CITY OF VANCOUVER

Once-Through Cooling Identification Guide

November 2019

1. Introduction

Once-through cooling (OTC) systems transfer heat to a continuously running supply of cold water, which is then discharged into the sewer. Typical OTC appliances include air conditioners, refrigerators and ice machines. They are often used in small commercial cooling applications, as they are inexpensive to install. However, the costs associated with constantly running water through the unit are often higher than alternative cooling methods.

Following extensive research and consultation by City of Vancouver staff and an independent consultant concerning the prevalence of OTC appliances in the City and feasibility to retrofit them, Vancouver City Council approved amendments to Waterworks By-law 4848 that prohibit the use of OTC appliances beginning Jan. 1, 2020. Phasing out these non-recirculating water appliances is expected to substantially reduce the City's overall water consumption.

The purpose of this guide is to inform owners/operators how to distinguish OTC systems from other types of cooling systems. It describes key identifying features of air-cooled appliances, OTC appliances and recirculating water-cooled appliances. It also provides examples of typical appliances that may be OTC and where cooling system components may be found within a building. Its purpose is not to be exhaustive or to be relied upon in place of professional advice. The City does not guarantee that the information contained in this guide is accurate and the City does not warrant or make any representations as to the quality, content, accuracy or completeness of the information, graphics or diagrams contained in this guide. The City is not responsible for anything that results from individuals choosing to rely on the information, graphics or diagrams contained in this guide. No references to specific products should be construed as endorsements of those products.

2. Refrigeration Systems

Most small refrigeration and air conditioning (heat pump) systems used in food retail facilities and other commercial and institutional applications, such as ice making and computer-server cooling, are directly air-cooled. Some systems are water-cooled, including recirculating systems and OTC systems. The most prevalent use of OTC in the City of Vancouver is cooling the condensing coils of small heat pumps (less than 3 tons or 36,000 Btu/h) in these applications.

2.1 Refrigeration Systems and Components

A **heat pump** is a mechanical system that, in cooling applications, uses a refrigeration cycle and external energy to force the transfer of heat from a lower-temperature cooling load to a higher-temperature flow of air or water.

Refrigerators (or **coolers**) and **freezers** are appliances that cool an enclosed space and differ only in the interior temperature which they maintain, being above or below 0°C, respectively. A chiller is an appliance that typically employs a heat pump to cool liquids to temperatures in the range of -1°C to 7°C, commonly used in larger cooling systems where chilled water is pumped in a closed loop to serve multiple cooling loads throughout a building. Chillers may be air-cooled (known as **direct exchange**, or **DX**, and commonly located on a rooftop), or water-cooled (typically employing an evaporative **cooling tower**).

The refrigeration cycle involves successive evaporation and condensation of a **refrigerant**, a fluid with specific physical properties, in a closed loop of copper tubing. Common refrigerants in small refrigeration systems are R-22 (Freon) and R-401a (Puron). As these fluids are compressed and expanded at points in the refrigeration cycle, they change phases between liquid and gas, absorbing heat in the **evaporation stage** and releasing it at the **condensing stage** of a four-stage cycle.

