DOCKETED	
Docket Number:	19-BSTD-02
Project Title:	Residential Alternative Calculation Method Variable Capacity Heat Pump Modeling Approach
TN #:	230237
Document Title:	Staff Report on the Variable Capacity Heat Pump Performance Compliance Option
Description:	Final staff report on the Variable Capacity Heat Pump performance compliance option for the California Energy Code.
Filer:	Adrian Ownby
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	10/16/2019 4:31:49 PM
Docketed Date:	10/16/2019

CALIFORNIA ENERGY COMMISSION

California Energy Commission

STAFF REPORT

Variable Capacity Heat Pump Performance Compliance Option

Gavin Newsom, Governor

September 2019 | CEC-400-2019-012

California Energy Commission

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ABSTRACT

Field studies of the performance of variable capacity heat pump (VCHP) systems conducted in Stockton, California from 2014 through 2018 determined that VCHP systems can deliver improved cooling energy savings and improved heating energy savings (as compared to single speed systems that meet the federally required minimum efficiency ratings). However, the actual amount of VCHP energy savings is not accurately predicted by the energy efficiency ratio (EER), seasonal energy efficiency ratio (SEER), and heating seasonal performance factor (HSPF) published for these systems in industry directories of certified product performance. Therefore, the published EER, SEER and HSPF information for these systems is not suitable for use with the computer modeling methods required by the performance standards specified in Section 150.1(b) of Title 24, Part 6.

More accurate methods of rating VCHP systems utilizing a load-based and climate-specific method of performance testing are under development based on the Canadian Standards Association publication CSA EXP07, but published VCHP performance ratings that rely on these new test procedures are not yet available. For this reason, until such time as more accurate performance ratings are made available for VCHP systems, California Energy Commission staff recommends the methodology presented in this report be used with VCHP system types identified in this report. This provides these system types the opportunity for better than minimum energy efficiency credit for compliance with the performance standards based on the observed real-world performance of the technology.

Keywords: Mini-split, multi-split, heat pump, variable refrigerant flow, VRF, variable refrigerant volume, VRV, variable capacity heat pump, VCHP, CSA EXP07, Alternative Calculation Method, ACM.

Please use the following citation for this report:

Miller, Jeff, Bruce Wilcox, Abram Conant. 2019. "*Variable Capacity Heat Pump Performance Compliance Option.*" California Energy Commission. CEC-400-2019-012

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EXECUTIVE SUMMARY

Background

Variable Capacity Heat Pump (VCHP) systems are an emerging technology in California and the rest of North America even though they are common in many other parts of the world. Prior research in North America has focused primarily on the technology's heating mode, while cooling mode energy performance and peak demand are important concerns in California.

VCHP systems with very high seasonal energy efficiency ratio (SEER) and heating seasonal performance factor (HSPF) ratings based on current test methods (AHRI 210/240) are currently available. However, these VCHP systems are not currently credited with improved energy performance in the California Title 24 building standards due to uncertainty regarding their installed performance.

VCHPs have been studied in the Central Valley Research Homes (CVRH) Project , a multi-year effort to test residential energy efficiency measures and technologies in four unoccupied, highly instrumented homes of different vintages in Stockton, California. (Wilcox, CEC)

CVRH Project Description

The CVRH project began in 2011 with funding from the California Energy Commission to perform three experiments.

- Develop packages of envelope and heating, ventilation and air conditioning (HVAC) efficiency retrofits that achieve 50 percent to 75 percent savings in heating and cooling energy in the experimental homes.
- Compare measured energy consumption at the four experimental homes with energy consumption estimates by six Home Energy Rating System (HERS) raters at each of the four homes.
- Compare monitored energy use of VCHPs to reference heating and cooling systems installed in the experimental homes.

Starting in the summer of 2015, the PG&E Codes & Standards and Emerging Technology program provided funding to evaluate VCHP system performance in three of the CVRH houses. Starting in 2016, Southern California Edison (SCE) provided funding in coordination with PG&E to continue the VCHP evaluation.

The project timeline proceeded as follows:

- Four homes leased in 2011
- 2012-2013 collected building baseline data
- 2013-2014 installed first package of building upgrades

- 2014-2015 installed second package of building upgrades, including VCHP systems in three homes
- 2015-2016 three VCHP configurations tested in three homes
- 2016-2017 six VCHP configurations tested in three homes
- 2017-2018 six VCHP configurations tested in three homes

CVRH Project Findings

VCHP system evaluation findings from the 2014-2018 studies include:

- SEER and HSPF ratings do not reliably predict the field installed energy performance of VCHP systems.
- Ductless VCHP systems with indoor units located in only some of the rooms of a house are unable to maintain comfort in the rooms that do not have an indoor unit. This is true even if constantly operating air transfer fans are used to distribute air through the house, and the continuously operating fans significantly increase energy use.
- Ducted VCHP systems are capable of providing comfort similar to centrally ducted single speed heat pump systems.
- Ductless VCHP systems were less able to control indoor temperatures throughout the house than the ducted VCHP system and the ducted reference HP systems.
- The industry's sizing practices for VCHPs are varied and poorly understood even by factory trained technicians.
- There is currently no reliable method of verifying correct installation and performance of mini and multi split VCHP systems, such as testing for correct refrigerant charge.

The published SEER and EER information for VCHP systems is not suitable for use for the computer modeling methods required by the performance standards specified Section 150.1(b) of Title 24, Part 6. And there are no reliable methods which a HERS Rater could use to accurately verify correct installation and performance of VCHP systems. Therefore, the only option for VCHP performance compliance with the Energy Standards has been to model the VCHP system as a minimally compliant heat pump.

More accurate methods of rating VCHP systems utilizing a new load-based and climate-specific method of performance testing are under development based on the Canadian Standards Association publication CSA EXP07:19, but published VCHP performance ratings that rely on these new test procedures are not yet available.

In the meantime, VCHP manufacturer stakeholders have requested that the Energy Commission make available a performance compliance credit that better represents the energy performance of VCHP systems.

To address the manufacturer's requests for a performance credit for VCHP systems, the data generated in the CVRH projects was used to develop algorithms for VCHP system performance as described in this report.

Staff proposes to incorporate these VCHP algorithms into the Alternative Calculation Method (ACM), and the residential California Building Energy Code Compliance (CBECC-Res) performance compliance software, for use for demonstrating compliance with the Performance Standards specified in Title 24 Part 6, section 150.1(b). Staff also proposes that field verification procedures described in this report and detailed in Appendix B be authorized, in accordance with the requirements in Standards section 10-109(h), for use for determining compliance with Title 24, Part 6, and the eligibility requirements of this proposed VCHP performance compliance option.

This report will describe the proposed VCHP performance compliance option, including the following details:

- The technical basis for the proposed VCHP algorithms,
- The eligibility requirements for the VCHP performance compliance option,
- The HERS field verification requirements for the VCHP performance compliance option.

CHAPTER 1:
VCHP Algorithm Technical Background

The CVRH project monitored different VCHP model numbers and system types during each year of the project. Monitoring for each year included a cooling season and a heating season. Research reports for each year are available.

- 2014-2015: VCHP systems were tested in three homes (see Proctor, Wilcox, 2016, CEC-500-2018-033).
- 2015-2016: three VCHP configurations were tested in three homes (see Wilcox, Conant, Chitwood, 2016, ET14PGE8761)
- 2016-2017: six VCHP configurations were tested in three homes (see Wilcox, Conant, Chitwood, 2018, PGE 2018_3)
- 2017-2018: six VCHP configurations tested in three homes (see Wilcox, Conant, Chitwood, 2019, C&S PGE 2019_1).

The system types evaluated included ductless mini-and multi-split systems and short-duct mini-splits with ducts inside the conditioned space. A conventional single speed split system with ducts located entirely inside the conditioned space (reference system) was also monitored in each house, and VCHP system energy performance was compared to that single speed reference system. Efficiency characteristics of the systems monitored in the CVRH projects are shown in Table 1.

The CVRH research demonstrated that ductless VCHP systems serving only common areas are not capable of controlling room temperatures throughout the home to meet satisfactory comfort criteria, even if the home incorporates use of continuously operating air transfer fans to circulate air into the rooms adjacent to the common area served by an indoor unit. Thus, in order for a VCHP to be eligible for this performance compliance option, the VCHP system shall be required to provide conditioned air directly to each habitable room in the dwelling unit. A habitable space is defined as a space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

As noted in Table 1, one VCHP system suffered from low refrigerant charge, and 8 systems were ductless installations for which each habitable room was not directly served by the VCHP system. Data for these systems was excluded from the analysis used to develop the algorithms proposed in this report; the algorithms are based on the remaining 10 systems that represent installations for which each habitable room was directly served by the system, and where the system had no known installation defects.

With the exception of the 2014 project, the Reference systems were SEER 14, HSPF 8.2 single speed heat pumps. The 2014 project used air conditioners and electric resistance heaters as the reference systems. Thus, for the purpose of this analysis, the 2014 results were adjusted to represent VCHP performance relative to a SEER 14, HSPF 8.2 reference system.

Table 1: VCHP Systems Monitored in CVRH Project

Model	Ref. SEER	Ref. EER	Ref. HSPF	VCHP SEER	VCHP EER	VCHP HSPF	Notes
Grange 2014-2015	15.5	11.9	3.4	21.7	13.4	9.4	Found to be 29% undercharged
Mayfair 2014-2015	16	13	3.4	21.5	14.5	12.2	[None.]
Caleb 2015-2016	14	12	8.2	20.9	12.68	10.52	Not all habitable rooms were served
Grange 2015-2016	14	11.5	8.2	25.5	13.8	11.5	Not all habitable rooms were served
Mayfair 2015-2016	14	11.5	8.2	16	12.5	10	[None.]
Caleb 2016-2017 Ducted	14	12	8.2	19.0	12.8	10.6	[None.]
Caleb 2016-2017 Ductless	14	12	8.2	21.0	13.2	10.4	Not all habitable rooms were served
Caleb 2016-2017 Ductless + Fans	14	12	8.2	21.0	13.2	10.4	Not all habitable rooms were served
Grange 2016-2017 Ducted	14	11.5	8.2	29.3	15.2	14	[None.]
Grange 2016-2017 Ductless	14	11.5	8.2	29.3	15.2	14	Not all habitable rooms were served
Grange 2016-2017 Ductless + Fans	14	11.5	8.2	29.3	15.2	14	Not all habitable rooms were served
Mayfair 2016-2017 Ducted	14	11.5	8.2	21	12.5	12	[None.]
Mayfair 2016-2017 Ductless	14	11.5	8.2	21	12.5	12	Not all habitable rooms were served
Mayfair 2016-2017 Ductless + Fans	14	11.5	8.2	21	12.5	12	Not all habitable rooms were served

Model	Ref. SEER	Ref. EER	Ref. HSPF	VCHP SEER	VCHP EER	VCHP HSPF	Notes
Caleb 2017-2018 Ducted	14	12	8.2	14.6	9.34	9.08	[None.]
Grange 2017-2018 Ducted 1 Ton	14	11.5	8.2	29.3	15.2	14	[None.]
Grange 2017 Ducted .75 Ton	14	11.5	8.2	33	18	14.2	[None.]
Mayfair 2017 Ducted 1.5 Ton	14	11.5	8.2	21	12.5	12	[None.]
Mayfair 2017 Ducted 1 Ton	14	11.5	8.2	26.1	13.8	12.5	[None.]

Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

Sources of Uncertainty in Applying the CVRH Results to CBECC-Res Assumptions

Indoor Temperature Control

The CVRH project was conducted in unoccupied houses, and a constant thermostat setpoint was used. When operated with a constant setpoint, the VCHP systems did not control indoor temperature in the same way as the single speed reference system with a traditional thermostat. As shown in Figure 1 and Figure 2, the reference system maintained indoor temperature at the thermostat location at or near setpoint at all times. In contrast, in many cases the VCHP systems allowed indoor temperature at the thermostat location to drift above setpoint during hot afternoon hours, and in some cases the VCHP systems overcooled the houses during lower load conditions.

