Natural Resources Canada / Ressources naturelles Canada

Natural Gas-Fired Hot Water Boiler

Retrofit Installation Guidelines

Canada

DISCLAIMER

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1. Intended audience and scope

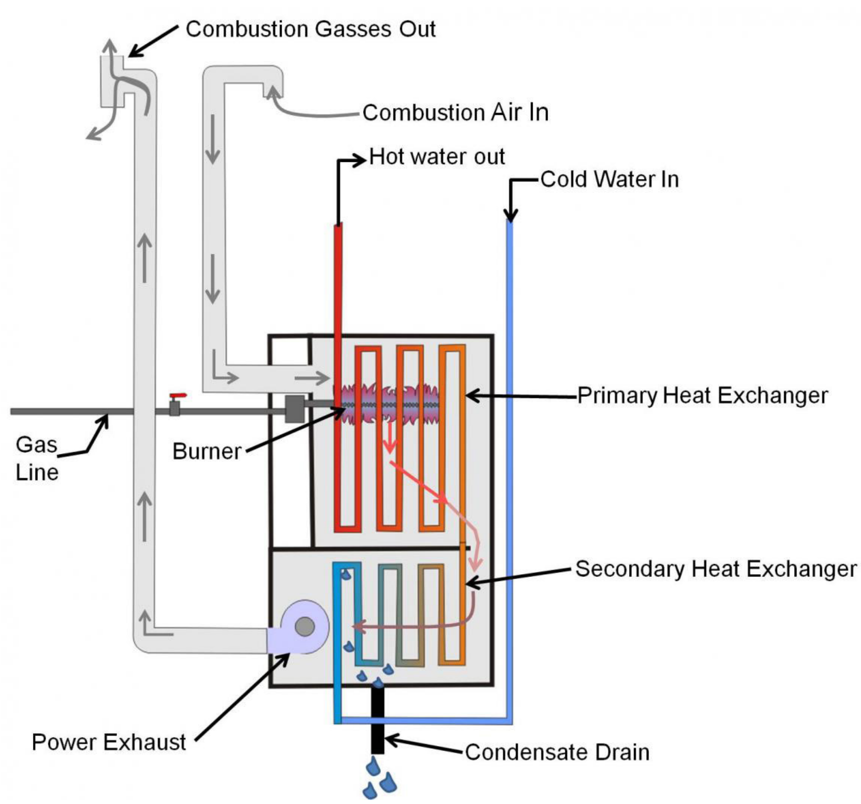
This document is intended as a general guidance reference for mechanical designers and contractors of both residential and commercial-sized boiler systems.

2. Consumer Information

Natural Gas-Fired Condensing Hot Water Boilers

Condensing boilers have either an additional heat exchanger or a larger heat exchanger that transfers more heat out of the hot combustion gasses and into the hot water. This means more heat goes into the water to heat the building and less heat goes out the exhaust, making condensing boilers more efficient. The temperature of the final exhaust is cooler than that of a less efficient boiler, which means that the exhaust can often be vented through the side of the building through a plastic pipe rather than up a chimney or exhaust stack. A liquid condensate is generated as the exhaust is cooled and is typically piped to a nearby drain.

