Introduction
This ARRISCRAFT•NOTE addresses some common sources of moisture infiltration relative to masonry veneer wall systems and highlights the negative effects moisture may have on a wall assembly. Strategies for the proper management of moisture are outlined and specific recommendations are reviewed relative to properly managing moisture in conjunction with the various wall components and elements.

Moisture may be considered the cancer of any masonry wall, particularly when the moisture penetrates the wall assembly in sufficient quantities over extended periods of time. It is critical to the long-term performance of a wall assembly that moisture infiltration be controlled and moisture drainage is effective. Otherwise, the potential for wall deterioration will greatly increase.

Common Sources or Moisture Infiltration
Moisture can occur within a wall assembly due to a variety of different causes. Some common defects in the design and construction of masonry veneer walls that allow moisture into the wall system include:

- uncontrolled passage of water vapour through the wall assembly, resulting in condensation;
- poorly detailed, constructed or maintained roof parapets;
- water from non-absorbent surfaces, such as sloping roof surfaces or sloping glass assemblies, allowed to flow down onto the vertical wall surfaces;
- poorly detailed or constructed mortar joints where the joint is not completely filled with mortar or poorly compacted and finished, thus allowing moisture to enter at openings in the mortar joints;
- lack of proper flashing and drainage elements at wall openings, shelf angles and at foundation level;
- masonry in direct contact with the ground and exposed to splash water;
- cracks in masonry induced by excessive foundation settlements, lack of movement joints or structural deflection of the supporting structure; and
- horizontal masonry surfaces with inadequate drainage. (*Ref. CMHC Best Practice Guide – Brick Veneer Concrete Masonry Unit Backing, 1997; pg. 3-12*.)

Effects of Moisture Penetration
Moisture, when present in sufficient quantities over extended periods of time, can contribute to the deterioration of the wall assembly by means of the following processes:

- unco ntrolled dimensional change resulting from moisture saturation of materials;
- metal corrosion leading to weakened or ineffective connectors and deterioration of mortar joints due to the expansion of the corroded metal;
- freeze-thaw cycling of saturated materials, resulting in spalling or scaling of the masonry units, or displacement of materials; and
- efflorescence. (*Ref. CMHC Best Practice Guide – Brick Veneer Concrete Masonry Unit Backing, 1997; pg. 3-12*.)

Moisture Management Strategies
There are a variety of strategies that can be implemented during the design and construction of a masonry veneer that will help ensure that the wall will perform better over the long term. Some of these include:

- control the passage of water vapour through the wall assembly;
- minimize the quantity of water that comes into contact with the exterior wall;
- ensure integrity of joints and junctions in the exterior wall;
- neutralize all the forces that can move water through openings in the wall; and
- drain moisture that does enter the wall.

Controlling the passage of water vapour through the wall will help prevent moisture form condensing within the wall assembly. Moisture will typically travel through a wall due to the mechanisms of vapour diffusion and/or air movement. Installing a vapour retarder membrane will help minimize the effects of vapour diffusion from areas of high humidity to areas of low humidity. Moisture travelling across a wall due to air movement can be controlled by designing and constructing an air barrier system as a part of the wall assembly. Typically, it is best to locate the air barrier within the assembly such that it is structurally ridged and protected from subsequent damage. Placement and location of the vapour retarder and air barrier will depend on the geographic location of the building and the anticipated set of design conditions.