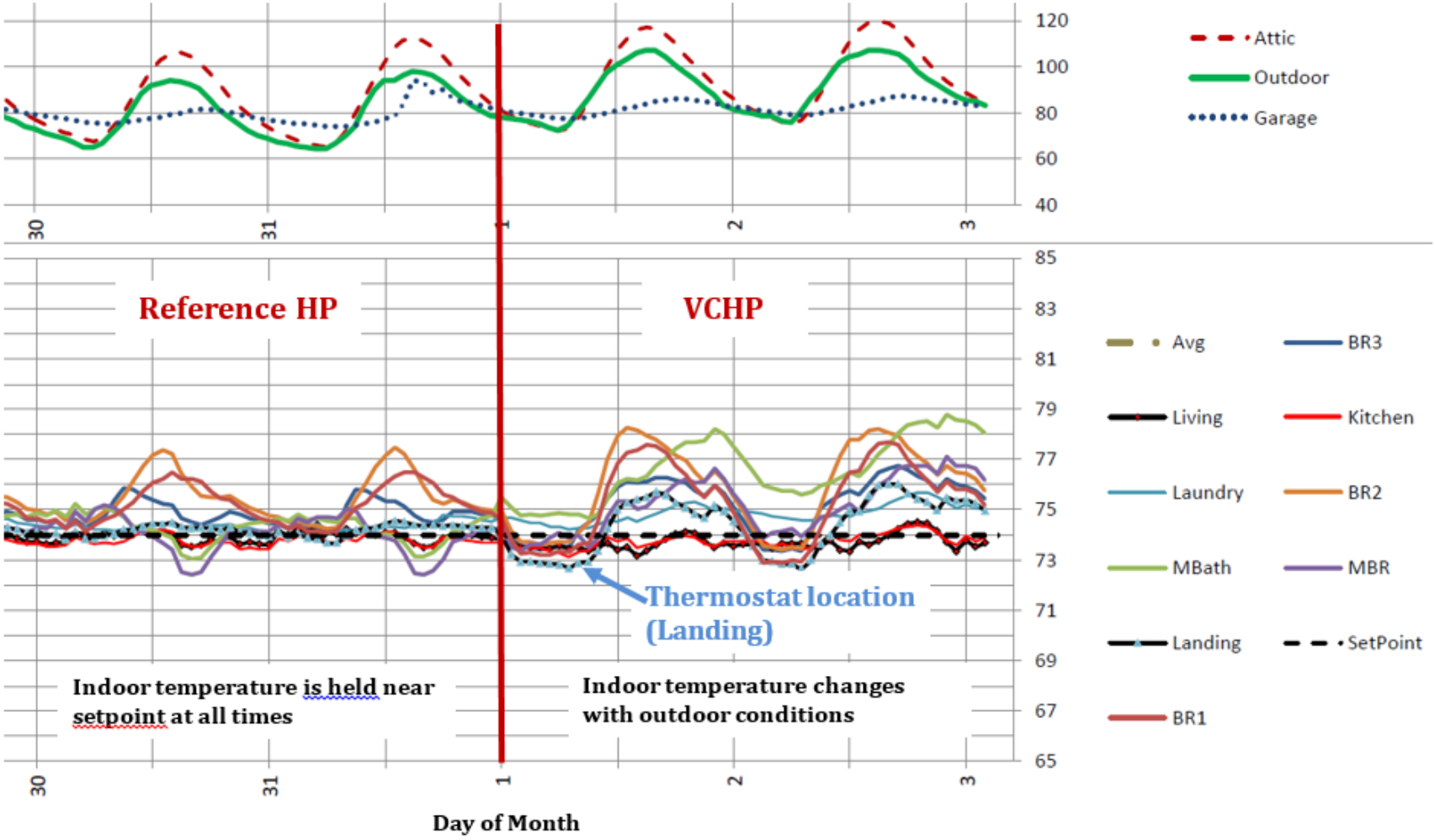
It is likely that occupants would respond to these uneven temperature control conditions by adjusting the thermostat setpoint, which would further increase the VCHP energy use during hot afternoons and cause actual energy use in occupied dwellings to be greater than the monitored values from the CVRH data used to develop the algorithms described in this report.

VCHP System Selection and Installation

VCHP systems are an emerging technology that is not widely used for space conditioning in residential newly constructed buildings. The VCHP systems that were used for CVRH projects were selected either by the system manufacturer or by the CVRH project team. Some of the systems were installed with direct assistance from the associated manufacturers.

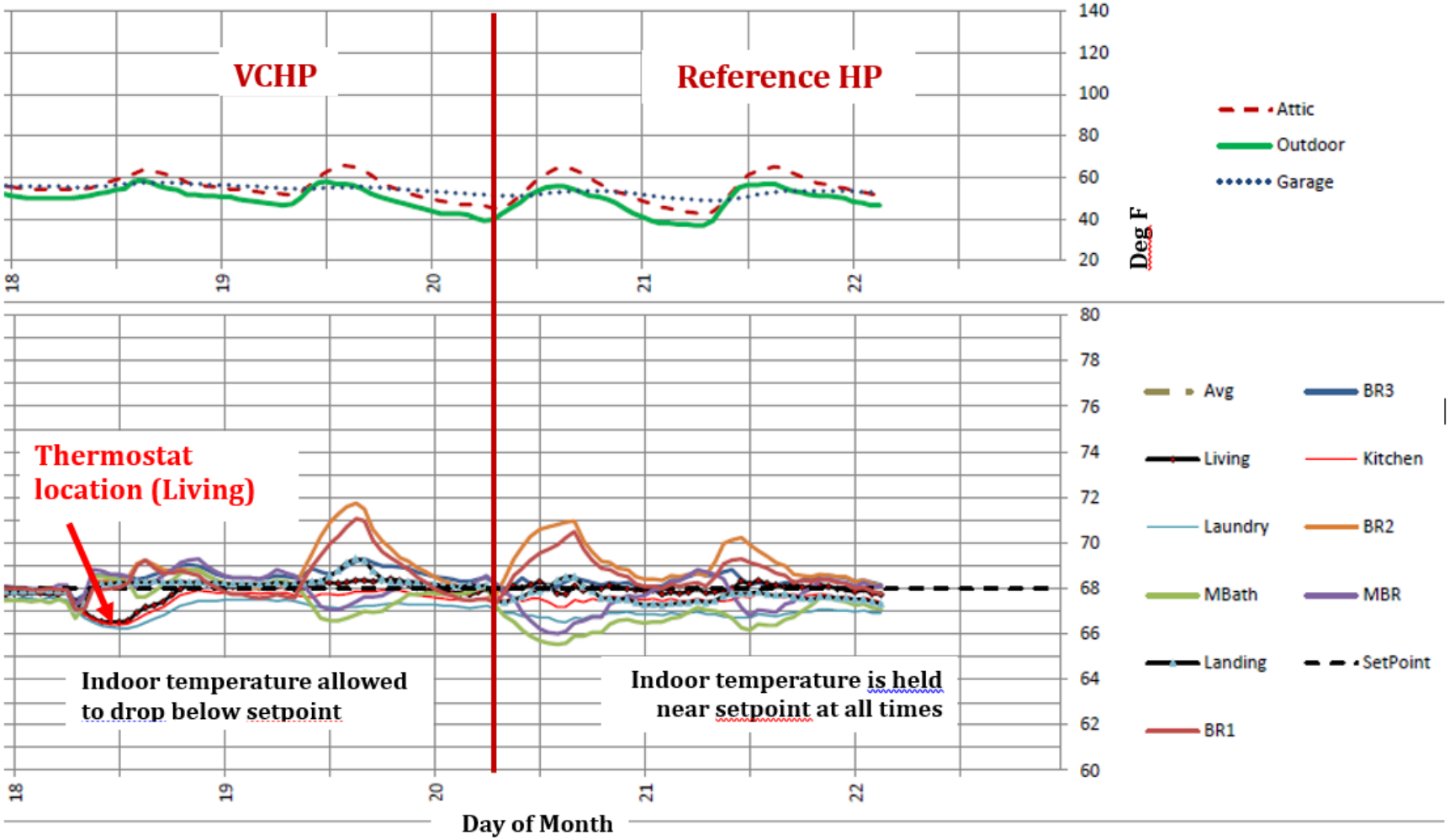
For typical system installation procedures used for newly constructed buildings, a builder would not likely receive the same level of guidance from highly skilled VCHP manufacturer engineers and technicians as was given to the installers of the systems in the CVRH projects. Builders are likely to prioritize low installation cost over the improved energy performance that may result from the highest quality system selection, design, and installation practices. It is uncertain whether the VCHP systems installed by builders would provide equivalent energy efficiency when operated in occupied homes as compared to the efficiency levels attained by the CVRH projects.

Figure 1: VCHP and Reference heat pump indoor temperature control differences, cooling season



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

Figure 2: VCHP and Reference heat pump indoor temperature control differences, heating season



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

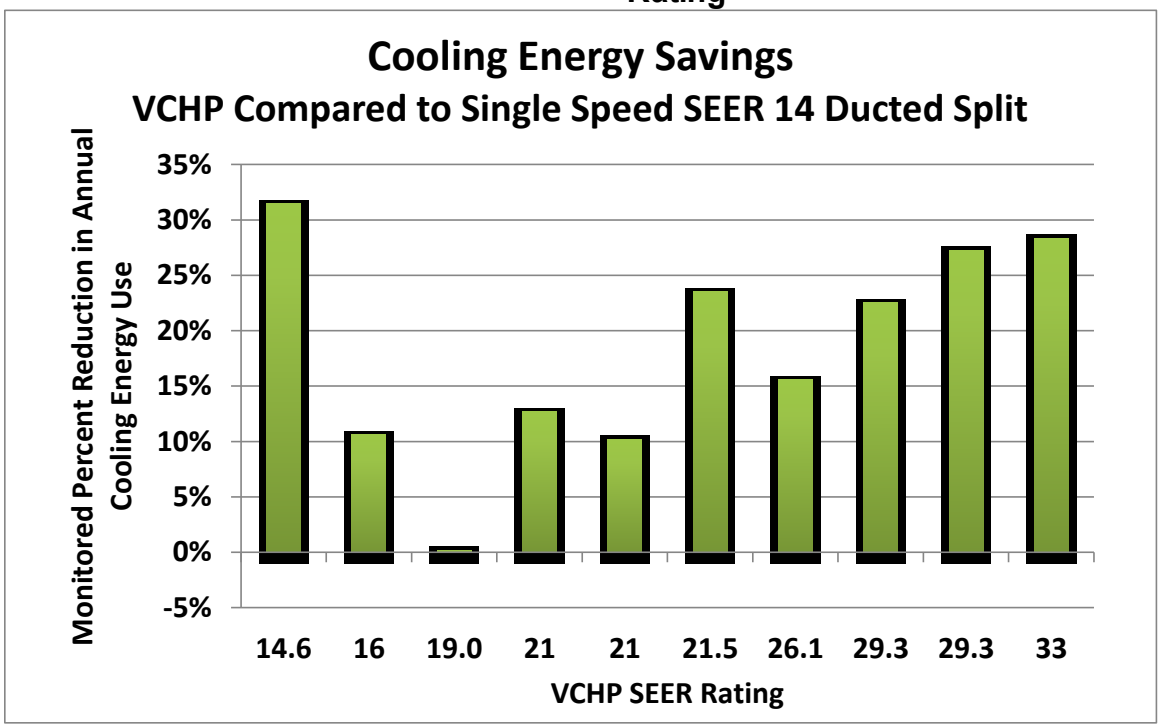
Cooling Performance

The CVRH projects found that VCHP system energy performance was not reliably predicted by the SEER rating. VCHP energy performance relative to the SEER 14 single speed reference system is shown in Figure 3.

The results represent performance when each system is controlled to a constant thermostat setpoint with no setbacks or occupant interactions. The results exclude indoor fan energy that occurs between compressor cycles; this excludes a substantial amount of energy for several of the VCHP systems that have been configured by the manufacturer to operate the indoor unit fan continuously by default. As default configurations can and do differ, the additional fan energy associated with continuous fan operation will be accounted for separately in CBECC-Res.

The higher SEER rated VCHP systems did not perform to expectations based on SEER. For example, a SEER 33 rated system would be expected to use 58% less cooling energy than a SEER 14 rated system, but the monitored results showed a cooling energy use reduction of only 28 percent. The lowest SEER rated VCHP system demonstrated the best energy performance relative to the single speed reference system.