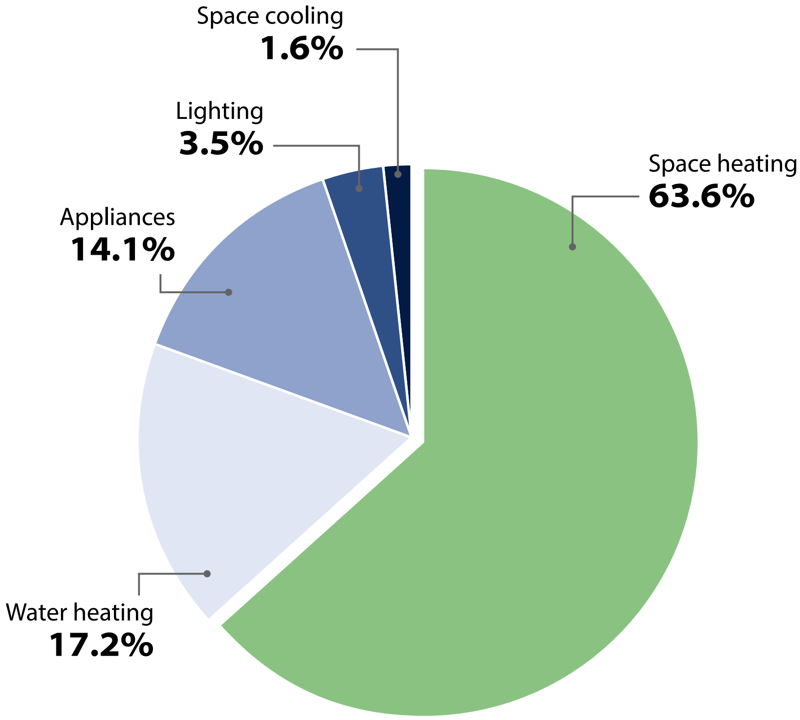
Figure 1. Condensing boiler



Source: U.S. Department of Energy (https://basc.pnnl.gov/resource-guides/condensing-boilers)

Because of the increased efficiency of condensing boilers, building owners or operators save money on natural gas or propane costs and generate fewer greenhouse gases and other combustion by-products. Canada's cold climate means that increasing the efficiency of space heating can have significant benefits for both individuals and the environment. Figure 2 shows the fraction of energy used to provide space heating in the average Canadian home.

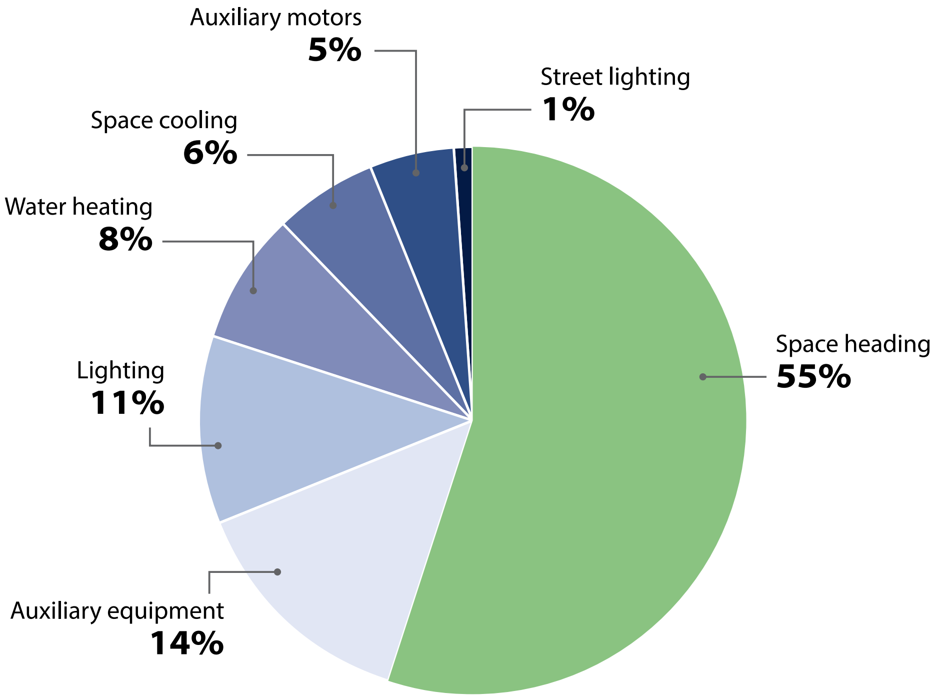
Figure 2. Energy used to provide space heating in the average Canadian home



Source: Distribution of residential energy use in Canada 2019, Nataural Resources Canada (**https://www.nrcan.gc.ca/energy-efficiency/products/product-information/heating-equipment-residential-use/13740**)

In the average Canadian commercial and institutional building, 55% of the energy use is due to space heating, as shown in Figure 3.

Figure 3. Energy used to provide space heating in an average Canadian commercial and institutional building



*total is not equal to 100% due to rounding

Source: Distribution of commercial energy use in Canada 2016, Nataural Resources Canada (https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-products/product-information/heating-and-cooling-equipment-commercial-use/21351)

Hot water gas-fired boilers imported into Canada or shipped across provincial lines are regulated by Canada's *Energy Efficiency Regulations*. The Office of Energy Efficiency is continuously reviewing energy efficiency requirements, looking for opportunities to save Canadian consumers money and to reduce environmental impacts. As an example, in 2010, the efficiency requirements for residential-sized furnaces were changed to require condensing performance.