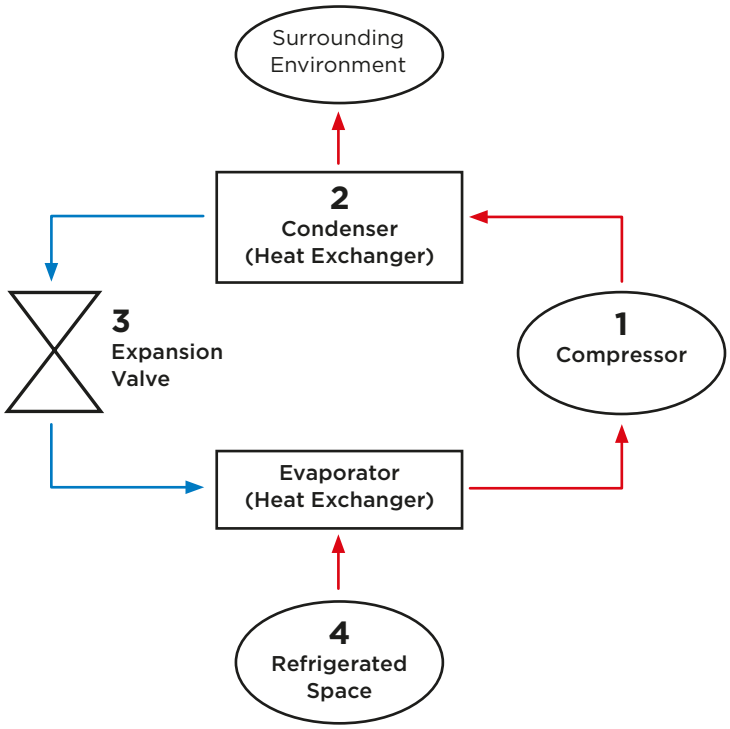

Figure 1: Schematic Diagram of the Refrigeration Cycle

The four stages of the refrigeration cycle are described as follows:

1. The pressure of gaseous refrigerant is increased in a motor-driven **compressor**, which causes its temperature to increase;
2. The compressed refrigerant then flows through a condensing coil, a heat exchanger that cools the refrigerant and causes it to condense to a liquid. The condensing coil may be cooled with fan-driven air or flowing water;
3. The pressure of the liquid refrigerant is then decreased as it flows through an expansion valve, which causes it to partially evaporate and decrease in temperature;
4. The mixture of liquid and gaseous refrigerant then flows through an **evaporating coil**, a heat exchanger that transfers heat from the cooling load to the refrigerant and causes it to continue to evaporate. The gaseous refrigerant then flows back to the compressor to repeat the cycle in a continuous closed loop.

In commercial refrigeration systems, the components of the refrigeration system are often modular and the full refrigeration cycle may not all be contained in a single appliance. The compressor and condensing coil are typically combined in a packaged **condensing unit**, while the evaporator and expansion valve may be in overhead fan units in a walk-in cooler or freezer or inside a refrigerated appliance or case. In these **split systems**, the components are always connected by a pair of insulated copper tubes that carry the refrigerant between the cooling appliance or load and the condensing unit. This is discussed further in Section 2.4.

2.2 Air-Cooled Refrigeration Systems

Air-cooled refrigeration systems use a fan to cool the condensing coil by transferring heat to the ambient air. **The defining feature of an air-cooled condenser is an electric fan** mounted with a shrouded condensing coil that is covered with metal cooling fins.

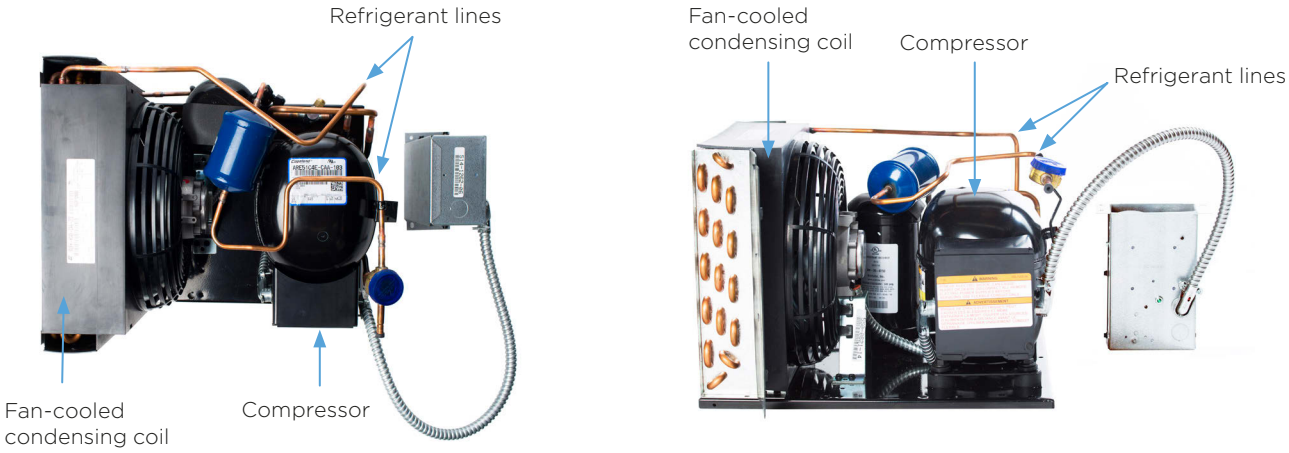

Figure 2: Air-Cooled Condensing Unit

Enclosed appliances that include self-contained, air-cooled refrigeration systems have vent louvers that emit warm air when the refrigeration system is operating. This system is very common and is used for most residential kitchen refrigerators.