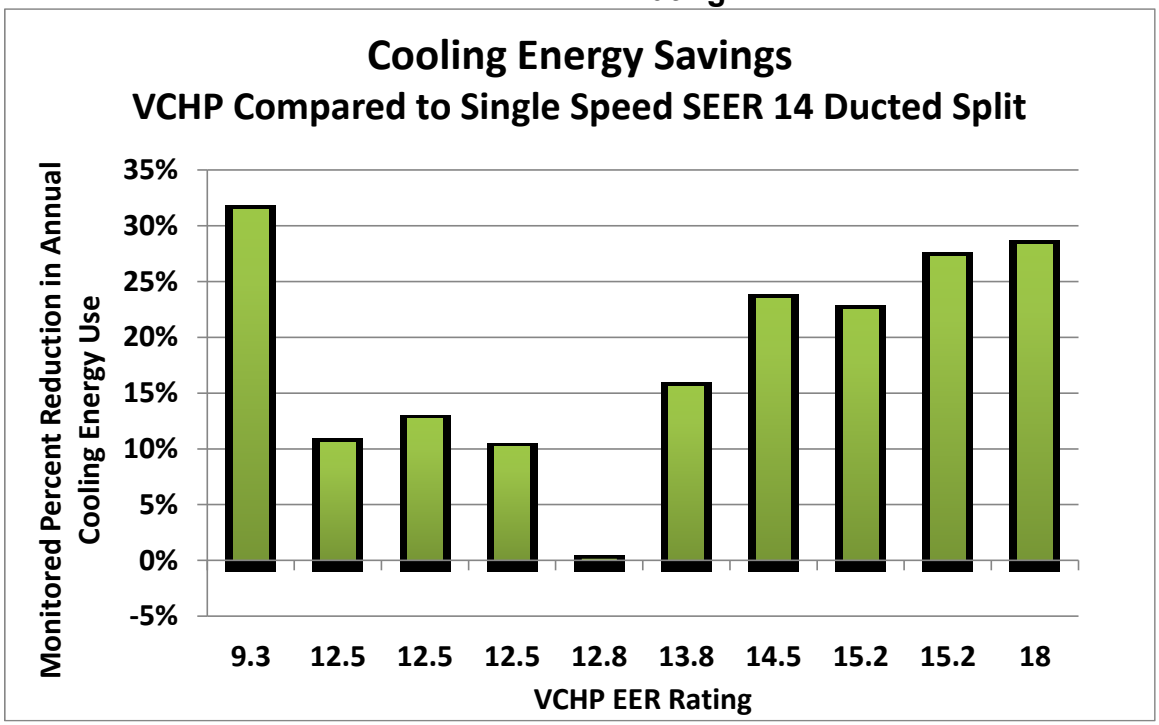
Figure 3: VCHP Cooling Energy Relative to SEER 14 Single Speed System, by SEER Rating



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

The EER rating was found to be a similarly poor predictor of cooling energy performance, as shown in Figure 4.

Figure 4: VCHP Cooling Energy Relative to SEER 14 Single Speed System, by EER Rating



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

As with the SEER values, the lowest rated system was the best performer.

The CVRH projects demonstrated that VCHP systems can deliver cooling energy savings over minimum efficiency single speed systems, but that the amount of energy savings is not well predicted by the SEER and EER ratings. The CVRH research justifies adopting a simplified CBECC-Res performance model that calculates improved energy performance over a single speed SEER 14 system, based on statistical analysis of the CVRH results, shown in Table 2.

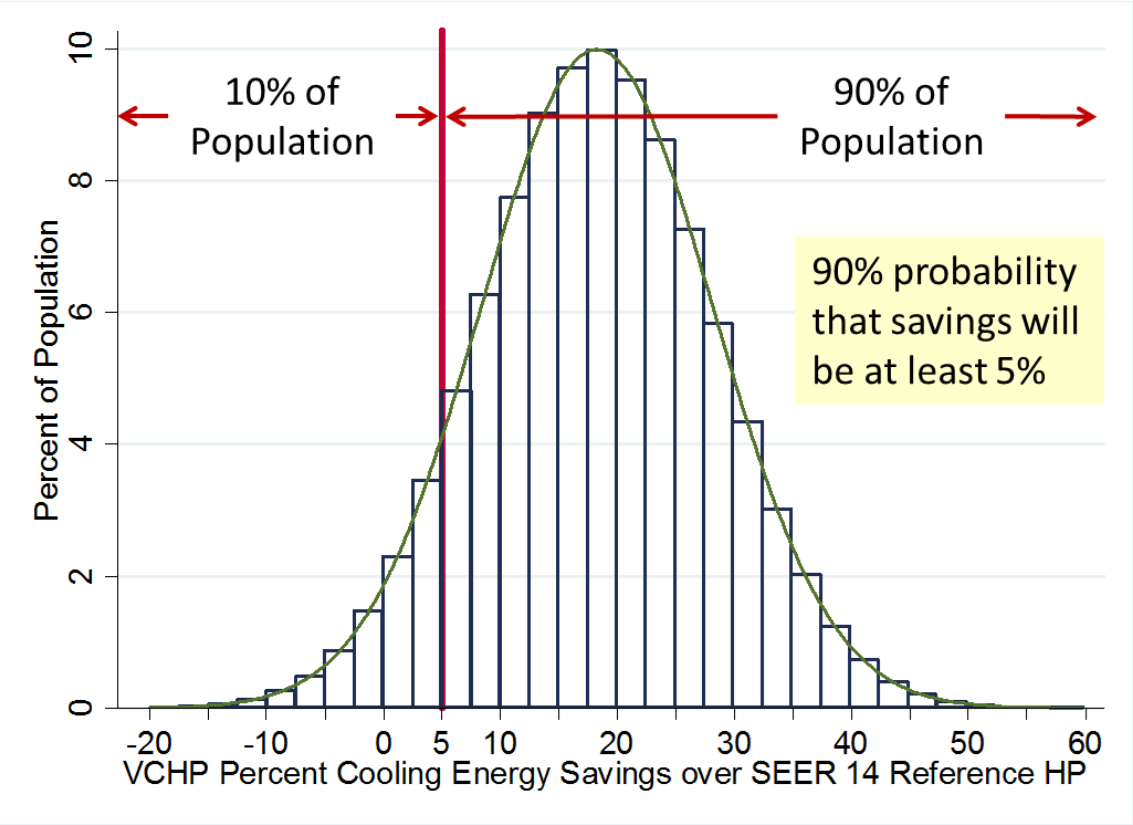
Table 2: VCHP Cooling Energy Performance Summary

Number of Test Cases	10
Mean Annual Cooling Energy Savings over SEER 14 Reference HP	18%
Minimum	0%
Maximum	31%
Standard Deviation	10%

Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

Based on these results as shown in Figure 5 below, CBECC-Res would calculate VCHP system cooling energy performance to be 5 percent better than a single speed SEER 14 / EER 11.6 system[1]. The same calculation will be used in the CBECC compliance software calculation regardless of the VCHP system's AHRI rating. This corresponds to a 90 percent probability that a typical VCHP system will achieve at least 5 percent savings, anticipating that the sample of VCHP systems tested in the CVRH projects is representative of the general population.

Figure 5: VCHP System Cooling Energy Performance Distribution Based On CVRH Results



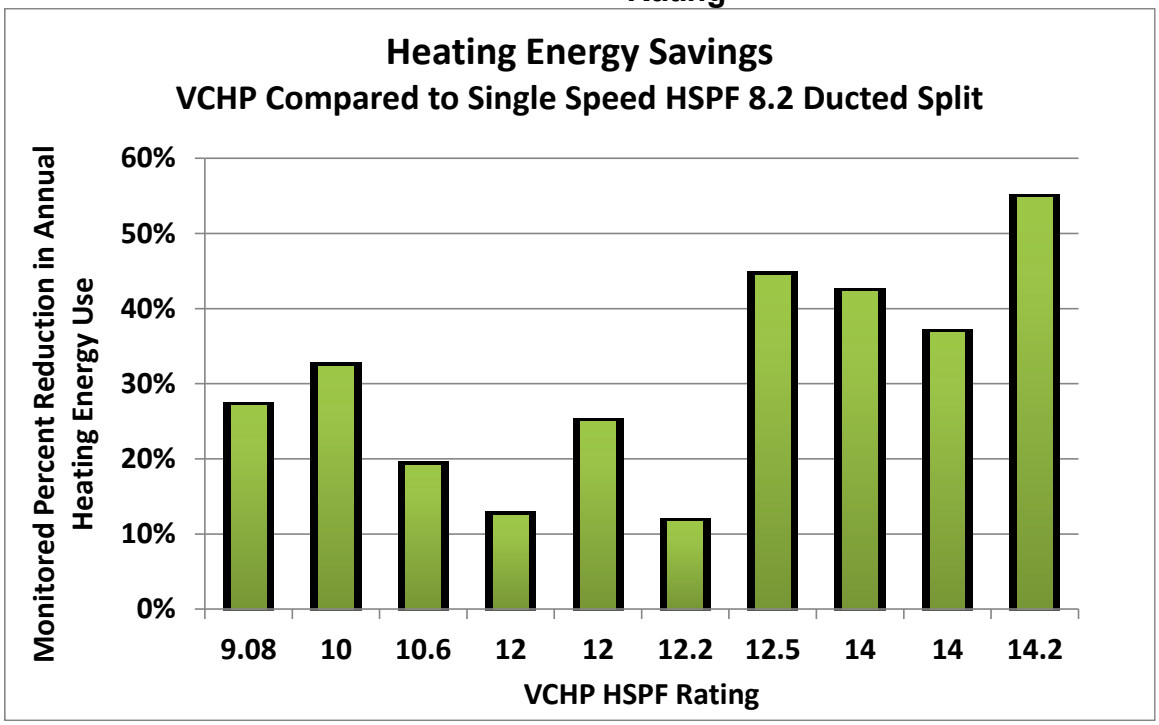
Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

[1] The 11.6 EER value described here is the average of the EER ratings of the 10 reference systems from the CVRH project that correspond to the 10 VCHP systems from Table 1 used to develop this CBECC algorithm.

Heating Performance

The CVRH projects found that VCHP system energy performance was not reliably predicted by the HSPF rating. VCHP energy performance relative to the HSPF 8.2 single speed Reference system is shown in Figure 6. These results represent performance when each system is controlled to a constant thermostat setpoint with no setbacks or occupant interactions. These results also exclude indoor fan energy that occurs between compressor cycles, which represents a significant amount of energy for several of the VCHP systems that have been configured by the manufacturer to operate the indoor fan continuously by default. Additional fan energy associated with continuous fan operation will be accounted for separately in CBECC-Res.

Figure 6: VCHP Heating Energy Relative to HSPF 8.2 Single Speed System, by HSPF Rating



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

The CVRH projects demonstrated that VCHP systems can deliver heating energy savings over minimum efficiency single speed systems, but that the amount of energy savings is not well predicted by the HSPF rating. The CVRH research justifies adopting a simplified CBECC-Res performance model that calculates improved energy performance over a single speed HSPF 8.2 system, based on statistical analysis of the CVRH results, shown in Table 3.