Amendment 15 of the *Energy Efficiency Regulations* set the following minimum efficiencies for both residential and commercial hot water gas-fired boilers. Although the efficiency of different-sized equipment is expressed with different metrics (AFUE, thermal efficiency, combustion efficiency), all of these minimum efficiencies would commonly be called "condensing."

- Residential boilers, including those with tankless domestic water heating coils: AFUE ≥ 90%, effective July 1, 2023.
- Commercial boilers: thermal/combustion efficiency ≥ 90%, effective January 1, 2025.

These regulations were developed after studies showed that:

- Equipment at or above the specified performance levels is readily available.
- Less fuel is required to provide the same level of comfort.
- Over the course of the equipment's lifetime, the typical consumer will save money: ongoing fuel savings will exceed any additional up-front or maintenance costs.
- A significant reduction in greenhouse gas emissions will be achieved.

As indicated by market research, most residential and commercial gas-fired boilers now being shipped into Canada and across provinces are condensing boilers.

Installing condensing boilers in new buildings or homes is usually straightforward because the heating distribution systems, vents and drains can be designed to suit condensing boilers. The installation of a condensing boiler in an existing home or building may require some changes to the heating system. Some of these are similar to the changes required when a condensing furnace is installed to replace an existing less-efficient furnace. For example:

- Condensing boilers require a direct exhaust pipe and typically use a direct combustion air intake pipe. The simplest option may be to run these pipes through the side of the house or building. Where this is not possible, the system designer or installer will provide other options.
- Condensing boilers produce corrosive condensate. This typically is discharged into a nearby drain, but other options will be considered where a nearby drain is not available. Neutralizing equipment (to reduce the acidity of the condensate) is required.
- Condensing boilers work best when the return water (water going into the boiler) temperature is low. The return water temperature depends on both the supply water temperature and on the amount of radiator or fan coil surface area distributing the heat. The installer may recommend controls to adjust the supply temperature based on the outside air temperature ("outdoor-air-reset") or additional radiators, fan coils, or heat distribution units if these are needed.

These changes, and the possible required workarounds, are well understood by experienced designers and installers.

3. Installation Guidelines

The following section provides general guidance for HVAC designers and installers involved in natural gas-fired condensing hot water boiler retrofits.

3.1 Introduction

When planning and conducting a gas-fired hot water condensing boiler retrofit in a building formerly heated by non-condensing boilers, system designers and installers reference manufacturer installation instructions and provincial and territorial building codes. The information in this document does not supersede manufacturer instructions and building code requirements.

The purpose of this document is to facilitate the transfer of information about condensing boiler retrofits from experienced industry players to those less experienced. Natural Resources Canada (NRCan) worked with boiler manufacturers, industry organizations, consultants, property management companies, and other industry leaders to develop this guidance.

3.2 Sizing

When a boiler retrofit is planned, the expected loads on the system should be calculated so that the boiler can be correctly sized.[1] If energy efficiency measures have been installed in the building (for example, more insulation or better-performing windows), or if the original boiler was oversized, the new boiler may not need to be as large as the one being replaced. Using a lower-capacity boiler may reduce both the up-front costs and ongoing energy costs. If a mix of condensing and non-condensing boilers will be used, consider code requirements and both current needs and future operation when more of the non-condensing boilers are replaced with condensing boilers.

1 For determining residential loads, CSA F280: *Determining the Required Capacity of Residential Space Heating and Cooling Appliances* is a recognized standard. For commercial loads, “In new construction, the building’s heating load should be calculated, and the boiler plant should be sized in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 90.1.” (**https://bit.ly/3RbX6qf**)

3.3 Venting Options and Boiler Location

The exhaust from a condensing boiler is at a lower temperature than that of a non-condensing boiler. This cooler exhaust may condense on the inside of the exhaust pipe. Because this condensate is corrosive, exhaust vent systems almost always need to be reconfigured during a retrofit.

