



USE OF CSA P.9-11 TO SPECIFY COMBINATION SPACE & WATER HEATING SYSTEMS:

Includes an Overview for Builders and a Specification
Process for Mechanical Designers and Installers.

V1.0 February 2017



Developed by Natural Resources Canada's
Local Energy Efficiency Partnerships (LEEP) team.

NRCan.LEEP.RNCan@Canada.ca

This technical document uses standard industry terminology, acronyms and equations. For plain language descriptors, please refer to the Appendix.

Imperial units are used to stay consistent with the P.9 Combo Performance Specification Summaries.

Acknowledgements:

Natural Resources Canada (NRCan) would like to thank builders who have participated in Local Energy Efficiency Partnerships (LEEP) initiatives. The need for this publication became evident through their work, and that of the manufacturers and designers they asked to respond to their interests.

The development of the combination system specification process was made feasible by the Office of Energy Efficiency's development of a searchable data base of P.9 tested systems.

Natural Resources Canada (NRCan) would also like to thank the many manufacturers that have developed efficient combination systems and had them tested to the P.9 standard at a third party testing laboratory.

Important Note:

The aim of this publication is to provide guidance on how to use P.9 ratings to select and specify an efficient and appropriately sized combination system. While other factors may also be important in selecting a combination system, they are beyond the scope of this publication.

Natural Resources Canada assumes no liability for injury, property damage, or loss from using information contained in this publication. This guide is distributed for informational purposes only and does not reflect the views of the Government of Canada nor constitute an endorsement of any commercial product or person.

Cat. No. M154-109/2017E-PDF

ISBN 978-0-660-07660-7

Aussi disponible en français sous le titre : «Utilisation de la norme CSA P.9-11 pour établir les spécifications des systèmes combinés de chauffage des locaux et de l'eau» au Canada

© Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources, 2016

TABLE OF CONTENTS

OVERVIEW FOR BUILDERS	1
P.9 TEST INFORMATION	3
SPECIFICATION PROCESS	4
For Mechanical Designers and Installers	4
STEP 1: DEFINE DESIGN REQUIREMENTS	5
EXAMPLE STEP 1: DEFINE DESIGN REQUIREMENTS	6
STEP 2: SELECT A COMBINATION SYSTEM THAT MEETS DESIGN REQUIREMENTS	9
EXAMPLE STEP 2: SELECT A COMBINATION SYSTEM THAT MEETS DESIGN REQUIREMENTS	11
STEP 3: MATCH THE 'AS INSTALLED' SYSTEM COMPONENTS, INSTALLATION AND COMMISSIONING TO THE 'AS TESTED' SYSTEM RESULTS	14
Locate the Major Components needed for the selected combination system	14
Installing the Combination System	15
Control Settings and Operation Points	15
APPENDIX	16
Terminology and Acronyms	16

OVERVIEW FOR BUILDERS

Builders need combination systems that are:

- sized correctly to reduce the risk of call-backs and complaints, and
- energy efficient to reduce your customers' energy costs.

It is now much easier to meet these needs when mechanical designers use CSA P.9-11 test results that provide capacity and efficiency ratings, component lists for purchasing, and information for installation and commissioning. These P.9 test results are readily available on over 60 tested systems, on a **Combo Performance Specification Summary (Ref. CSA Standard P.9-11)**, and its use by designers and installers is explained in the balance of this document. The use of these test results can take the guesswork out of right-sizing systems, minimizing the risk of under or over sizing.

It is important to use CSA P.9-11 efficiency ratings as simply knowing the efficiency of a water heater in water heating mode **does not** provide useful information on the efficiency of a combination system in space heating mode. The National Building Code (and some provincial building codes) recently set a minimum requirement for systems using the CSA P.9-11 **Thermal Performance Factor (TPF)**.

