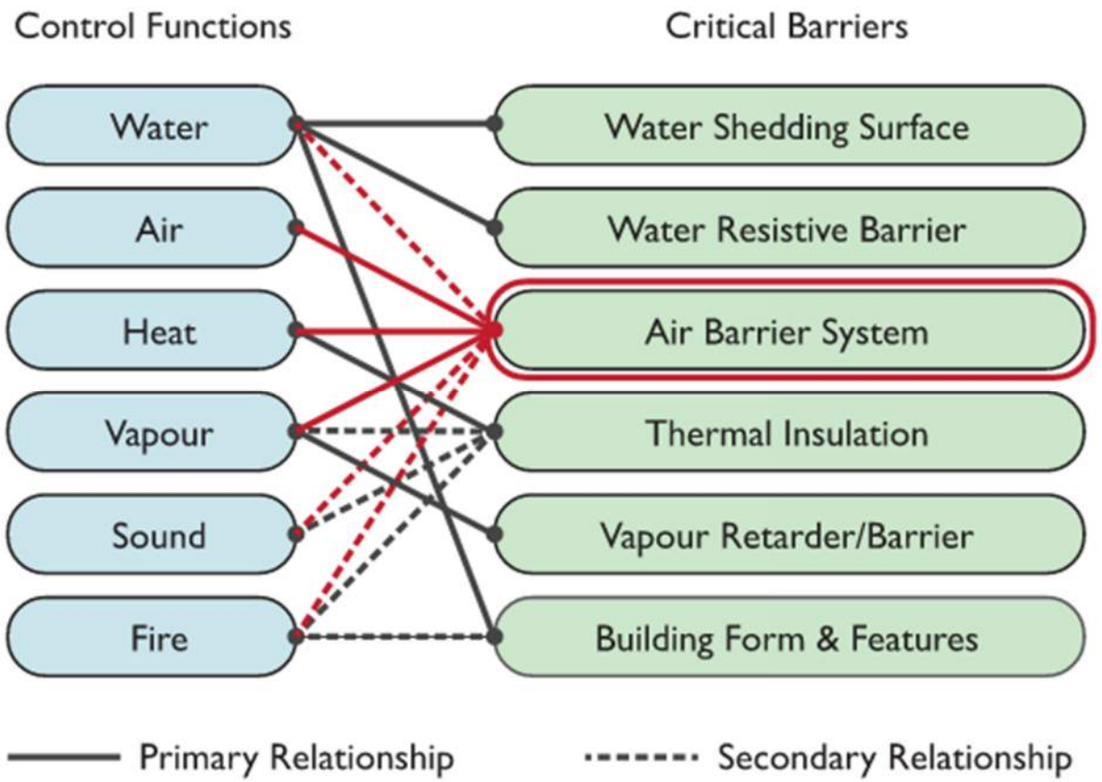
5.4.1.1. Required Resistance to Air Leakage
(See Appendix A.)

1) Except as provided in Sentence (2), where a *building* component or assembly separates interior *conditioned space* from exterior space, interior space from the ground, or environmentally dissimilar interior spaces, the component or assembly shall contain an *air barrier system*.

5.4.1.2. Air Barrier System Properties

1) Except as provided in Sentence (2), sheet and panel type materials intended to provide the principal resistance to air leakage shall have an air leakage characteristic not greater than 0.02 L/(s • m^2) measured at an air pressure difference of 75 Pa. (See Appendix A.)

BRITISH COLUMBIA BUILDING CODE 1998



BC HOUSING ILLUSTRATED GUIDE ACHIEVING AIRTIGHT BUILDINGS SEPTEMBER 2017

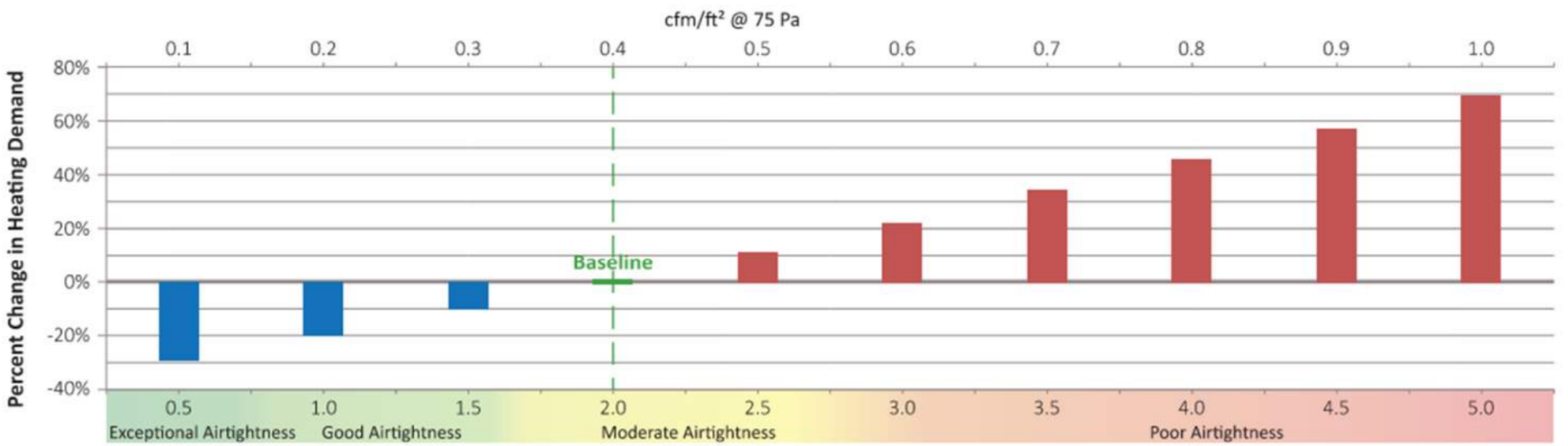
Importance

Energy Performance

- Six storey, 4700 m^2 wood-frame residential building
- Climate Zone 4
- Effective R-25 wall and U-0.27 glazing
- 60% efficient heat recovery ventilation
- Drain water heat recovery and low-flow fixtures
- LED lighting and occupant sensors in corridors

