Best Practice Guidelines For Replacement Window Installations
A Project Initiated By The Building Performance Association

Background
The Building Performance Association (BPA) represents the contractors, utilities and suppliers who are involved in providing energy retrofits to residential buildings in British Columbia. BPA members decided that due to recent changes in the requirements for window installations in new “moisture prone” multi-family buildings they would review the current methods of installing replacement windows to determine what “best practices” should be recommended to their industry.

Project Focus
BPA requested the project be completed based on the following:
- The focus is residential projects only, primarily single family homes
- Installation procedures for “leaky building” rehabilitation projects are not included
- Tests are of the window installation methods only, not the windows themselves
- The focus is windows and patio doors, not entry doors or other exterior products

Project Funding & Management
Funding of approximately $20,000 was provided entirely by industry groups including contractors, window manufacturers, utilities, financing programs, and trade associations. Ken Farrish was contracted as Project Manager, a test hut was built at BCIT, and Sheltair Scientific, a building performance consulting firm, was contracted to perform tests to the ASTM Standard E1105-96.

Testing Procedure
A 10’ by 12’ test hut was built specifically for this project on the grounds of the BC Institute of Technology. Aluminum-framed nail-on-flange windows were installed on each wall. Each wall of the hut was finished with a different cladding system including stucco, channeled cedar, beveled cedar and beveled vinyl. New vinyl windows were then installed by three different BPA contractors using the three most common methods of replacement window installation:
- Full removal by collapsing and removing the entire old metal frame
- Full removal by cutout of the old metal frame, leaving the old nailing flange in place
- Piggyback the new window by installing it over the old metal frame

Recommendations For Developing Best Practices
As a result of testing the following points are recommended as the basis for developing Best Practice For Replacement Window Installations in the coastal regions of BC.
- Water may enter a wall from the exterior at any number of different places
- Certain types of homes and walls are more likely to have potential for wall water problems
- It is not within the average home improvement contractors technical capability to find the reason and/or source of all water entry or to prevent all water from entering the wall
- A contractors objective should be to put best efforts towards managing water (deflect & drain) so that it does not enter to the inside of the walls at any of the window/wall joints
- It is the contractors responsibility to notify the homeowner of pre-existing conditions that show signs of potential wall water problems
- Installation procedures must be simple and flexible since on-site situations of existing homes vary due to age, design, building materials and construction quality
- Customers have a maintenance responsibility with respect to water entry into walls
- There are additional time and costs involved in providing these services to the customer

Based on these points the following best practices are recommended.
Best Practice Guidelines – Replacing Windows In Moisture Prone Walls

Objective Of These Guidelines
When windows in moisture-prone walls are being replaced the objective is to manage the path of exterior water flow at window/wall joints so that water does not remain on the inside of walls.

The “Deflect & Drain” Strategy
These best practice guidelines address the objective by using strategies to “deflect and drain” water from window areas on moisture-prone houses. The deflect and drain strategy involves:
- Deflecting water away from window opening at top of window opening
- Providing unobstructed pathways for water to drain from top of window opening down to sill
- Draining water from window opening to outside at sill of window

Format Of These Guidelines
These guidelines are written in “objective” format and contain recommendations on “what-to-accomplish” (objectives) rather than specifically “how-to-do” (methods). Installers can meet these objectives in various ways depending on circumstances found on each jobsite. Any procedures, product references, or drawings provided in these guidelines are considered acceptable solutions to meeting an objective, rather than the only method of meeting that objective.

Each installation step is organized in the following format, similar to that being proposed for the new Objective Based British Columbia and National Building Code;

Objective: States in broad terms what that step of the guideline is intended to achieve
Acceptable Solution: Provides one or more possible solutions to meeting the objective

Guidelines - Step 1  Wall Moisture Assessment Procedure

Objective: Determine if house is considered moisture-prone based on pre-existing conditions
Acceptable Solution: Perform the following Wall Moisture Assessment Procedure of BPA

Assessment #1: Is house location and structure likely to be exposed to wind driven rain?
- Is the local area known to be excessively windy?
  - Some examples are Abbotsford/Sumas, Ladner, Campbell River
- Is the location of the house highly “exposed” to wind-driven rain?
  - Is the south and/or east side of the building open to the weather?
  - Is it unprotected by surrounding trees, houses, buildings etc.?
- Is the structure such that rain is likely to enter the walls?
  - Are roof overhangs inadequate (1 foot for every 4 feet between window and roof)
  - Are there no flashings installed where required?
  - Does the height of the house increase its exposure (2-stories or more)
  - Is the siding/cladding the vertical channel type?
Action: If “yes” to any of above perform Moisture Measurement Test (Assessment #3)

