Mould in Housing

Information for First Nation Builders and Renovators

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Cette publication est aussi disponible en français sous le titre : *La moisissure dans les maisons : information pour les constructeurs et les rénovateurs d'habitations des Premières Nations* (n° de produit 67302).

The information in this publication is a result of current research and knowledge. Readers should evaluate the information, materials and techniques cautiously for themselves and consult appropriate professional resources to see if the information, materials and techniques apply to them. The images and text are guides only. Project and site-specific factors (climate, cost, aesthetics) must also be considered.

Mould in Housing Information for First Nation Builders and Renovators

Issued also in French under title : La moisissure dans les maisons : information pour les constructeurs et les rénovateurs d'habitations des Premières Nations.

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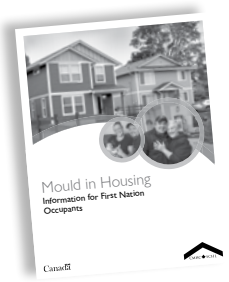
INTRODUCTION

The *Builders and Renovators Manual* of the *Mould in Housing* series will help housing managers, builders, contractors, renovators, technical service providers and mould remediation specialists in First Nation communities to recognize when there is a mould problem and take the necessary steps to deal with the problem. This manual may also be suitable for:

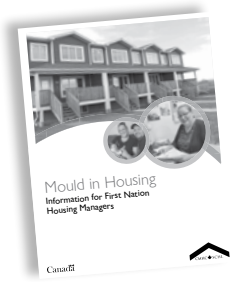
- Chiefs and Councils;
- First Nation housing departments, including housing committees, housing managers, maintenance supervisors, property management/maintenance officers, construction supervisors, crew leaders and labourers;
- trades—builders, contractors and renovators; and
- technical service providers (inspectors).

Please note that this manual is part of the *Mould in Housing* series. Housing managers are encouraged to read the *Occupants' Manual* and the *Housing Managers' Manual* before reading the *Builders and Renovators Manual*.

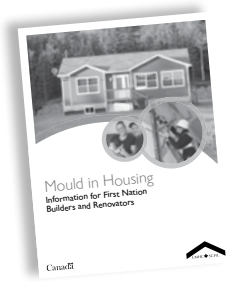
ABOUT THE *MOULD IN HOUSING* SERIES



Occupants' Manual
This first manual of the series includes information written for home occupants and any other individuals who want to learn basic information about mould (product # 67237).



Housing Managers' Manual
This second manual suggests possible roles of key players and identifies the training they need to deal with mould issues. The Manual includes information on specialized topics and is directed to technical service providers and housing managers (product # 67299).



Builders and Renovators' Manual
This final manual of the series includes information on technical and specialized topics and is directed to housing managers, builders, contractors, renovators, technical service providers and mould remediation specialists (product # 67301).

If you have any questions or comments about this document or other CMHC publications, please call 1-800-668-2642.

RENOVATING HOUSES TO PREVENT MOULD

- Correct conditions that lead to mould growth.
- Renovate to keep the home dry.
- Treat the house as a system; changes to exterior walls may affect indoor air quality.
- Get organized to make sure work is done quickly, properly, on time and on budget.
- Develop a plan to keep the renovated home mould-free.

GENERAL RENOVATION STRATEGY

Sometimes, it takes more than cleaning and fixing a localized moisture problem to deal with mould. Longer-term solutions may require larger renovations. Before starting, it is important to understand why the mould grew in the first place so the right solution can be put in place to prevent it from coming back.

Renovating a home to deal with mould may involve foundation work, siding and window retrofits, roof repairs, plumbing improvements and modification or replacement of heating and ventilation systems. It all depends on the moisture source and the extent of the damage done.

Moisture sources need to be repaired

Having an overall strategy on how to prioritize houses for repair will make these decisions easier. The strategy could include such factors as occupant health, number of children or elderly people in the house, the extent of the mould problem and the sources of the project financing.

Renovate with the idea that the house is a system where the building envelope, mechanical system and lifestyle habits of the occupants are all interconnected. For example, replacing windows and improving the insulation levels and airtightness of the walls can reduce the amount of air that leaks into the house. However, this may result in indoor air quality problems like high humidity, lingering odours and stale air. It may be necessary to improve or provide mechanical ventilation to balance the work done to the windows and walls and make sure the house is both energy-efficient and fit to live in.

Follow these guidelines for any renovation work to make sure the job gets done properly, on time and on budget—with as little disruption to the occupants as possible.

Getting started

- Identify the work that is required to address the causes of mould and obtain estimates from your technical service providers.
- Develop a renovation strategy. Include a description of the work to be done, the budget, materials to be used, site and occupant protection requirements, waste management and schedule. Get drawings done if necessary. Proper preparation at this stage will help contractors to better understand the project, be better prepared to get the work done and provide comparable quotes for the work.
- Ensure that project financing is in place so that you can complete the project.
- Get at least three bids for the work, based on your renovation plan. The selection of the renovator should be based on knowledge, experience, references, understanding of the project, as well as cost.
- Write a contract. Make sure the contract includes descriptions of the work, schedule, payment and responsibilities, and deals with other matters such as contractor insurance requirements and permits.

The following sections outline some of the key considerations for common renovation projects undertaken as a part of an overall strategy to deal with mould problems in houses. Note that these are general guidelines only.

A specific renovation strategy must be developed to address the mould problems, house characteristics and objectives of each renovation project.