BC HOUSING ILLUSTRATED GUIDE ACHIEVING AIRTIGHT BUILDINGS SEPTEMBER 2017

Energy Performance

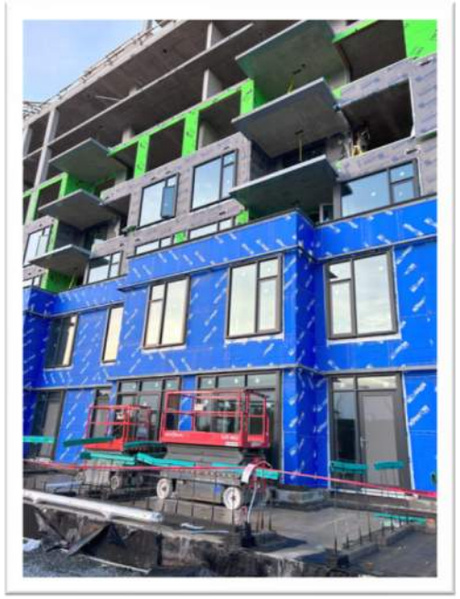


Heating energy demand changes due to improved airtightness

BC HOUSING ILLUSTRATED GUIDE ACHIEVING AIRTIGHT BUILDINGS SEPTEMBER 2017

Air Barrier Approaches

SELF-ADHERED SHEATHING MEMBRANE APPROACH



LOOSE-LAID SHEATHING MEMBRANE APPROACH

INTERIOR AIR BARRIER APPROACH

X

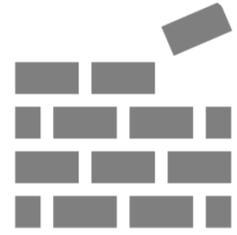
Team

OWNER

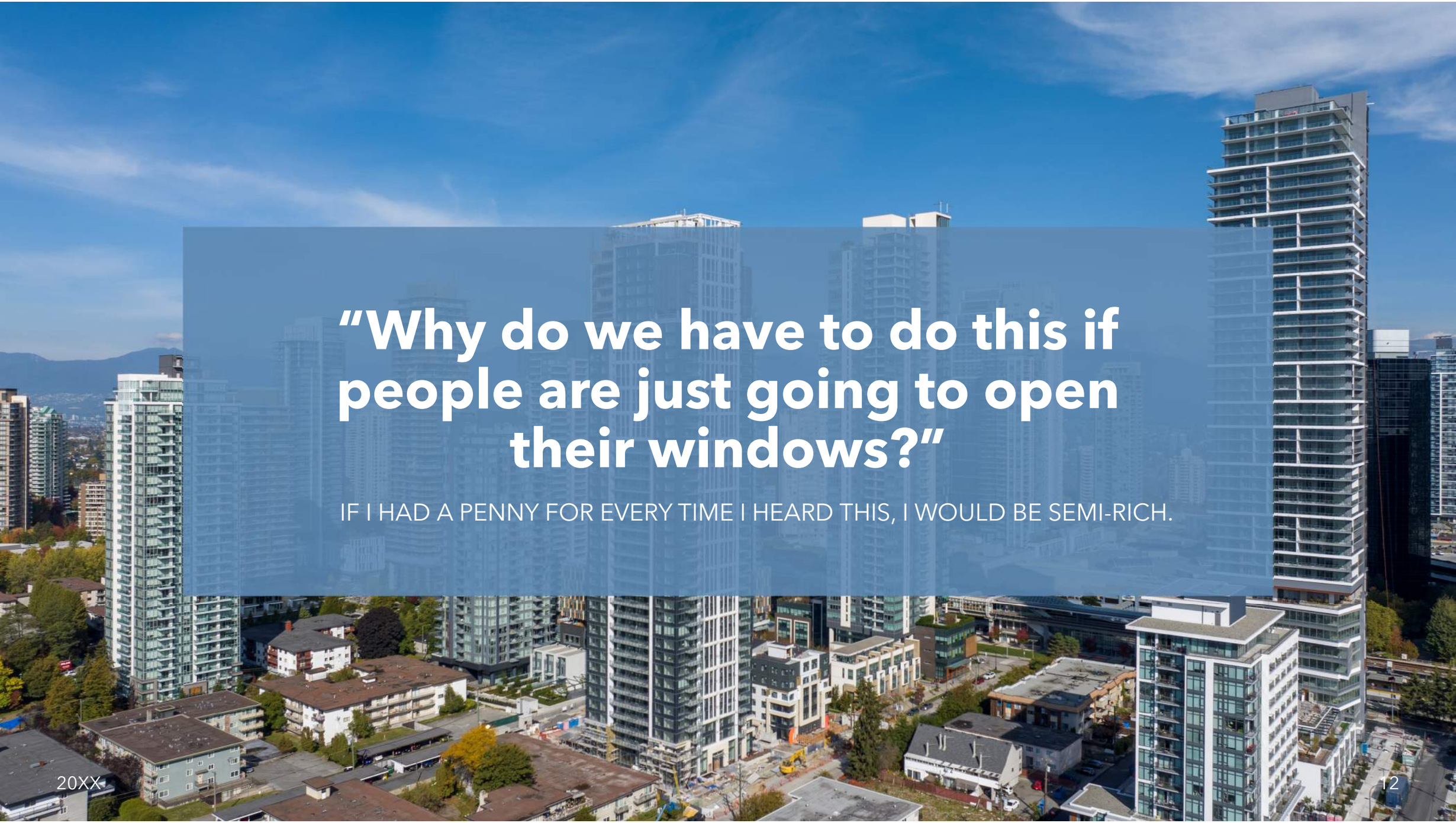
GENERAL CONTRACTOR

ARCHITECT

TESTING AGENCY / BUILDING ENVELOPE CONSULTANT



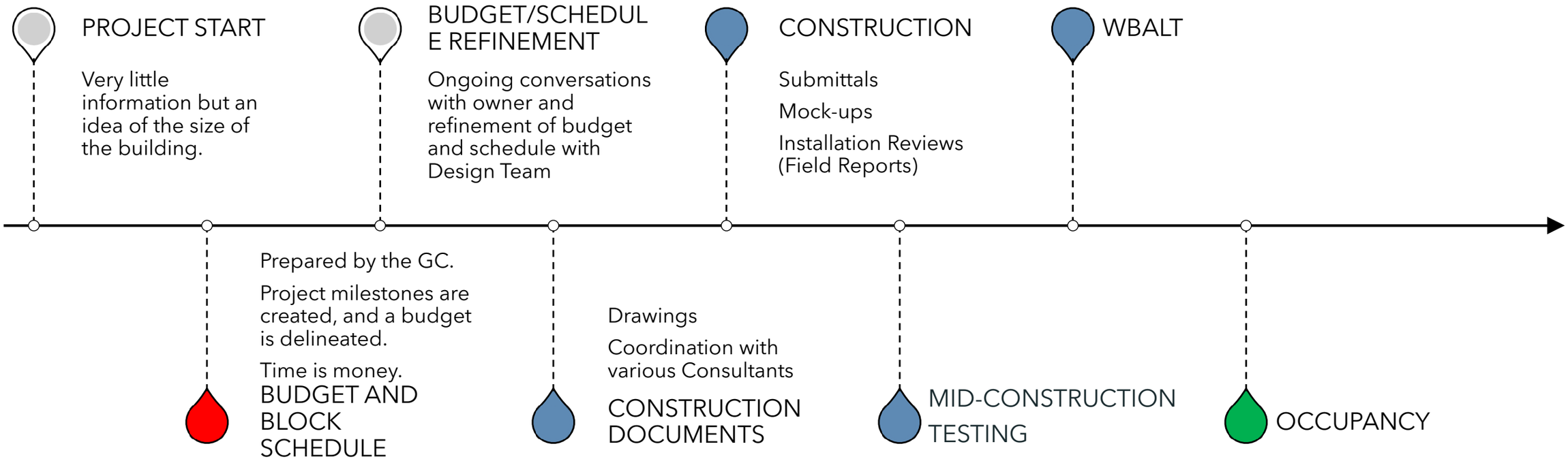
TRADES



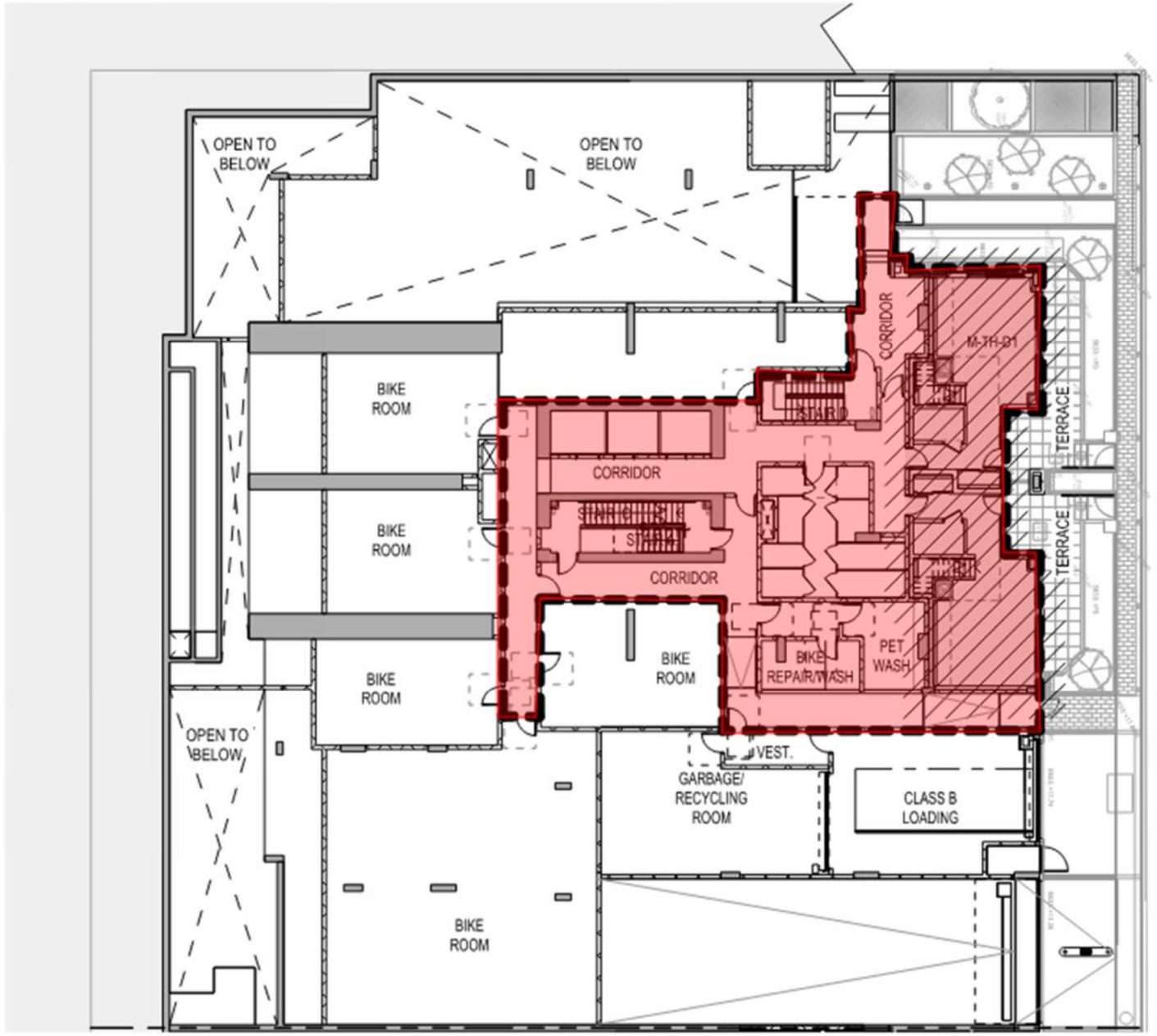
“Why do we have to do this if people are just going to open their windows?”

IF I HAD A PENNY FOR EVERY TIME I HEARD THIS, I WOULD BE SEMI-RICH.

