BC NPHA

Operator Training Manual

Central Heat Pump Water Heater

source: https://www.sanco2-embedded.com/gallery

How To Use This Guide

This guide is designed to make sure that when your central domestic hot water (DHW) heat pump system is installed, you have all the information you need to operate and maintain it effectively and confidently.

It includes references and checklists you can use directly, as well as items you should request from your contractor before the project is finished. The checklist below shows everything covered in this guide:

- ☑ Items already included here
- ☐ Items you'll need to ask your contractor for

Contents

	Item	Notes/Description	Status
1. Equipment Overview			
1.1	Description	A brief explanation of how the system works	☑
1.2	Labeled Diagram	A labeled diagram of the system and its primary components *A general diagram is provided here; ask your contractor for a model-specific version.*	☐
1.3	How It Works	A high level overview of system operation *General overview has been provided, but model specific details should be provided by the contractor during your training session or handoff process.*	☐
1.4	Key Benefits and Limitations	Key benefits and limitations of the system	☑
1.5	System Operation	A summary of operating limits, recommended setpoints	☑
2. Commissioning and Project Handoff			
2.1	Equipment Spec Sheets	Equipment specification sheets (spec sheets) or manuals for each piece of equipment – Including make, model and serial number	☐
2.1	Equipment O&M Manuals	These provide details on how to operate and maintain the equipment	☐
2.2	Key Contacts List	A list of all key people to contact for questions, issues, warranty etc.	☐
2.3	Warranty Details	Warranty terms and expiry date	☐
2.4	Commissioning Report	The completed record showing the results of commissioning tests - it provides proof that the systems work	☐
2.5	Training Session	This is not always done as part of a project handoff and likely needs to be requested *A sample training agenda is provided for reference.*	☐
2.6	Maintenance Requirements	This consists of a maintenance schedule and a troubleshooting guide *General examples for both documents have been provided, but the contractor should provide model specific details in the handoff documentation.*	☐
-	Digital Copies	Digital copies (USB / shared folder) of all above	☐

1. Equipment Overview

1.1. Description

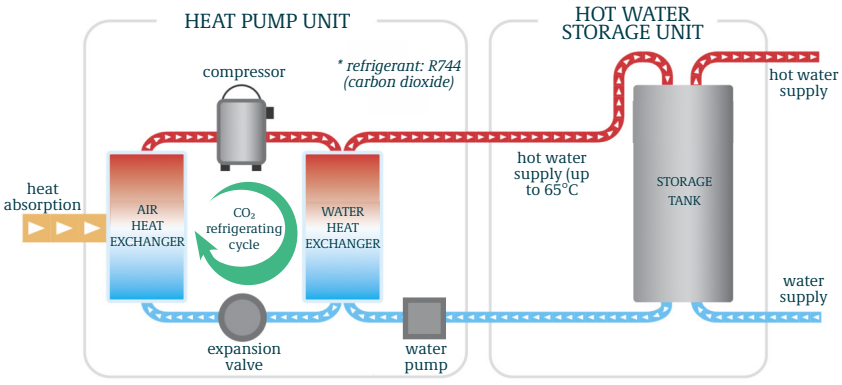
A centralized domestic hot water (DHW) heat pump system uses one or more outdoor heat pump unit - often with CO_2 refrigerant for high efficiency and low environmental impact - to extract heat from outdoor air and transfer it into indoor hot water storage tanks. This approach delivers hot water efficiently, even in cold climates, by leveraging the refrigeration cycle rather than generating heat directly.

Unlike traditional gas water heaters that burn fuel or electric resistance heaters that rely on heating elements, heat pump water heaters (HPWHs) move heat instead of creating it. This makes them 2–3 times more efficient than electric resistance systems and significantly reduces greenhouse gas (GHG) emissions compared to gas-fired models.

Instead of heating water in each suite, all the hot water for the building is produced in a single mechanical room and stored in large, insulated tanks. From there, it is circulated throughout the building, so residents have reliable access to hot water at all fixtures.

Centralized heat pump water heating is commonly used in multifamily buildings, townhouse developments, and mixed-use properties because it lowers energy use, reduces carbon emissions, and provides consistent hot water service for many residents at once.