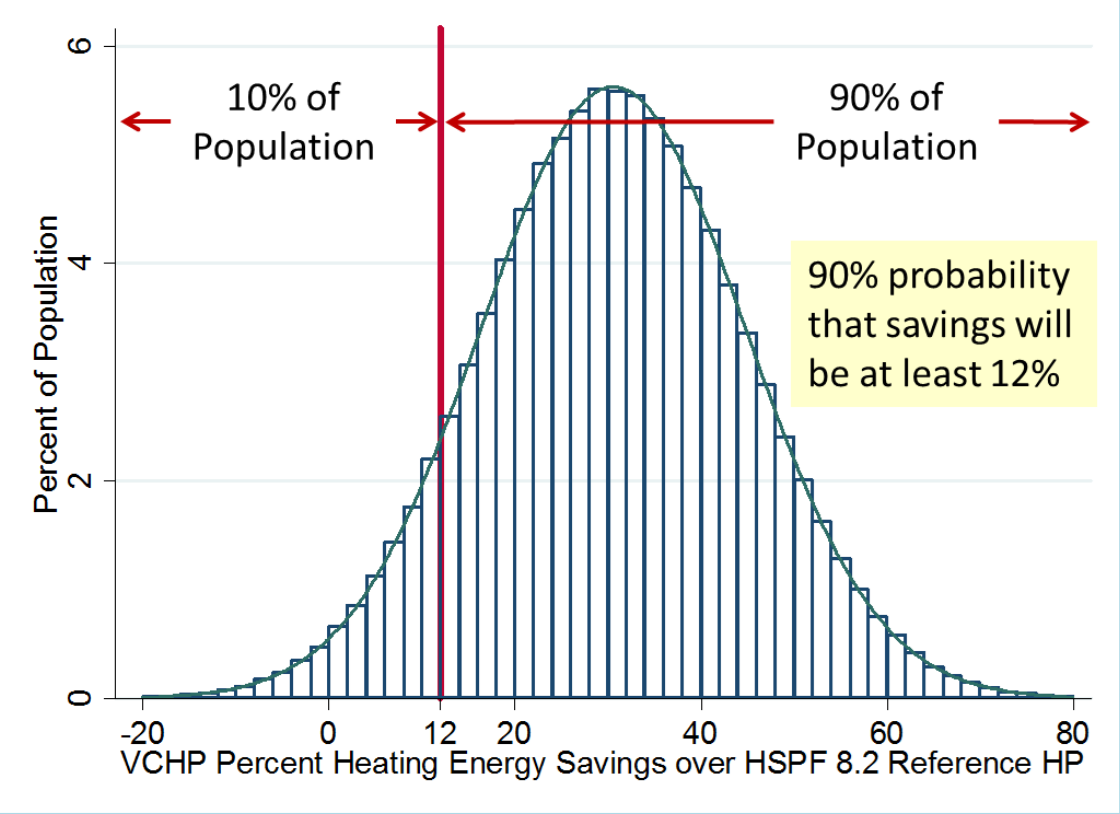
Table 3: VCHP Heating Energy Performance Summary

Number of Test Cases	10
Mean Annual Heating Energy Savings over HSPF 8.2 Reference HP	31%
Minimum	12%
Maximum	55%
Standard Deviation	14%

Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

Based on these results as shown in Figure 7 below, CBECC-Res will calculate VCHP system heating energy performance that is 12 percent better than a single speed HSPF 8.2 system. The same calculation will be used in the CBECC compliance software calculation regardless of the VCHP system's AHRI rating. This corresponds to a 90 percent probability that a typical VCHP system will achieve at least 12 percent savings, anticipating that the sample of VCHP systems tested in the CVRH projects is representative of the general population.

Figure 7: VCHP System Heating Energy Performance Distribution Based On CVRH Results



Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

Fan Energy

Two indoor fan energy components must be addressed in the CBECC-Res algorithms:

- Fan energy that occurs during compressor cycles
- Fan energy that occurs when the compressor is off

Compressor Cycle Fan Energy

The CBECC-Res VCHP algorithms described in this report calculate performance referenced to a single speed minimum efficiency SEER 14 / HSPF 8.2 heat pump. The VCHP systems provide a 5 percent improvement in cooling efficiency and a 12 percent improvement in heating efficiency compared to the minimum efficiency (reference) heat pump, based on direct comparison of the measured energy performance of each system from the CVRH data. This comparison includes all fan energy that occurred during compressor cycles for the VCHP and single speed reference heat pump systems.

The simplified VCHP algorithm described in this report must calculate the performance of a proposed VCHP system relative to a single speed (reference) heat pump, and that relationship is derived from the CVRH comparison of VCHP systems to a single speed reference heat pump system. Therefore in order to account for fan energy, the simplified algorithm proposed in this report will incorporate a single speed heat pump model with fan efficacy equivalent to the CVRH single speed reference heat pump system fans. The average value of the monitored CVRH single speed reference heat pump system fan efficacy was 0.35 w/cfm as shown in table 4, which is lower than the standard design value of 0.58 w/cfm fan efficacy specified in the 2016 and 2019 Title 24 standards for heat pump air-handling units.

Table 4: CVRH Reference HP Fan Efficacy

Reference HP	Fan Efficacy (W/cfm)
Grange	0.29
Mayfair	0.34
Caleb 2015	0.40
Caleb 2017	0.38
Average	**0.35**

Source: Proctor Engineering Group, LTD., Bruce Wilcox, 2018

The CBECC algorithm will calculate fan energy using the following conventions:

- CBECC software users will not be prompted to input a proposed value for fan efficacy when using the VCHP compliance option.
- The VCHP model will always use 0.58 w/cfm for the standard design fan efficacy.
- The VCHP model will always use 0.35 w/cfm for the proposed design fan efficacy.

- These VCHP standard design and proposed design fan efficacy values will be applied to the energy calculations for both ducted and ductless systems during periods when the algorithm determines the compressor is operating to provide comfort conditioning.

Continuous Fan Energy

Fan energy use that occurs when the compressor is off is an important consideration because the majority of VCHP systems tested in the CVRH project operated the indoor fan continuously according to the manufacturer's factory default control setting.

"Default" means that when the system is purchased and installed without making any changes to any control settings, the indoor fan operates continuously whenever the system is in cooling or heating mode, including during times when the system is not providing any cooling or heating. The VCHP systems tested in the CVRH project provided installers and/or users with control options to disable the default constant fan operation. The actions required to configure fan operation vary by manufacturer and model number, and sometimes are not well documented in the manufacturer's literature. In some cases, modifying other control settings may cause fan controls to be reset, or may cause other settings to be reset back to the factory default mode. The average VCHP fan energy use monitored in the CVRH project during continuous fan operation was 50 W per ton of nominal cooling capacity.

Staff proposes to make available to manufacturers, the option to certify to the Energy Commission that their VCHP systems do not operate the fan continuously by default. Thus the CBECC-Res calculations for VCHP energy use will include a calculated energy contribution attributed to continuous fan operation equal to the average of the monitored energy use for continuous fan operation from the CVRH projects data (50 W per ton of nominal cooling capacity). This additional fan energy use will be incurred during each hour when there is no cooling load during cooling season, or during each hour when there is no heating load during heating season (i.e. when the algorithm determines the compressor is not operating to provide comfort conditioning) unless one of the following exceptions applies:

- If the VCHP system is ductless, then continuous fan energy is expected to be insignificant, and will be set to a value of zero in the CBECC-Res calculations. This is supported by the CVRH data, which shows ductless indoor units, operating at very low fan speed, use less than 10W when the compressor is off.
- If the VCHP system is ducted and the installed system is from a manufacturer who has certified to the Energy Commission that the applicable combination of outdoor unit and indoor unit(s) does not operate the indoor unit fan(s) continuously by default, then continuous fan energy shall be set to a value of zero in the CBECC-Res calculations. A HERS verification will confirm that installed systems are included in the Energy Commission listings of certified VCHP products, and that the installed indoor units do not run the fan continuously during periods when there is no call for conditioning.

Air Distribution Type Definitions and Assumptions for Fan Energy Calculations

Since continuous fan energy is applied to ducted systems, but is not applied to ductless systems, it is necessary for inputs to the CBECC-Res software to identify the system type. Three system types are proposed:

- **VCHP - Ducted**: The system may have one or more indoor units connected to a single outdoor unit, and all indoor units are ducted types. A calculated energy contribution attributed to continuous fan energy is applied to the system unless the system indoor unit + outdoor unit combinations are certified by the manufacturer to not operate the indoor fan continuously by default.
- **VCHP - Ductless**: The system may have one or more indoor units connected to a single outdoor unit, and all indoor units are ductless types. A calculated energy contribution attributed to continuous fan energy is not applied.
- **VCHP - Mixed Ducted and Ductless**: The system has multiple indoor units connected to a single outdoor unit, and the indoor units are a combination of both ducted and ductless types. A calculated energy contribution attributed to continuous fan energy is applied to the ducted fraction of the system, which will be assumed to be applicable to 50 percent of system total capacity. The continuous fan energy use will be applied unless the system indoor unit + outdoor unit combinations are certified by the manufacturer as models that do not operate the indoor unit fan(s) continuously by default.

CHAPTER 2
VCHP Performance Compliance Option Scope

The VCHP algorithms described in this report shall be used to determine performance compliance for only the equipment types that have been studied under the CVRH projects, specifically:

- Mini- and multi-split VCHP systems with, low-static pressure (as defined below) ducted indoor units.
- Mini and multi-split VCHP systems with ductless indoor units.

Ductless indoor units are those that meet the following criteria:

- The unit meets the AHRI 210/240-2017 definition of a non-ducted indoor unit: "An Indoor Unit designed to be permanently installed, mounted to/in ceilings and/or room walls, and/or to floors, and that directly heats or cools air within the conditioned space."
- The unit is installed with no connection to any external ductwork.

(Note: system configurations that provide ductless conditioned air to each habitable room in the dwelling were tested as part of the 2018-19 CVRH projects, but the project analysis was not yet available as of August 2019).

The 2017 Department of Energy (DOE) final rule on test procedures for central air conditioners and heat pumps[2] defines two classifications of ducted indoor units for mini- and multi-split systems:

- Low-static systems "*produce greater than 0.01 in. wc. and a maximum of 0.35 in. wc. external static pressure when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling*"
- Mid static systems "*produce greater than 0.20 in. wc. and a maximum of 0.65 in. wc. when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling*"

The ducted VCHP systems tested in the CVRH projects are representative of low-static systems according to the 2017 DOE definition above. Mid static VCHP systems as defined above have not been evaluated by the CVRH project. The maximum operating pressure for mid-static systems is 0.65 inch wc., thus mid-static systems are equivalent to the air handlers used in conventional central air conditioning systems – i.e. gas furnaces rated for 0.5 inch wc. The algorithms described in this report that are applicable to ducted systems should be applied only to ducted systems that meet the DOE's low-static pressure system definition adopted in 2017 and effective in 2023.

[2] *Energy Conservation Program: Test Procedures for Central Air Conditioners and Heat Pumps*, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017. Incorporated via amendment into 10 CFR Parts 429 and 430.

The current performance ratings information, and equipment type classifications given in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Directory of Certified Product Performance do not identify these low-static systems or provide a means to differentiate between low-static systems and those designed to operate at higher static pressures. This is because the DOE test procedure currently in effect for residential central air conditioners and heat pumps evaluates all ducted systems at low static pressure, with the exception of small duct high velocity systems as shown in Table 5 below.

Table 5: AHRI 210/240-2017 External Static Pressure for Ducted Systems (Currently in Effect)

Minimum External Static Pressure for Ducted Systems Tested with an Indoor AMS Installed		
Rated Cooling[1] or Heating[2] Capacity, Btu/h	Minimum External Resistance, in H_2O	
	All Other Systems	Small-duct, High-velocity Systems
Up Through 28,800	0.10	1.10
29,000 to 42,500	0.15	1.15
43,000 to 65,000	0.20	1.20

Note:

1 For air-conditioners and heat pumps, the value cited by the manufacturer in published literature for the unit's capacity when operated at the A_{Full} Test conditions.

2 For heating-only heat pumps, the value the manufacturer cites in published literature for the unit's capacity when operated at the $H1_{Full}$ Test conditions.

The upcoming DOE procedures evaluate systems at different static pressures depending on their classification as low-static, mid-static or conventional systems as shown in Table 6 below.

Table 6: DOE 2017 Final Rule External Static Pressure for Ducted Systems (Effective 2023)

MINIMUM EXTERNAL STATIC PRESSURE REQUIREMENTS	
CAC/HP variety	**Minimum external static pressure (in. wc.)**
Conventional (i.e., all central air conditioners and heat pumps not otherwise listed in this table)	0.50
Ceiling-mount and Wall-mount	0.30
Mobile Home	0.30
Low-Static	0.10
Mid-Static	0.30
Small Duct, High Velocity	1.15
Space-Constrained (indoor and single-package units only)	0.30

CHAPTER 3
VCHP Performance Compliance Option Eligibility Requirements

All applicable eligibility requirements described in this section shall be met in order for the system to receive the VCHP performance compliance credit described in this report. All Title 24, Part 6 standards requirements that are applicable to these systems shall also be met unless those Title 24 standards requirements are amended or excepted by the eligibility requirements in this report. For clarity, some Title 24, Part 6 standards requirements are included without amendment as eligibility requirements in this report.