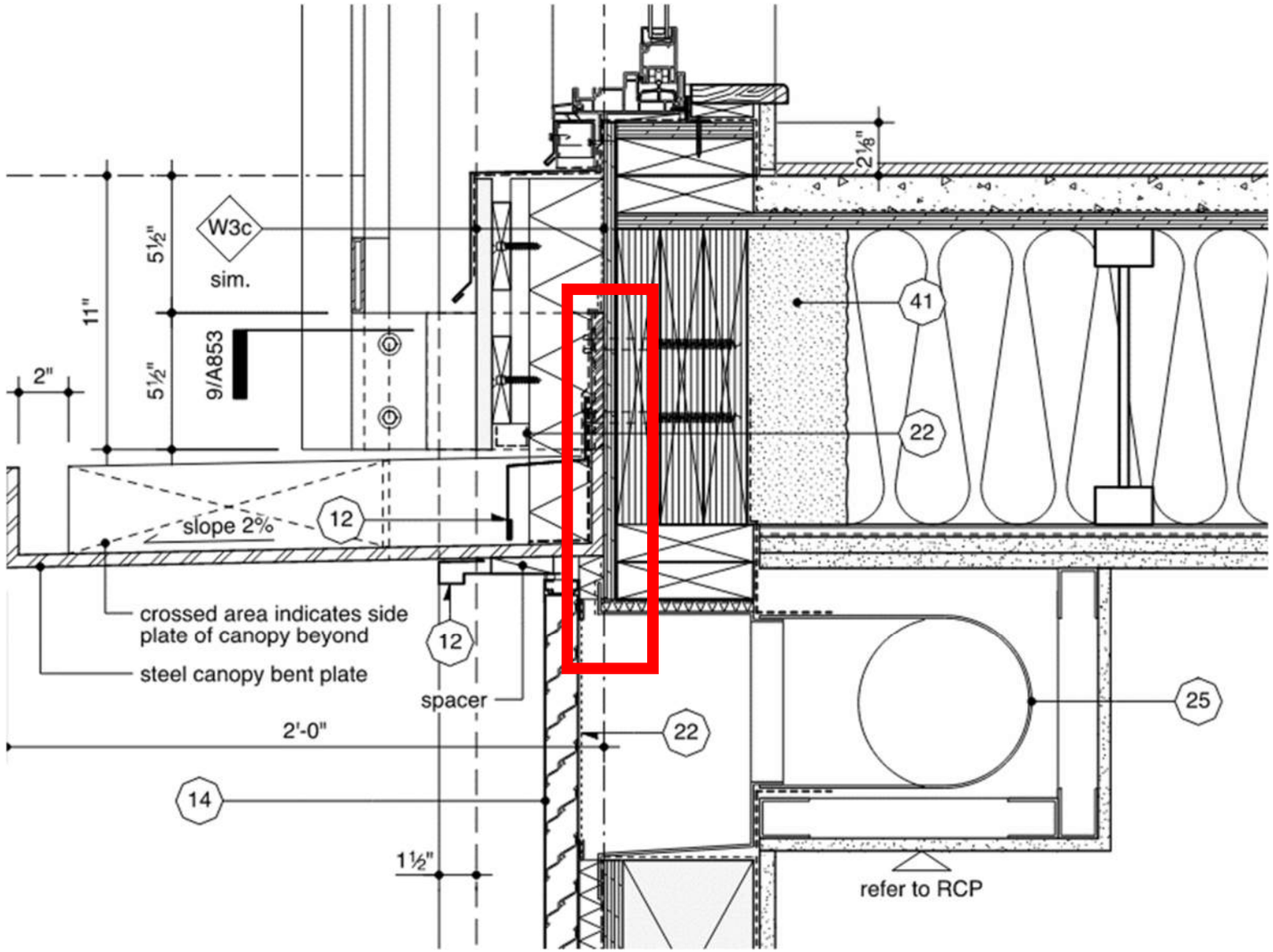
Project Timeline



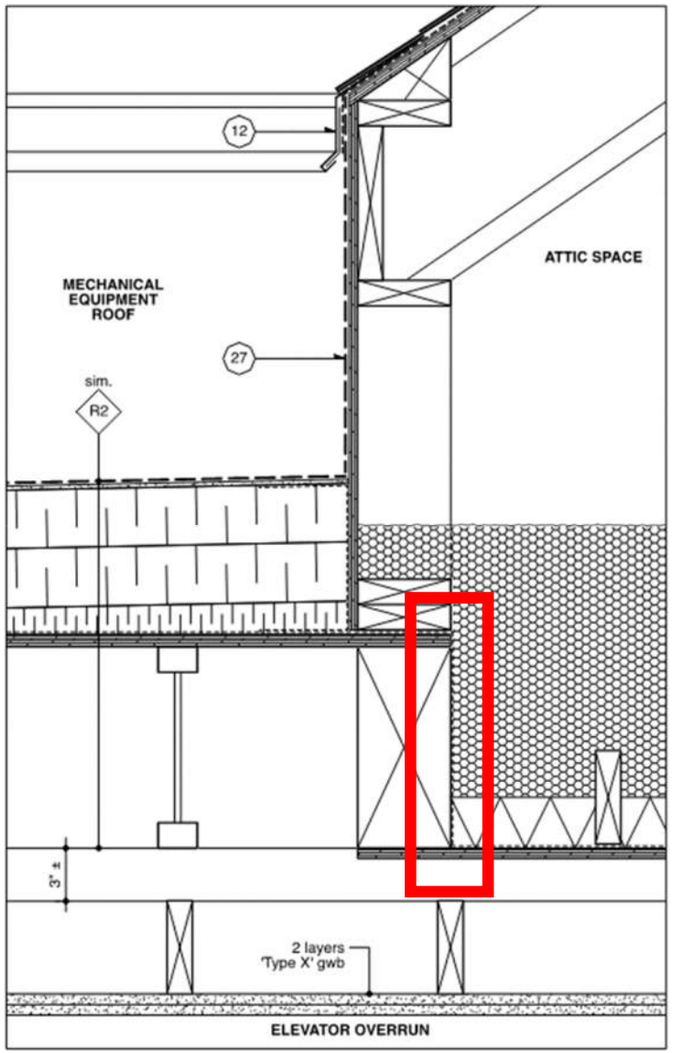
Construction Documents



Air Barrier Boundary



Coordination



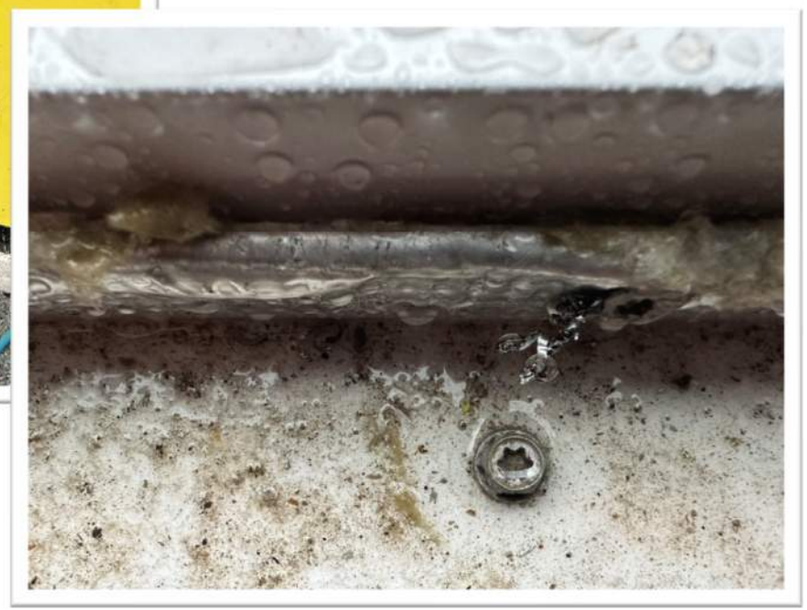
Constructability

Construction

Submittal Review

$150,000 increase over loose laid sheathing membrane.

INCREASE IN COST OF SELF-ADHERED SHEATHING MEMBRANE OVER LOOSE-LAID SEALED MEMBRANE APPROACH.



Mock-ups

Building Envelope Mock-ups

Ongoing Building Envelope Reviews w/ Project Teams

Field Testing

Field Testing

Mid-Construction Testing

Mid-Construction Testing

QUALITATIVE TESTING

PROS

- Testing the air barrier detailing.
- Easier to set up
- Discontinuities are easily identifiable.

CONS

- No metric on actual air leakage.

Mid-Construction Testing

Mid-Construction Testing

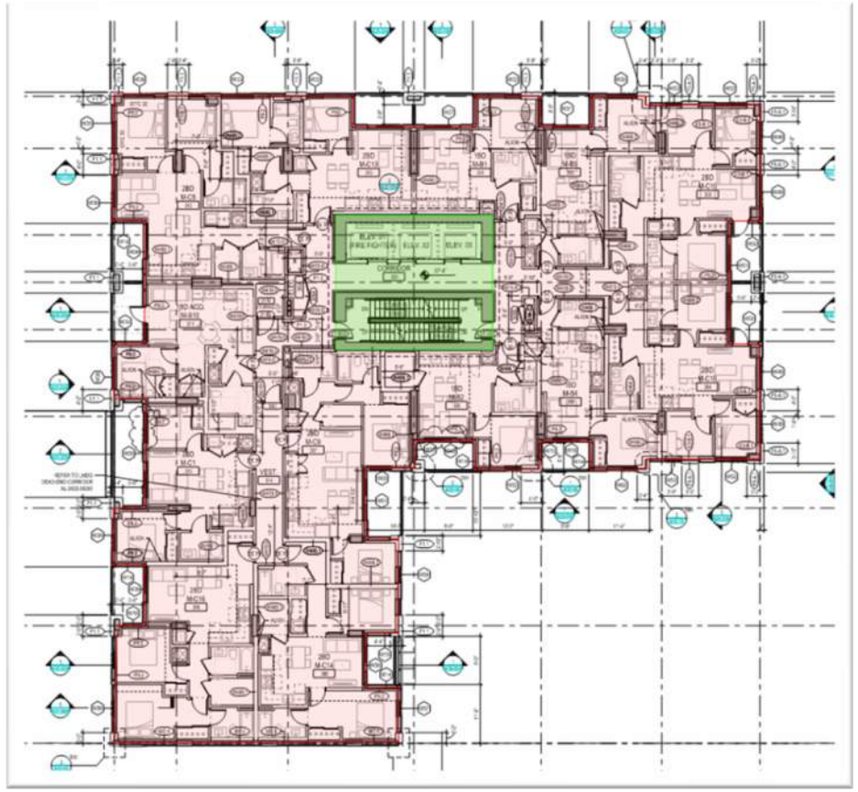
QUANTITATIVE TESTING

PROS

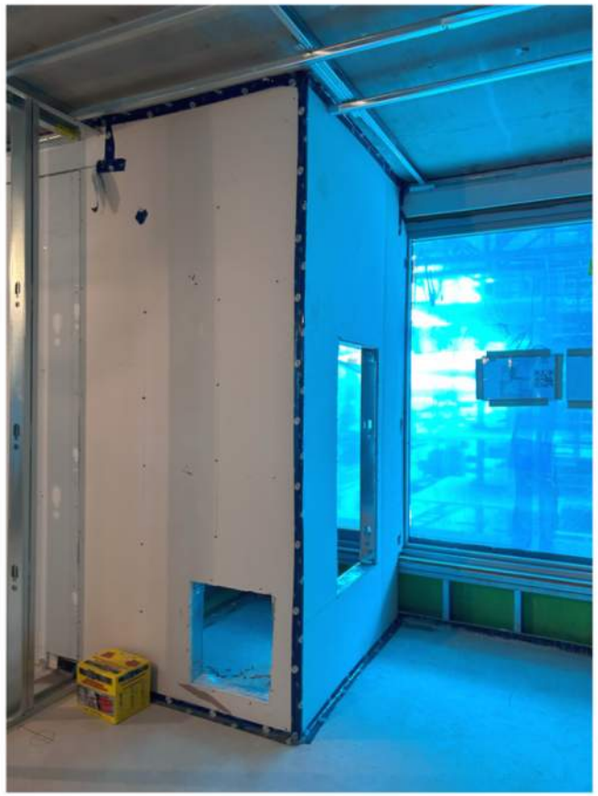
- Actual Metric of the air leakage

CONS

- What are we testing?
- Construction sequencing issues.