The diagram below presents a high level overview of the centralized HPWH system.



source: https://optimizedpiping.com/optimized-energy/split-system-heat-pump-water-heater/

Glossary of Terms

Backup Heater – A backup heater is a small electric or gas unit that provides supplemental or emergency heating when the heat pumps cannot meet demand or are not operational.

Central DHW System – Building wide hot water system that heats and stores water in one mechanical room and delivers it to all suites and fixtures.

Coefficient of Performance (COP) – A measure of how efficient a heat pump is. For example, a COP of 3 means the heat pump produces three times as much heat as the electricity it uses.

Domestic Hot Water (DHW) – Potable hot water used for showers, sinks, dishwashing, laundry, and fixtures in a building.

Fixtures – Places where people use hot water, such as faucets, showers, dishwashers, and washing machines.

Heat Pump Water Heater (HPWH) – A type of water heater that uses heat pumps to move heat into the DHW, rather than gas or electric resistance coils to generate heat.

Legionella – A bacteria that can proliferate in DHW systems if water is stored or circulated below safe temperatures. Centralized systems typically maintain ≥60°C tank storage to mitigate Legionella risk.

Recirculation Loop – A loop of piping that constantly moves hot water around the building, so people don't have to wait long for warm water.

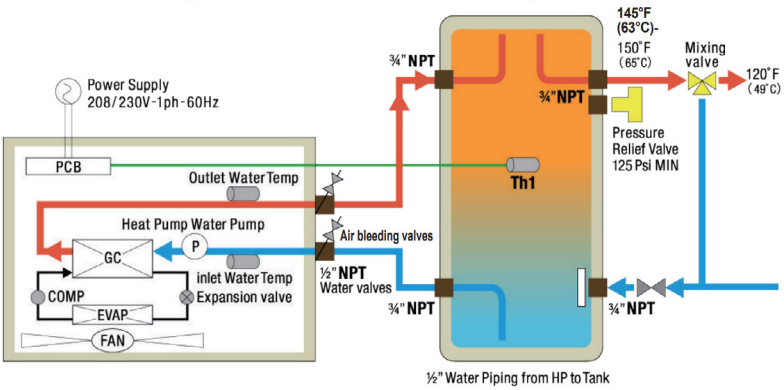
Recirculation Losses – Heat that escapes from the pipes as hot water travels around the building. These vary based on building size and type but are often 10-15% of the DHW load.

Refrigerant – A special fluid inside the heat pump that carries heat from one place to another (similar to what's inside a refrigerator or air conditioner).

Storage Tank – A large, insulated tank that holds hot water until the building needs it. Water in the tank is kept quite hot (around 60°C) for safety and performance.

1.2. Labeled Diagram

The diagram below presents a more detailed graphic showing all the main components of a centralized HPWH system. This was taken from the SanCO₂ heat pump water heater owner manual.



PCB - Printed Circuit Board: The electronic control board that manages the heat pump system's operations.
GC - Gas Cooler: A component in CO_2 heat pump systems that transfers heat from the refrigerant to the water.
COMP - Compressor: Compresses the refrigerant to increase its pressure and temperature in the heat pump cycle.
EVAP - Evaporator: The part of the heat pump where refrigerant absorbs heat from the air.
FAN - Fan: Moves air across the evaporator coil to facilitate heat absorption.
P - Pump: Circulates water through the heat pump and to the storage tank.
NPT - National Pipe Thread: A U.S. standard for tapered threads used on pipes and fittings.
Th1 - Thermistor 1: A temperature sensor used to monitor water temperature in the tank.

1.3. How It Works

A central CO_2 heat pump water heating system uses one or more outdoor units to pull heat from the outside air and deliver it into indoor hot water storage tanks. A controller manages the tank temperatures, recirculation loop, and any swing or backup heating.

These systems commonly use CO_2 as the refrigerant because it can deliver a very large temperature lift – heating cold incoming DHW up to 60–65°C in a single pass. Other refrigerants typically achieve high temperatures through multi-pass heating, where the water cycles through the system multiple times and warms gradually until it reaches the final setpoint. Both approaches are used by heat pump manufacturers.

But wait, how does it MOVE heat?