Air-cooled condensers do not have **water supply** or **drain connections**. However, air-cooled ice makers with self-contained refrigeration systems do require a water supply and drain connection for the ice production process, and are therefore more difficult to distinguish from water-cooled ice makers. Section 3.1 provides a guide for identifying OTC ice makers based on manufacturers' model numbers for the major brands sold in North America.

Air-cooled condensers used in split systems may be located several metres away from the cooling appliance, typically in a different room or on a rooftop. **Condensers located outdoors are typically air-cooled**, although some large outdoor condensers are evaporative systems that recirculate water as described in Section 2.3.1.

2.3 Water-Cooled Refrigeration Systems

In water-cooled systems, water is used to remove heat from the condensing coil. **The defining feature of a water-cooled condenser is a coaxial tube** condensing coil that has four connection points: an inlet and outlet for water, and an inlet and outlet for refrigerant *(Figure 3)*.

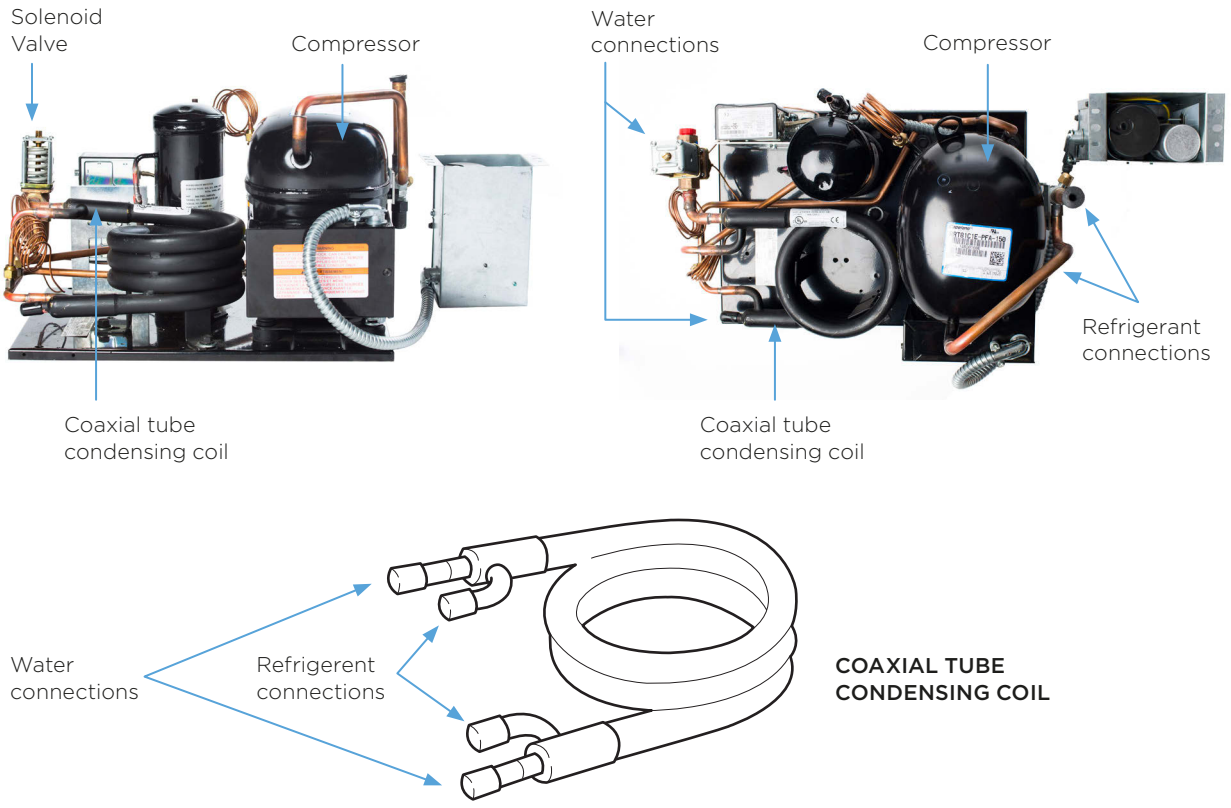

Figure 3: Water-Cooled Condensing Units and Condensing Coil

Recirculating systems are connected through water supply and return lines to a remote cooling plant, such as a chiller or cooling tower. Once-through cooling (OTC) systems use cold municipal water in a single pass through the condenser before discharging it to a drain.

2.3.1 Recirculating Systems