Assessment #2: Are there visual signs of moisture problems?
- On the exterior check the south and east sides for visual signs of excessive weathering
  - Are fascia boards, wood trim, or cladding more weathered than on the other sides?
  - Does the siding/cladding have cracks, broken joints/miters, staining or mold?
- On the Interior check for visual signs of excessive moisture
  - Is there any mold, staining, discolouration, “punky” drywall, etc. around the windows?
Action: If “yes” to any of above perform Moisture Measurement Test (Assessment #3)
Assessment #3 – Does the moisture measurement test show signs of moisture problems?

- Use an intrusive type (with probes) moisture measurement meter that rates moisture content of wood by percentage, such as:
  - Delmhorst - J4 Analogue unit
    - Salton Fabrication at 604-888-0122, or Coe Manufacturing at 602-276-1722
  - Protimeter – Mini BLD2000
    - Alternative Inspection Products at 604-931-8428
- Perform test on a window that is considered to be most moisture prone by;
  - Accessing bottom window sill/jamb joints at approximately center of wall cavity
    - If window is fully removed this area will be easily accessible
    - If old frame is in place provide access by drilling holes in corners of old frame
  - Checking framing members to determine if they are “punky” or show signs of rot
  - Inserting probes of moisture meter as per manufacturers instructions
  - Take measurement and document moisture content readings

Action: If signs of rot are visible, or if moisture measurement is over 19% (as per BC Building Code), document results and notify homeowner (Assessment #4)

Assessment #4 – Have documentation, notification, and recommendations been provided?

- Documentation at this stage is necessary to demonstrate that due diligence was performed by the contractor and should be completed in the following way;
  - Document results of moisture measurement test on company’s work order for that job
  - Notify homeowner of pre-existing conditions that signify a moisture-prone wall
  - Recommend windows be installed according to best practices for water management
  - Inform homeowner of additional costs or issues associated with installation methods

Action: Install windows according to following best practice guidelines

Guidelines - Step 2 Removing Old Window And/Or Components

Objective: Provide clear access for proper installation of new window

Acceptable Solutions:

- Full removal of old frame using “collapsing” method, or
- Full removal of old frame using “cutout method, or
- Removal of components to “piggyback” new window over old frame

Guidelines - Step 3 Ensure Structural Soundness Of Building Components

Objective: Ensure no visible adjacent building materials are in a state of deterioration

Acceptable Solutions:

- Check for signs of moisture damage, rot, or deterioration
- If found, document results and notify homeowner
- Replace defective materials using kiln dried lumber

Guidelines - Step 4 Provide For Water Deflection At Top Of Window Opening

Objective: Prevent water from above window draining down cladding and onto window/wall joints

Acceptable Solutions: Install drip cap (header flashing) on wall above window opening

- Building code (Sec 15.1.9) states header flashing is not required if distance from top of window opening to overhang is less than ¼ of eave overhang depth.
- Flashing material to be appropriate for exterior use:
  - Galvanized Steel: With minimum thickness of .38mm, or
  - PVC: With minimum thickness of 1mm
  - Profile to be sloped to ensure water drains off of surface (angled to 10° or more)
  - Shaped “dams” at ends to prevent water from running over edge
  - Width to extend at least 1” beyond edge of new window flange
Guidelines - Step 4 (cont.)

- **Note:** Cutting kerf into cladding is not recommended as it weakens cladding material
- **Placement Option A:** Onto sheathing behind building paper:
  - Attachment to sheathing by nail, screw or "blind seal" caulk is acceptable
  - Apply bead of caulk on underside of flashing at sheathing/flashing joint
- **Placement Option B:** On surface of cladding:
  - Apply "blind seal" bead of caulk to attach flashing to cladding
  - Apply bead of caulk at top and bottom of flashing/cladding joint

Guidelines - Step 5  Provide For Water Drainage At Sill Of Window Opening

**Objective:** Provide method of draining water to outside of window opening at sill area

**Acceptable Solutions:**

- Install "pan flashing" to cover sill from inside of new window to outside of cladding:
  - Type of material to be appropriate for use (membrane, metal, vinyl)
  - Sloped downwards to ensure water drains to outside of wall
  - Shaped “dams” at ends to prevent water from running over edge
  - Shaped “dam” at inside edge to prevent water from running to inside
  - Width to extend across sill and approximately 6” up each jamb
- Attach to wall materials as per manufacturers instructions