Mid-Construction Testing



Whole Building Testing

Testing Procedure

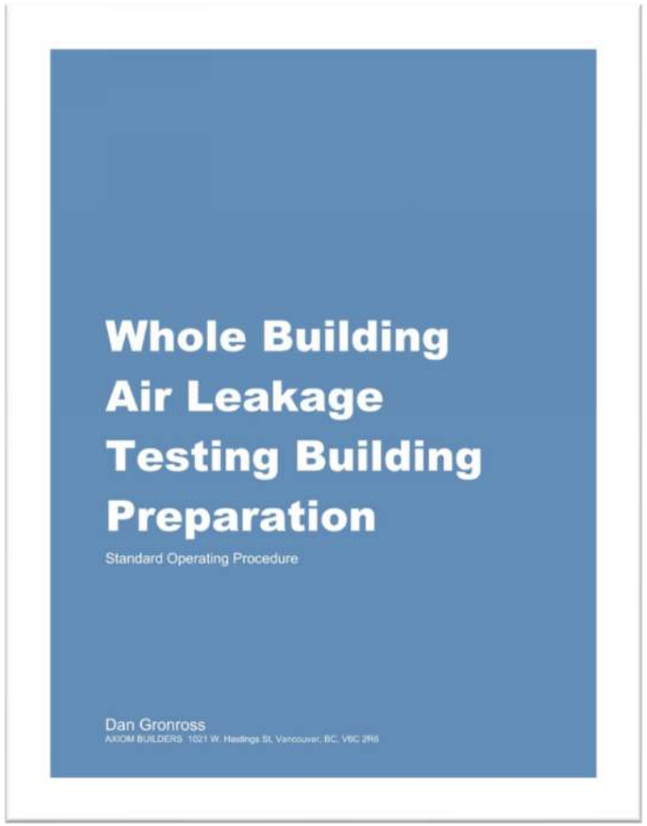
ASTM E-779 – Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

What Are We Testing?

What Are We Testing?

To get an accurate reading building preparation becomes key.

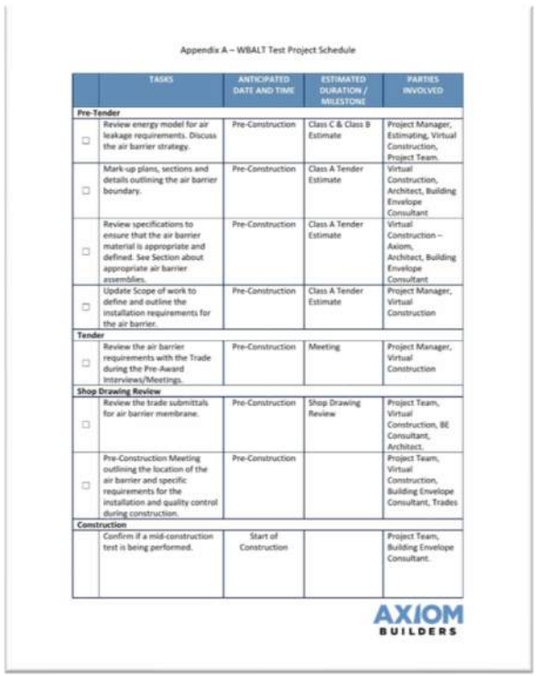
Standard Operating Procedure



- Guide for field staff to use in preparing the building for the test

- Air Barrier requirements
  - Examples
  - Checklists

Standard Operating Procedure



Appendix A – WBALT Test Project Schedule

	TASKS	ANTICIPATED DATE AND TIME	ESTIMATED DURATION / MILESTONE	PARTIES INVOLVED
Pre-Tender				
☐	Review energy model for air leakage requirements. Discuss the air barrier strategy.	Pre-Construction	Class C & Class B Estimate	Project Manager, Estimating, Virtual Construction, Project Team.
☐	Mark-up plans, sections and details outlining the air barrier boundary.	Pre-Construction	Class A Tender Estimate	Virtual Construction, Architect, Building Envelope Consultant
☐	Review specifications to ensure that the air barrier material is appropriate and defined. See Section about appropriate air barrier assemblies.	Pre-Construction	Class A Tender Estimate	Virtual Construction – Axiom, Architect, Building Envelope Consultant
☐	Update Scope of work to define and outline the installation requirements for the air barrier.	Pre-Construction	Class A Tender Estimate	Project Manager, Virtual Construction
Tender				
☐	Review the air barrier requirements with the Trade during the Pre-Award Interviews/Meetings.	Pre-Construction	Meeting	Project Manager, Virtual Construction
Shop Drawing Review				
☐	Review the trade submittals for air barrier membrane.	Pre-Construction	Shop Drawing Review	Project Team, Virtual Construction, BE Consultant, Architect.
☐	Pre-Construction Meeting outlining the location of the air barrier and specific requirements for the installation and quality control during construction.	Pre-Construction		Project Team, Virtual Construction, Building Envelope Consultant, Trades
Construction				
	Confirm if a mid-construction test is being performed.	Start of Construction		Project Team, Building Envelope Consultant.

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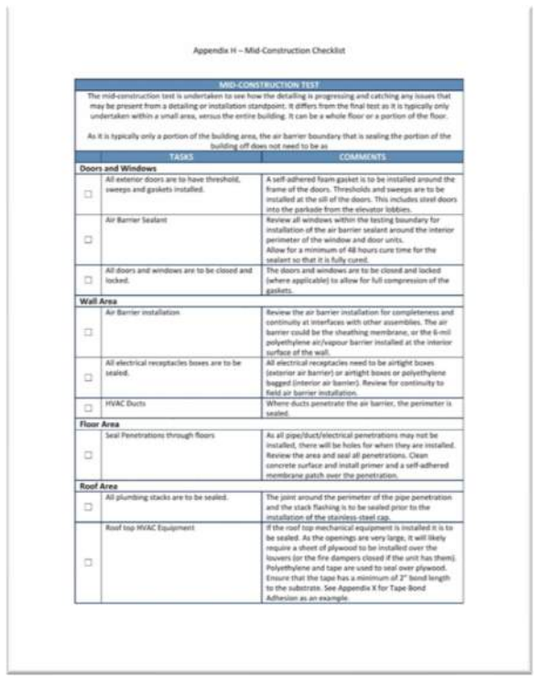


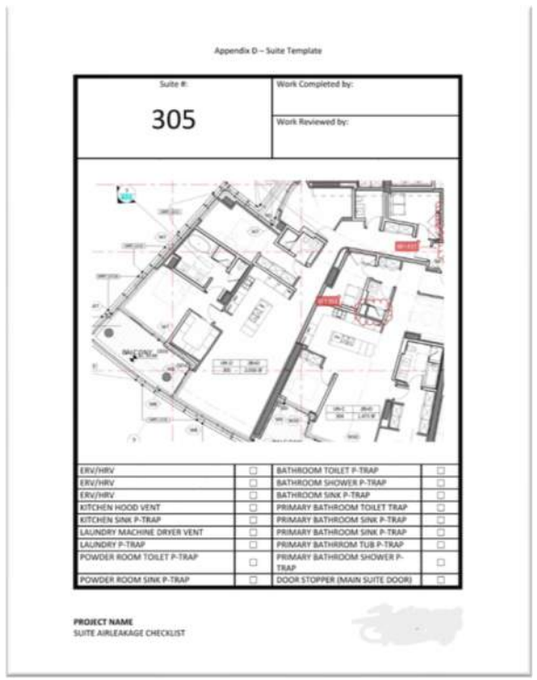
Appendix H – Mid-Construction Checklist

MID-CONSTRUCTION TEST

The mid-construction test is undertaken to see how the detailing is progressing and catching any issues that may be present from a detailing or installation standpoint. It differs from the final test as it is typically only undertaken within a small area, versus the entire building. It can be a whole floor or a portion of the floor.

As it is typically only a portion of the building area, the air barrier boundary that is sealing the portion of the building off does not need to be as

	TASKS	COMMENTS
Doors and Windows		
☐	All exterior doors are to have threshold, sweeps and gaskets installed.	A self-adhered foam gasket is to be installed around the frame of the doors. Thresholds and sweeps are to be installed at the sill of the doors. This includes steel doors into the parkade from the elevator lobbies.
☐	Air Barrier Sealant	Review all windows within the testing boundary for installation of the air barrier sealant around the interior perimeter of the window and door units. Allow for a minimum of 48 hours cure time for the sealant so that it is fully cured.
☐	All doors and windows are to be closed and locked.	The doors and windows are to be closed and locked (where applicable) to allow for full compression of the gaskets.
Wall Area		
☐	Air Barrier installation	Review the air barrier installation for completeness and continuity at interfaces with other assemblies. The air barrier could be the sheathing membrane, or the 6-mil polyethylene air/vapour barrier installed at the interior surface of the wall.
☐	All electrical receptacles boxes are to be sealed.	All electrical receptacles need to be airtight boxes (exterior air barrier) or airtight boxes or polyethylene bagged (interior air barrier). Review for continuity to field air barrier installation.
☐	HVAC Ducts	Where ducts penetrate the air barrier, the perimeter is sealed.
Floor Area		
☐	Seal Penetrations through floors	As all pipe/duct/electrical penetrations may not be installed, there will be holes for when they are installed. Review the area and seal all penetrations. Clean concrete surface and install primer and a self-adhered membrane patch over the penetration.
Roof Area		
☐	All plumbing stacks are to be sealed.	The joint around the perimeter of the pipe penetration and the stack flashing is to be sealed prior to the installation of the stainless-steel cap.
☐	Roof top HVAC Equipment	If the roof top mechanical equipment is installed it is to be sealed. As the openings are very large, it will likely require a sheet of plywood to be installed over the louvers (or the fire dampers closed if the unit has them). Polyethylene and tape are used to seal over plywood. Ensure that the tape has a minimum of 2" bond length to the substrate. See Appendix X for Tape Bond Adhesion as an example.