Requirements Applicable to Both Ducted and Ductless VCHP Systems

All ducted and ductless VCHP systems shall comply with the following requirements:

1. **Conditioned Air Supply to All Rooms.** Dwelling units shall be provided with heating and cooling supply airflow in each habitable[3] room either by use of a ductless VCHP indoor unit located in the room, or by use of ducts connected directly to the supply air outlet of a ducted VCHP indoor unit. Transfer fans do not meet this requirement. Compliance will be confirmed by a HERS Rater according to a new HERS procedure proposed to be approved with this compliance option
2. **Indoor Units Located Entirely in Conditioned Space.** All ducted and ductless indoor units shall be located entirely in conditioned space[4] as verified by a HERS rater. Ductless systems shall be visually verified according to a new HERS procedure proposed to be approved with this compliance option. Verification of ducted systems is described below in the ducted system requirements section.

Ducts entirely in conditioned space are located inside the thermal envelope, and also inside the pressure boundary of the dwelling. If parts of the indoor air handling unit, duct system, or terminal devices are in locations such as unconditioned attics that are outside the dwelling pressure boundary or thermal boundary, then the system is not considered to be entirely in conditioned space.

[3] From Title 24, Part 6, Section 100.1 definitions: HABITABLE SPACE is space in a building for living, sleeping, eating or cooking, excluding bathrooms, toilets, hallways, storage areas, closets, utility rooms and similar areas.

[4] From Title 24, Part 6, Section 100.1 definitions: CONDITIONED SPACE is an enclosed space within a building that is either directly conditioned or indirectly conditioned. DIRECTLY CONDITIONED SPACE is an enclosed space that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft², or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft². Directly conditioned space does not include process space. INDIRECTLY CONDITIONED SPACE is enclosed space that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have fixed vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

Thus for example:

- Ductless indoor units that are mounted on the interior surface of dwelling unit walls, ceilings, or floors are generally considered to be entirely in conditioned space.
- Duct systems and indoor air handling units that are located in dropped ceilings, interior walls, chases or closets, that are inside the thermal envelope and inside the pressure boundary of the dwelling, are generally considered to be entirely in conditioned space.

3. **Wall Mounted Thermostats in zones > 150 ft^2**. All VCHP indoor units serving zones larger than 150 square feet shall be controlled by external wall mounted thermostats located within the zone served.
4. **HERS Verified Refrigerant Charge**. The installed system shall have refrigerant charge verified by a HERS Rater according to the procedures in RA3.2.
5. **Compliance with Section 150.0(m)13 is not required.** Compliance with Section 150.0(m)13 is not required for systems that use this VCHP compliance option. However, requirements for verification of minimum airflow rates for ducted VCHP system indoor units are specified as eligibility requirements for this compliance option.

Additional Requirements Applicable to Ducted VCHP Indoor Units

In addition to the eligibility requirements listed above that are applicable to all system types that use the VCHP compliance option described in this report, systems with one or more ducted indoor units shall also comply with the following requirements.

1. **HERS Verified Ducts Entirely in Conditioned Space**. Each ducted indoor unit shall be HERS verified according to the procedures in RA3.1.4.3.8 to confirm the system is located entirely in conditioned space. This field diagnostic protocol uses a visual verification to confirm the ducts are located entirely in conditioned space, and verifies the ducted system is inside the pressure boundary by confirming that the duct leakage to outside is no more than 25 cfm.
2. **Certification of Non-Continuous Default Fan Operation – for Optional Fan Energy Credit**. The manufacturer shall provide certification to the Energy Commission that the system does not operate the indoor unit fan continuously by default as a prerequisite to receiving the fan energy credit. Refer also to the discussion of default settings in "continuous fan energy" section in this report for additional information.
3. **HERS Verification of Non-Continuous Fan Operation – for Optional Credit**. When credit is claimed for use of a ducted system that does not operate the fan continuously when the controls use the factory default setting, the system's indoor unit(s) shall be verified in the field to confirm the fan does not operate continuously when:
    - the system is in cooling mode and the thermostat is not calling for cooling.
    - the system is in heating mode and the thermostat is not calling for heating.

"Default" refers to:

- the control settings that are present in the unit when it ships from the factory, and
- the control settings that are activated when a "factory reset" or equivalent controls reset is performed that is intended to restore the original as-shipped settings.

The default control settings shall not operate the indoor fan when the compressor is off, except for a fan overrun (fan off delay) of less than 10 minutes that occurs at the end of the compressor on cycle.

4. **Certification of Low-Static VCHP System**. The manufacturer shall certify to the Energy Commission that the system is a VCHP that meets the definition of a low-static system as defined in the new DOE rule adopted January 5, 2017. Certified low-static system model numbers will be published in a list on the Energy Commission website. Certification shall include submittal of manufacturer installation documentation that provides instruction for topics such as configuring indoor unit fans to operate at airflow rates equal to or greater than 350 cfm/ton, and methods for installing wall-mounted thermostats. Note: these listings of certified low-static VCHP systems are not included in the scope of the Title 20 Appliance Efficiency Database.
5. **HERS Verification of Low-Static VCHP Certification Listing**. The manufacturer's model number(s) must be included in listings of certified low-static pressure VCHP systems published on the Energy Commission's website.
6. **HERS Verification of Indoor Unit 350 cfm/ton airflow**. Each new ducted indoor unit shall have airflow verified by a HERS Rater to confirm the airflow at full capacity in cooling mode is equal to or greater than 350 cfm/ton of nominal cooling capacity. 300 cfm/ton shall be verified for altered systems if required for compliance with the refrigerant charge verification procedure. For single-split systems, the nominal capacity of the outdoor unit is used for the compliance calculations. For multiple-split systems, the nominal cooling capacity of the indoor unit is used for the compliance calculations.
7. **HERS Verification of Air Filter Sizing for Ducted Indoor Units**. In order to ensure that ducted low-static systems will operate to provide the required airflow rates, and will not consume fan energy in excess of the fan energy consumed by systems monitored in the CVRH project, the following two amendments (a and b below) to the air filter requirements in Section 150.0(m)12 shall be met by the system in order to receive the VCHP compliance credit. A HERS rater shall verify the air filter sizing and verify the air filter label specifies performance that meets a clean filter pressure drop less than or equal to 0.1 inch wc.
    a. **Ducted Low-static VCHP systems with any length of duct shall comply with air filter requirements**. Ducted VCHP system indoor units that use any length of duct shall comply with applicable air filter requirements in Energy Standards sections 150.0(m)12B, 150.0(m)12C, 150.0(m)12D, and 150.0(m)12E. Indoor units that are ductless shall not be required to comply with sections 150.0(m)12B, 150.0(m)12C, 150.0(m)12D, and 150.0(m)12E.

Note: this requirement is a modification to Section 150.0(m)12Ai that shall be applicable only to systems that utilize this VCHP compliance option.

b. **System Air Filters Shall have clean Filter Pressure drop ≤ 0.1 inch wc.** The systems shall be equipped with air filters that meet sizing and pressure drop requirements according to either i or ii below:

   i. Nominal two-inch minimum depth filter(s) shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch wc at the design airflow rate, or

   ii. Nominal one-inch minimum depth filter(s) shall be allowed if the filter(s) are sized based on a maximum face velocity of 150 ft. per minute at the design airflow rate, and a maximum allowable clean-filter pressure drop of 0.1 inch wc.

Note: item i above is a modification to Sections 150.0(m)12Biia, and 150.0(m)12Di that shall be applicable only to systems that utilize this VCHP compliance option. This modification maintains the 150.0(m)12Biia allowance for 2-inch filters to be sized by the system designer, however it specifies the air filter sizing shall result in a maximum clean filter pressure drop of 0.1 inch wc. which is a modification to the pressure drop requirement in 150.0(m)12Di.

Note: item ii above does not specify a modification to sections 150.0(m)12Bii, or 150.0(m)12Dii, but is included here in order to provide context for the two air filter sizing options (a and b) given in Section 150.0(m)12Bii.

CHAPTER 4
SUMMARY OF CREDIT AND REQUIREMENTS

Staff proposes to incorporate the VCHP algorithms described in this report into the Alternative Calculation Method (ACM), and the residential California Building Energy Code Compliance (CBECC-Res) performance compliance software, for use for demonstrating compliance with the Performance Standards specified in Title 24 Part 6, section 150.1(b). Staff also proposes that field verification procedures described in this report and as detailed in Appendix B be authorized, in accordance with the requirements in Standards section 10-109(h), for use for determining compliance with Title 24, Part 6, and the eligibility requirements of this proposed VCHP performance compliance option.

General Description of the Algorithm Approach:

- Credit for cooling 5 percent as compared to a single speed SEER 14 / EER 11.7 system
- Credit for heating 12 percent as compared to a single speed HSPF 8.2 system
- Also assume additional energy use for ducted systems due to continuous fan operation equal to 50 W per ton of nominal cooling capacity. This additional fan energy use will be incurred during each hour where there is no cooling load during cooling season, or heating load during heating season unless the system is from a manufacturer who has certified to the Energy Commission that the applicable combination of outdoor unit and indoor unit(s) does not operate the indoor fan(s) continuously by default.

Eligibility Requirements:

1. The performance compliance credit is applicable only to these system types:
    - Ducted mini and multi split VCHP systems with low-static indoor units (low-static as defined by 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017)
    - Mini and multi-split VCHP systems with ductless indoor units
2. Dwelling units shall be provided with heating and cooling supply airflow in each habitable room by use of a ductless VCHP indoor unit located in the room, or by use of ducts connected directly to the supply air outlet of a ducted VCHP indoor unit. Transfer fans do not meet this requirement.
3. All ducts, ducted indoor units, and ductless indoor units must be located entirely in conditioned space.
4. New ducted systems shall provide a minimum of 350 cfm/ton of nominal cooling capacity (300 cfm/ton for altered systems complying with refrigerant charge verification).
5. All VCHP indoor units serving zones larger than 150 square feet shall be controlled by external wall mounted thermostats located within the zone served.

6. The manufacturer of ducted indoor units shall certify to the Energy Commission that the system is a VCHP that meets the definition of a low-static system as defined in the new DOE rule adopted January 5, 2017. The manufacturer's model number(s) shall be included in listings of certified-to-the-Energy Commission low-static pressure VCHP systems which will be published on the Energy Commission's website
7. The manufacturer may certify to the Energy Commission that their ducted indoor unit + outdoor unit combination does not operate the fan continuously by default. This certification is required in order to receive credit for non-continuous fan operation.
8. Air filter sizing shall be required for all ducted systems, regardless of duct length. The maximum allowable clean filter pressure drop for the required MERV 13 air filters shall be 0.1 inch wc..
9. It must be possible for a HERS Rater to view the manufacturer indoor unit and outdoor unit make/model/serial number in the field-installed unit in order to comply with the required field verifications.

Field Verification Requirements

1. The installed system must have refrigerant charge verified by a HERS Rater according to applicable procedures in RA3.2, as specified in Title 24, Part 6 Standards Sections 150.1(c)7A and 150.2(b)1Fii, or 150.2(b)1Fiii.
2. Ducted indoor units shall be HERS verified to meet the Verified Low Leakage Ducts in Conditioned Space requirements according to the procedure in RA3.1.4.3.8.
3. Ductless systems shall be HERS verified to visually confirm ductless indoor units are located entirely in conditioned space.
4. HERS Rater shall confirm all habitable rooms are provided with conditioned airflow.
5. HERS Rater shall confirm zones greater than 150 ft^2 have a wall mounted thermostat.
6. HERS verification shall confirm that the manufacturer's model number of installed ducted units are included in listings of certified low-static pressure VCHP systems published on the Energy Commission's website.
7. If non-continuous fan operation is claimed for credit in CBECC-Res, HERS verification shall confirm that the installed system's indoor unit + outdoor unit combination is certified to the Energy Commission and listed on the Energy Commission website as a type that does not operate the fan continuously by default. Additionally, HERS field verification of the installed system operation shall confirm that the installed system's indoor unit fan does not run continuously when the system is not calling for conditioning.
8. Each new ducted indoor unit must have airflow verified by a HERS Rater to confirm the airflow at full capacity in cooling mode is equal to or greater than 350 cfm/ton of nominal cooling capacity of the indoor unit. 300 cfm/ton shall be verified for altered systems if required for compliance with the refrigerant charge verification procedure.