Guidelines - Step 6  Provide Moisture Barrier At Jambs Of Window Opening

**Objective:** Prevent moisture from entering wall cavity

**Acceptable Solutions:**

- Install building paper or house wrap:
  - Height to extend from top of window opening down to overlap pan flashing
  - Placement to cover jambs from inside of new window to outside of cladding
- Attach to wall materials as per manufacturers instructions

Guidelines - Step 7  Provide Drainage Path At Header Of Window Opening

**Objective:** Allow water that enters wall above window opening to drain into window opening

**Acceptable Solutions:**

- If old frame has been removed, clear area between sheathing and cladding:
  - Remove or cut slot in building paper or other obstructions
- If old frame has been left in place, provide method for water to drain through old frame
  - Drill drain holes of at least ¼ inch into inside channel of old frame
  - Provide “dam” at ends of old frame to ensure water drains through new drain holes
    - Drill hole in each corner and fill (caulk) cavity between old frame and wall

Guidelines - Step 8  Ensure Drainage Path Around New Replacement Window

**Objective:** Allow water that enters window opening to drain down to pan flashing on sill

**Acceptable Solutions:**

- Install window as per manufacturers instructions:
  - Provide proper shimming and ensure window is square, plumb, and level
- Provide air barrier and insulation at interior joints of new window and wall at head/sill/jambs
  - Use of rod & caulk or foam is acceptable
  - **Note:** Depth of foam/caulk not to exceed 1” from inside of new window
    - Allow path for water to drain down new window frame and onto pan flashing
- Seal air leakage pathways (fastener holes) between window frame and wall
Guidelines - Step 9  Provide Exterior Weather Sealing of New Window

Objective: Prevent exterior water from entering window cavity by reducing pressure differentials

Acceptable Solutions:
- Seal exterior window/cladding joints at header and jambs
  - NOTE: On sill ensure water drainage pathways are not obstructed
  - Use only exterior grade caulking, installed as per manufacturers instructions

Guidelines - Step 10  Provide Interior Air Sealing of New Window

Objective: Prevent exterior water from entering window cavity by reducing pressure differentials

Acceptable Solution:
- Seal full perimeter of new window at interior joints of window and wall
  - Seal sill at joints of new window and back dam of pan flashing
  - Seal header and jambs at joints of new window and interior trim

Guidelines - Step 11  Provide Maintenance Recommendations To Homeowner

Objective: Homeowner understands purpose and procedures of maintenance

Acceptable Solution:
- Explain window operation procedures
  - Opening, closing, hardware operation, etc.
- Review warranty policy, procedures, and limitations
- Review maintenance requirements
  - Inspect and replace caulking, cleaning, vent removal, etc.
**PIGGYBACK METHOD**

**EXISTING WALL**
- STUCCO
- 2 LAYERS 30 MIN. B.P. LAPPED SHEATHING FRAMING
- POLYETHYLENE AB. & VB.
- GYPSUM WALL BOARD

**SEALANT BEAR**
- PREFINISHED FLASHING WITH FOLDED END DAMS TO EXTEND 1" PAST END OF WINDOW FRAME
- SLOPED MINIMUM 10 DEGREES

**EXISTING WINDOW FRAME**
- DRILL 1/4 IN. DIA. HOLES IN EXISTING FRAME TO PROVIDE DRAINAGE

**NEW WINDOW INSTALL AS PER MANUFACTURERS INSTRUCTIONS**
- TRIM
- SEALANT (AIR BARRIER)

**EXISTING WALL**
- STUCCO
- 2 LAYERS 30 MIN. B.P. LAPPED SHEATHING FRAMING
- POLYETHYLENE AB. & VB.
- GYPSUM WALL BOARD

**SEALANT (AIR BARRIER)**
- EXAMINE EXISTING FRAMING FOR DECAY & MOISTURE
- ROD AND CAULK OR FOAM AIR BARRIER/INSULATION

**TRIM**
- PAN FLASHING
- PROVIDE DRAINAGE AT SILL

**NEW WINDOW INSTALL AS PER MANUFACTURERS INSTRUCTIONS**
- TRIM