Appendix D – Suite Template

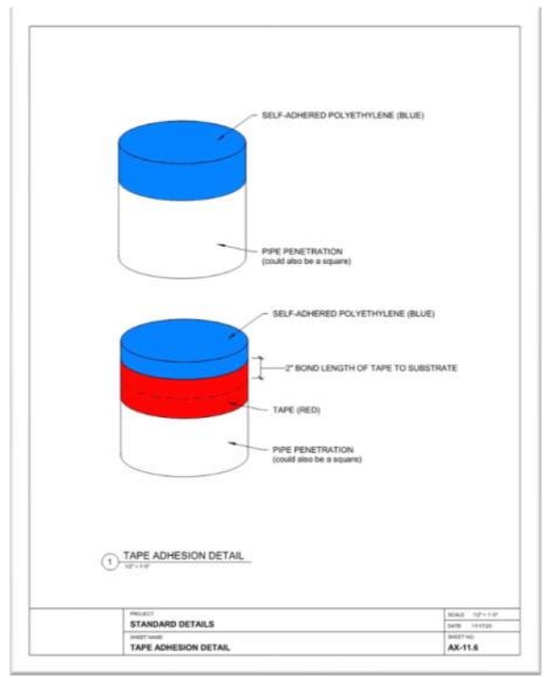
Suite #: 305

Work Completed by:

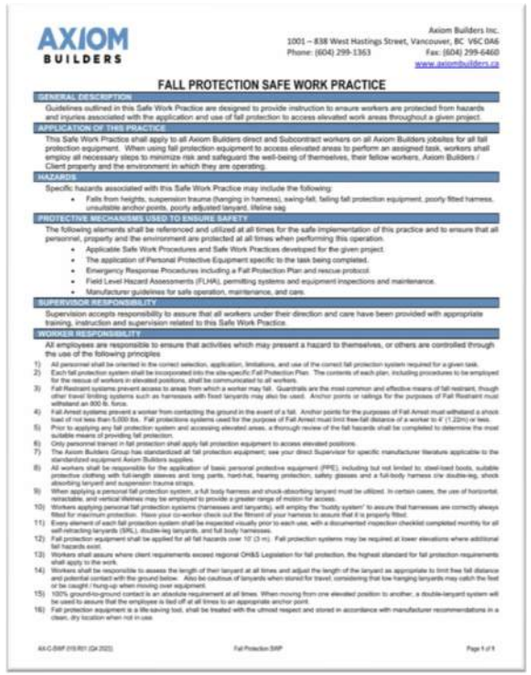
Work Reviewed by:

ERV/HRV	☐	BATHROOM TOILET P-TRAP	☐
ERV/HRV	☐	BATHROOM SHOWER P-TRAP	☐
ERV/HRV	☐	BATHROOM SINK P-TRAP	☐
KITCHEN HOOD VENT	☐	PRIMARY BATHROOM TOILET TRAP	☐
KITCHEN SINK P-TRAP	☐	PRIMARY BATHROOM SINK P-TRAP	☐
LAUNDRY MACHINE DRYER VENT	☐	PRIMARY BATHROOM SINK P-TRAP	☐
LAUNDRY P-TRAP	☐	PRIMARY BATHRROM TUB P-TRAP	☐
POWDER ROOM TOILET P-TRAP	☐	PRIMARY BATHROOM SHOWER P-TRAP	☐
POWDER ROOM SINK P-TRAP	☐	DOOR STOPPER (MAIN SUITE DOOR)	☐

PROJECT NAME
SUITE AIRLEAKAGE CHECKLIST



Standard Operating Procedure



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FALL PROTECTION SAFE WORK PRACTICE

GENERAL DESCRIPTION

Guidelines outlined in this Safe Work Practice are designed to provide instruction to ensure workers are protected from hazards and injuries associated with the application and use of fall protection to access elevated work areas throughout a given project.

APPLICATION OF THIS PRACTICE

This Safe Work Practice shall apply to all Axiom Builders direct and Subcontract workers on all Axiom Builders jobsites for all fall protection equipment. When using fall protection equipment to access elevated areas to perform an assigned task, workers shall employ all necessary steps to minimize risk and safeguard the well-being of themselves, their fellow workers, Axiom Builders / Client property and the environment in which they are operating.

HAZARDS

Specific hazards associated with this Safe Work Practice may include the following:

- Falls from heights, suspension trauma (hanging in harness), swing-fall, failing fall protection equipment, poorly fitted harness, unsuitable anchor points, poorly adjusted lanyard, lifeline sag.

PROTECTIVE MECHANISMS USED TO ENSURE SAFETY

The following elements shall be referenced and utilized at all times for the safe implementation of this practice and to ensure that all personnel, property and the environment are protected at all times when performing this operation.

- Applicable Safe Work Procedures and Safe Work Practices developed for the given project.
- The application of Personal Protective Equipment specific to the task being completed.
- Emergency Response Procedures including a Fall Protection Plan and rescue protocol.
- Field Level Hazard Assessments (FLHA), permitting systems and equipment inspections and maintenance.
- Manufacturer guidelines for safe operation, maintenance, and care.

SUPERVISOR RESPONSIBILITY

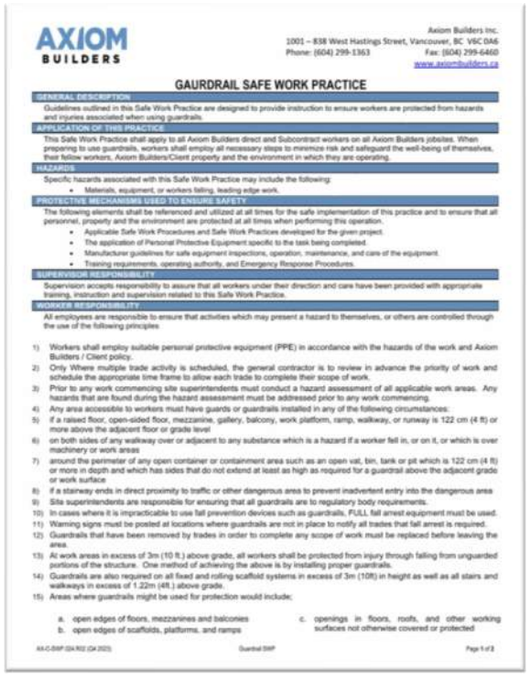
Supervision accepts responsibility to assure that all workers under their direction and care have been provided with appropriate training, instruction and supervision related to this Safe Work Practice.

WORKER RESPONSIBILITY

All employees are responsible to ensure that activities which may present a hazard to themselves, or others are controlled through the use of the following principles

1) All personnel shall be oriented in the correct selection, application, limitations, and use of the correct fall protection system required for a given task.
2) Each fall protection system shall be incorporated into the site-specific Fall Protection Plan. The contents of each plan, including procedures to be employed for the rescue of workers in elevated positions, shall be communicated to all workers.
3) Fall Restraint systems prevent access to areas from which a worker may fall. Guardrails are the most common and effective means of fall restraint, though other travel limiting systems such as harnesses with fixed lanyards may also be used. Anchor points or railings for the purposes of Fall Restraint must withstand an 800 lb. force.
4) Fall Arrest systems prevent a worker from contacting the ground in the event of a fall. Anchor points for the purposes of Fall Arrest must withstand a shock load of not less than 5,000 lbs. Fall protections systems used for the purpose of Fall Arrest must limit free-fall distance of a worker to 4' (1.22m) or less.
5) Prior to applying any fall protection system and accessing elevated areas, a thorough review of the fall hazards shall be completed to determine the most suitable means of providing fall protection.
6) Only personnel trained in fall protection shall apply fall protection equipment to access elevated positions.
7) The Axiom Builders Group has standardized all fall protection equipment; see your direct Supervisor for specific manufacturer literature applicable to the standardized equipment Axiom Builders supplies.
8) All workers shall be responsible for the application of basic personal protective equipment (PPE), including but not limited to; steel-toed boots, suitable protective clothing with full-length sleeves and long pants, hard-hat, hearing protection, safety glasses and a full-body harness c/w double-leg, shock absorbing lanyard and suspension trauma straps.
9) When applying a personal fall protection system, a full body harness and shock-absorbing lanyard must be utilized. In certain cases, the use of horizontal, retractable, and vertical lifelines may be employed to provide a greater range of motion for access.
10) Workers applying personal fall protection systems (harnesses and lanyards), will employ the "buddy system" to assure that harnesses are correctly always fitted for maximum protection. Have your co-worker check out the fitment of your harness to assure that it is properly fitted.
11) Every element of each fall protection system shall be inspected visually prior to each use, with a documented inspection checklist completed monthly for all self-retracting lanyards (SRL), double-leg lanyards, and full body harnesses.
12) Fall protection equipment shall be applied for all fall hazards over 10' (3 m). Fall protection systems may be required at lower elevations where additional fall hazards exist.
13) Workers shall assure where client requirements exceed regional OH&S Legislation for fall protection, the highest standard for fall protection requirements shall apply to the work.
14) Workers shall be responsible to assess the length of their lanyard at all times and adjust the length of the lanyard as appropriate to limit free fall distance and potential contact with the ground below. Also be cautious of lanyards when stored for travel, considering that low hanging lanyards may catch the feet or be caught / hung-up when moving over equipment.
15) 100% ground-to-ground contact is an absolute requirement at all times. When moving from one elevated position to another, a double-lanyard system will be used to assure that the employee is tied-off at all times to an appropriate anchor point.
16) Fall protection equipment is a life-saving tool, shall be treated with the utmost respect and stored in accordance with manufacturer recommendations in a clean, dry location when not in use.