Help your mechanical designer to set the proper design requirements for system selection by providing them with information on the following P.9 Factors:

- A. **Water Heating Capacity** is used to size the on-demand water heaters that are typically used in P.9 rated combination systems.
 - Builder to provide house plans, high and low flow faucet specifications, and any concurrent shower needs beyond those in the mechanical designer's typical sizing assumptions
- B. **Space Heating Capacity** will be determined using CSA F280-12 in the same way it would for any other heating system.
- C. **External Static Pressure (ESP)** refers to the *air pressure differential across the air handler*.
 - Builder to discuss your distribution system needs including: single or multi-zoned; traditional, medium or small diameter branch ducts; floor or high wall supply registers; and, level of duct sealing.
- D. **Thermal Performance Factor (TPF)**.
 - Builders can ask their Energy Advisors about setting high TPF requirements to help meet whole home performance goals (including Energy Star Building Option Package points)
- E. **Annual Electricity (AE) Consumption:** *Optional*, could use to help pick between similar options

- F. **Interconnect Piping** is the equivalent length of piping used when a system is tested to P.9.
- Builder to note if water heater and air handler are to be close-coupled or, if to be far apart, discuss locations with designer, and ask about potential effects on ratings and how any necessary adjustments will be identified.

Ask your designer for copies of the following information for the recommended system:

- **Table of Requirements and Selected System Ratings** prepared by your designer, it references test results to verify that the selected system meets the design requirements for your project.
- **Combo Performance Specification Summary (Ref. CSA Standard P.9-11)** for the test results of the manufacturer's system. Provides crucial information for purchasing of components, installation and commissioning to ensure the system 'as installed' can match the 'as tested' system.
- **Manufacturer installation schematic** to review installation and commissioning with the installer.

Attach a copy of the above three items near the water heater manual for future reference.

SPECIFICATION PROCESS

For Mechanical Designers and Installers

Purpose: This section steps mechanical designers and installers through using crucial third-party P.9 test information to select and specify an efficient and appropriately sized combination system. The test results for each system are reported in a **Combo Performance Specification Summary, Ref. CSA Standard P.9-11** (called a **P.9 Performance Summary** in the balance of this document). The P.9 test results provide a level playing field for comparing combination systems and can help you reduce your risk of under sizing combination systems so they can not meet design loads, or over sizing systems that increase builder costs.

The **P.9 Performance Summary** also contains crucial information required for the selected system 'as installed' to achieve the P.9 test ratings.

Format: The document will guide you on where, and how, to obtain the test ratings for your design requirements:

- A: Water Heating Capacity
- B: Space Heating Capacity
- C: Total External Static Pressure (ESP)
- D: Thermal Performance Factor (TPF)
- E: Annual Electricity Consumption (AE): Optional
- F: Interconnect Piping

Procedure to specify combination systems using the *P.9 test results*:

-  **STEP 1:** Define design requirements
-  **STEP 2:** Select a combination system that meets design requirements:
 - Create a short-list of candidate systems using the design requirements
 - Select a combination system from those short-listed
 - Confirm that the selected system meets design requirements using P.9 Performance Summary information
 - Provide builder with documentation
-  **STEP 3:** Specify components and installation requirements needed to achieve the P.9 performance ratings.

Before starting on the design requirements, arrange a meeting with the builder to review the information you will need from him/her to develop them. Ask that they read the 'Overview for Builders' ahead of time so they are more prepared for your meeting.



STEP 1: DEFINE DESIGN REQUIREMENTS

It is critical to use the following P.9 factors for all steps in this document:

A: Water Heating Capacity:

Peak water heating loads are typically much higher than peak space heating loads. Start by identifying combination systems that have sufficient hot water delivery capacity to meet the design requirements at the minimum supply water temperature for the house location.

P.9 water heating capacities are listed as One-Hour delivery ratings (OHR) and the related requirements can easily be established based on more commonly used flowrate based ratings.

B: Space Heating Capacity:

Building codes require that the space heating capacity rating of the equipment be equal to or greater than the home's design heating load calculated using CSA F280-12 design load.

Calculate this design load and then apply a safety factor of your choosing to define the minimum space heating capacity requirement for the combination system. The size of the safety factor may depend on the clarity of design details that impact heat loss and past experience with the builder.

C: Total External Static Pressure (ESP):

The maximum total ESP the system can operate with at the required space heating capacity is determined based on the duct design. Alternatively, an experienced designer may estimate the maximum ESP based upon the type of distribution system the builder wants, use this to help select the combination system, and then develop the duct design using temperature and flow rate information listed in the **P.9 Performance Summary**.