FOUNDATION RENOVATIONS

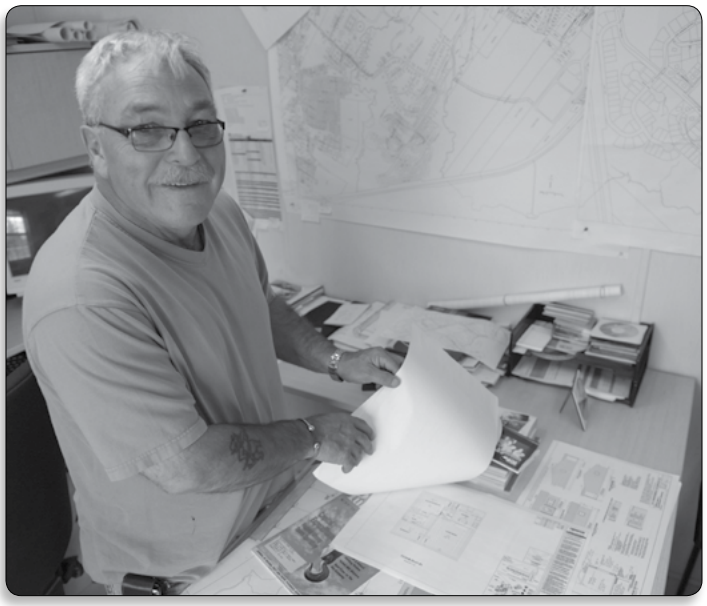
For damp basements and crawl spaces with unfinished floors (sand, gravel, earth or rock), the renovation must deal with the moisture that can seep up through the floor into the foundation and the house above.

Strategy A

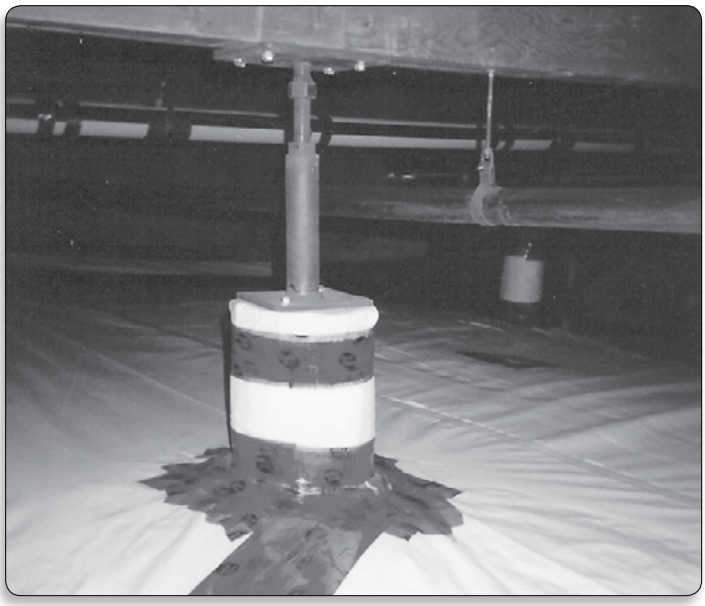
If the furnace and forced-air ducts are in the basement, direct the renovation at making the foundation area warm and dry. Include the following key features as part of your renovation strategy:

- Apply plastic sheeting over the unfinished floor with carefully overlapped and sealed joints. Seal the sheeting to the foundation walls and any support

Proper preparation will help your renovation team better understand the project



Apply and seal plastic sheeting over unfinished basement floors and crawl spaces

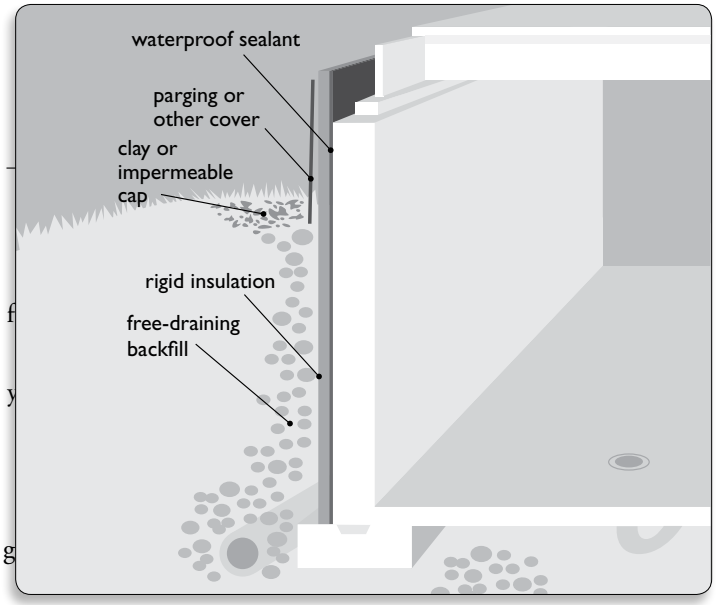


columns or drains. Otherwise, it can actually stimulate mould growth and make mould odour problems worse. Hold the plastic sheeting in place with regularly spaced bricks or blocks. Provide paving stones to walk or crawl on to prevent ripping the plastic during installation, as well as for service people who may have to work in the basement later on.

- Pour concrete floor slab on top of the plastic sheeting to better protect it.
- Provide proper insulation for the foundation wall. Insulate the exterior from the top of the foundation wall to at least 600 mm (2 ft.) below finished grade with extruded polystyrene board insulation. Complete with a protective finish coating and a metal drip cap. An added improvement would be to install a 600-mm (2-ft.) wide skirt of extruded polystyrene laid horizontally (on a slight outward slope) at the bottom of the newly installed exterior foundation wall insulation where it terminates below grade. This helps to keep the foundation warmer without having to excavate deeper than necessary.
- Provide well-insulated ground floor joist spaces. In the basement, install insulation and a sealed air/vapour barrier in the joist spaces along the inside face of the rim joist, from the underside of the floor sheathing to the top of the foundation wall. When insulating the foundation on the exterior, remove the exterior finish up to the top of the floor framing and insulate that area in the same manner. Consider installing a new foundation moisture protection system.
- For more persistent or larger basement dampness or leakage problems, bigger renovations may be required. For example, it may be necessary to excavate the foundation walls down to the footings to install a completely new foundation moisture protection system. This can include:
  - sealing cracks and snap-tie holes;
  - installing new dampproofing or waterproofing membranes on the walls;
  - installing full-height, free-draining exterior insulation;
  - installing new perimeter drainage that runs to a clear exit, is connected to the community storm sewer system or to the sump pit;
  - installing free-draining backfill; and
  - sloping the finished grade away from the house.