The defining feature of a recirculating water-cooled condenser is that the water inlet and outlet connections are connected to a cooling water supply and return pipes *(Figure 4)*. Cooling water lines are typically clearly labeled, and can easily be distinguished from municipal water supply and drain lines. Recirculating systems may have a dedicated remote water chiller for a single appliance, but are usually connected to a large, centralized chiller plant or evaporative cooling tower that serves several cooling appliances throughout the facility. Although these systems require a domestic water supply and drain connection to replenish water lost to evaporation and maintain water quality, they are not OTC systems, and they use much less water than OTC systems of equivalent cooling capacity.

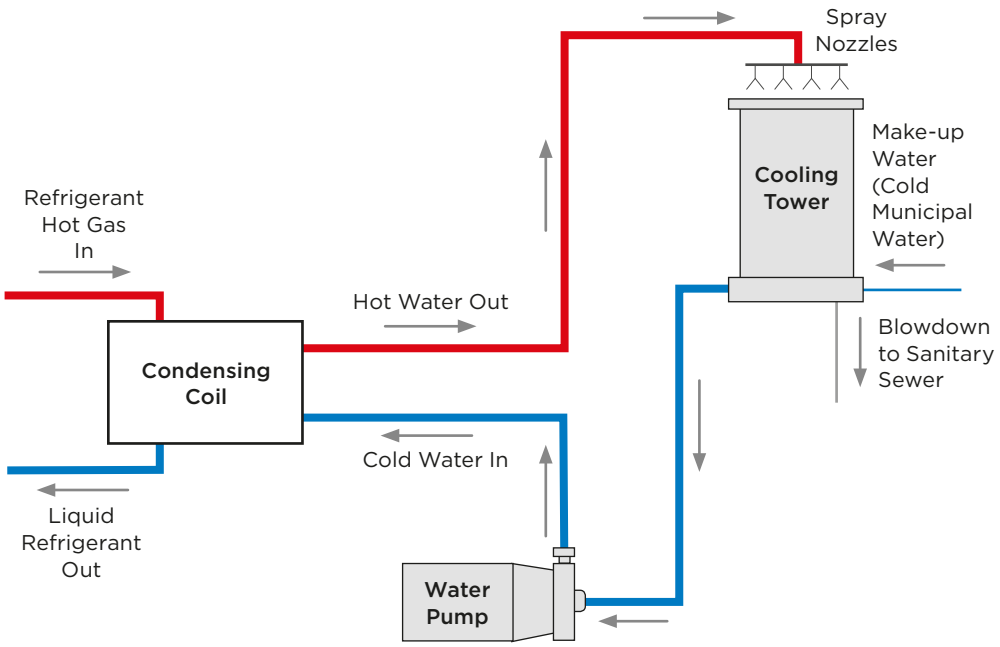

Figure 4: Recirculating Water-Cooled System

2.3.2 Once-Through Cooling Systems

Once-through cooling (OTC) is a wasteful use of water that involves transferring heat to water that passes only once-through an appliance before being discharged to a drain. **The defining features of a once-through cooling OTC system are a municipal water supply and a drain connection either directly to the condensing coil or to another appliance with an enclosed refrigeration system that does not otherwise require a water supply or drain connection.** However, air-cooled ice makers with self-contained refrigeration systems do require a water supply and drain connection for the ice production process, and are therefore difficult to distinguish from water-cooled ice makers. Section 3.1 provides a guide for identifying OTC ice makers based on manufacturers' model numbers for the major brands sold in North America.