NOTE: Installing a P.9 system with a total ESP rating that is lower than the design will negatively impact the "as-installed" performance of the combination system, resulting in lower space heating capacity and lower space heating efficiency than shown on the **P.9 Performance Summary**. This may result in an inability of the combination system to meet the house space heating loads.

D: Thermal Performance Factor (TPF):

TPF defines the gas-use efficiency based on both space and water heating test ratings. Higher values equate to higher efficiency and lower energy costs. The NRCan performance listing shows a wide range of TPF values. The minimum acceptable TPF may be set by the building code or in relation to any high performance housing program that the builder plans to enroll the home with.

E: Annual Electricity Consumption (AE): Optional

This value estimates the annual electricity usage in kilowatt-hours by fans, pumps and controls under typical usage conditions. There are a wide range of AE values for combination systems.

The builder or designer will not normally set a specific target for electricity consumption, but will use published AE values to compare performance of different candidate combination systems. Choosing equipment with lower AE values will result in lower electricity costs for the homeowner.

F: Interconnect Piping

Where the water heater and air handler can be close coupled to each other, P.9 tested space heating capacities should be possible with simple interconnect piping designs. Where they are to be located further apart, contact the manufacturer to determine the effect on ratings and identify necessary adjustments.

EXAMPLE STEP 1: DEFINE DESIGN REQUIREMENTS

This example illustrates use of P.9 Factors (A-F) to define requirements for selecting a combination system for the example house (right).

The builder provided all the information that enabled the designer to complete the combination system design requirements. These design requirements will be used in STEP 2 to screen for possible candidate systems.

Of note—the designer set the minimum acceptable TPF to a level that enabled the builder to obtain some Building Option Package (BOP) points for Energy Star® for New Houses (ESNH).



Figure 2: Example House

Table 1: Example of Combination System Design Requirements

P.9 Factors	Design Requirement	Design Requirement Description
A. Water Heating Capacity	<p>≥15.2 L/min with an inlet water temperature of 10°C.</p> <p>This equates to a required OHR of 1,021 L (per h) or more</p> <p>See Figure 3 for details on conversion and scaling factor.</p>	<p>The designer determined that the domestic hot water (DHW) capacity requirement for the example house is 15.2 L/min. The minimum inlet water temperature at the design location is 10°C.</p> <p>The P.9 rated combination systems in the current NRCan listings use on-demand hot water heaters. Manufacturers normally rate capacity of on-demand water heaters by a flowrate (i.e., USGPM or L/min) at a specified temperature rise.</p> <p>In contrast, the <i>P.9 Performance Summary</i> specifies output capacity by a One-Hour Delivery Rating (OHR) (i.e. L/h) at an inlet water temperature of 14.4°C and a delivery temperature of 49.0°C.</p>
B. Space Heating Capacity	<p>≥40,500 Btu/h (11.9 kW)</p>	<p>Based on the building heat loss analysis using CSA F280-12 and applying a safety factor set by the mechanical designer, the minimum space heating capacity required is 40,500 Btu/h (11.9 kW), including the safety factor.</p>
C. Total External Static Pressure (ESP)	<p><i>ESP (Return):</i> 0.15"w.c.</p> <p><i>ESP (Supply):</i> 0.25"w.c.</p> <p><i>Design airflow: 850 actual CFM</i></p> <p>Total ESP: 0.40"w.c. at 850 ACFM</p>	<p>Based on the ducting system specified by the designer for the house model, the total ESP requirement is 0.40"w.c. (100 Pa) at a design airflow of 850 ACFM (400 L/s).</p>
D. Thermal Performance Factor (TPF)	<p>≥0.93</p>	<p>The builder plans to register the home with Energy Star, and requires Building Option Package (BOP) points for the combination system. In our design example, 0.93 is the minimum TPF threshold to achieve the BOP points needed.</p>
E. Annual Electricity Consumption (AE)	<p>Not specified</p>	<p>The Builder wants to use less electricity where possible but has not specified a minimum level for the combination system.</p>
F. Interconnect Piping	<p>Not specified</p>	<p>The Builder chose to close couple the water heater and the air handler. Once a system is selected, a piping layout will be obtained so that the equivalent length of interconnect piping is less than or equal to that of the system when tested to P.9.</p>

Note regarding One-Hour Rating of On-demand Water Heaters:

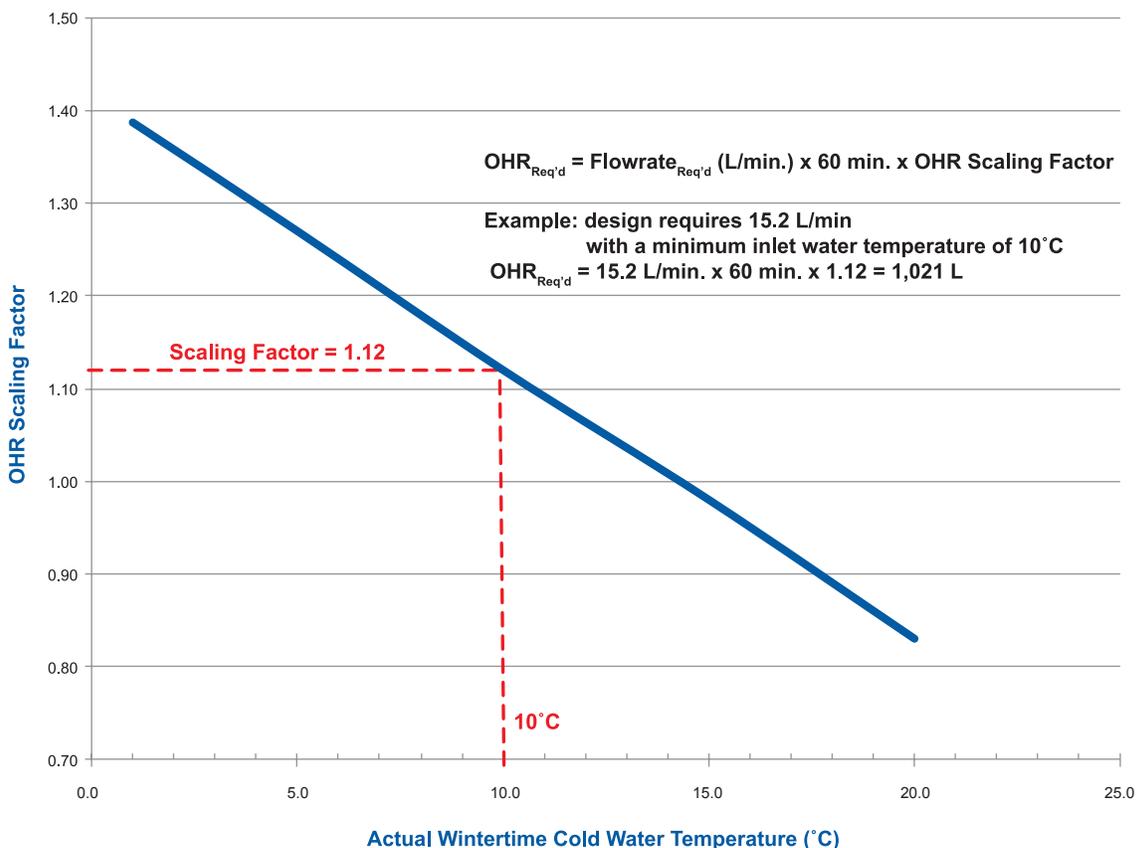
Manufacturers normally rate the capacity of on-demand water heaters by a flowrate (i.e., USGPM or L/min) at a specified temperature rise. In contrast, the **P.9 Performance Summary** specifies output capacity by a **One-Hour Delivery Rating (OHR)** (i.e. L/h) at an inlet water temperature of 14.4°C and a delivery temperature of 49.0°C.

The actual delivery capacity of an on-demand water heater will vary with the cold water inlet temperature. Figure 3 provides **OHR scaling factors** to adjust the OHR requirement to compensate for variations in minimum inlet water temperature at the design location.

The **Required One-Hour Delivery Rating (OHR_{req'd})** for an on-demand water heater is summarized by the following equation:

$$\text{OHR}_{\text{req'd}} = \text{Flowrate}_{\text{req'd}} \text{ (L/min)} \times 60 \text{ min} \times \text{OHR Scaling Factor}$$

Figure 3: OHR Scaling Factor to Adjust for Minimum Inlet Water Temperature



One-Hour Rating of Storage-Tank Water Heaters:

For combination systems using storage tank water heaters, refer to the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) Skilltech Academy's *Worksheet for Integrated Combo System Design*, for guidelines to size tank capacity to meet peak domestic hot water (DHW) demands.