Insulate foundation walls

Example of a foundation moisture protection system



Strategy B

It may be possible to insulate and air seal the house from the foundation, essentially making the basement area an "outside" space, if:

- the furnace, forced-air ducts and plumbing services are not in the basement; or
- the house is heated with electric baseboards; or
- it is not possible to prevent the foundation from becoming damp or wet and moving the home or installing a new foundation is not possible.

Key renovation features may include the following:

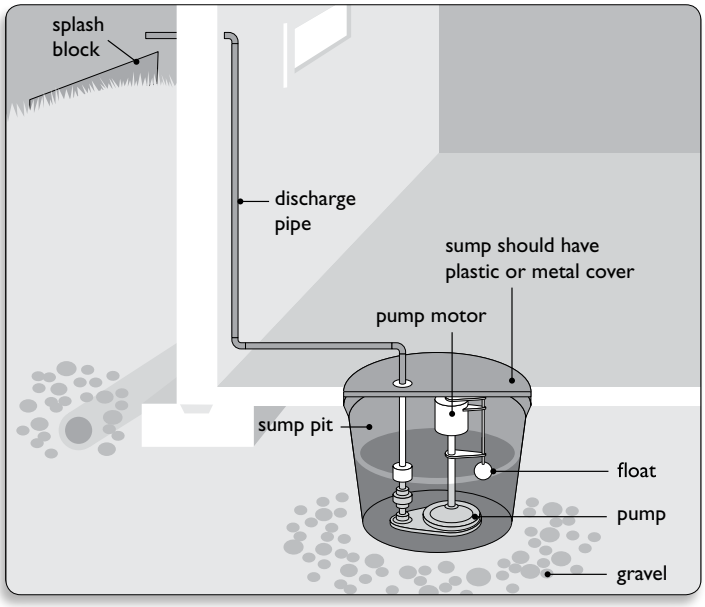
- Seal any openings between the house and the basement. Remove or seal off stairs to the basement.
- Use spray-applied foam insulation to the underside of the floor sheathing and joists to seal and insulate the house from the foundation. Make sure to use spray foam that provides the required air, vapour and moisture barrier.
- Other insulation products can be used in conjunction with air, vapour and moisture barriers to provide the required seal and insulation between the house and foundation.
- Install vents in the foundation walls with an exhaust fan to the outside to help promote drying when outdoor conditions are not too humid.

This strategy is temporary. Moisture and mould problems that continue to exist in the basement may eventually spread to the house.

For either strategy, other renovation work may include:

- Install a sump pit with a sealed cover and a basement floor drain with a backwater valve (backflow preventer), if required for drainage, before the basement floor is covered. Install a submersible sump pump in the sump pit to pump any collected water to a suitable exit point. Connect the sump pit to existing or newly installed outside perimeter or under-floor drainage tiles.
- Seal snap-tie holes in the poured concrete foundation walls, wall cracks or floor cracks from the inside using a suitable epoxy sealant.
- Make sure the finished grade slopes away from the foundation by at least 150 mm (6 in.) over 3 m (10 ft.). This may require the installation of window wells. Make sure that the finished grade leaves at least 200 mm (8 in.) of foundation exposed above grade.
- Do not paint the surface of concrete or masonry walls. This may cause mould to develop if the basement is humid. It is best to leave these surfaces unpainted unless the proper exterior work has been done to prevent moisture from coming through.
- Provide a capillary break between any untreated wood and concrete. Unprotected wood in contact

Sump pump installation



with concrete will continue to decay and will need to be replaced.

- Place basement window wells so the tops are well above the finished grade and the wells are securely fastened and sealed to the wall. Drain the bottom of the window well to the perimeter tile or some other suitable location. There should be at least 200 mm between the bottom of the window and the floor of the well. Otherwise, water may accumulate in the wells and leak into the basement through or around the windows.
- Make sure any downspouts from eavestroughing drain the water from the roof to a point well away from the foundation walls.

Dealing with high water tables and wet sites

A new foundation may be required if the present site is too wet and it is very difficult and costly to make sure water cannot get into the existing basement. The house can be jacked and moved, if necessary.

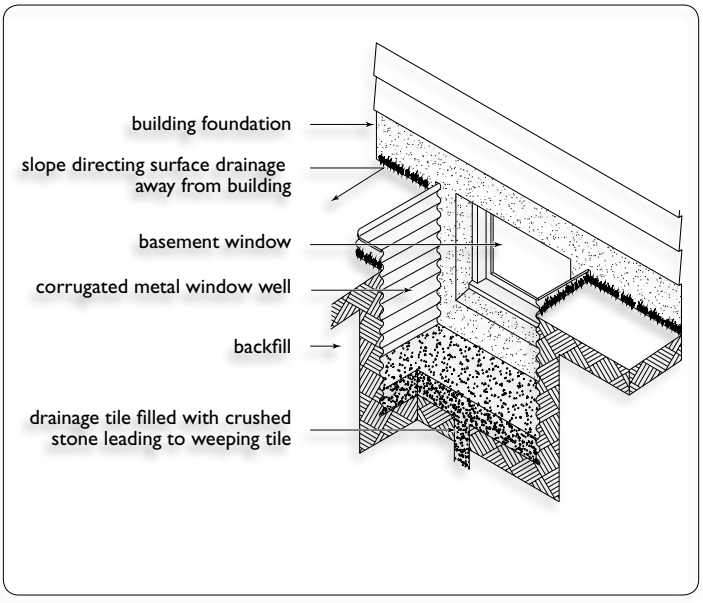
Install new basement footings above the water table level (but below the frost line). Include foundation waterproofing (instead of dampproofing), exterior foundation wall insulation, free-draining backfill, a new perimeter drainage system, a floor drain and, if necessary, a sump pit. The new basement floor should include the grandular fill. Installation of insulation, 6-mil polyethylene vapour/moisture barrier and a new concrete floor slab.