9. HERS verification shall confirm the air filter sizing is correct, and confirm the installed air filter label specifies performance that meets a clean filter pressure drop less than or equal to 0.1 inch wc. at the design airflow rate.

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Glossary

ACM	Alternative Calculation Method
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
CBECC-Res	California Building Energy Code Compliance Software – Residential
CVRH	Central Valley Research Homes
DOE	U.S. Department of Energy
EER	Energy Efficiency Ratio
HERS	Home Energy Rating System
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation and Air Conditioning
SEER	Seasonal Energy Efficiency Ratio
VCHP	Variable Capacity Heat Pump

APPENDIX A:
Comparison with Standard Design Split Heat Pump

Appendix A provides data output from computer modeling of dwellings that used the proposed VCHP compliance option.

Table A-1. EDR Compliance Comparison with Standard Design Split Heat Pump

	EDR Efficiency				EDR Flexibility				EDR Total			
	Standard	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**
CZ01	66.7	57.2	9.5	14%	21.4	21.3	0.1	0%	45.3	35.9	9.4	21%
CZ02	53.2	48.6	4.6	9%	20.4	20.5	-0.1	0%	32.8	28.1	4.7	14%
CZ03	55.5	51.2	4.3	8%	22.4	22.3	0.1	0%	33.1	28.9	4.2	13%
CZ04	53.3	48.5	4.8	9%	21.2	21.2	0.0	0%	32.1	27.3	4.8	15%
CZ05	53.9	50.0	3.9	7%	21.6	21.7	-0.1	0%	32.3	28.3	4.0	12%
CZ06	56.0	53.1	2.9	5%	25.9	25.9	0.0	0%	30.1	27.2	2.9	10%
CZ07	55.8	54.9	0.9	2%	28.0	28.0	0.0	0%	27.8	26.9	0.9	3%
CZ08	51.7	49.4	2.3	4%	25.0	25.0	0.0	0%	26.7	24.4	2.3	9%
CZ09	52.1	48.4	3.7	7%	22.8	22.7	0.1	0%	29.3	25.7	3.6	12%
CZ10	50.5	46.6	3.9	8%	21.5	21.5	0.0	0%	29.0	25.1	3.9	13%
CZ11	49.8	44.3	5.5	11%	20.1	20.1	0.0	0%	29.7	24.2	5.5	19%
CZ12	49.8	45.3	4.5	9%	18.9	18.9	0.0	0%	30.9	26.4	4.5	15%
CZ13	50.7	45.0	5.7	11%	20.5	20.5	0.0	0%	30.2	24.5	5.7	19%
CZ14	51.8	45.8	6.0	12%	20.8	20.7	0.1	0%	31.0	25.1	5.9	19%

	EDR Efficiency				EDR Flexibility				EDR Total			
	Standard	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**
CZ15	51.5	45.5	6.0	12%	26.0	26.0	0.0	0%	25.5	19.5	6.0	24%
CZ16	64.9	55.5	9.4	14%	17.9	17.9	0.0	0%	47.0	37.6	9.4	20%
Average	**54.2**	**49.3**	**4.9**	**9%**	**22.2**	**22.1**	**0.0**	**0%**	**32.0**	**27.2**	**4.9**	**15%**

Source: California Energy Commission

The data in Table A-1 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features and Standard Design PV; Split HP, Ducts in 2019 prescriptive attic, with maximum fan W/cfm. The VCHP was sized at full load. The split system was sized at 75% with backup resistance heat.

Table A-2. 2019 TDV Comparison with Standard Design Split Heat Pump

	Heating kTDV/ft²				Cooling kTDV/ft2				Total kTDV/ft2			
	Standard	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**
CZ01	45.7	27.7	18.0	39%	0.0	0.0	0.0		86.3	68.3	18.0	21%
CZ02	25.8	17.4	8.3	32%	2.8	1.8	1.0	35%	65.4	56.1	9.3	14%
CZ03	18.9	11.4	7.5	40%	0.0	0.0	0.0		58.4	50.8	7.5	13%
CZ04	20.7	13.4	7.3	35%	4.9	3.1	1.8	37%	61.6	52.5	9.1	15%
CZ05	17.9	10.8	7.1	40%	0.0	0.0	0.0		58.7	51.6	7.1	12%
CZ06	8.7	5.8	2.9	33%	3.8	2.3	1.5	40%	45.7	41.3	4.4	10%
CZ07	3.1	2.1	1.0	32%	0.7	0.4	0.3	42%	38.6	37.3	1.3	3%
CZ08	4.6	3.4	1.2	26%	12.0	9.4	2.7	22%	44.9	41.0	3.9	9%
CZ09	6.9	5.1	1.9	27%	23.4	18.2	5.2	22%	56.4	49.3	7.1	13%
CZ10	8.5	6.1	2.4	28%	24.1	18.7	5.4	22%	58.9	51.1	7.8	13%
CZ11	23.9	16.8	7.1	30%	38.8	30.8	8.0	21%	81.8	66.7	15.1	18%
CZ12	22.8	16.4	6.3	28%	21.2	16.7	4.5	21%	74.2	63.4	10.8	15%
CZ13	20.8	15.0	5.8	28%	41.7	32.0	9.7	23%	81.5	66.1	15.5	19%
CZ14	23.7	16.5	7.2	30%	36.0	27.9	8.1	22%	79.1	63.9	15.2	19%
CZ15	1.9	1.5	0.5	25%	87.9	70.1	17.8	20%	77.6	59.3	18.3	24%
CZ16	61.8	41.2	20.6	33%	4.5	3.1	1.4	31%	109.2	87.3	21.9	20%
Average	**19.7**	**13.2**	**6.6**	**32%**	**18.9**	**14.7**	**4.2**	**28%**	**67.4**	**56.6**	**10.8**	**15%**

Source: California Energy Commission

The data in Table A-2 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features, Split HP, Ducts in 2019 prescriptive attic, with maximum fan W/cfm. The VCHP was sized at full load. The split system was sized at 75% with backup resistance heat.

Table A-3. Energy Use Comparison with Standard Design Split Heat Pump

	Heating kWh				Cooling kWh			
	Standard	**VCHP**	**Diff**	**% Diff**	**Standard**	**VCHP**	**Diff**	**% Diff**
CZ01	4532	2730	1802	40%	0	0	0	
CZ02	2750	1860	890	32%	23	16	8	34%
CZ03	1942	1164	779	40%	0	0	0	
CZ04	2212	1430	782	35%	39	25	14	35%
CZ05	1881	1128	752	40%	0	0	0	
CZ06	957	639	318	33%	49	30	19	39%
CZ07	331	226	105	32%	6	3	3	43%
CZ08	511	378	133	26%	307	268	39	13%
CZ09	777	570	206	27%	594	494	100	17%
CZ10	949	686	263	28%	764	617	147	19%
CZ11	2559	1799	760	30%	1615	1287	329	20%
CZ12	2433	1757	676	28%	412	341	70	17%
CZ13	2206	1589	617	28%	1793	1423	370	21%
CZ14	2622	1828	793	30%	1579	1243	336	21%
CZ15	214	161	53	25%	5376	4340	1036	19%
CZ16	5582	3692	1890	34%	215	151	65	30%
Average	**2029**	**1352**	**676**	**32%**	**798**	**640**	**158**	**25%**

Source: California Energy Commission

The data in Table A-3 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features, Split HP, Ducts in 2019 prescriptive attic, with maximum fan W/cfm. The VCHP was sized at full load. The split system was sized at 75% with backup resistance heat.

Table A-4. 2019 EDR Compliance Comparison with Split Heat Pump and Ducts in Conditioned Space

	EDR Efficiency				EDR Flexibility				EDR Total			
	VLLDCS	**VCHP**	**Diff**	**% Diff**	**VLLDCS**	**VCHP**	**Diff**	**% Diff**	**VLLDCS**	**VCHP**	**Diff**	**% Diff**
CZ01	60.7	57.2	3.5	6%	21.3	21.3	0.0	0%	39.4	35.9	3.5	9%
CZ02	50.8	48.6	2.2	4%	20.4	20.5	-0.1	0%	30.4	28.1	2.3	8%
CZ03	52.5	51.2	1.3	2%	22.4	22.3	0.1	0%	30.1	28.9	1.2	4%
CZ04	51.2	48.5	2.7	5%	21.2	21.2	0.0	0%	30.0	27.3	2.7	9%
CZ05	51.4	50.0	1.4	3%	21.6	21.7	-0.1	0%	29.8	28.3	1.5	5%
CZ06	54.3	53.1	1.2	2%	25.9	25.9	0.0	0%	28.4	27.2	1.2	4%
CZ07	55.2	54.9	0.3	1%	28.0	28.0	0.0	0%	27.2	26.9	0.3	1%
CZ08	50.6	49.4	1.2	2%	25.0	25.0	0.0	0%	25.6	24.4	1.2	5%
CZ09	50.5	48.4	2.1	4%	22.8	22.7	0.1	0%	27.7	25.7	2.0	7%
CZ10	48.6	46.6	2.0	4%	21.5	21.5	0.0	0%	27.1	25.1	2.0	7%
CZ11	47.7	44.3	3.4	7%	20.0	20.1	-0.1	-1%	27.7	24.2	3.5	13%
CZ12	48.0	45.3	2.7	6%	18.9	18.9	0.0	0%	29.1	26.4	2.7	9%
CZ13	48.4	45.0	3.4	7%	20.5	20.5	0.0	0%	27.9	24.5	3.4	12%
CZ14	49.4	45.8	3.6	7%	20.8	20.7	0.1	0%	28.6	25.1	3.5	12%
CZ15	49.5	45.5	4.0	8%	26.0	26.0	0.0	0%	23.5	19.5	4.0	17%
CZ16	61.0	55.5	5.5	9%	17.9	17.9	0.0	0%	43.1	37.6	5.5	13%
Average	**51.9**	**49.3**	**2.6**	**5%**	**22.1**	**22.1**	**0.00**	**0%**	**29.7**	**27.2**	**2.5**	**8%**

Source: California Energy Commission

The data in Table A-4 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features and Standard Design PV, a split system HP with verified low leakage ducts in conditioned space, and maximum fan W/cfm. The VCHP system was sized at full load. The split system was sized at 75 percent with backup resistance heat.

Table A-5. TDV Comparison with Standard Design Split Heat Pump & Ducts in Conditioned Space

	Heating kTDV/ft2				Cooling kTDV/ft2				Total kTDV/ft2			
	VLLDCS	**VCHP**	**Diff**	**% Diff**	**VLLDCS**	**VCHP**	**Diff**	**% Diff**	**VLLDCS**	**VCHP**	**Diff**	**% Diff**
CZ01	34.4	27.7	6.7	19%	0.0	0.0	0.0		75.0	68.3	6.6	9%
CZ02	21.7	17.4	4.3	20%	2.1	1.8	0.3	14%	60.7	56.1	4.5	7%
CZ03	13.7	11.4	2.3	17%	0.0	0.0	0.0		53.1	50.8	2.3	4%
CZ04	17.5	13.4	4.2	24%	3.9	3.1	0.9	22%	57.5	52.5	5.0	9%
CZ05	13.4	10.8	2.6	19%	0.0	0.0	0.0		54.1	51.6	2.6	5%
CZ06	7.1	5.8	1.3	18%	2.9	2.3	0.6	20%	43.1	41.3	1.8	4%
CZ07	2.4	2.1	0.4	14%	0.5	0.4	0.1	21%	37.7	37.3	0.5	1%
CZ08	4.1	3.4	0.7	17%	10.7	9.4	1.3	12%	43.0	41.0	2.0	5%
CZ09	6.2	5.1	1.1	18%	21.0	18.2	2.9	14%	53.3	49.3	4.0	7%
CZ10	7.6	6.1	1.4	19%	21.3	18.7	2.6	12%	55.2	51.1	4.1	7%
CZ11	21.4	16.8	4.6	21%	35.8	30.8	5.0	14%	76.2	66.7	9.5	12%
CZ12	20.4	16.4	3.9	19%	19.3	16.7	2.6	13%	69.8	63.4	6.5	9%
CZ13	18.8	15.0	3.8	20%	37.5	32.0	5.5	15%	75.3	66.1	9.3	12%
CZ14	21.0	16.5	4.5	21%	32.5	27.9	4.6	14%	72.9	63.9	9.0	12%
CZ15	1.8	1.5	0.3	18%	82.0	70.1	11.9	14%	71.4	59.3	12.1	17%
CZ16	53.2	41.2	12.0	23%	3.9	3.1	0.8	21%	100.1	87.3	12.8	13%
Average	**16.5**	**13.2**	**3.4**	**19%**	**17.1**	**14.7**	**2.4**	**16%**	**62.4**	**56.6**	**5.8**	**8%**

Source: California Energy Commission

The data in Table A-5 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features, a split system HP with verified low leakage ducts in conditioned space, and maximum fan W/cfm. The VCHP was sized at full load. The split system was sized at 75 percent with backup resistance heat.