3.3.1 Vent Material Selection

Condensing boilers require exhaust vents constructed from corrosion-resistant materials. CAN/CSA B149.1 *National Gas and Propane Code*, provincial/territorial and local building codes, boiler manufacturer's installation instructions, ULC-S636 *Standard for Type BH gas Venting Systems*, and local authorities must be consulted to determine the correct exhaust vent materials.

PVC piping may be allowed by the applicable codes when the exhaust flue gas temperature never exceeds 65ºC/149ºF. Because condensing boilers are typically capable of producing flue gas temperatures well above 65ºC/149ºF, certified CPCV, polypropylene or stainless-steel piping may be required, depending on the exhaust temperature. Some building owners routinely choose stainless steel BH venting because it allows the use of the boilers at high temperatures on peak heating days. If either the combustion air intake or exhaust vent passes through a fire rated assembly, they must either be constructed from non-combustible materials (e.g., stainless steel) or insulated with fire-stop materials, following applicable codes.

Vent lengths and weight of vent system must also be considered when selecting a vent material.

The standard ULC-S636 requires that vent materials (including pipe, fittings and joining methods) must be manufactured by a single manufacturer to work together. Some local authorities having jurisdiction have interpreted this to mean that exhaust and combustion air vent materials must be the same.

The local authorities having jurisdiction may look at the maximum allowable flue gas exhaust temperature for the boiler model, not the temperature to which the boiler is set to operate. Some may allow exhaust vent materials to be chosen based on operating temperature if the temperature restriction is set with a DIP switch or in some other hard-to-change manner.

It may be helpful to understand that U.S. and Canadian vent material requirements differ: *ULC-S636 Standard for Type BH gas Venting Systems* is used in Canada while *UL 1738 Venting Systems for Gas-Burning Appliances, Categories II, III, and IV* is used in the U.S.

3.3.2 Boiler and Vent Locations

The lower temperature exhaust from condensing boilers presents both additional options for the exhaust vent location and, possibly, some challenges.

Side Venting

Commercial boilers in existing buildings may be in mechanical rooms in the basement or on lower floors. In some of these buildings, side-venting a condensing boiler is possible. CSA B149.1: *Natural Gas and Propane Installation Code*, typically referenced by Canadian building codes, provides details on where side-vent terminations are and are not allowed. (For example: an exhaust vent must be high enough to be above the snow level and must be at least 7 feet above a paved sidewalk.)

Occupant perception may also need to be considered when choosing sidewall exhaust vent locations: one building manager noted that exhaust from condensing boiler contains high volumes of water vapour, making it visible to building tenants in cold weather. When operable windows are nearby, this can cause perceived health risks, even though the vents are installed in a code-compliant manner.

When the boiler is in the basement, boring through concrete floors to get to ground level, or creating an underground chase that vents above ground at an appropriate location may be a cost-effective option.

Other Vent Locations

If side venting is not possible, either the new vent must be run through the existing vent path, or an alternative must be found. Challenges may include:

- boiler manufacturers' limits on the maximum length of combustion air and exhaust vents.
- the existing exhaust vent is too large: condensing boilers typically require smaller diameter exhaust vents than non-condensing boilers.
- existing chimneys and exhaust vents may not go straight up to the roof without bends, complicating the installation of a liner.

The following guidance may be helpful:

Calculate Vent Length Before Specifying Boiler

Different brands/models have different maximum combustion air and exhaust vent length requirements. If vent length might be a challenge, determine the required vent length before choosing the boiler brand/model. This will allow for the possibility of choosing a boiler with a longer maximum vent length.

There may be options to increase the maximum allowable vent length for a specific installation. These include:

- Increasing the exhaust vent diameter.
- Using a variable-speed external fan to push exhaust through the exhaust vent.
- Using flue gas dampers to control negative pressures.

Combustion air and exhaust vent systems not specifically covered in the certified documentation for the boiler may be possible and are generally referred to as "engineered systems." Both the manufacturer and the local authority having jurisdiction must be consulted to determine whether an engineered vent system is acceptable.

Relocate Boiler

Relocating basement boilers to a mechanical penthouse location may be a most cost-effective solution and might also free up space in a valuable location. The feasibility of this option will depend on whether the proposed location is structurally strong enough for the weight of the boilers and associated equipment and whether the hot water distribution piping can be suitably reconfigured.