Clean up any mould in the house before the house is set on the new foundation or the mould will just travel to the new foundation.

Discourage the use of the newly renovated foundation space for storage, bedrooms or family rooms. It can be difficult to monitor the condition of the foundation once it is filled with furniture, boxes and personal possessions.

If basement storage is necessary, consider installing shelving that keeps belongings off the floor, away from exterior walls and allows air to circulate.

Detail of a window well in basement wall



ROOF RENOVATIONS

- If ice damming is a problem, or if the shingles are nearing the end of their service life, replace the shingles and install additional protective measures. Apply a self-adhering protective membrane to the roof sheathing at the eaves extending up the roof deck; new flashings around chimneys, vents and plumbing penetrations; and drip edges.
- Flashings prevent water entry between changes in materials and changes in planes, for example, where different kinds of building materials meet or at transitions between horizontal and vertical materials.

Install foundation footings above high water table levels

Keep the basement bare and clean

They are typically used around chimneys as well as plumbing and vent stacks. They are also found in roof valleys, over and beneath window and door openings and in other critical areas. Flashings should be designed and installed to work without caulking. Install a concrete or metal cap over masonry chimneys to direct water away from the flue and to protect any brick joints from water. Protect the point at which the chimney directly joins the roof with flashing and a chimney saddle, where water may be trapped behind the chimney.

- Install louvers and screens to gable-end and soffit vents to prevent rain and pests from entering the attic area.
- Install downspout extensions to eavestroughs and downspouts that discharge roof water onto splash blocks at least 3 m (10 ft.) away from the building.
- Extend roof overhangs to better protect the walls and windows from rain.
- To deal with ice damming problems, look for opportunities to seal air leakage points between the house and the attic, add insulation, and ensure good ventilation where the roof meets the exterior walls.

EXTERIOR WALL RENOVATIONS

Renovation work to the walls provides a good opportunity to add insulation and to air seal in order to reduce heating costs, improve comfort and reduce cold spots on walls where condensation and mould growth can occur. Consult with a residential energy advisor about what improvements can be done, the costs and benefits.

Replacing siding provides an opportunity to install a proper "rainscreen" system that can help drain and dry the walls after it rains.

Rainscreen assemblies include:

- Lapped sheathing paper (for example, building paper or house wraps) over the exterior wall sheathing.
- Vertical strapping to create a drainage space between the wall and the exterior cladding such as horizontal siding. For situations where vertical siding is desired, the strapping can be installed in an inclined fashion (not horizontal).
- Drip Caps and flashings have end-dams and drip edges installed directly over windows and doors to shed water away from the wall assembly. The vertical leg of the flashing is installed under the sheathing paper.
- Sill pans and flashings installed underneath windows and doors to protect the underlying wall assembly from water leakages. Flashings at the sill locations are installed over top of the sheathing paper.

Strapping provides drainage space between the wall and siding

- Siding mounted on the strapping.
- Caulking around windows and doors.

Find and fix leaks. Take advantage of the renovation work being done on walls to find and fix air (and water) leaks around existing windows and doors, plumbing penetrations, vent hoods, utility connections and wiring. Caulk small holes and narrow openings. Spray foam insulation on larger gaps.

A blower door test can be used during the renovation work to help locate air leakage and paths to ensure the air sealing measures are well done.

WINDOW AND DOOR RENOVATIONS

- Replace older or damaged windows and doors while the siding work is being done. Features of condensation-resistant windows are listed in the "Window design" section on page 14.
- Check to make sure the weather stripping on doors and windows is in good condition and the windows and doors seal tightly when closed.
- Replace sealed window units that have lost their seals.

BATHROOM AND KITCHEN RENOVATIONS

If the bathroom or kitchen was gutted as part of a mould cleanup, take the opportunity to install durable moisture-resistant materials, and make sure there is adequate insulation in the exterior walls and ceilings and new plumbing is leak- and condensation-resistant. The bathroom renovation strategy can include:

- Using cement board in bathtub/shower stalls and for the sink backsplash.
- Choosing durable wall/backsplash finishes such as ceramic tile.
- Insulating and air sealing exterior walls and ceilings.
- Installing moisture resistant flooring.
- Providing quiet, energy-efficient bathroom fans and controls.
- Insulating pipes.
- Removing windows from shower stalls.
- Using one piece or sectional shower and bathtub enclosures.
- Using high-quality, cleanable paint.

Siding work is a good time to replace old windows and doors

A complete renovation strategy can help prevent mould problems in bathrooms

VENTILATION SYSTEM RENOVATIONS

Bathroom fans

- Ensure that existing bathroom exhaust fans are working and are vented directly to the outside through plastic-covered, insulated sheet metal ducting with sealed joints. The duct should be sloped downwards to the exterior hood to encourage proper drainage of any condensation that may form in the duct. Exhaust fans must not be vented into the attic or soffit.
- Replace noisy or ineffective bathroom exhaust fans with energy-efficient, quieter units (2.5 sones or less). Good bathroom fans often include a centrifugal ("squirrel cage") blower that is very effective at moving air and dealing with humidity and odours. Bathroom fans typically have airflows between 25 and 50 L/s (50 and 100 CFM). However, there is no point in installing a higher capacity exhaust fan on a small exhaust duct as the duct will restrict the performance of the fan. A quiet fan is more likely to be used by the occupants for longer periods.
- Install controls such as crank-type, dehumidistat, or electronic timers to control the operation of bathroom fans. The timers allow bathroom fans to run for longer periods of time to clear the air after the bathroom is used and can also shut off the fans automatically to save energy.