AX-C-SWP (15) R01 (Q4 2022) Fall Protection SWP Page 1 of 1



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GAURDRAIL SAFE WORK PRACTICE

GENERAL DESCRIPTION

Guidelines outlined in this Safe Work Practice are designed to provide instruction to ensure workers are protected from hazards and injuries associated when using guardrails.

APPLICATION OF THIS PRACTICE

This Safe Work Practice shall apply to all Axiom Builders direct and Subcontract workers on all Axiom Builders jobsites. When preparing to use guardrails, workers shall employ all necessary steps to minimize risk and safeguard the well-being of themselves, their fellow workers, Axiom Builders/Client property and the environment in which they are operating.

HAZARDS

Specific hazards associated with this Safe Work Practice may include the following:

- Materials, equipment, or workers falling, leading edge work.

PROTECTIVE MECHANISMS USED TO ENSURE SAFETY

The following elements shall be referenced and utilized at all times for the safe implementation of this practice and to ensure that all personnel, property and the environment are protected at all times when performing this operation.

- Applicable Safe Work Procedures and Safe Work Practices developed for the given project.
- The application of Personal Protective Equipment specific to the task being completed.
- Manufacturer guidelines for safe equipment inspections, operation, maintenance, and care of the equipment.
- Training requirements, operating authority, and Emergency Response Procedures.

SUPERVISOR RESPONSIBILITY

Supervision accepts responsibility to assure that all workers under their direction and care have been provided with appropriate training, instruction and supervision related to this Safe Work Practice.

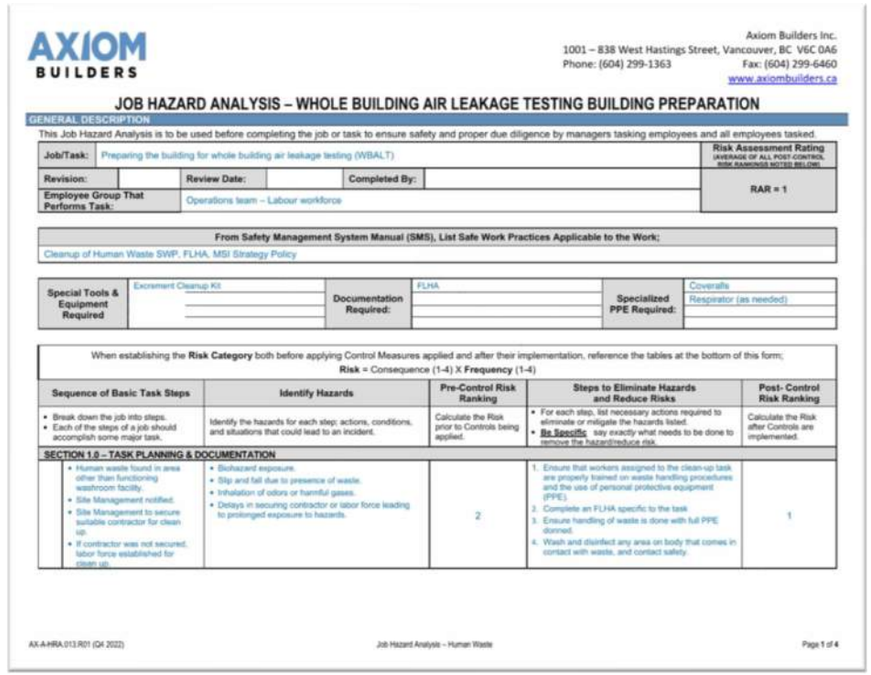
WORKER RESPONSIBILITY

All employees are responsible to ensure that activities which may present a hazard to themselves, or others are controlled through the use of the following principles

1) Workers shall employ suitable personal protective equipment (PPE) in accordance with the hazards of the work and Axiom Builders / Client policy.
2) Only Where multiple trade activity is scheduled, the general contractor is to review in advance the priority of work and schedule the appropriate time frame to allow each trade to complete their scope of work.
3) Prior to any work commencing site superintendents must conduct a hazard assessment of all applicable work areas. Any hazards that are found during the hazard assessment must be addressed prior to any work commencing.
4) Any area accessible to workers must have guards or guardrails installed in any of the following circumstances:
5) if a raised floor, open-sided floor, mezzanine, gallery, balcony, work platform, ramp, walkway, or runway is 122 cm (4 ft) or more above the adjacent floor or grade level
6) on both sides of any walkway over or adjacent to any substance which is a hazard if a worker fell in, or on it, or which is over machinery or work areas
7) around the perimeter of any open container or containment area such as an open vat, bin, tank or pit which is 122 cm (4 ft) or more in depth and which has sides that do not extend at least as high as required for a guardrail above the adjacent grade or work surface
8) if a stairway ends in direct proximity to traffic or other dangerous area to prevent inadvertent entry into the dangerous area
9) Site superintendents are responsible to for ensuring that all guardrails are to regulatory body requirements.
10) In cases where it is impracticable to use fall prevention devices such as guardrails, FULL fall arrest equipment must be used.
11) Warning signs must be posted at locations where guardrails are not in place to notify all trades that fall arrest is required.
12) Guardrails that have been removed by trades in order to complete any scope of work must be replaced before leaving the area.
13) At work areas in excess of 3m (10 ft.) above grade, all workers shall be protected from injury through falling from unguarded portions of the structure. One method of achieving the above is by installing proper guardrails.
14) Guardrails are also required on all fixed and rolling scaffold systems in excess of 3m (10ft) in height as well as all stairs and walkways in excess of 1.22m (4ft.) above grade.
15) Areas where guardrails might be used for protection would include;

    a. open edges of floors, mezzanines and balconies
    b. open edges of scaffolds, platforms, and ramps
    c. openings in floors, roofs, and other working surfaces not otherwise covered or protected

AX-C-SWP (24) R02 (Q4 2022) Guardrail SWP Page 1 of 2



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JOB HAZARD ANALYSIS – WHOLE BUILDING AIR LEAKAGE TESTING BUILDING PREPARATION

GENERAL DESCRIPTION

This Job Hazard Analysis is to be used before completing the job or task to ensure safety and proper due diligence by managers tasking employees and all employees tasked.

Job/Task:	Preparing the building for whole building air leakage testing (WBALT)					**Risk Assessment Rating** (AVERAGE OF ALL POST-CONTROL RISK RANKINGS NOTED BELOW)
Revision:		**Review Date:**		**Completed By:**		**RAR = 1**
Employee Group That Performs Task:	Operations team – Labour workforce					

From Safety Management System Manual (SMS), List Safe Work Practices Applicable to the Work;

Cleanup of Human Waste SWP, FLHA, MSI Strategy Policy

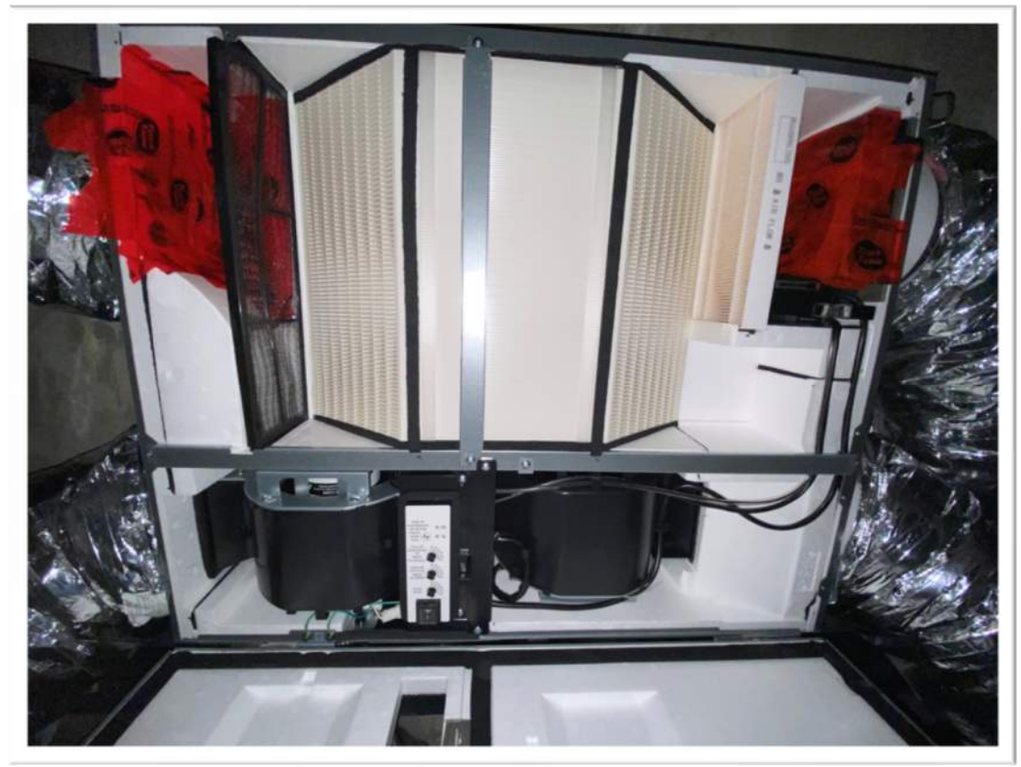
Special Tools & Equipment Required	Excrement Cleanup Kit	**Documentation Required:**	FLHA	**Specialized PPE Required:**	Coveralls Respirator (as needed)

When establishing the **Risk Category** both before applying Control Measures applied and after their implementation, reference the tables at the bottom of this form;
Risk = Consequence (1-4) X **Frequency** (1-4)

Sequence of Basic Task Steps	Identify Hazards	Pre-Control Risk Ranking	Steps to Eliminate Hazards and Reduce Risks	Post- Control Risk Ranking
• Break down the job into steps. • Each of the steps of a job should accomplish some major task.	Identify the hazards for each step; actions, conditions, and situations that could lead to an incident.	Calculate the Risk prior to Controls being applied.	• For each step, list necessary actions required to eliminate or mitigate the hazards listed. • **Be Specific**: say exactly what needs to be done to remove the hazard/reduce risk.	Calculate the Risk after Controls are implemented.
SECTION 1.0 – TASK PLANNING & DOCUMENTATION				
• Human waste found in area other than functioning washroom facility. • Site Management notified. • Site Management to secure suitable contractor for clean up. • If contractor was not secured, labor force established for clean up.	• Biohazard exposure. • Slip and fall due to presence of waste. • Inhalation of odors or harmful gases. • Delays in securing contractor or labor force leading to prolonged exposure to hazards.	2	1. Ensure that workers assigned to the clean-up task are properly trained on waste handling procedures and the use of personal protective equipment (PPE). 2. Complete an FLHA specific to the task. 3. Ensure handling of waste is done with full PPE donned. 4. Wash and disinfect any area on body that comes in contact with waste, and contact safety.	1

AX-A-HRA 013 R01 (Q4 2022) Job Hazard Analysis – Human Waste Page 1 of 4

Suite Preparation



Building Preparation

Costs?