Reuse of Existing Vent Location, Lining

Because building codes have changed since many older boilers were installed, boiler room and venting changes may be needed regardless of the equipment being installed. Specifically, the amount of ventilation air supplied to the mechanical room may need to be increased and the reuse of existing exhaust vents may require them to be relined with stainless steel vent liners.

Common Exhaust Vents

A bank of atmospheric boilers may use a common exhaust vent. If a boiler with a common exhaust vent fails and needs to be replaced by a condensing boiler, the following challenges need to be considered:

- Condensing boilers cannot use the same common exhaust vent as atmospheric boilers: exhaust from the pressurized exhaust systems of the condensing boilers could be pushed through a non-operating atmospheric boiler, creating a potentially life-threatening air quality problem in the building.
- If a new exhaust vent is installed for the condensing boiler, the existing atmospheric vent may then be oversized for the remaining non-condensing boilers.

In addition, an existing atmospheric exhaust vent might serve both boilers and other appliances such as dedicated water heaters. Removing the boiler(s) from this atmospheric exhaust vent could result in an "abandoned" water heater: if the exhaust vent cross-section is too large for the remaining non-condensing application, the exhaust air may not have enough buoyancy to properly move through the vent. Another concern is that the exhaust may cool down more quickly than anticipated, causing condensation in an exhaust vent not designed to resist condensation.

In some circumstances, it may be possible to establish a new side-wall vent for the condensing boiler, leaving the other boilers and appliances on the original exhaust vent. This solution may require that the existing exhaust vent diameter be reduced using a liner. Correctly operated draft dampers on common exhaust vent systems may also solve over-size problems. Another option for "abandoned" water heaters is to replace them with indirect water heaters that are heated by the condensing boiler and therefore don't require venting.

There may be a business case to replace all boilers at once. If they were all installed at the same time, they will reach end-of-life at the same time. If venting needs to be reworked, it may be most efficient to tackle the job once.

Boiler Location and Access

When the space for a new boiler is constrained or access to the mechanical room is challenging, it may be possible to engage a manufacturer representative to supervise the disassembly and reassembly of the boiler, preserving the warranty. In some cases, disassembling the boiler so it can be moved to a penthouse mechanical room is more cost-effective than using a crane to lift the boiler to the roof.

When a concrete block wall is in the way of a boiler replacement, it may be easiest to temporarily remove that wall.

Condensing boilers are typically smaller than the non-condensing boilers they are replacing and therefore less likely to cause problems in tight areas.

3.3.3 Combustion Testing

Combustion analysis provides information on how efficiently and safely boilers are operating. Too much carbon monoxide in the exhaust means that the fuel is not being completely combusted. Too much oxygen means that too much air is being provided to the combustion. In either case, the boiler combustion is not optimized. Although combustion testing is important for all boiler installations, it is particularly important for condensing boilers. Combustion testing is typically done during the start-up process and during annual maintenance.

3.4 Condensate Drains

The condensate produced by a condensing boiler is typically first neutralized and then drained to an interior drain. Building codes generally require a drain in mechanical rooms. If the drain is not conveniently located, a condensate pump might be required.

3.5 Return Water Temperature Control

Condensing boilers only operate in condensing mode when the return water temperature is sufficiently low (typically under 130°F). If the heat distribution system has adequate heat transfer surface (e.g., enough radiators, fan coils, or heat distribution units), the supply temperature can be set so that heating loads are met and return water temperatures are low enough for the boiler to operate in condensing mode. A heat distribution system designed for a non-condensing boiler may not have adequate heat transfer surface to allow for this type of operation. As a result, a condensing boiler may not operate in condensing mode for some or all the season. This will impact the boiler's performance and should be taken into consideration when the exhaust vent material is chosen.

Methods of increasing the amount of time a condensing boiler operates in condensing mode include:

- Adding additional distribution heat transfer area.
- Resetting the supply temperature based on the outdoor air temperatures. (When the outside temperature is warmer, less heat is required, and the supply temperature can be lower.)
- When condensing and non-condensing boilers are in the same system, properly sizing and sequencing the two types of boilers. If the boilers are piped in series, the condensing boiler should be first in line, so it has the coldest return water.
- When a boiler provides both space and domestic hot water heating, cascading the hot water from the indirect water heater (which requires a higher temperature) to the space heating loop.
- Using variable speed distribution pumps.