Install ventilation controls to help owners use ventilation equipment to maintain good indoor air quality

Exhaust kitchen range hoods directly outside to remove cooking-related moisture from the house

Kitchen range hoods

- Install kitchen range hoods that exhaust directly outside. Recirculating range hoods do not control cooking-related moisture loads. Range hoods should have multi-speed controls. Quiet range hoods may be used more often and for longer periods of time, providing better control of cooking-related moisture and odours.
- Range hood ducts must be well sealed and, if they pass through unheated space, they must be insulated. Kitchen exhaust ducts must be either accessible for cleaning or equipped with a grease filter.

Clothes dryer venting

- Replace plastic clothes dryer flex duct with aluminum duct. Make sure the joints in the dryer duct are sealed with foil-type tape and the duct is as short and straight as possible.
- Ensure the dryer duct vents directly outside.
- Check and clean dryer exhaust ducts to remove lint.
- Make sure the exterior damper operates freely, closes firmly and any screen or grille is clear of lint.
- If the dryer duct is long and the dryer takes a long time to dry clothes, install a booster fan to help vent the dryer.

Heat recovery ventilation system

A heat recovery ventilation (HRV) system can be installed either with its own dedicated ducting system or integrated with an existing forced-air heating system. The HRV transfers heat from the exhaust air to the incoming supply air reducing ventilation-related heating costs.

HRVs can provide effective and efficient ventilation for all houses. If an HRV is installed, individual bathroom fans and fresh air intakes may not be necessary. Kitchen range hoods should be vented outdoors in order to remove cooking odours and moisture.

If the ventilation and heating systems are integrated, set the furnace fan for continuous operation and good air circulation. HRVs should be installed and maintained by qualified personnel certified by organizations such as the Heating, Refrigeration and Air Conditioning Institute (HRAI). Key features of an HRV system include the following:

- Fresh air inlet and exhaust air outlets high enough above grade so they don't get buried in snow, well separated to limit the risk of cross-contamination, and are not located near driveways, under decks or in attics.
- The HRV is mounted in a warm and dry location and is accessible for maintenance.
- Fresh air ducting to the furnace return air plenum for circulation to the house by the furnace ducting, or fresh air ducting to each room in the house.
- If ducted to each room, high wall supply air grilles that deliver the fresh air up near the ceiling level to prevent drafts.
- Exhaust air grilles in the kitchen and bathrooms. Additional bathroom fans are optional. Do not connect an HRV to a kitchen range hood. The kitchen exhaust grille must not be located near the stove.
- A control panel installed in a central location to turn the HRV on and off and to control speed settings.

ATTENTION

Proper design and operation of ventilation systems are important. See the "Ventilation cautions" section on page 17 for key considerations to keep in mind when modifying a home's ventilation systems.

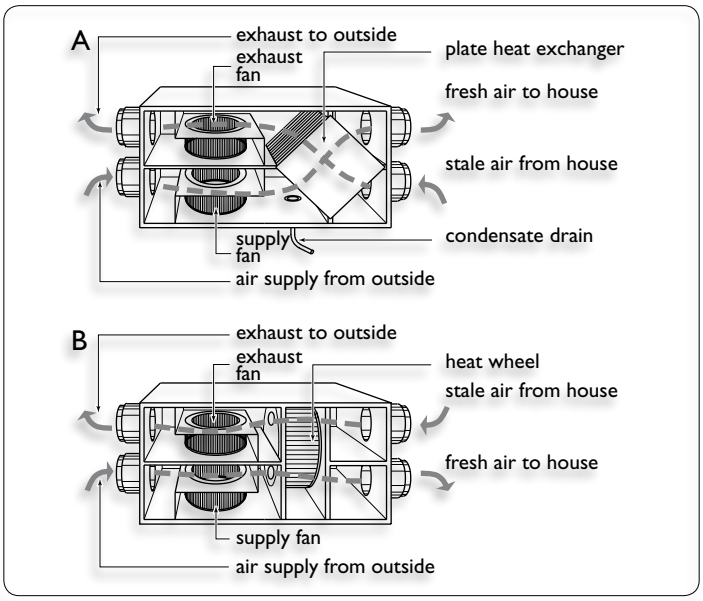
SPACE HEATING SYSTEM RENOVATIONS

Forced-air systems

- It may be a good time to replace an older furnace or one in poor condition, especially if insulation has been added to the house and air sealing work was undertaken. Get a heat loss calculation done so the replacement furnace can be properly sized for the renovated house. High-efficiency, sealed-combustion furnaces can provide lower-cost heating and are not affected by the operation of exhaust fans.
- Study the location of floor grilles to see if any changes are required for better air circulation through the house. Add more grilles to deal with cold rooms. Relocate grills to avoid obstruction by furniture and appliances.

HRVs can provide effective and efficient ventilation for all houses

Common types of HRVs



- If there is not a return air grille in every room, make sure doors are undercut by at least 25 mm (1 in.) to allow air out of the room and back towards the furnace when the doors are closed. Alternatively, transfer grilles can be installed in doors or in the walls between rooms. Make sure room air can easily find its way back to a return air grille or the furnace.
- Clean the ductwork if necessary. Often, all that is required is the vacuuming of the ducts immediately behind the supply and return air grilles.
- Ensure any dampers in the supply and return air ducts and plenums are properly positioned to encourage good airflow.
- Install a new furnace filter box to accommodate a higher-efficiency filter on the return air plenum where it enters the furnace.