Includes:
General Labour to prep the suites
General Labour to prep the building

$300 - $350 per Suite

Does not Include:
Project Team Involvement
Materials to prep suite/building

How are we doing?

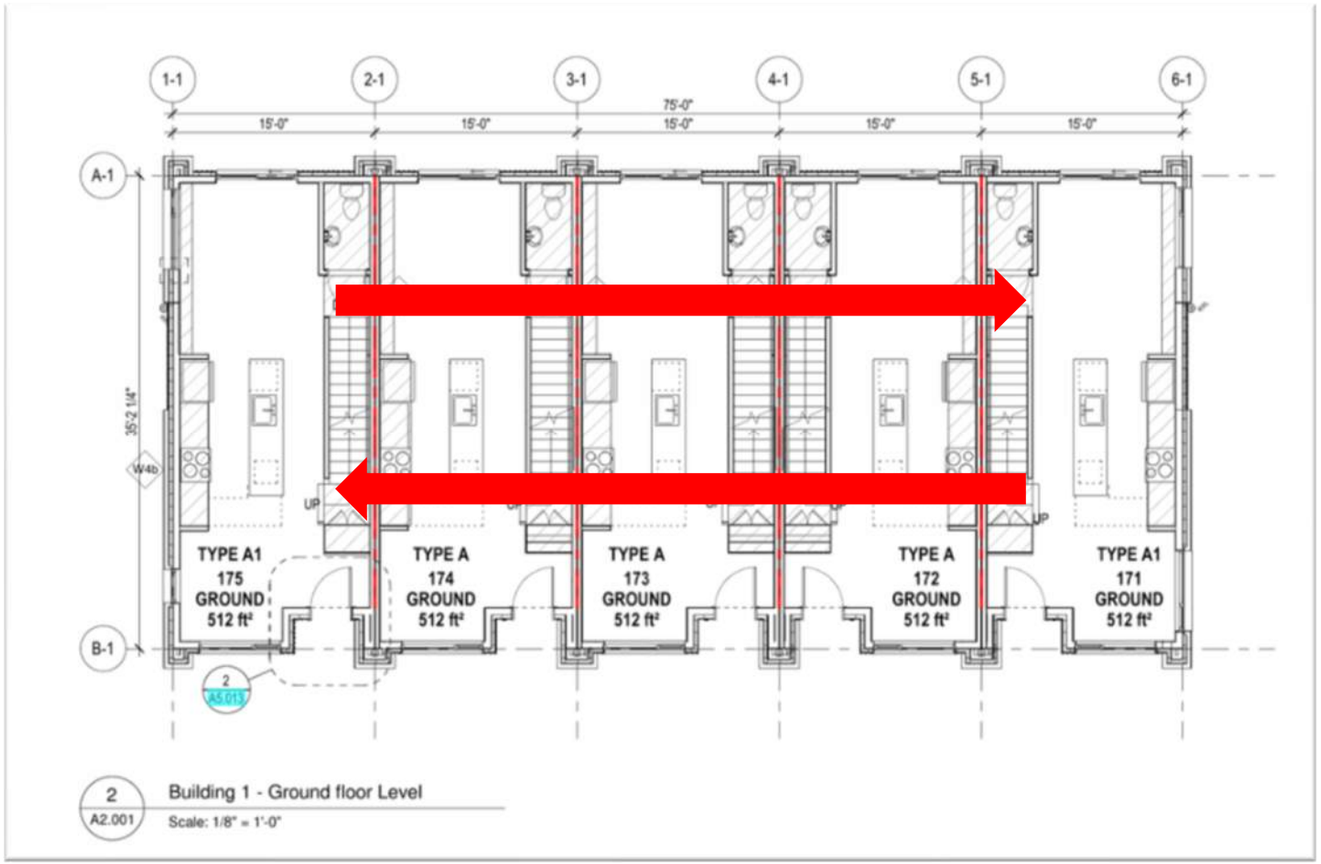
	BLDG TYPE	LEAKAGE RATE	TESTED	PASSED	SOP
BLDG 1	HR-C	2.0	0.9	YES	YES
BLDG 2	HR-C	1.0	1.65	NO	NO
BLDG 3	HR-C	2.0	2.2	NO	YES
BLDG 4	HR-C	2.0	2.1	NO	NO
BLDG 5	HR-C	2.0	1.1	YES	YES

How are we doing?

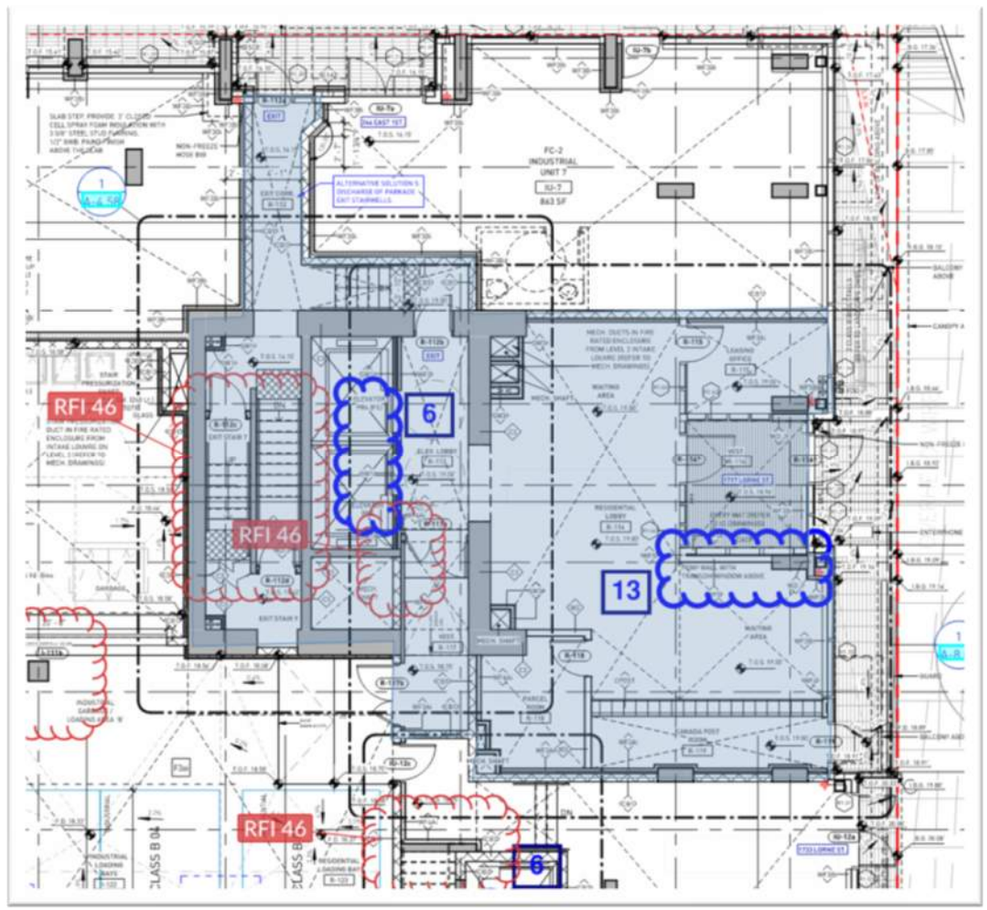
	BLDG TYPE	LEAKAGE RATE	TESTED	PASSED	SOP
BLDG 6	LR-W	2.0	2.1	NO	NO
BLDG 7	LR-C	2.0	0.89	YES	YES
BLDG 8	LR-W	1.0	1.9	NO	NO
BLDG 9	LR-W	1.0	1.4	NO	NO
BLDG 10	LR-W	1.0	2.4	NO	NO