STEP 2: SELECT A COMBINATION SYSTEM THAT MEETS DESIGN REQUIREMENTS

To select a combination system:

- **Create a short-list** of candidate systems using the design requirements for P.9 Factors A-F.
- **Select** a combination system from those short-listed.
- **Confirm** that the selected system meets design requirements.
- **Provide** builder with copies of your **Table of Requirements and Selected System Ratings**, and the manufacturer's **P.9 Performance Summary** and **System Schematic**.

Create a short-list:

To identify candidate systems that will satisfy design requirements, download NRCan's frequently updated on-line listing of P.9 tested combination systems from <http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.search-recherche&appliance=P9COMBO>. The designer can download, into a spreadsheet format, the entire on-line list of tested systems or only those from manufacturer(s) of interest.

To eliminate systems that don't meet your requirements, sort the spreadsheet in the following sequence:

1. Sort by A) **Water Heating Capacity** column, and then delete all rows showing systems with insufficient water heating capacities for your particular application.
2. Repeat this process, of sorting columns followed by deleting rows, in the following sequence: B) **Space Heating Capacity**, C) **Total External Static Pressure (ESP)** and D) **Thermal Performance Factor (TPF)**. If desired, repeat for E) **Annual Electricity Consumption (AE)**.

This will result in a short-list of candidate combination systems that meet the minimum design requirement levels for these P.9 Factors.

Where the required equivalent length of **Interconnect Piping** must be greater than that used during P.9 testing, contact the manufacturers to determine the effect on ratings and identify necessary adjustments.

Select a combination system:

1. Review the short-listed candidate systems and eliminate those with significant **overcapacity**.
2. Apply your business factors (such as cost, durability, local supply and servicing) to further reduce the short-list to a few final candidate systems.
3. Obtain the actual **P.9 Performance Summaries** and **System Schematics** from the manufacturers to get access to additional test information that is **not** available on NRCan's on-line database. The incremental information, necessary for specifying system components and for installers, is available in the *Description of Major Components* section and is described later in this document.
4. Select a preferred combination system.

Confirm that the selected system meets design requirements:

1. Review your design requirements against the actual ratings on the **P.9 Performance Summary** to confirm that your preferred system meets your design requirements.
2. Create a **Table of Requirements and Selected System Ratings** to provide to the builder.

Provide builder with documentation:

Provide copies of your **Table of Requirements and Selected System Ratings**, and the manufacturer's **P.9 Performance Summary** and **System Schematic**.

EXAMPLE STEP 2: SELECT A COMBINATION SYSTEM THAT MEETS DESIGN REQUIREMENTS

Create a Short-List of Candidate Systems using Design Requirements:

The designer downloaded all the manufacturer P.9 tested combination systems from NRCan's on-line database. (This example uses the 64 systems that were listed on October 31, 2016.) The designer applied the design requirements one at a time, in order, from A to E, to screen for possible systems that met the minimum design requirements. A summary of the screening results for the example house is shown below.

Table 2: Combination System Screening to Identify a Short-list of Candidate Systems

P.9 Factors	Design Requirement	Range of performance from P.9-11 combination systems available on the date of analysis	Screening Results
A. Water Heating Capacity	OHR \geq 1,021 L (at an inlet water temp of 14.4°C)	All the P.9 rated combination systems listed use on-demand hot water heaters. The DHW capacity rating provided on the P.9 sheet is the One-Hour Delivery Rating (OHR) . OHR values of listed P.9 systems range from 504 to 1,459 L.	55 of 64 systems pass the hot water capacity screen.
B. Space Heating Capacity	\geq40,500 Btu/h (11.9 kW)	Space heating capacity of P.9 tested systems that passed the previous screen range from 17,868 to 94,371 Btu/h	29 of 55 systems pass the space heating capacity screen.
C. Total External Static Pressure (ESP)	\geq0.40"w.c. at 850 ACFM	Total external static pressure (ESP) values of P.9 tested systems that passed the previous screens range from 0.4 to 1.1"w.c. They are calculated by adding the ESP-values for the return and supply-ducts.	29 of 29 systems pass the ESP screen.
D. Thermal Performance Factor (TPF)	\geq0.93	Thermal Performance Factor (TPF) values of P.9 tested systems that passed the previous screens range from 0.80 to 0.98.	9 of 29 systems pass the TPF screen.
E. Annual Electricity Consumption (AE)	Not specified	Annual Electricity (AE) consumption values of P.9 tested systems that passed the previous screens range from 1,358 to 3,353 kWh.	9 of 9 systems pass the AE screen.
F. Interconnect Piping	Not specified	Interconnect Piping values of P.9 tested systems that passed the previous screens range from 20 to 24 equivalent feet of $\frac{3}{4}$ " PEX piping.	9 of 9 systems pass the Interconnect Piping screen.