Table A-6. Energy Use Comparison with Standard Design Split Heat Pump and Ducts in Conditioned Space

	Heating kWh				Cooling kWh			
	VLLDCS	**VCHP**	**Diff**	**% Diff**	**VLLDCS**	**VCHP**	**Diff**	**% Diff**
CZ01	3390	2730	660	19%	0	0	0	
CZ02	2315	1860	454	20%	18	16	3	14%
CZ03	1398	1164	235	17%	0	0	0	
CZ04	1875	1430	444	24%	32	25	7	21%
CZ05	1397	1128	268	19%	0	0	0	
CZ06	777	639	138	18%	38	30	8	20%
CZ07	264	226	38	14%	4	3	1	21%
CZ08	455	378	77	17%	289	268	21	7%
CZ09	698	570	127	18%	553	494	59	11%
CZ10	845	686	159	19%	699	617	82	12%
CZ11	2286	1799	488	21%	1490	1287	203	14%
CZ12	2176	1757	419	19%	380	341	39	10%
CZ13	1996	1589	408	20%	1650	1423	226	14%
CZ14	2325	1828	497	21%	1441	1243	198	14%
CZ15	196	161	36	18%	5065	4340	725	14%
CZ16	4794	3692	1102	23%	191	151	40	21%
Average	**1699**	**1352**	**347**	**19%**	**741**	**640**	**101**	**15%**

Source: California Energy Commission

The data in Table A-6 was calculated for a 2700 ft^2 prototype with 2019 prescriptive features, a split system HP with verified low leakage ducts in conditioned space, and maximum fan W/cfm. The VCHP was sized at full load. The split system was sized at 75 percent with backup resistance heat.

APPENDIX B:
Eligibility Verification Protocols

The procedures in this appendix shall be used in conjunction with applicable verification protocols published in the 2019 Residential Appendices to determine whether a VCHP system meets the eligibility requirements for the VCHP performance compliance option described in this report. Section SC3.4.4.3 below organizes and references all of the verification procedures required to demonstrate compliance with the eligibility requirements for a system. A Certificate of Installation and Certificate of Verification shall be registered with a California Title 24 Data Registry to document compliance with all verification procedures specified in SC3.4.4.3.

Two of the procedures in this appendix shall be applicable both for systems that use the VCHP compliance option described in this report, and also for systems that do not use the VCHP compliance option described in this report. The two procedures are:

- SC3.1.4.2.2 Nominal Air Handler Airflow
- SC3.3.3.4.1 Airflow Calculation (cfm/ton)

SC3.1.4.2.2 and SC3.3.3.4.1 shall be used in conjunction with current RA3 procedures to enable verification of system airflow rate and duct leakage for ducted multiple-split systems.

The procedures in this appendix shall be published on the residential special case compliance webpage at the following URL:

Link to special case compliance webpage

The procedures in this appendix are expected to be incorporated into the Residential Appendices during the next update to the CA Energy Code.

SC3.4.4.3 Variable Capacity Heat Pump Performance Compliance Option Eligibility Verification

When a performance certificate of compliance indicates a space conditioning system requires verification of the variable capacity heat pump (VCHP) compliance option eligibility requirements, the installed VCHP system shall be field verified to confirm compliance with the eligibility requirements as specified in this section.

If field verification determines the VCHP does not comply with all eligibility requirements in this section, then the dwelling in which the VCHP is installed shall not be eligible to claim the VCHP performance compliance credit for that space conditioning system.

Compliance with Section 150.0(m)11 (Duct System Sealing and Leakage Testing) is not required for systems that use this VCHP performance compliance option, however there are requirements to verify that VCHP system indoor unit ducts are located entirely in conditioned space that are specified as eligibility requirements for this compliance option.

Compliance with Section 150.0(m)13 is not required for systems that use this VCHP performance compliance option, however there are requirements for verification of minimum

airflow rates for VCHP system indoor units that are specified as eligibility requirements for this compliance option.

(a) **Low-static system certification for ducted systems**. The manufacturer of ducted indoor units shall certify to the Energy Commission that the system is a VCHP that meets the definition of a low-static system as defined in 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017). The manufacturer's model number(s) shall be included in listings of certified-to-the-Energy Commission low-static pressure VCHP systems which will be published on the Energy Commission's website

If the installed VCHP system has ducted indoor units, then verification of the Energy Commission listings of certified VCHP systems shall confirm the installed system is included in the Energy Commission listings of certified low static systems.

If the VCHP model is not included in the Energy Commission listings of certified low static systems, then the system does not comply with the VCHP compliance option eligibility requirements.

(b) **Non-continuous default fan operation certification for ducted systems**. The manufacturer may elect to certify to the Energy Commission that their ducted indoor unit + outdoor unit combination does not operate the indoor unit fan continuously by default. This certification is required in order to receive credit for the non-continuous fan operation component of the VCHP compliance option credit.

If the installed VCHP system has ducted indoor units, and the certificate of compliance indicates credit has been taken for non-continuous default fan operation, then visual inspection of the Energy Commission listings of certified VCHP systems shall confirm the installed system is included in the Energy Commission listings and the certification indicates the system is a type with indoor units that do not run the fan continuously during periods when there is no call for conditioning.

If the model is not included in the Energy Commission listings of certified low static systems as a type with indoor units that do not run the fan continuously during periods when there is no call for conditioning, then the system does not comply with the VCHP compliance option eligibility requirements.

A revised certificate of compliance may be submitted to the enforcement agency that does not specify credit for non-continuous default fan operation.

(c) **Refrigerant charge verification.** The installed system shall have refrigerant charge verified in accordance with applicable procedures in RA3.2, as specified in Standards Sections 150.1(c)7A and 150.2(b)1Fii, or 150.2(b)1Fiii.

If the system does not meet the refrigerant charge verification requirements, then the system does not comply with the VCHP compliance option eligibility requirements.

(d) **Low leakage ducts located entirely in conditioned space verification**. Ducted indoor units shall be verified in accordance with the Verified Low Leakage Ducts in Conditioned Space procedure in Section RA3.1.4.3.8.

If the system does not meet the RA3.1.4.3.8 requirements, then the system does not comply with the VCHP compliance option eligibility requirements.

(e) **Ductless space conditioning system indoor units located entirely in conditioned space verification**. Ductless systems shall be verified in accordance with the ductless space conditioning system indoor units located entirely in conditioned space procedure in SC3.1.4.1.8 to visually confirm ductless indoor units are located entirely in conditioned space.

If the system is not considered to be entirely in conditioned space according to SC3.1.4.1.8 requirements, then the system does not comply with the VCHP compliance option eligibility requirements.

(f) **Space-Conditioning System Airflow Supply to All Habitable Spaces**. Field verification according to the procedure in SC3.1.4.1.7 shall confirm that airflow is supplied to all habitable spaces in a dwelling that specifies use of the VCHP compliance option.

If space conditioning system airflow is not supplied to all habitable spaces in the dwelling as determined by the procedure in SC3.1.4.1.7, then the system does not comply with the VCHP compliance option eligibility requirements.

(g) **Wall mounted thermostat in zones > 150 ft^2**. Field verification according to the procedure in SC3.4.5 shall confirm that VCHP space conditioning zones in the dwelling that are greater than 150 ft^2, are controlled by a permanently installed wall-mounted thermostat.

If a zone area served by an indoor unit is greater than 150 ft^2, and the indoor unit is not controlled by a permanently installed wall-mounted thermostat located in the zone served by the indoor unit as determined according to the procedure in SC3.4.5, then the system does not comply with the VCHP compliance option eligibility requirements.

(h) **Non-continuous fan operation - field verification**. If non-continuous indoor unit fan operation is specified for improved compliance credit for ducted VCHP systems in the CBECC-Res model, and thus the certificate of compliance indicates field verification of non-continuous indoor unit fan operation is required, then the system shall be field verified in accordance with the procedures in SC3.4.6 to confirm that the installed system's indoor unit + outdoor unit combination does not operate the fan continuously when the system thermostat is not calling for conditioning.

If field verification according to SC3.4.6 determines the installed system's indoor unit + outdoor unit combination operates the fan continuously when the system thermostat is not calling for conditioning, then the system does not comply with the VCHP compliance option eligibility requirements.

A revised certificate of compliance may be submitted to the enforcement agency that does not specify credit for non-continuous default fan operation.

(i) **Minimum airflow rate verification**. Each new ducted indoor unit shall have airflow verified in accordance with the procedures in RA3.3 to confirm the airflow at full capacity in cooling mode is equal to or greater than 350 cfm/ton of nominal cooling

capacity. 300 cfm/ton shall be verified for altered systems if required for compliance with the refrigerant charge verification procedure.

For indoor units of single-split systems, the measured value for airflow in cfm shall be converted into cfm per ton by dividing the measured indoor unit airflow rate by the nominal tons of outdoor unit cooling capacity

For indoor units of multiple-split systems, the measured value for airflow in cfm shall be converted into cfm per ton by dividing the measured indoor unit airflow rate by the nominal tons of indoor unit cooling capacity

If the indoor unit does not meet or exceed the 350 cfm/ton minimum airflow rate required for new systems, or the 300 cfm/ton required for altered systems meeting the refrigerant charge minimum airflow rate, then the system does not comply with the VCHP compliance option eligibility requirements.

(j) **Air filter sizing**. Ducted low-static VCHP indoor units with any length of duct shall have the air filters for the return air inlets verified to confirm the air filter sizing conforms to the procedures in i or ii below as applicable.

i. Nominal 2-inch or greater depth air filters shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch wc at the air filter's design airflow rate. Field verification of the system designers sizing methodology shall not be required for nominal 2-inch or greater depth air filters, however verification that the installed 2-inch or greater depth air filter is rated to meet a clean filter pressure drop of less than or equal to 0.1 inch wc at the air filter's design airflow rate shall conform to the procedures in SC3.1.4.8.

If any of the indoor unit's applicable nominal 2-inch or greater depth air filters fails to meet the maximum 0.1 inch wc. clean filter pressure drop requirement as verified according to the procedure in SC3.1.4.8, then the system does not comply with the VCHP compliance option eligibility requirements.

ii. Nominal one-inch minimum depth air filters shall be allowed if the filter face area is sized based on a maximum face velocity of 150 ft. per minute at the air filter design airflow rate according to the procedures in SC3.1.4.7.

All of the indoor unit air filters that are required to be sized and verified according to a face velocity specification shall comply, otherwise the indoor unit does not comply. If any of the indoor unit's applicable nominal 1-inch depth air filters has a face area less than the required face area determined according to the procedures in SC3.1.4.7, then the system does not comply with the VCHP compliance option eligibility requirements.

(k) **Air filter maximum pressure drop**. Ducted low-static VCHP indoor units with any length of duct shall have the air filters for the return air inlets verified according to the procedures in SC3.1.4.8 to confirm the air filter is rated to provide a clean filter pressure drop less than or equal to 0.1 inch wc., at an airflow rate greater than or equal to the air filter's design airflow rate.

If verification of the indoor unit's air filters according to the procedures in SC3.1.4.8 determines that one or more of the air filters does not provide clean filter pressure drop less

than or equal to 0.1 inch wc., at an airflow rate greater than or equal to the air filter's design airflow rate, then the system does not comply with the VCHP compliance option eligibility requirements.