Baseboard heating systems

- Disconnect power and inspect and clean all baseboard heaters, including the heat transfer fins.
- Check that the thermostatic controls are working.
- Make sure that there is a baseboard heater in each room and that it is not blocked by furniture. Relocate furniture or baseboard heaters if necessary.
- Make sure the heaters are the right size. Undersized heaters may cause some rooms to be colder than others and condensation may occur on windows, walls and ceiling surfaces. Upgrade baseboards as needed.

Increase airflow in rooms with no air return grilles by undercutting the door by one inch

DESIGNING AND BUILDING HOUSES TO PREVENT MOULD

- With careful design, planning and supervision, houses can be built to be mould-resistant.
- Choose a well-drained building site.
- Use a simple design that is easy to construct and maintain.
- Make sure walls, attics, windows and doors are well-insulated.
- Incorporate an energy-efficient space heating system.
- Install a heat recovery ventilation system.

This section provides information on some of the key details and features of mould-resistant houses so that when it comes time to build new housing in the community housing managers know what to plan for.

BUILDING SITE CONSIDERATIONS

- Locate building sites in well-drained areas outside of flood plains. Constructing houses, especially ones with full basements, on wet sites can lead to chronic basement leakage problems and mould growth.
- In community planning, some sites should be left vacant because of the risks posed by high water tables, poor drainage and flooding.

Community planning must take into account that some wet sites should be left vacant

DESIGN CONSIDERATIONS

- Houses with simple designs are easier to build and maintain. Complex floor plans can lead to roofs that are harder to build and maintain and more likely to leak. Simple designs can be interesting. Variations in exterior appearance of neighbouring houses can be achieved by reversing plan layouts, changing the direction of roof slopes on adjacent houses, and changing siding, roofing and exterior trim colours. Changes in interior appearance can also be achieved with different wall, floor and trim colours, as well as different cabinet and door styles.
- Detailed drawings and specifications that both contractors and inspectors can follow are needed. The drawings should contain details for any construction features that require more information to be built correctly. Specifications should list all of the products, materials and systems to be used in the construction of the house and any other special instructions. The upfront investment in a good set of drawings and specifications reduces errors and omissions.

Successful designs take into account cultural and day-to-day activities of the occupants

- The drawings and specifications should also be part of the construction contract with the builder, so that it is clear to all parties what is to be built and how.
- Successful designs must meet the cultural and day-to-day activity requirements of the occupants. For example, if a basement is not going to be included, the design should include suitable work and storage spaces.
- Other design strategies that can help prevent mould include:
  - avoiding locating closets next to exterior walls (to prevent cold, dead air spaces);
  - developing floor plans that encourage the location of furniture along interior walls (to avoid creating cold, dead air spaces between furniture and exterior walls);
  - designing rooms that are easily heated and ventilated; and
  - locating space heating, ventilation and plumbing systems in warm areas that are easily accessed for service, inspections and problem detection.
- The National Building Code of Canada (NBC) provides minimum requirements for certain, but not all, elements of a house. Simply building to the requirements of the NBC may not result in a house that meets all expectations. Drawings and specifications that reference best practices or require compliance with established programs, such as Natural Resources Canada's R-2000 standard and the ENERGY STAR® Program, can provide houses that have better comfort, enhanced durability, healthier indoor air and improved energy efficiency.

BASEMENT DESIGN

- The easiest way to avoid basement moisture and mould problems is to avoid building basements at all. Slab-on-grade foundations can be the best choice for mould-resistant foundations.
- If a shallow foundation (or crawl space) is needed, a decision must be made whether or not to heat the crawl space. Heated crawl spaces are easier to keep warm, dry and mould-free. It can be difficult to control moisture conditions in unheated crawl spaces, and mould problems can occur and spread to the rest of the house.
- Heated crawl spaces are not separated from the heated portions of the house. The temperature may be different, but the crawl space air is connected to the house air, so special measures are not needed to seal the house from the crawl space area. This type of crawl space must be built as if it were a shallow basement, with air barriers, vapour barriers, exterior insulation, heating, cooling and ventilation similar to those of the rest of the house and suitable for the climate. They also require exterior dampproofing and perimeter drainage. Install 6-mil polyethylene sheeting over compacted granular fill. Install rigid insulator underneath the concrete slab. Install a floor drain and sump pit, if necessary.

Slab-on-grade foundation can be the best choice for mould-resistance

ROOF DESIGN

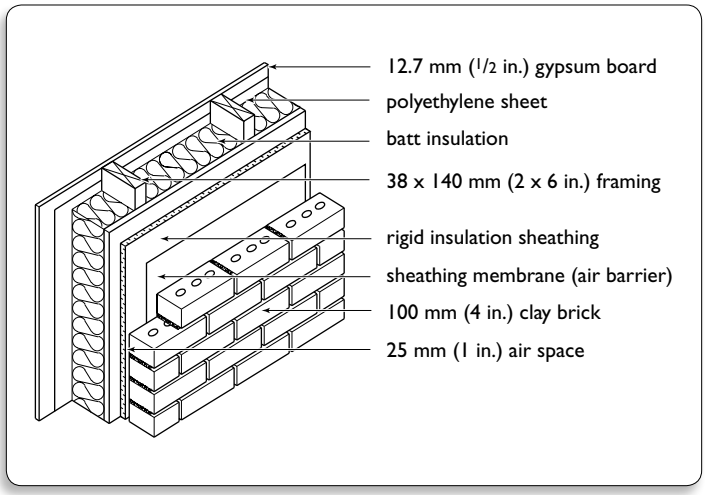
- Roofs should be as simple as possible to limit the risk of water leaks.
- Provide good overhangs to protect walls, windows and doors below.
- Limit the number of penetrations though the roof for pipes, vents and exhaust hoods.
- Use raised heel trusses to provide sufficient space for full attic insulation over the exterior walls.
- Install eavestroughs and downspouts with horizontal extensions to direct rainwater and melted snow away from the house.
- Use self-adhering eave protection over the roof sheathing to protect against water leaks due to ice damming.