The heat pump uses a refrigerant that is colder than the outdoor air, even in low temperatures. Heat flows naturally into the refrigerant, which the compressor then squeezes to make much hotter. This concentrated heat is transferred to the indoor water tanks. The system is not creating heat with electric coils – it is moving and concentrating heat already available in the air.

Glossary of Terms continued ...

Supply Water Setpoint – The temperature of the hot water delivered to the building after mixing with cold water, usually 45–50°C.

Swing Tank – A small, electrically heated tank located at the end of the hot water system. Its primary function is to maintain stable hot water temperature in the recirculation loop by compensating for heat losses. It ensures hot water is always available at fixtures and can provide supplemental heating during short bursts of high demand. While it helps stabilize the system, it is not typically large enough to serve as a full backup and cannot meet the building's entire hot-water load if the heat pumps are offline.

Tank Setpoint – The temperature the system keeps the main hot water tank at, usually around 60°C. Keeping the tank hotter than the supply temperature makes the system safer and helps heat pumps work more efficiently.

Thermostatic Mixing Valve – A safety device that mixes very hot tank water with cold water, so the temperature sent to fixtures (taps, showers etc.) is safe and comfortable.

Uniform Energy Factor (UEF) – A simple rating that tells you how efficient a hot water system is over a typical day. Higher numbers mean better efficiency. This rating includes standby losses.

1.3.1. Performance Rating Metrics

Unit	Use	What It Means
Coefficient of Performance (COP)	Heating	Instant measure of heat output per unit of electricity. *COP 3 = 3 units of heat out for every 1 unit of electricity in.*
Uniform Energy Factor (UEF)	Heating (seasonal)	Measures the water heater's efficiency over a full day of typical hot water use. Higher UEF means lower operating cost. *This is the main rating used for HPWHs.*
First-Hour Rating (FHR)	DHW delivery	The amount of hot water (in liters or gallons) the unit can supply in the first hour starting from a full tank. Reflects real world performance during high demand times.
Recovery Rate	Heating speed	How quickly the unit can reheat the water after the tank has been drained. HPWHs recover more slowly in heat-pump-only mode but much faster in hybrid of full electric resistance mode.
Standby Loss	Efficiency	How much heat escapes from the tank over time when no water is being used. Lower standby loss means better insulation and lower energy waste.

1.4. Key Benefits and Limitations

1.4.1. Benefits

- **Energy Efficient:** By moving heat rather than generating it (as gas or electric resistance heaters do), it can be 3-4 times more efficient than traditional electric water heaters. This reduces energy use, costs and green house gas emissions. Efficiency improves even further when heat pumps draw air from warmer areas – such as parkades, laundry rooms, or spaces with waste heat – instead of from outdoor ambient conditions.
- **Lower Operating Costs:** Electricity use is significantly reduced compared to standard electric water heaters, leading to long-term savings for building owners.

1.4.2. Limitations

- **Space Requirements:** Because heat pumps produce hot water more slowly than gas or electric heaters, they rely on larger storage tanks to meet peak demand, which increases mechanical room space needs.
- **Lower Output in Cold Conditions:** Heat pump efficiency and heating capacity decrease as outdoor temperatures fall, meaning they produce less hot water during cold weather. To maintain reliable supply, systems typically include a backup or swing heater that supports the heat pumps during peak demand or extreme cold.
- **More Complex:** Central heat pump systems include multiple storage tanks, recirculation pumps, valves, sensors, and advanced controls. These added components make the system more complex than a standard water heater and require regular maintenance, commissioning, and monitoring to ensure reliable performance and efficiency.
- **Higher Upfront Cost:** Heat pump water heating systems generally cost more upfront than traditional electric or gas heaters because they require specialized outdoor units, larger storage tanks, and additional controls. However, the lower operating costs can offset the higher initial investment over time.

1.5. System Operation

1.5.1. Operating Range and Supplemental Heating

Most central DHW heat pumps operate efficiently between –10°C and 40°C depending on make and model. The swing tank in the system is meant to manage recirculation losses.

When outdoor temperatures drop and heat pump capacity decreases – or during peak DHW load conditions – the system relies on supplemental heating sources (such as the swing tank or a small backup heater) to maintain a reliable hot water supply.

This supplemental heating is also used for Legionella risk management, raising tank temperatures overnight to reduce bacterial growth and maintain safe water conditions.