3.6 Multiple Boiler Installations

Large buildings may have multiple boilers. These systems present some additional retrofit challenges.

Some existing boiler plants have multiple non-condensing boilers of the same model or manufacturer. If one of these fails, it will need to be replaced by a condensing boiler, possibly from a different manufacturer. There may be a business case for replacing all the boilers at the same time. However, building automation systems (BAS) typically can work with any type of boiler, allowing boilers of different types and manufacturers to be controlled together. If a BAS is not already present, a simple, small controller can be installed for boiler control.

Hybrid boiler plants (systems with both condensing and non-condensing boilers) balance cost and efficiency. A hybrid system is controlled so that the non-condensing boilers operate when high supply water temperatures are needed (e.g., loads are high). When loads are lower and the supply temperature can be lowered, the condensing boiler is able to meet the full load while operating in condensing mode. The boilers should be piped and operated to minimize the return water into the condensing boiler(s).

3.7 Controls

Commercial condensing boilers can be controlled by:

- Building automation systems (BAS): These may offer more flexibility, but also may require more expertise to set up and optimize. Some property management firms will have their own BAS expert, others will contract with a BAS contractor.
- Local controllers, typically available from the boiler manufacturer: These require less expertise to set up and commission but may not be as flexible. Depending on control protocols and algorithms, they may not work in a mixed condensing/non-condensing boiler plant.
- A combination of BAS and local controllers. For example, the BAS may provide the "need heat" signal while the local controller controls the boiler(s) to provide heat in the optimal manner.

3.8 Commissioning

Proper commissioning of boiler systems is essential for a successful installation. Incorrect operation of a boiler or boiler plant can reduce the system efficiency and even cause significant and costly damage to the boiler and the rest of the system.

Proper commissioning is even more important when operating a mixed condensing/non-condensing boiler plant. The system designer will have provided a control sequence that specifies which boiler should provide first-stage operation, and how additional boilers are brought on as the load increases. It is important to verify that the plant operates as designed during all load scenarios. It is very likely that additional tweaks (such as variable speed drive pump settings) will be needed to optimize the operation for a specific building.

During commissioning, all actuators and temperature sensors need to be calibrated and the readings need to be recorded for future reference. If sensors are not functioning properly, they need to be moved to a better location and then recalibrated. The location of differential pressure sensors is particularly critical.

A detailed plan should be made for ongoing or periodic re-commissioning. There are a number of sources of information on commissioning and re-commissioning:

- Equipment-specific information is provided in the certified installation and operations manual for the given boiler.
- NRCan's recommissioning website provides a link to the NRCan re-commissioning guide and other commissioning and recommissioning information sources. (**https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-buildings/energy-efficiency-existing-build/recommissioning-existing-buildings/20705**)

3.9 Effective Maintenance

All manufacturers provide maintenance guidelines. Most require an annual maintenance walkabout and combustion analysis.

In addition to yearly maintenance, there may be a need to inspect the system more frequently under certain conditions. For example, during snowy or cold weather, both exhaust and intake points must be clear of snow and ice.

3.10 Operator Training

As with many building technologies, educating local operators is an important step in ensuring the expected energy and cost savings are obtained. Operator training should be part of the start-up process.

Boiler operators will need to understand, for example, that:

- A return water temperature of less than 130ºF is desirable, rather than cause for alarm.
- Condensate neutralizing systems need to be regularly maintained.

Building staff not trained on proper boiler operation and maintenance should be reminded not to change the system or controls. System "tweaks" made by untrained staff can significantly impact energy use and increase maintenance and repair costs.

4. Case Studies

The following case studies were collected to illustrate common barriers and workarounds to condensing boiler retrofit installations in various types of buildings:

4.1 One Queen Street East (Toronto, ON)

Property Manager: Cushman & Wakefield Asset Services ULC.

Installer/contractor: City Core Mechanical Limited.