Minimizing the quantity of water that contacts the exterior wall is particularly challenging near the top of buildings. Parapets, the junction of the parapet with the

roof, and the junction of the other vertical wall elements and the roof are the most vulnerable to moisture penetration, although any horizontal projections from the main vertical wall surface (including the grade-to-wall junction) are also vulnerable. To minimize these effects the following guidelines should be implemented:

- use cap flashings at window sills, roof parapets and other horizontal masonry surfaces and ensure that overhangs and drips are provided to drain the water away from the wall;
- ensure that metal cap flashings are properly lapped and sealed against water leakage and always provide an under-cap flexible flashing membrane between the metal and the sub-assembly;
- keep the exterior wythe of masonry at least 150 mm (6") above finished grade or provide some other design element that will segregate the masonry from moisture laden soil;
- do not drain water from a sloping roof or skylight directly onto the wall's surface. Use architectural elements such as gutters, overhangs, downspouts, etc., to properly drain water away from the wall;
- consider providing roof overhangs to reduce the quantity of water coming into direct contact with the wall; and
- eliminate water spray from ground sprinkler systems.

Applying a proprietary water repellent coating to the surface of the masonry veneer is an unacceptable substitute for proper design and construction. These coatings, even if described as "breathable", inhibit the natural evaporative properties of the masonry units, causing them to remain wetter longer, particularly if the source of moisture is from within the wall assembly. Such coatings have been known to contribute to wall deterioration and could result in costly repairs.

It is our opinion that better constructed wall systems provide better solutions to moisture management and control. We caution building designers not to rely upon the application of a water repellent sealer to replace good masonry wall design and construction methods.

Ensuring the integrity of the joints and junctions in the exterior wall will also assist with minimizing the potential for moisture infiltration of the wall. Consider and implement the following guidelines;

- ensure head and bed joints are filled solid with mortar and that the mortar joint has been tightly compressed and tooled to a well-weathering profile;
- ensure that movement joints and junctions between dissimilar materials are properly designed, constructed and maintained;
- minimize joints between sills, caps, copings and watertable units by using the maximum lengths possible and ensure joints are properly sealed with a good quality backer rod and joint sealant;
- design walls to avoid cracking of joints by strategically placing properly constructed movement joints in the building veneer. Refer to the ARRISCRAFT•NOTE (Vol. I, No. 1) titled Building Movement Joints for recommendations pertaining to the design and placement of the building movement joints; and
- ensure the proper design, construction and maintenance of metal parapet wall caps and/or flashing membranes

Neutralizing the forces that can move water through openings in walls will assist with preventing moisture and water vapour being "driven" across or through the wall assembly. Wall assemblies should be designed and constructed in accordance with the following:

- reduce the air pressure differential by applying the rain screen principle to the design of the wall assembly. Refer to ARRISCRAFT•NOTE (Vol. I, No. 2) titled The Rain Screen Principle for further information;
- provide overhangs and drips at flashings and sills to direct water away from masonry materials;
- slope surfaces (at least 1:12) that are likely to retain water to make them drain water away from the wall; and
- overlap materials to counter effects of the momentum of water, eg. by lapping the building paper over the vertical leg of the flashing membranes to ensure the continuity of flow of the moisture.

Draining moisture that does enter the wall is critical to maintaining the weather-resistant nature of the wall assembly and to avoid prolonged saturation of the masonry. Implement the following guidelines:

- ensure that a clear draining cavity at least 25 mm (1") in width exists between the masonry veneer and the other wall components;
- provide flashing membranes in the cavity over openings, at shelf angles and at the foundation level to drain any water that does enter the cavity; and
- provide drainage openings, such as weep vents, regularly spaced above flashing membranes to let the water quickly exit the wall assembly.

Additional information may be found by referring to the CMHC Best Practice Guide – Brick Veneer Concrete Masonry Unit Backing, pg.3-15.

Other Construction Issues
Other issues of moisture management include the storage and handling of products on site and the protection of walls during their construction from moisture infiltration.