1.5.2. Legionella Risk

Legionella is a type of bacteria that can grow in water systems and cause illness, including Legionnaires' disease and Pontiac fever. These bacteria thrive under certain conditions that can occur in buildings and homes, especially when:

- Water sits still for long periods (stagnant water).
- Water is kept at warm temperatures, particularly 20°C to 50°C.
- There is buildup inside the plumbing system, such as biofilm, scale, or sediment.

Maintaining proper water temperatures and avoiding long periods of stagnation are important steps in reducing this risk.

More information: National Research Council of Canada – Legionella Risk Overview

1.5.3. Hot Water Setpoints

The National Plumbing Code of Canada (NPC) 2015 states that electric storage-type water heaters should be set to 60°C to help reduce the growth of Legionella bacteria.

Keeping the tank at this higher temperature helps reduce the risk of Legionella bacteria, which can grow in warm, stagnant water. Storing water at 60°C is especially important in systems where water may sit in pipes or tanks for longer periods.

To keep occupants safe from scalding, the water delivered to taps and showers should be kept below 52°C and below 49°C in homes with children, seniors, or people with disabilities. This lower outlet temperature is typically achieved in one of two ways:

- A mixing valve in the plumbing system, which automatically blends hot and cold water before it reaches fixtures.
- Thermostatic mixing valves built into individual fixtures, which are common in modern showers and faucets.

Many older buildings may not have a central mixing valve, so it's important to confirm whether temperature-limiting devices are present before setting the water heater temperature.

2. Commissioning and Project Handoff

2.1. Spec Sheets and Manuals

Your contractor should provide a specification sheet (spec sheet) and manual for each piece of equipment that's installed. Because manuals often cover several different models, make sure you know the exact make and model of your unit. You can usually find this in the commissioning reports.

While these manuals are helpful, they're often long and hard to follow. That's why it's a good idea to also ask your contractor for a training session and a simplified user guide. These guides are shorter and can be helpful to understand how to operate and take care of your system day-to-day.

2.2. Key Contact List

Contact Type	Contact When?	Company / Name	Phone / Email
Manufacturer	For warranty questions or if you need information about the equipment. **Warranty end date: mmddyyyy** **Unit warranty must be registered with the manufacturer*		
Controller or Thermostat Manufacturer	For warranty questions or if you need information about the equipment.		
General Contractor (Installer)	For any questions about the system or if something isn't working within the warranty period; typically one year after install.		
Service Contractor (If different)	For repairs or issues that come up more after the warranty period.		

2.3. Warranty Details

Make sure you know when warranty expires as well as how to reach the contractor and/or manufacturer if you need to submit a warranty claim.

2.4. Commissioning Report

2.4.1. Overview

When a new HPWH is installed, the contractor follows a process to make sure everything is set up and working the way it should. This process involves two key parts:

- **Startup/Commissioning Checklist:** A step-by-step list the contractor uses to confirm the system is installed correctly and operating as intended.
- **Commissioning Report:** The completed record showing the results of those checks and tests. It confirms the system works properly, provides key details like model and serial numbers, and documents that the owner/operator has been shown how to use and maintain the system.

While only the **commissioning report** will be provided to you at the end of the project, we've included examples of both the checklist and the report so you can understand the process. If the contractor does not have a clear commissioning checklist, or if the report is unclear, this reference can help you know what types of checks they should be performing and documenting.

2.4.2. Commissioning Checklist Example

An example commissioning checklist based off the SanCO₂ GS5 Installation manual is found below.

Section	What To Check	Why It Matters
Before Start Up		

Install Details	• Units (tank + heat pump) are installed in the planned location with adequate clearance for service and ventilation.
	• Heat pump has sufficient airflow; if installed indoors, appropriate ventilation grills or mechanical ventilation is provided.
	• Units are securely mounted, level, and anchored as required.
	• Piping is correct size, neatly routed, protected, and properly insulated.
	• No water leaks from any supply, hot water, or heat pump piping.
	• Pipe length between the tank and heat pump is within manufacturer limits.
	• Pressure relief (PR) valve is installed at the top of the tank with:
	  • Correct pressure rating per manufacturer requirements.
	  • Unobstructed drainage to a safe discharge point.
	• Union joints are installed where required for serviceability.
	• Freeze-protection heaters or trace heaters (if used) are connected to a 24-hour continuous power source.
	• Electrical wiring between tank and heat pump is properly connected and grounded.
	• Installation area is free of flammable materials and floor is properly waterproofed and drained.
	• Required inspection/service space has been maintained per installation manual.
	• System air purge has been completed and verified.
	• Mixing/Anti scald valve is installed and the setting is correct.
		Ensures good airflow and easy access for service; prevents noise, vibration, and damage; helps avoid future leaks or wear.