Building/System Description:

One Queen Street East is a 27-story office and retail building constructed in 1991. It is connected to an adjacent seven-story historical building, also containing both office and retail space and the complex is certified LEED EB: O&M Platinum. The boiler plant for One Queen Street consists of four near-condensing and two fully condensing boilers located in the mechanical penthouse. These were installed when the old atmospheric boilers reached end-of-life. The modulating condensing boilers come online first and are assisted by the near-condensing boilers when loads are high.

Challenge:

Because the boiler plant is in the penthouse, the new boilers needed to be moved into place at the top of the building.

Solution:

Although a crane could have been used to lift the boilers into place, the best solution was to disassemble them and transport them up the freight elevator. Both the condensing boiler and the near-condensing boiler manufacturers' representatives supervised the disassembly, reassembly, and start-up to preserve the warranties.

4.2 Office Building (Ottawa, ON)

Building/System Description:

During the construction of the building, three condensing boilers were installed in a basement mechanical room to provide space heating. The exhaust was vented through the roof, and because of the vent length, exhaust fans were required to provide sufficient draw.

Challenge:

After installation, the boilers would not stay running. This problem was eventually resolved by removing the vent exhaust fans on the roof. Condensate pooled on the mechanical room floor, but the pooling was eliminated by adjusting the angle at which the exhaust vent stack connected to the boiler. The installation problems appeared to have been solved and the boiler plant ran through the winter in this configuration.

During summer maintenance, the maintenance team discovered more than expected corrosion of the boiler parts. Some parts were replaced at that time, but several years later the boilers had to be completely rebuilt. The corrosion occurred because exhaust gases condensed on the inside of the vent stack and ran down the stack into the boiler, corroding the inside of the boilers. Had the exhaust fans been operating correctly, condensate would not have condensed on the inside of the vent and the boiler corrosion would not have occurred.

Solution:

Eventually, the problem of the boilers turning off was traced to poor coordination of the roof-level vent exhaust fans and the boiler combustion fans. Because these fans used different control protocols, they were not ramping up or slowing down appropriately as combustion conditions changed.

This cautionary example underscores the importance of thorough commissioning, both immediately after installation and ongoing.

4.3 Castleview Apartments (Ottawa, ON)

Building/System Description:

This multi-unit residential building was constructed in 1974 and contains 242 suites on 26 floors. Six gas-fired hot water boilers provide space heating for the building. A heat exchanger between the space heating boiler plant and the domestic hot water loop is in place but would only be used in case of a water heater failure. One of the atmospheric boilers was replaced with a condensing boiler as an energy-efficiency measure.

Challenge:

The boilers in this building were piped in series, with the condensing boiler last in the sequence. When all the boilers were atmospheric, it didn't matter that the last boiler received the warmest return water. However, condensing boilers are most efficient when they are supplied with cooler return water. As a result, the condensing boiler was operating most efficiently only when the heating load was low enough to be met just by the condensing boiler. In colder weather, when the atmospheric boilers came online to help meet the load, the efficiency of the condensing boiler was reduced.

Solution:

To improve the seasonal efficiency of the condensing boiler, the boiler plant was re-piped so that the condensing boiler is first in line and now receives the coldest return water. This allows the condensing boiler to operate as efficiently as possible.

4.4 Single Family Residence (Scarborough, ON)

Building/System Description:

The boiler room in this single-family home is in the middle of the basement. The existing mid-efficiency boiler was replaced by a condensing boiler.

Challenge:

The original atmospheric boiler exhaust vented through a central chimney. The central location of the boiler room prevented running the combustion air intake and the exhaust through the side of the house.

Solution:

Both the combustion air intake and the exhaust were vented through the existing chimney. The chimney liner was first removed, then a 2″ PVC gas vent pipe was run through the chimney chase for both intake and exhaust. Because of the diameter of the chimney chase, the boiler model was carefully chosen to allow the use of a 2″ pipe.

Additional Information:

Some boilers require the use of 3″ pipe for intake and exhaust; this may be too large to fit through an existing chimney. If the chimney has an offset, flexible pipe will be required.

In this home, the water heater was not vented through the same chimney and therefore was not considered when planning the boiler replacement. In a home where both the boiler to be replaced and the water heater are using the same chimney, the water heater will need to be replaced. Options to be considered include an indirect water heater, an electric tank water heater, and an electric instantaneous water heater.