Delivery Storage and Handling: How materials are handled and stored on site could have some bearing on the amount of moisture that will be present within the wall assembly after initial construction. It is considered prudent to limit the quantity of moisture in the materials to the least amount necessary. Protecting materials from excessive moisture prior to their use will assist in avoiding subsequent moisture being "installed" into the wall. Consider the following guidelines:

- deliver mortar materials in original, unbroken and undamaged packages with the maker's name and brand distinctly marked thereon, and upon delivery store in a shed until used on the work;
- store or pile sand on a plank platform and protect from dirt and rubbish. Store mortar materials and sand in such a manner as to prevent deterioration or contamination by foreign materials;
- deliver masonry units to the site in approved protective film. Prevent damage to units;
- lift skids with proper and sufficiently long slings or forks with protection to prevent damage to units. Protect edges and corners;
- store masonry units in a manner designed to prevent damage and staining of units;
- stack units on timbers or platforms at least 75 mm (3") above grade;
- place polyethylene or other plastic film between wood and other finished surfaces of units when stored over an extended period of time;
- cover stored units with protective enclosure if exposed to weather; and
- do not use de-icing compounds to remove snow and ice from masonry surfaces.

Wall Protection: properly covering the tops or partially completed masonry walls during the construction phase is equally critical to ensuring the wall's performance, at least during the early phases of the building's life cycle. The tops of walls should be covered at the end of every work day and especially in times of inclement weather to protect them from any moisture infiltration due to rain or snow. Often times the tops of walls also need to be protected for an extended period until the permanent wall cap assembly is constructed. Tarpaulins or other weather-resistant material should be securely tied with metal clamps and weighted into position to ensure they do not become displaced. The use of mortar boards, scaffold planks and light plastic sheets weighted with scraps of masonry units is unacceptable as suitable covering. (*Ref. BIA Technical Note 7B revised, Water Resistance of Brick Masonry – Construction and Workmanship, Part III, pp 4-5.*)

Summary
This ARRISCRAFT•NOTE addresses some common sources of moisture penetration of a masonry veneer wall and highlights the negative effects the presence of moisture may have on the wall assembly. Various strategies for proper moisture management are outlined with specific recommendations being made relative to a variety of different wall components.

The information and suggestions contained herein are based upon the available data and information published by the listed references and the experience of Arriscraft International architectural and engineering staff. More detailed information may be found by referring to any of the related references listed below.

The information contained herein must be used in conjunction with good technical judgement and a competent understanding of masonry construction. Final decisions on the use of the information contained in this ARRISCRAFT•NOTE are not within the purview of Arriscraft International and must rest with the project designer or owner, or both. It remains the sole responsibility of the designer to properly design the project, ensure all architectural and engineering principles are properly applied throughout, and ensure that any suggestions made by Arriscraft International are appropriate in the instance and are properly incorporated through the project.

Related References
1. Brick Industry Association, Technical Notes on Brick Construction 7 Revised, Water Resistance of Brick Masonry – Design and Detailing, Part I, February 1998 (Reissued April 2001).
2. Brick Industry Association, Technical Notes on Brick Construction 7A Revised, Water Resistance of Brick Masonry – Materials, Part II, December 1995 (Reissued August 2001).
3. Brick Industry Association, Technical Notes on Brick Construction 7B Revised, Water Resistance of Brick Masonry – Construction and Workmanship, Part III, April 1998 (Reissued August 2002).
4. Brick Industry Association, Technical Notes on Brick Construction 7C Revised, Moisture Control in Brick and Tile Walls – Condensation, February 1965 (Reissued March 2004).

5. Brick Industry Association, Technical Notes on Brick Construction 7F Revised, Moisture Resistance of Brick Masonry – Maintenance, January 1987 (Reissued October 1998).
6. Brick Industry Association, Technical Notes on Brick Construction 36 Revised, Brick Masonry Details, Sills and Soffits, July/August 1981 (Reissued January 1988).
7. Brick Industry Association, Technical Notes on Brick Construction 36A Revised, Brick Masonry Details, Caps and Copings, Corbels and Racking, September/October 1981 (Reissued February 2001).
8. Canada Mortgage and Housing Corporation, Best Practice Guide, Brick Veneer Concrete Masonry Unit Backing, 1997.
9. Drysdale, Hamid, Baker; Masonry Structures - Behavior and Design - Second Edition, The Masonry Society, 1999.

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