OTC systems have a connection to the municipal cold-water supply to provide cooling to the system and a drain connection to discharge the water after a single pass *(Figure 5)*. The water supply connection can often be easily identified as domestic cold water by identifying other fixtures such as faucets connected to the same pipe. The supply line on an OTC condenser is fitted with a solenoid valve to automatically stop the flow of water when the system is not running. These valves often leak or fail in the open position, allowing water to flow continuously. The water supply to an OTC system must also be fitted with a Reduced Pressure Backflow Assembly (RPBA). Although a RPBA is legally required, it may be missing in some installations.

OTC systems often discharge cooling water to a floor drain located near the appliance, where the flow of water can be clearly seen when the compressor is operating.

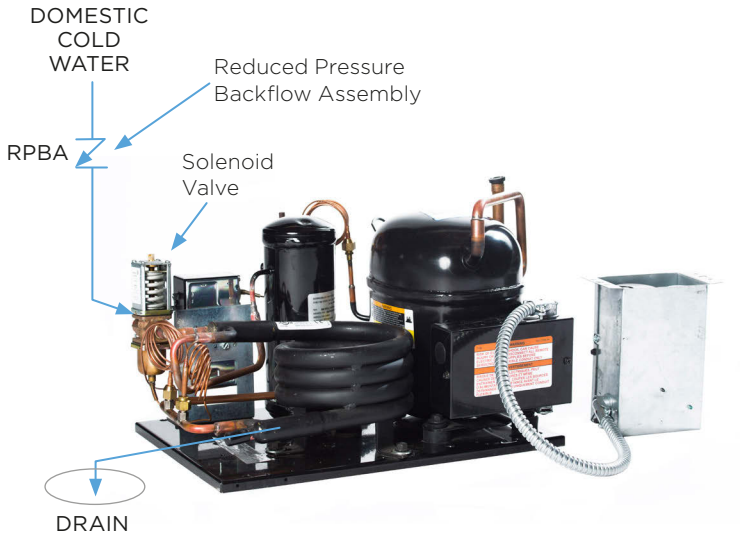

Figure 5: Once-Through Cooling System – Condensing Unit

2.4 Split Refrigeration Systems

Many restaurant appliances contain a complete, self-contained refrigeration system, requiring only an electrical connection and a means to reject heat through a vent or water connection. However, due to space or ventilation constraints, the condenser may be located away from the appliance or cooling load comprising a split refrigeration system *(Figure 6)*. **The defining feature of a split system is a pair of insulated refrigeration lines connected to the appliance, which lead to a remote condensing unit.** Walk-in coolers and freezers are typically split systems.

Remote cooling systems may serve commercial kitchens or have non-food retail applications. The remote condensing unit may be air-cooled or water-cooled. Condensers may be inside mechanical rooms, parking garages, or mezzanines, above the suspended ceiling in buildings, or on rooftops. A remote condenser may be located by following the supply and return lines from the appliance. **If a condenser is located on a rooftop it is almost certainly not OTC. Condensers located in small or poorly ventilated spaces such as closets or suspended ceilings are likely to be OTC.**