Challenges - Design

Challenges - Design

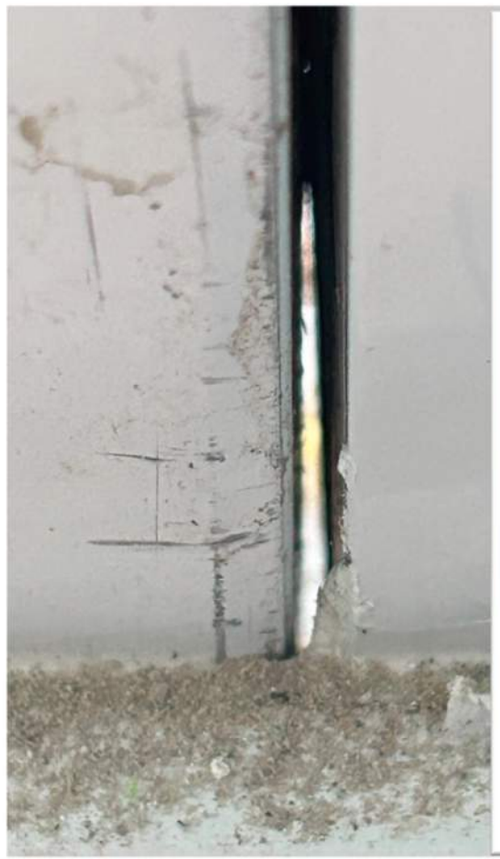


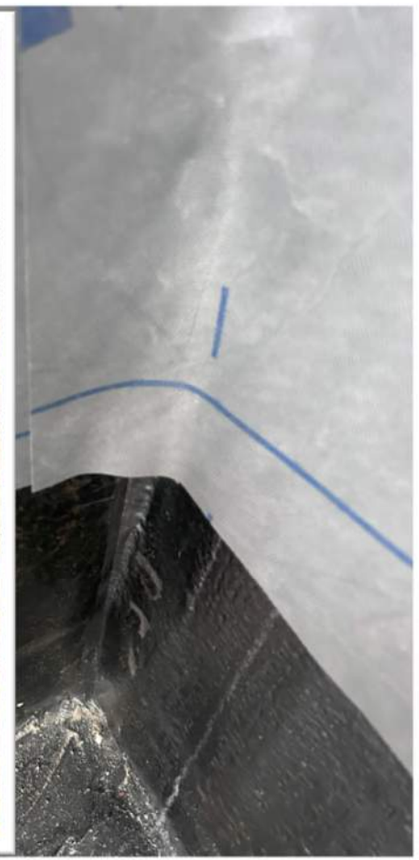
Challenges - Sequencing



SH0

Challenges - Trades





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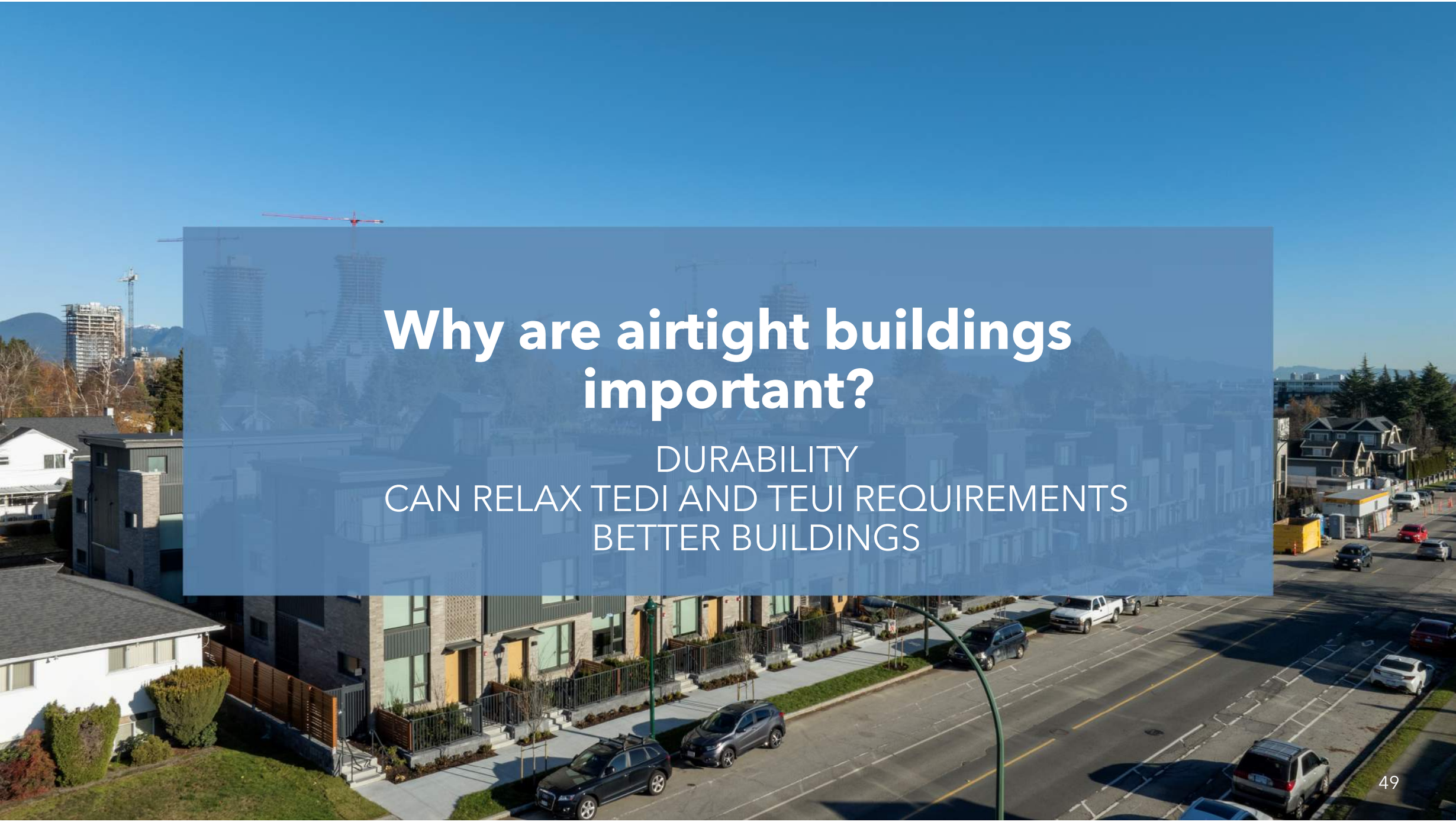
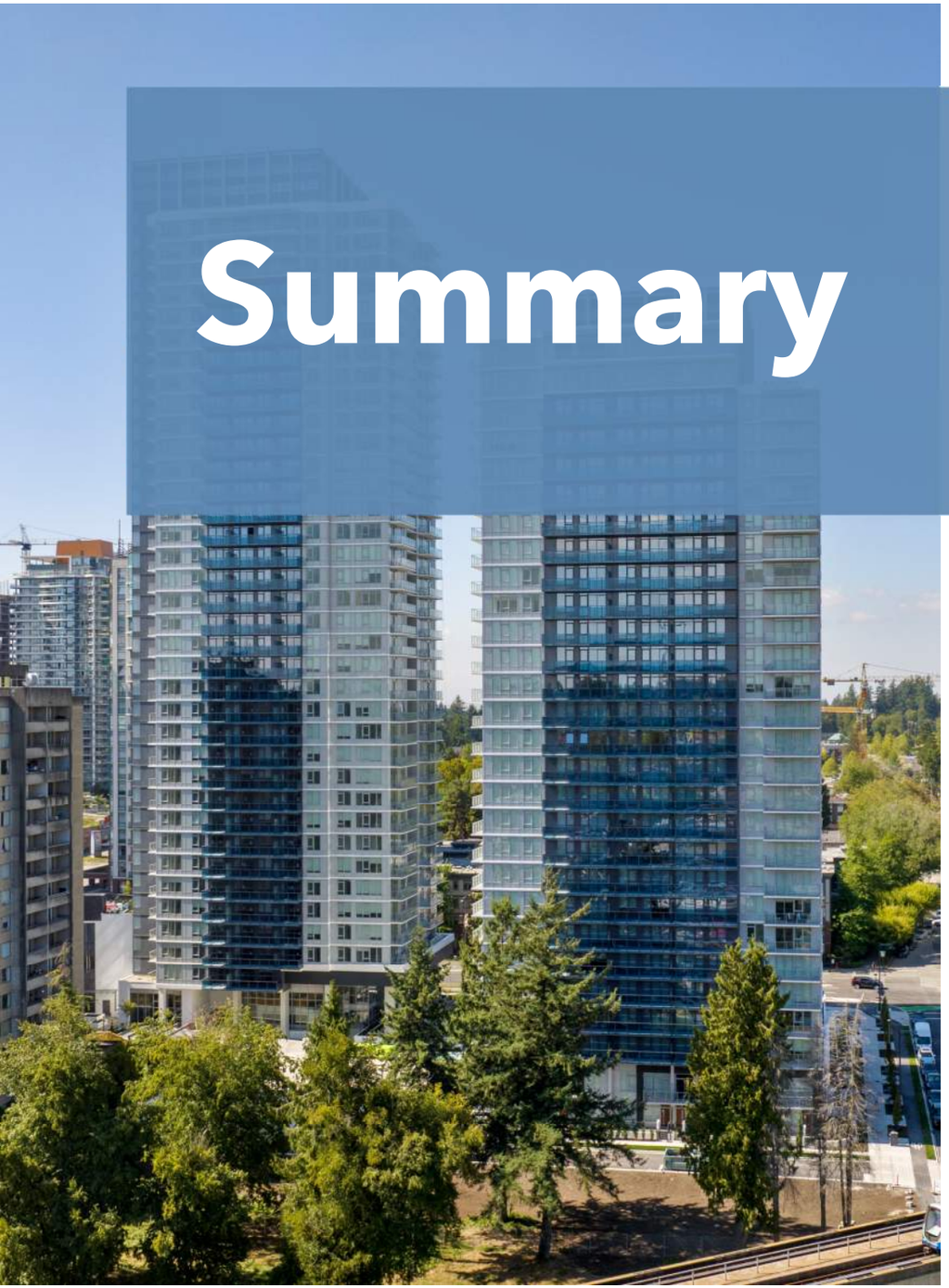
SH0 All four images included? Confirm
Susie Hang, 2024-04-09T22:24:30.125

Challenges - Trades



Why are airtight buildings important?

DURABILITY
CAN RELAX TEDI AND TEUI REQUIREMENTS
BETTER BUILDINGS



Summary

- Planning
- QA/QC
- Communication
- Team Effort
- We can all learn from this!

Special Thanks

ALLY BEREDO

PROJECT TEAMS

Thank you

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AXIOM BUILDERS