Simple house and roof designs are easier to build and to maintain

EXTERIOR WALL DESIGN

- There are many options for the construction of exterior walls, including wood or steel frame, structural insulated panels (SIPs) and insulated concrete forms (ICFs).
- All wall types can benefit from a rainscreen system to help make sure that the wall drains and dries quickly if it is wetted by rain or by interior moisture sources. The basic components of a rainscreen assembly are listed in the "Exterior wall renovations" section on page 6.
- Exterior walls must be airtight to prevent moisture in the indoor air from working its way into the wall system where it can cause damage and support mould growth. Use a blower door test to determine the air leakage characteristics of a house. Use it during construction to test the air barrier system before the house is drywalled, to make sure that the house is as airtight as possible to reduce heating costs and to enhance durability.
- Insulation helps prevent mould growth by reducing cold spots where condensation can form. Applying rigid insulation over the exterior of the walls reduces heat loss and helps prevent cold spots on the interior of the walls by insulating the wall studs that would otherwise be cold.

Exterior walls must be airtight and highly insulated to prevent mould growth



WINDOW DESIGN

Windows should be energy-efficient to avoid condensation that can wet surrounding surfaces and lead to moisture damage and mould growth. Windows with higher resistance to condensation can include the following:

- Argon gas-filled, double- or triple-glazed, thermal units.
- Insulating edge spacers between the glass panes to improve energy performance and reduce the risks of condensation.
- Casement operable units with a number of latching points to ensure the windows are well-sealed when closed.
- Spray foam insulation between the window frames and rough stud openings.
- Vinyl, fibreglass or metal clad wood frames. Wood frames can offer good performance if they are properly maintained and indoor humidity conditions are controlled.

The materials used on window returns or sills, below the window, should be moisture-resistant.

Energy-efficient windows help to prevent condensation that can wet surrounding surfaces if interior moisture levels are controlled adequately

BATHROOM AND KITCHEN DESIGN

Kitchens and bathrooms can be designed and built to be mould resistant. Key design features include:

- Durable surfaces that are moisture resistant and easy to clean.
- Walls and ceilings that are well insulated and air sealed.
- One piece or sectional bathtub/shower stalls.
- Cement board surrounds in bathtub/shower stalls and for the sink backsplash.
- Quiet, energy-efficient bathroom fans, range hoods or HRV and controls (see "Ventilation system renovations" on page 8).
- Insulated hot and cold water pipes.

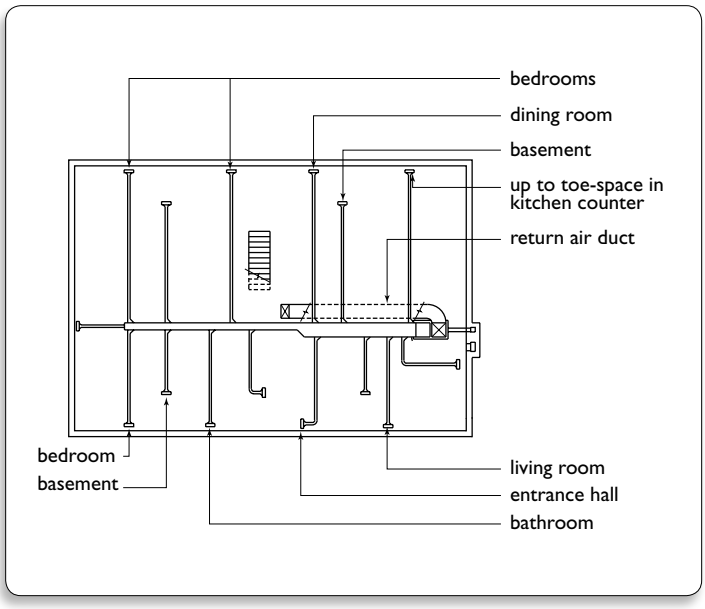
SPACE HEATING SYSTEM DESIGN

The choice of space heating systems depends on the availability and cost of fuel and electricity. The following considerations are essential to keeping a house mould-free.

Forced-air systems

- ***Proper sizing***—Heating systems must be properly sized to work efficiently and effectively through a heat loss calculation. Improperly sized furnaces may not be able to maintain the right temperature in the house, and condensation might occur on cold exterior wall, ceiling or foundation surfaces. Oversized furnaces cycle on and off and provide poor control of indoor air temperature. Higher-efficiency heating systems and fan-motor sets may cost more but cost less to operate over time.
- ***Location***—Furnaces and ductwork must be located inside the house and not in unheated attics, basements or garages.
- ***Combustion safety***—Fuel-fired appliances that resist backdrafting (such as sealed-combustion, power-vented or direct-vented appliances) are safer.
- ***Good air distribution***—The furnace's air handling system must distribute warm air evenly throughout the house. Provide supply air grilles and return air grilles in each room. If return air grilles cannot be located in each room, locate them centrally as long as doors between rooms are undercut or air transfer grilles are provided. Locate supply air and return air grilles away from one another and in places where they are not blocked by furniture.
- ***Ducts***—Properly design and install all duct systems to ensure good air circulation. Seal all joints with mastic or foil tape. Locate ducts in warm areas of the house (not in unheated crawl spaces or attics). Return air ducts should be metal.
- ***Accessibility***—Locate the furnace in a room where it can be easily serviced. Provide access to the ductwork to make future cleanings easier.
- ***Controls***—Provide dampers in duct systems to adjust airflows and heat distribution. Provide access to the dampers, so they can be adjusted later. Provide a thermostat that is easy for the occupants to understand and use.
- ***Filtration***—Provide a furnace filter box to accommodate higher-efficiency filters on the return air plenum where it enters the furnace.