Heat Pump Condensate Drain	• Condensate drain has proper slope and drains freely to a safe discharge point. • No leaks or pooling at or near the heat pump. • Drain line is insulated or heat-traced where freezing conditions may occur. • Base pan drainage is clear and unobstructed for defrost water.	Condensate forms in the heat pump during defrost cycle where it drains through the base pan or to the ground. Both must be checked to avoid leaks, pooling, or icing.
When The System Is Turned On		
Noise Levels	• Check heat pump noise level – does it meet requirements (typically 55 dB daytime, 45 dB nighttime).	Confirms proper operation without excessive noise.
Operation	• Incoming water supply pressure meets manufacturer and warranty requirements. • Heat pump system powers on and controls initialize without errors. • Temperature setpoints meet Legionella mitigation requirements (≥140°F / 60°C storage).	Once domestic hot water systems are commissioned, there should be no requirement for the operator to modify the system throughout the year.

- Tank temperature sensors read correctly; heat pump cycles off when setpoint is achieved.
- Thermostatic mixing valve outlet temperature is correct and stable.
- Pressure-reducing valve (if installed) is clean and functioning.
- If applicable, test the full Legionella mitigation sequence to verify operation.
- Earth leakage breaker (GFCI/RCD) functions correctly using test button.

2.4.3. Start Up/Commissioning Report Example

2.4.3.1. System Information

Item	Heat Pump	Tank
Manufacturer / Model	SANC02/GS5-45HPC	SAN-119GLBK
Serial Numbers	0221-007	19125113T
Capacity	15,000 BTU	119 Gallon
Refrigerant	CO_2	N/A

2.4.3.2. Key Checks

Test	Status
Water tanks and heat pumps level, secured, and clear of obstructions	☐
Piping is correct size, insulated and sealed	☐
Water tank pressure relief valve has been piped to a safe drain	☐
Heat pump condensate drain line, sloped correctly and tested	☐
Temperature setpoints and tank readings verified as correct	☐
No visible leaks from tanks or piping connections	☐
Electrical connections tight, grounded and labeled	☐
System is properly labeled (including heat pumps, tanks, breakers, etc)	☐

2.4.3.3. Functional Tests

Test	Status
Power ON – system energizes with no error codes	☐
Tanks heat to programmed temperature setpoint	☐
Heat pump cycles off when tank reaches temperature	☐
Heat pump noise levels acceptable	☐
Condenser noise levels acceptable	☐
Condensate drains freely with no leaks or pooling	☐
Thermostatic mixing valve temperature is correct	☐
Legionella mitigation sequence tested and functioning	☐

2.5. Training Session

As part of handoff, ask your contractor(s) to conduct a formal training session for facilities and maintenance staff. This has proven to be the best way to make sure everyone understands the system.

A sample agenda for a training session is laid out below. Consider recording the training for future reference or for new staff.

- System overview and walkthrough
  - Labeled diagrams should be presented here
- Controls and operation
  - Explain how the unit works, how to control it – live demo
- Maintenance schedule and requirements
  - Provide details on maintenance requirements
- Documentation review, including manuals and warranty information
  - Make it clear where to find all the information
- Operational quirks and seasonal tips
- Training session deliverables
  - Simplified user guides (if available)
  - Simplified maintenance guides

2.6. Maintenance Requirements

The operation and maintenance information for your system is usually included in the equipment manual and should also be covered during your training session and project handoff. Be sure to review this information carefully and confirm that clear instructions are provided – either in the documents you receive, during training, or ideally in both places. This will help you feel confident in operating and maintaining your equipment. You'll want to make sure that both a maintenance schedule and a troubleshooting guide are provided.