Select a combination system from those short-listed:

Application of the P.9 screening factors resulted in nine (9) possible combination systems that met the minimum requirements for the example house. For those 9 systems, the designer assessed and eliminated the systems with significant space heating **overcapacity** as short-listed systems ranged from 41,555 to 94,371 Btu/h (12.2 to 27.6 kW). Overcapacity against other P.9 Factors eliminated more systems, resulting in a final short-list of three (3) candidate systems that closely matched the design requirements.

The designer obtained the **P.9 Performance Summaries** and the manufacturer's **System Schematics** for the final three (3) candidate systems to make the final selection of a combination system that best met the design requirements as well as the additional business factors such as cost, durability, local supply, and servicing.

Confirm selected system meets design requirements:

For the selected system, the designer used the **P.9 Performance Summary** to obtain the data for the P.9 screening factors. The ratings were used to create the following **Table of Requirements and Selected System Ratings** that compares and confirms that the selected system met the design requirements.

Figure 4: Example of the P.9 Performance Summary information used for developing the "Table of Requirements and Selected System Ratings"

COMBO PERFORMANCE SPECIFICATION SUMMARY (Ref. CSA Standard P.9-11)			
Testing Agency: HVAC Testing Labs		Model Number: XA-COMB-175-900L	
System Integrator: X-Ample HVAC Inc. 100 Main Street Ottawa, ON		Nameplate Information: 120 Volts N/A Amps Nominal Burner Input: 51.2 kW 175,000 Btu/hr	
Date First Issued: September 19, 2016		Date Revised:	
Rationale:		Rationale:	
PERFORMANCE RATING		D Thermal Performance Factor (TPF) 0.95	
Thermal Performance Factor (TPF) 0.95		E Annual Electricity Consumption (AE) 1,801 kWh/y	
Annual Electricity Consumption (AE) 1,801 kWh/y			
Function-Based Performance Ratings			
Efficiency Ratings		Maximum Capacity Rating	
Composite Space Heating Efficiency (CSHE) 95 (%)		Space heating (all ratings below are at a PLF of 1) Capacity 41,980 Btu/hr 12.3 kW	
Water Heating Performance Factor (WHPF) 0.96		C	
Recovery Efficiency 97 (%)		Airflow 900 SCFM 424 L/s	
Thermal Standby loss - Circ fan off see comments W		ESP (Return) 0.2 " w.c. 50 Pa	
Thermal Standby loss - Circ fan on see comments W		ESP (Supply) 0.2 " w.c. 50 Pa	
		Return air temperature 21.6 °C	
		Air temperature rise 35.3 °C	
		Entering water temperature to coil 81.1 °C	
		Water flow rate 3.1 USGPM 11.5 L/min	
		A	
		DHW One-Hour Deliver Rating (OHR) 1,140 L	
		OHR - no call for space heating 1,142 L	
		OHR - concurrent call for space heating 1,142 L	
		Additional Electrical Rating	
		Standby power (P(Girc)) 90 W	
		Standby power (P(Ccont)) 14 W	
		Daily electricity use for water heating (E _{180-24h}) 0.18 kWh	
		Annual electricity use for water heating (AE _{water}) 66 kWh	
Space Heating Part Load Efficiency Ratings			
Part Load Factor (PLF)	Net Efficiency	Average Electricity Use	Circulating Blower Electricity Use*
@ PLF 1	93 (%)	440 W	290 W
@ PLF 0.4	97 (%)	315 W	285 W
@ PLF 0.15	91 (%)	170 W	285 W
* measured when circulation blower running			
Concurrent Space & DHW Test Results			
Water draw at 49.43°C with or without concurrent call for heat			
Flow (L/min)	Time to reach temperature (minutes)	Time within ±3°C tolerance (minutes)	
		with	without heating call
3	1.0	1.0	indefinite
15	0.4	0.4	indefinite
Description of Major Components of Packaged Combo			
Heat Generator (HG) make, model: X-Ample HVAC, XA-HG-175		Interconnect piping (length, nom.dia., insulation): 24 ft. equivalent, 3/4-in PEX (nominal), R4 insulation	
Air Handler (AH) make, model: X-Ample HVAC, XA-AH-900L		Automatic means for adjusting water temperature while space heating (Y/N): Y	
Circulating blower motor make, model, size, type: X-Ample HVAC, MTR-05, 1/2 HP, ECM		Related type, make and model number: X-Ample 'Combo control' kit, XA-CC-100	
Circulator make, model and location: X-Ample, CIR-05, internal to heat generator		Interconnect piping (length, nom.dia., insulation): 24 ft. equivalent, 3/4-in PEX (nominal), R4 insulation	
Additional controls external to HG		Thermostatic mixing valve c/w check valves, X-Ample XA-TMV-100, set to 120°F (49°C) for DHW	
Automatic means for adjusting Related type, make		Outdoor temperature sensor - included in 'Combo control' kit	
Interconnect piping (length, Other:		DHW flow switch - included in 'Combo control' kit	
Test Agency Comments:			
Water heater temperature set to 120°F (49°C) for DHW tests			
Water heater temperature programmed to 180°F (82°C) for space heating (PLF=1)			
Pump exercise sequence does not initiate burner operation			
Pump exercise sequence: 1 minute every 24-hrs			
Circulating blower has a 10 second 'On' delay			
Circulating blower has a 30 second 'Off' delay			
All controls set to factory default unless otherwise specified			
No storage tank - thermal standby test not required			
Conversions: 249 Pascals = 1" of Water 1 kW = 3413 Btu/h			