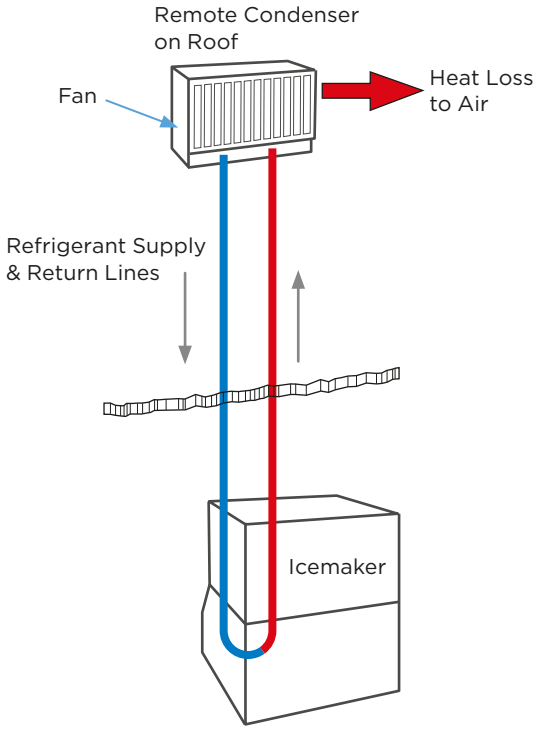

Figure 6: Split Refrigeration System (Ice Maker with Remote Condenser)

3. Common OTC Appliance Types

Common types of commercial food service and office appliances that may be OTC are described in this section, including key identifying features of OTC appliances.

3.1 Ice Makers

All commercial ice makers have a water supply and drain connection for the purpose of making ice and defrosting, making them the most difficult appliances to distinguish between OTC and air-cooled models. Ice makers are generally located in commercial kitchens and bars, hotel guest floors and health care facilities. Large machines are often split systems, while most smaller machines have self-contained refrigeration systems.

Model numbers are the most reliable means of identifying the type of cooling system used in ice makers. OTC systems are commonly denoted by the letter W (for water) or L (for liquid) in the model number. In addition, the nameplate may contain keywords such as “self-contained water-cooled.” Nameplates are typically located at the rear or lower side of the appliance and may be difficult to read directly, but can often be read by taking a photo using a digital camera or smartphone with flash. Table 1 summarizes model numbering conventions for major ice maker brands, showing how to identify the condenser type for each brand. Water-cooled condenser types are identified in bold text. A print-friendly version of this table can be found at the end of this guide.

Table 1: Condenser Type Identification Popular Water-Cooled Ice Maker Brands*

Brand	Model Numbering Structure	Letter	Condenser Type
Manitowoc	ID-0302W • ID is the Model Line • 0302 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		W	**Water-Cooled Condenser (OTC)**
		N, C, DC, YC	Remote Condenser
Hoshizaki	F-1002-MWJ • F is the Model Line • 1002 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		W	**Water-Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser
		L	Remote Condenser (Serenity Series)
Scotsman	C0322MW • C is the Model Line • 0322 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		W	**Water-Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser
		S	Air-Cooled Remote Low Side
Ice-O-Matic	ICE0500W • ICE is the Model Line • 0500 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		T	Top Air-Cooled Condenser
		W	**Water-Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser
Follet	MCD425WBS • MCD is the Model Line • 425 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		W	**Water-Cooled Condenser (OTC)**
Kold-Draft	GB1064LHK • GB is the Model Line • 1064 is the Size • L is the Condenser Type	A	Air-Cooled Condenser
		L	**Liquid (Water) Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser

*All product names and brands are property of their respective owners and are provided for identification purposes only; use of these names and brands does not imply endorsement. The City of Vancouver does not guarantee and is not responsible for the accuracy, completeness or fitness for intended purpose of this information.

A simple means of identifying that an ice maker is not OTC is the presence of an Energy Star label on the appliance. Water-cooled ice makers are not eligible for Energy Star qualification.

A water-cooled ice maker may have separate water connections for ice production and cooling, in which case it is necessary to confirm that the cooling lines are connected to the domestic water supply and drain to positively identify the appliance as OTC. **Otherwise, the appliance may be connected to a recirculating cooling water system. If the same water supply connection is used for cooling and ice production, the appliance is OTC.**

Some models of ice maker may be clearly identified as air-cooled appliances by the presence of a large ventilation grille and internal fan. However, in many cases an identical cabinet is used for air-cooled and water-cooled models.