2.6.1. Maintenance Schedule

The maintenance schedule should outline the types of checks and service tasks needed to keep your equipment running efficiently. This usually includes:

- **System Inspections** – such as checking for leaks, electrical connections, and controls.
- **Annual Maintenance** – typical maintenance task to be completed to ensure efficient operations.

An example maintenance schedule is provided below. This is based off the SanCO₂ heat pump water heater owner manual.

Frequency	Task	Responsible
Monthly	• Check for unusual noise or vibration from heat pump units. • Verify tank temperatures are meeting setpoint (SP). • Ensure condensate drains are clear. • Check for error codes (especially during freeze events) – the unit will not start up until the error code is cleared. Note any new error codes.	On Site Staff
Annually (System)	• Draw water from the tank via a faucet: check the delivered mixed temperature vs customer requirement. Adjust the mixing valve if needed. • Draw water from the tank to start the heat pump. Check the unit parameter mode to check delivered water temperature vs SP. • If drain down freeze protection system is installed, cycle the power to check valve operation – restart system and ensure unit operation. • Check for operation of the trace heat protection (if applicable).	Licensed HVAC Contractor
Annually (Heat Pump)	• Remove the top and side covers of the heat pump unit and check the evaporator for any dirt or debris. • To clean the unit, simply blow away the debris with an air hose or spray the unit down with a water hose, coil cleaning solutions can be used without problem. • If applicable, remove and clean filter on cold water inlet connection • Check for leaks of any kind from pipes and tears in insulation. • Heat pump panels MUST be reinstalled before completing this step. Spray the evaporator coil down after the debris removal using a water hose (evaporator coil cleaning solutions can be used without problem). • A drain/air bleed valve is installed underneath the unit base. Open the valve to ensure no sediment or air is in the system. • Check and verify voltage to the heat pumps. Make sure wiring is tight and secure.	User / Licensed HVAC Contractor
Annually (Tanks)	• Open the pressure relief valve to prevent sticking, ensure water is discharged. • Check the thermistor connection in to the thermistor well and the wiring connection to the terminals (both sides of the terminal).	Licensed HVAC Contractor

2.6.2. Troubleshooting Guide

The troubleshooting guide should list common problems you may encounter and simple steps to resolve them. Some examples, taken from the SanC02 Gen5 Owners Manual, are provided below.

Warning Sign/ Issue	Initial Onsite Checks	Where to Find More Info	Escalate To...
No hot water comes out of water tap OR Temperature of hot water is too low	• Air removing procedure from the heat pump system may be insufficient. • Open the water drain plugs on the heat pump unit to remove air from water circuit. Be careful about burning!	Owners manual	Installer (within 1 year) or Service Contractor
	• Filter on cold inlet connector maybe blocked. • Check the filter and remove if there is any blockage.	Owners manual	Installer (within 1 year) or Service Contractor
	• Water flow speed may be dropped due to the heat pump piping bend, blockage or crush. • Check for any piping bend or crush and remove if any.	Owners manual	Installer (within 1 year) or Service Contractor
	• Pipes may be frozen. • If frozen area is found on the piping, melt the ice on the pipe and provide a heat insulation.	Owners manual	Installer (within 1 year) or Service Contractor
	• Stop valve is closed. • Open the valve.	Owners manual	Installer (within 1 year) or Service Contractor
	• Air absorption is not sufficient due to a blockage on the evaporator. • Remove the object blocking the air flow through the evaporator (e.g. fallen leaves, grass, snow, etc.).	Owners manual	Installer (within 1 year) or Service Contractor
Unit won't turn on	• Make sure power is on at breaker or wall switch. • Look for error code or message on unit (especially after freeze events). Unit will not start until error code is cleared.	Owners manual	Installer (within 1 year) or Service Contractor
Tank overheating / too hot	• Verify temperature setpoints. • Check mixing valve operation. • Confirm sensor probes are fully inserted. • Inspect controls wiring.	Owners manual	Installer (within 1 year) or Service Contractor
Unusual noise / vibration	• Look for loose panels. • Make sure nothing is touching the unit.	Operation manual – maintenance section	Installer (within 1 year) or Service Contractor
Error code showing	• Note the exact code – check manual for next steps. • Cycle unit off and on and look to determine If the error code persists.	Operation manual – troubleshooting section	Installer (within 1 year) or Service Contractor