Basement plan showing typical heating layout



ATTENTION

Wood heating differs from other space heating options. It can be challenging due to the physical demands involved. Special knowledge and skills are required to safely and effectively use wood as a heating source. Installation of wood heating appliances should be done by trained and certified installers who have completed courses such as the Wood Energy Technical Training (WETT) Program.

Occupants should be advised not to store firewood in the house as this can be a large moisture source and can bring mould spores from outdoors.

Electric or hot water baseboard and in-floor systems

- ***Proper sizing***—Properly size electric and hot water baseboard and in-floor systems by using a heat loss calculation. Improperly sized systems may not maintain proper temperatures throughout the house and condensation might occur on cold exterior wall, ceiling or foundation surfaces.
- ***Controls***—Provide a thermostat in each room for electric and hot water baseboards. In-floor systems can be controlled by room or by larger zones.

Install mechanical equipment in locations that are easy to reach

Provide a thermostat for baseboard heaters in each room

Air-conditioning systems

- Select high-efficiency air conditioning systems to reduce operating costs.
- Size air conditioners between 90 and 100% of the design cooling load. Oversized cooling systems can result in indoor humidity levels being too high for comfort. An undersized air conditioner offers better dehumidification performance.
- Make sure condensate pans from air conditioners drain properly to avoid moisture problems. Drainage pans must be accessible for cleaning.

ATTENTION

Depressurization protection: When non-direct vented or non-mechanically vented combustion equipment (fuel-fired furnaces, water heaters, wood fireplaces, wood stoves, and so on) is used in a house, tests should be done to determine whether or not exhaust fans installed in the house can depressurize the home to the point where combustion equipment can backdraft combustion products, including carbon monoxide, into the house. A source of make-up air may be required to replace air vented by exhaust systems, to prevent house depressurization. Always provide carbon monoxide detectors in houses that have combustion equipment installed.

Always install carbon monoxide detectors in homes equipped with combustion equipment

VENTILATION SYSTEM DESIGN

Properly designed and installed, ventilation systems can quickly deal with moisture, odour and stale air problems in the home. Key features of ventilation systems are presented on page 8.

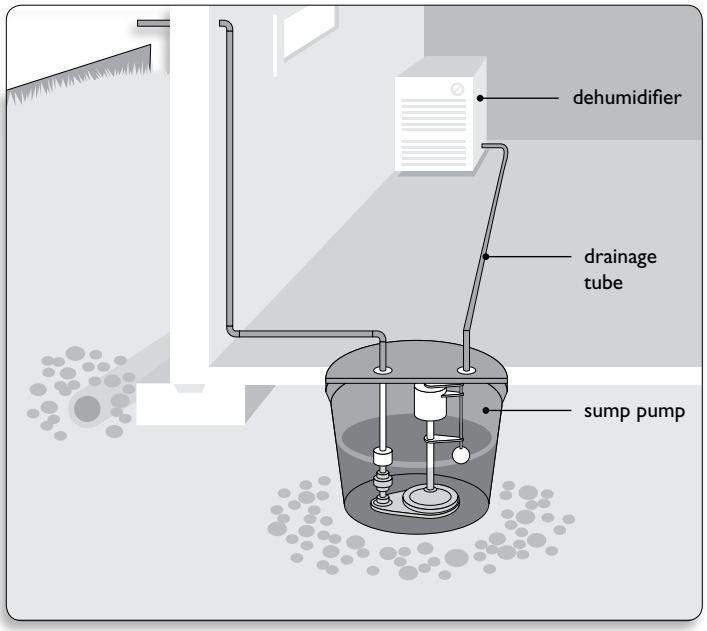
A heat recovery ventilation (HRV) system offers the most effective and efficient way of meeting the ventilation needs of houses. See the "Heat recovery ventilation system" section on page 8 for a detailed description of HRV system requirements.

HRV systems should be designed and installed by trained and certified contractors.

Ventilation cautions

- Locate fresh air intake hoods away from driveways or other exhaust hoods so they do not bring in potentially polluted air.
- Ventilation will not reduce humidity in the house if the weather outside is warmer and more humid than it is inside. Cool basement surfaces get condensation in spring and summer when warm humid air enters the basement. Use a dehumidifier to help control moisture conditions. Connect the dehumidifier

Connect the dehumidifier directly to the sump pit to reduce the frequency at which the occupants must drain the reservoir



directly to a drain, sump pit or other drainage location to avoid having to constantly drain the reservoir.

- Operate and maintain ventilation systems properly especially HRVs. Inspect annually or more frequently as recommended by the manufacturer.
- Operating the ventilation systems too much can result in higher heating costs and can dry out the indoor air making occupants uncomfortable. Install a humidistat in a central location so that the occupants can check. Proper sizing of the ventilation system and the provision of suitable controls can help keep indoor humidity at a moderate level.

WARNING: Exhaust fans can prevent combustion equipment such as wood stoves, fireplaces, gas or oil furnaces and water heaters from venting properly. When an exhaust fan vents air from the house, an equal amount of air must come back into the house through available cracks and holes and other openings. If the house is well sealed, exhaust fans may prevent proper venting by drawing air down chimneys and in through vents serving combustion equipment. Referred to as "backdrafting," this can cause dangerous combustion gases to be drawn into the house.

Test the house to determine if a combustion venting failure risk exists and whether or not corrective measures, such as make-up air ducts and fans, should be included. Install carbon monoxide sensors in houses with combustion equipment.

For more information, including reports, videos, fact sheets, success stories, case studies, visit www.cmhc.ca/firstnations or contact your CMHC First Nation Housing consultant www.cmhc.ca/contactfnh

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