Table 3: Requirements and Selected System Ratings

P.9 Factors	Design Requirement	Ratings for the Selected System	NOTES TO DESIGNER FOR THIS EXAMPLE:
A. Water Heating Capacity	OHR \geq 1,021 L (at inlet water temperature of 14.4°C)	OHR is 1,140 L (at inlet water temperature of 14.4°C)	The adjusted delivery rating for the selected system at inlet water temperature of 10°C is $1,140/1.12 = 1,018$ L/h or 17 L/min, which is greater than the original DHW design requirement of 15.2 L/min.
B. Space Heating Capacity	$\geq 40,500$ Btu/h (11.9 kW)	41,980 Btu/h (12.3 kW)	The rated output of the selected system is close to the required space heating capacity, which will minimize short-cycling of the space heating system and help minimize equipment cost.
C. Total External Static Pressure (ESP)	≥ 0.40 "w.c. at 850 ACFM*	0.40"w.c. at 900 SCFM*	The selected combination system can meet the space heating design requirements using the duct system that has already been designed for the home.**
D. Thermal Performance Factor (TPF)	≥ 0.93	0.95	The selected system meets the builder's TPF requirements. This includes gaining BOP points for Energy Star.
E. Annual Electricity Consumption (AE)	Not specified	1,801 kWh/y	This equipment selection will help minimized electricity usage by the HVAC system as its AE-rating is in the lower-half of the AE range for the short-listed systems.
F. Interconnect Piping	Not specified	25 feet equivalent of $\frac{3}{4}$ inch PEX (nominal)	The manufacturer provided specifications for the interconnect piping used under test conditions so it can be replicated when this close coupled water heater and air handler are installed.

* For typical HVAC design conditions, numerically ACFM and SCFM values will vary little with the ACFM-value being slightly larger than the SCFM-value for the same airflow condition.

** Alternatively, had the designer estimated the ESP design requirement based on prior duct design experience, the duct system could now be designed for the selected system using information contained in Sections B and C of the P.9 Performance Summary.

Provide Builder with Documentation

The designer provided the builder with copies of their *Table of Requirements and Selected System Ratings*, and the manufacturer's *P.9 Performance Summary* and *System Schematic*.