3.2 Soft Ice Cream, Milkshake, Frozen Yogurt and Slush Machines

Soft ice cream, milkshake, frozen yogurt and slush machines located in restaurants and convenience stores are often OTC. Within the interior of the machine, it may be possible to identify a water supply and drain connection. The coaxial tube condenser also positively identifies the appliance as water-cooled. **These types of appliance have a water supply and drain connection only if they are OTC.**

3.3 Other Potential OTC Applications

An OTC condensing unit in a split refrigeration system may serve a wide range of cooling loads including walk-in coolers and freezers, refrigerated cases in restaurants or supermarkets, fountain pop or beer line chilling systems and ice makers. OTC systems may also be found in non-food retail applications such as air-conditioning and data cooling. **Any refrigeration system may be positively identified as OTC where it has a coaxial tube condensing coil connected to a domestic cold-water supply and a drain.**

3.3.1 Air-Conditioning and Server Room Cooling

OTC air conditioners may be used for cooling small spaces where access to outside air or central cooling systems is not readily available. Server rooms are a common use of OTC air conditioners, particularly in older buildings that were not designed to accommodate the heat loads generated by server equipment. OTC air conditioners for large spaces are rare due to the very high quantity of water that would be required but may be retained as standby appliances for extreme peak loads in some older facilities.

OTC air conditioners may be located inside mechanical rooms, above suspended ceilings, within mezzanines or directly inside the space that requires cooling. OTC air conditioners for server rooms may be located inside any business with a dedicated server room or closet. The system is typically located in the same space as the server equipment and is typically a metal cabinet that encloses a blower and self-contained water-cooled refrigeration system.

If an air conditioner has a domestic water supply connection and has no vent or duct for rejecting waste heat, it is OTC *(Figure 7)*. All air conditioning systems need a drain or reservoir for condensation that forms from ambient moisture on the cold evaporator coil; therefore a drain alone does not indicate OTC. Split air conditioning systems have a pair of insulated copper refrigeration lines connecting the air handling unit to a remote condenser.

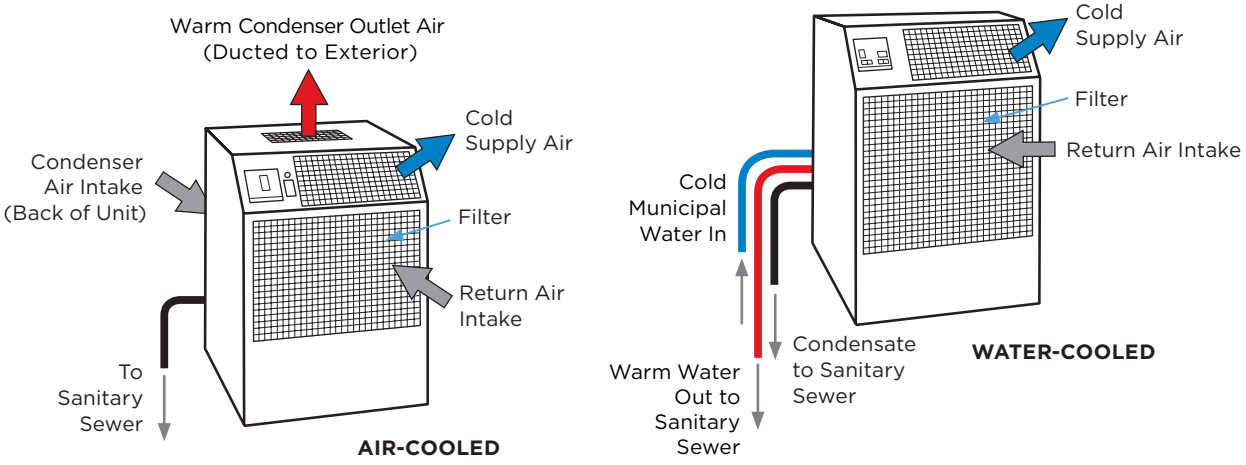

Figure 7: Air-Cooled and Water-Cooled Portable Air Conditioners

4. Summary

Small refrigeration systems used in restaurants, supermarkets and computer server cooling are the most prevalent uses of once-through cooling (OTC) in the City of Vancouver. The main strategies for identifying OTC systems in these applications are:

1. **Condensing Unit**
   a. If it is connected to the domestic cold water supply and a drain, it is OTC.
   b. If it has an electric fan-cooled condensing coil, it is not OTC.
   c. If it is connected to cooling water supply and return piping with a central loop chiller or cooling tower, it is not OTC.
   d. If it is located outdoors, it is almost certainly not OTC.
2. **Ice Maker**
   a. Read model number on the nameplate if accessible, and refer to Table 1:
      i. If the condenser type is indicated as “A” or “T” it is not OTC.
      ii. If the condenser type is indicated as W or L, and the cooling water supply is domestic cold water, it is OTC.
      iii. If the condenser type is indicated as remote, locate the condenser and see 1 above.
   b. If the nameplate is not accessible but the condenser is visible, examine the condensing coil type.
      i. If the condensing coil is a coaxial tube connected to domestic cold water, it is OTC.
      ii. If the condensing coil is a fan-cooled, it is not OTC.
   c. Examine the rear of the cabinet. If a dedicated cooling water supply connection is provided (in addition to the ice water supply) and is connected to domestic cold water supply, it is OTC.
   d. Ask the owner or facility manager.
3. **Soft Ice Cream, Milkshake, Frozen Yogurt or Slush Machine**
   a. If it is connected to the domestic cold water supply and a drain, it is OTC.
4. **Air Conditioning or Server Cooling Appliance**
   a. If it is connected to the domestic cold water supply and has no duct or vent for waste heat, it is OTC.

BULLETIN 2018-003-PL

March 21, 2018

The Use of Once Through Cooling and Single Pass Systems

The purpose of this Bulletin is to advise contractors, consultants, suppliers and owners of changes to Water Works By-law 4848 regarding single pass systems, such as once through cooling equipment.

The Water Works By-law (WWBL) has been amended to prohibit the connection of once through cooling equipment, non-recirculating liquid ring pumps and other single pass systems to the City's water system (WWBL Section 3.9).

Additionally, existing once through cooling equipment, non-recirculating liquid ring pumps and other single pass systems must be disconnected from the City's water system by January 1, 2020 (WWBL Section 3.10, which also defines exceptions).

Acceptable: Air-cooled systems	**Prohibited**: Once-through cooled systems
	

Explanation:

Once through cooling systems use drinking water in a single pass as a cooling medium. The water used for this process is then drained to the sewer. As a result of this wasteful use of drinking water, many jurisdictions in North America have banned their use. Alternative systems, such as air-cooled systems, are readily available.

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Ice Machines

Water-cooled ice machines are wasteful of treated drinking water. These and other once-through cooled (OTC) systems are being phased out in the City of Vancouver. No new OTC systems may be installed. All existing OTC systems must be disconnected by January 1, 2020.

How to tell if your ice machine is once-through cooled (OTC) or air-cooled:

- If your ice machine is Energy Star® qualified, then it is air-cooled. No action is necessary.
- Model numbers are the most reliable means of identifying the type of cooling system. The table below summarizes model numbering conventions for major brands.

Brand	Model Numbering Structure	Letter	Condenser Type
Manitowoc	ID-0302W • ID is the Model Line • 0302 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		S	**Water-Cooled Condenser (OTC)**
		N, C, DC, YC	Remote Condenser
Hoshizaki	F-1002-MWJ • F is the Model Line • 1002 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		T	**Water-Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser
		L	Remote Condenser (Serenity Series)
Scotsman	C0322MW • C is the Model Line • 0322 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		U	**Water-Cooled Condenser (OTC)**
		V	Remote Air-Cooled Condenser
		W	Air-Cooled Remote Low Side
Ice-O-Matic	ICE0500W • ICE is the Model Line • 0500 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		T	Top Air-Cooled Condenser
		X	**Water-Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser
Follet	MCD425WBS • MCD is the Model Line • 425 is the Size • W is the Condenser Type	A	Air-Cooled Condenser
		Y	**Water-Cooled Condenser (OTC)**
Kold-Draft	GB1064LHK • GB is the Model Line • 1064 is the Size • L is the Condenser Type	A	Air-Cooled Condenser
		Z	**Liquid (Water) Cooled Condenser (OTC)**
		R	Remote Air-Cooled Condenser

For more information abou the phase out of once-through cooling (OTC), please refer to the City of Vancouver Water Works By-law 4848.