4.5 College View Apartments (Toronto, ON)

Building owner and manager: Toronto Community Housing (TCHC).

Building/System Description:

This 20-storey apartment building provides supportive housing for seniors. The building complex was constructed in 1970 with a gross floor area of 18,690 m^2 (201,179 ft^2) and has 340 living units. Four atmospheric boilers in the penthouse mechanical room provided hot water to radiant tube and fin heaters in the perimeter areas of the building. Most living units have two radiators; additional unit heaters and radiators supply the common areas. The heat distribution system is a two-pipe system with common heating water risers. In addition to providing space heating, the boilers also supplied the domestic hot water system.

Challenge:

Like many original hydronic heating systems, the existing radiators are designed for high-temperature water supply. Condensing boilers are more efficient when the hot water supply temperature is lower.

Solution:

Toronto Community Housing has been replacing old boilers with condensing boilers without changing the distribution system. Although the boilers run in a non-condensing mode during the coldest part of the year, outdoor air temperature reset controls allow the boilers to run in condensing mode during the shoulder season. This saves energy and avoids overheating.[2]

In this building, the four existing boilers were replaced by three condensing boilers to supply the space heating loads (N+1 redundancy). Four semi-instantaneous water heaters were installed to supply domestic hot water. Separating the space heating and domestic hot water systems allows for optimal control.

When the maintenance requirements for radiators in a building with condensing boilers pass a certain threshold, Toronto Community Housing replaces the old high-temperature radiators with units that have more fin area. This allows the hot water supply temperature to be lowered and increases the portion of the year that the boiler plant runs in condensing mode. TCHC has considered using radiators with fans, which would allow the hot water supply temperature to be lowered even further. Because of the increased capital and maintenance costs of these radiators, they have preferred to use radiators without fans.

Other Considerations:

TCHC notes that they prefer to use stainless steel BH venting. This allows high-temperature boiler operation on peak heating days and eliminates the concern about breaching fire-rated assemblies with combustible venting materials.

2 An atmospheric boiler plant that is turned down too low may result in flooded (and therefore damaged) heat exchangers. Sometimes the only safe option for an atmospheric boiler during the shoulder season is to provide too much heat.

4.6 Winnipeg School Division

Building/System Description:

Many older Winnipeg schools were designed to be heated by steam boilers. Steam coils in the air handling units heat the outdoor air and steam radiators handle perimeter losses. These systems have reached end-of-life and are being replaced by natural gas hot-water boiler systems. These comprehensive conversions typically include:

- New condensing hot water boilers, with new exhaust vent and air intake.
- New distribution piping and radiators sized for the supply temperatures used by condensing boilers.
- Hot water to glycol heat exchangers and glycol loops to supply air handler coils to reduce the chance of freezing.
- Electronic thermostats and digital controls.
- Millwork replacement, where necessary, to accommodate the larger hot water radiators. Asbestos abatement is also often necessary.

Challenge:

The school boiler system replacements must occur in a narrow window of time. The bulk of the work occurs during July and August. The system must be ready-certified to provide heating in the first week of October. Often unforeseen circumstances, such as the discovery of asbestos, mould, or code-related issues, can greatly impact the schedule of a boiler replacement project.

Solution:

The following steps were used in an 80,000 ft^2, 3-storey elementary school originally constructed in 1914:

- In the first year:
  - One of the two steam boilers was removed, and two condensing boilers were installed in the same location as the removed boiler. (The condensing boiler footprint is much smaller than the steam boiler footprint.)
  - The piping and radiation units in the gym addition (constructed in 1965) were retrofitted during the first summer and were supplied by the condensing boilers the first winter. One of the original steam boilers had enough capacity to heat the original building for the first winter.
- In the second year:
  - The piping and radiation units for the rest of the building were replaced and connected to the condensing boilers.
  - The second steam boiler was removed.

Other Benefits:

Non-energy-efficiency benefits included: more space in the mechanical room (because the new boilers are smaller than the old ones), no steam trap maintenance, less control maintenance (because of the switch from pneumatic to electronic controls), and less danger of coil freeze-up in the air handling units (because of the glycol loops).