STEP 3: MATCH THE 'AS INSTALLED' SYSTEM COMPONENTS, INSTALLATION AND COMMISSIONING TO THE 'AS TESTED' SYSTEM RESULTS

IMPORTANT: For the selected system to perform “as tested”, **YOU MUST REFER TO THE ACTUAL P.9 Performance Summary and System Schematic** from the manufacturer to obtain the information required for:

- Purchasing
- Installation and commissioning

Locate the Major Components needed for the selected combination system

The **major components** purchased for the field installation should **match exactly with those listed on the P.9 Performance Summary (shown as section G on the example, Figure 1)** even if purchasing of the listed components is required from more than one supply source. Not using the exact components may degrade the “as-installed” performance and result in lower space-heating capacity and efficiency than shown on the **P.9 Performance Summary. This may result in an inability of the combination system to meet the home’s space heating loads.**

Figure 5: Description of Major Components

G	Description of Major Components of Packaged Combo	
Heat Generator (HG) make, model:		X-Ample HVAC, XA-HG-175
Air Handler (AH) make, model:		X-Ample HVAC, XA-AH-900L
Circulating blower motor make, model, size, type:		X-Ample HVAC, MTR-05, 1/2 HP, ECM
Circulator make, model and location:		X-Ample, CIR-05, internal to heat generator
Additional controls external to HG and AH:		None
Automatic means for adjusting water temperature while space heating (Y/N):		Y
Related type, make and model number:		X-Ample 'Combo control' kit, XA-CC-100
Interconnect piping (length, nom.dia., insulation):		24 ft. equivalent, 3/4-in PEX (nominal), R4 insulation
Other:		Thermostatic mixing valve c/w check valves, X-Ample XA-TMV-100, set to 120°F (49°C) for DHW Outdoor temperature sensor - included in 'Combo control' kit DHW flow switch - included in 'Combo control' kit

Installing the Combination System

Refer to the selected combination system's **System Schematic** and the **Interconnect Piping** specifications in addition to the installation instructions provided by each component manufacturer.

Control Settings and Operation Points

When installers are commissioning the complete combination system to operate so the "as installed" performance aligns with the "as tested", sections G (shown previously), H, B and C of the **P.9 Performance Summary** shown in Figure 1 will be particularly helpful include:

Figure 6: Test Agency Comments

H	Test Agency Comments:	
	Water heater temperature set to 120°F (49°C) for DHW tests	
	Water heater temperature programmed to 180°F (82°C) for space heating (PLF=1)	
	Pump exercise sequence does not initiate burner operation	
	Pump exercise sequence: 1 minute every 24-hrs	
	Circulating blower has a 10 second 'On' delay	
	Circulating blower has a 30 second 'Off' delay	
	All controls set to factory default unless otherwise specified	
No storage tank - thermal standby test not required		

Figure 7: Maximum Capacity Ratings and Related Information

B	Space heating (all ratings below are at a PLF of 1)		
	Capacity	41,980 Btu/hr	12.3 kW
C	Airflow	900 SCFM	424 L/s
	ESP (Return)	0.2 " w.c.	50 Pa
	ESP (Supply)	0.2 " .c.	50 Pa
	Return air temperature		21.6 °C
	Air temperature rise		35.3 °C
	Entering water temperature to coil		81.1 °C
	Water flow rate	3.1 USGPM	11.5 L/min

APPENDIX

Terminology and Acronyms

ACFM	Actual Cubic Feet per Minute
°C	Degrees Celcius
AE	Annual Electricity Consumption
BOP	Building Option Package
Btu/h	British Thermal Units per hour
Combo	Combination System
CSA	Canadian Standards Association
DHW	Domestic Hot Water
ESNH	Energy Star for New Houses
ESP	External Static Pressure
h	Hour
HRAI	Heating Refrigeration and Air Conditioning Institute of Canada
kW	Kilowatt
L	Litres
L/min	Litres per minute
LEEP	Local Energy Efficiency Partnerships
OHR	One-Hour delivery Rating
P.9	CSA P.9-11 Standard: Test method for determining the performance of combined space and water heating systems (combos)
SCFM	Standard Cubic Feet per Minute
TPF	Thermal Performance Factor
USGPM	United States Gallons Per Minute
"W.C.	Inches of Water Column