SC3.1.4.1.7 Verification of Space-Conditioning System Airflow Supply to All Habitable Spaces

A visual inspection shall confirm that all habitable spaces in the dwelling unit receive space-conditioning system airflow either by use of a ductless space-conditioning system indoor unit located on the wall, ceiling, or floor of the habitable space, or by use of space-conditioning system air supply registers located in the habitable space that use ductwork connected from the register directly to the supply air outlet of a ducted space-conditioning system air handling unit. Refer to Standards Section 100.1 for the definition of habitable space. Transfer fans that move air from one space in the dwelling to a different space in the dwelling, but do not heat or cool the air transferred, do not meet the requirement for providing space-conditioning system airflow.

SC3.1.4.1.8 Verification of Ductless Space-Conditioning System Indoor Units Located Entirely in Conditioned Space

A visual inspection shall confirm that ductless indoor units are located entirely in conditioned space in accordance with the following requirements:

(a) Ductless indoor unit types that mount entirely on the interior surface of dwelling unit walls, ceilings, or floors shall be considered to be entirely in conditioned space. Penetrations in the wall, ceiling or floor surface necessary for the indoor unit refrigerant piping, condensate drain, or electrical connections shall be allowed, provided the penetrations are well sealed.

(b) Ductless indoor units that penetrate the interior surface of dwelling unit walls, ceilings, or floors, and protrude through cut-out openings in the dwelling unit walls, ceilings, or floors shall be inspected to determine whether the indoor unit is installed inside both the thermal boundary and the air barrier of the dwelling as follows:

i. If the ductless indoor unit protrudes through the air barrier into unconditioned spaces such as attics, crawl spaces, garages, or outdoors, the indoor unit shall not be considered to be located entirely in conditioned space.

ii. If the indoor unit protrudes into indirectly conditioned spaces such as drop ceilings, or floor assemblies in a single family or multifamily multi-story building, that are wholly inside both the thermal boundary and the air barrier of the dwelling, then the unit shall be considered to be located entirely in conditioned space. Verification at an early stage of building construction may be necessary in order for this visual verification to be possible.

If field verification according to SC3.1.4.1.8 determines the installed system's ductless indoor units are not located entirely in conditioned space, then the system does not comply with the VCHP compliance option eligibility requirements.

SC3.1.4.2.2 Nominal Air Handler Airflow

- For heating-only systems the nominal air handler airflow shall be 21.7 CFM per kBtu/hr of rated heating output capacity.
- For cooling systems that are packaged systems, or split systems with only one indoor unit, the nominal air handler airflow shall be 350 CFM per nominal ton of outdoor condensing unit cooling capacity, otherwise the heating-only value, whichever is greater.
- For small duct high velocity systems, the nominal air handler airflow shall be 250 CFM per nominal ton of outdoor condensing unit cooling capacity.
- For multiple-split systems that provide cooling, the nominal air handler airflow for each indoor unit shall be 350 CFM per nominal ton of indoor unit cooling capacity.

SC3.1.4.7 Verification of Air Filter Sizing According to Face Velocity Specification

When compliance requires verification that a ducted system's indoor unit air filters have been sized in accordance with a maximum face velocity specification, the following procedure shall be used.

(a) **Indoor unit design airflow rate**. Record the design airflow rate for the indoor unit in CFM as specified by the system designer. The design airflow rate shall be equal to or greater than the minimum airflow rate required for compliance with the standards. Alternatively, if the design airflow rate for the indoor unit is not available, calculate and record the nominal air handler airflow rate for the indoor unit in accordance with the specifications in SC3.1.4.2.2.

(b) **Air filter design airflow rate**. For indoor units with only one filtered return air inlet, the air filter design airflow rate in CFM is equal to the indoor unit design airflow rate determined in step (a). For indoor units with more than one filtered return air inlet, the system designer shall determine what portion of the total indoor unit airflow is equal to the air filter design airflow for each air filter, ensuring that the sum total of all individual air filter design airflow rates is equal to the total indoor unit design airflow rate determined in step (a).

(c) **Air filter grille/rack sticker**. Standards Section 150.0(m)12Biv requires that air filter installation locations shall have the air filter design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate posted on a label/sticker, inside or near the location of the filter grille/rack such that this information will be visible to a person replacing the air filter.

Field inspection shall verify that each air filter installation location has the required sticker. If the air filter installation location does not have the required sticker, the indoor unit does not comply.

(d) **Air filter maximum face velocity allowed**. Record the maximum allowable face velocity value in ft/min required for compliance for each air filter.

(e) **Minimum air filter face area allowed**. For each air filter, divide the air filter design airflow rate in ft^3/min by the maximum allowable face velocity in ft/min. The result is

the minimum allowable total air filter face area in ft^2 for the air filter. Convert the calculated face area from square feet to square inches by multiplying the face area in square feet by 144.

Note: the air filter face area is the nominal area of the side of the air filter that is perpendicular to the direction of the airflow through the air filter.

(f) **Installed air filter nominal dimensions**. Measure and record the installed nominal length dimension in inches and nominal width dimension in inches for the side of the filter that is perpendicular to the direction of the airflow through the air filter installed in the return air grille/rack of the indoor unit. If there is more than one filtered return air inlet for the indoor unit, measure and record the length dimension and width dimension of each of the air filters.

(g) **Installed air filter face area**. For each of the filtered return air inlets for the indoor unit, multiply the nominal air filter length dimension by the nominal air filter width dimension to calculate the nominal air filter face area in square inches.

(h) **Determining compliance.** For each of the filtered return air inlets for the indoor unit, if the installed air filter face area is greater than or equal to the minimum air filter face area allowed as determined in step (e), then the air filter complies. All of the indoor unit air filters that are required be sized and verified according to a face velocity specification shall comply, otherwise the indoor unit does not comply.

SC3.1.4.8 Verification of Air Filter Pressure Drop Rating

When compliance requires field verification to confirm that a ducted system's indoor unit air filter(s) comply with a minimum clean filter pressure drop requirement, the following steps shall be followed. When there is more than one filtered return air inlet for the indoor unit, all of the indoor unit's air filter devices shall be field verified.

(a) **Indoor unit design airflow rate**. Record the design airflow rate for the indoor unit in CFM as specified by the system designer. The design airflow rate shall be equal to or greater than the minimum airflow rate required for compliance with the standards. Alternatively, if the design airflow rate for the indoor unit is not available, calculate and record the nominal air handler airflow rate for the indoor unit in accordance with the specifications in SC3.1.4.2.2.

(b) **Air filter design airflow rate**. For indoor units with only one filtered return air inlet, the air filter design airflow rate in CFM is equal to the indoor unit design airflow rate determined in step (a). For indoor units with more than one filtered return air inlet, the system designer shall determine what portion of the total indoor unit airflow is equal to the air filter design airflow for each air filter, ensuring that the sum total of all individual air filter design airflow rates is equal to the total indoor unit design airflow rate determined in step (a).

(c) **Air filter grille/rack sticker**. Standards Section 150.0(m)12Biv requires that air filter installation locations shall have the air filter design airflow rate, and maximum allowable clean-filter pressure drop at the design airflow rate posted on a label/sticker, inside or

near the location of the filter grille/rack such that this information will be visible to a person replacing the air filter.

Field inspection shall verify that each air filter installation location has the required sticker. If the air filter installation location does not have the required sticker, the indoor unit does not comply.

(d) **Air filter manufacturer's performance rating label**. Standards section 150.0(m)12E requires that the air filter placed in the filter grille/rack shall be labeled by the air filter manufacturer to disclose the clean filter pressure drop performance determined according to ASHRAE Standard 52.2 or AHRI Standard 680. The required air filter label information includes clean filter pressure drop ratings at a range of airflow rates.

Field inspection shall verify that the air filter installed in the filter grille/rack has the required performance rating label. If an installed air filter does not have the required manufacturer's performance rating label, then the indoor unit does not comply.

(e) **Determining clean filter pressure drop compliance**. Inspection of the air filter manufacturer's performance rating label shall verify that the air filter is rated to provide a clean filter pressure drop less than or equal to the value required for compliance, at an airflow rate greater than or equal to the design airflow for the filter. Interpolation of the manufacturer's airflow and pressure drop rating values published on the air filter performance rating label is allowed when determining compliance. Field diagnostic pressure measurements of operating indoor units to determine the pressure drop of installed air filters are not required for demonstrating compliance.

If all of the indoor unit air filters are rated to operate at a pressure drop less than or equal to the value required for compliance, and at an airflow rate greater than or equal to the design airflow for the air filter, then the indoor unit complies.

SC3.3.3.4.1 Airflow Calculation (cfm/ton)

For packaged systems, and for split systems with only one indoor unit, the measured value for airflow (cfm) shall be converted to cfm per ton by dividing the measured system airflow rate by the nominal tons of outdoor condensing unit cooling capacity.

For indoor units of multiple-split systems, the measured value for airflow in cfm shall be converted into cfm per ton by dividing the measured indoor unit airflow rate by the nominal tons of indoor unit cooling coil capacity.

SC3.4.5 Verification of Wall-Mounted Thermostat

When compliance requires verification that a wall-mounted, thermostat has been installed to control a space conditioning system's indoor unit operation, the system's indoor unit thermostat(s) shall be verified according to the following procedures. If a system has more than one indoor unit, then all of the system's indoor unit thermostats shall be verified according to this procedure.

(a) If the conditioned floor area (ft^2) of the zone served by an indoor unit is not a criterion for determining the compliance requirement for wall-mounted thermostats, then skip to subsection (b) below.

Otherwise, if the conditioned floor area (ft^2) of the zone served by an indoor unit is a criterion for determining the compliance requirements for wall-mounted thermostats in the zone, then record the conditioned floor area served by the indoor unit.

i. If the zone area size (ft^2) criterion indicates that a wall-mounted thermostat is not required for the zone, then the indoor unit complies and no further thermostat verification is required for the zone served by the indoor unit.

ii. If the zone area size (ft^2) criterion indicates that a wall-mounted thermostat is required for the zone, then perform the remaining steps that follow.

(b) If possible, locate the wall-mounted thermostat that controls the indoor unit, and verify whether or not the thermostat controls the indoor unit by setting the thermostat to a cooling setpoint that is less than the room temperature, or alternatively by setting the thermostat to a heating setpoint that is greater than the room temperature.

If there is no wall-mounted thermostat installed in the zone that controls the indoor unit, then the indoor unit does not comply.

If there is a wall-mounted thermostat installed that controls the indoor unit, but it is not located within the zone served by the indoor unit, then the indoor unit does not comply.

(c) For a wall-mounted thermostat installed in the zone that controls the indoor unit located in step (b), by visual inspection determine if the thermostat is mounted permanently to the wall. Wall-mounted brackets or other means that facilitate non-permanent attachment of handheld thermostats to the wall do not meet this requirement.

If the thermostat is not permanently mounted to the wall, then the indoor unit does not comply.

SC3.4.6 Verification of Non-Continuous Indoor Unit Fan Operation

When compliance requires field verification that an installed space conditioning system indoor unit does not operate the air distribution fan during periods when the space does not require heating or cooling, the system's indoor unit operation shall be field verified according to the following procedures. If a system has more than one indoor unit, then all of the system's applicable indoor units shall be verified according to this procedure.

(a) If possible, locate the manufacturer's indoor unit + outdoor unit combination in the Energy Commission listing of systems that have been certified by the manufacturer as systems that do not operate the air distribution fan during periods when the space does not require heating or cooling.

https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment

Record the result of the search for the system model(s). If the manufacturer's indoor unit + outdoor unit combination is not included in the CEC listing, then the indoor unit does not comply.

(b) Switch the system to heating mode.

(c) Switch on the heating system by setting the thermostat to a setpoint that is greater than the room temperature.

(d) Verify the thermostat activates the indoor unit airflow.

(e) Switch off the heating system by setting the thermostat to a setpoint that is less than the room temperature.

(f) Verify the indoor unit air circulation fan does not operate when the compressor is off, except for a fan overrun (fan off delay) of less than 10 minutes that may occur at the end of the compressor on cycle.

(g) Switch the system to cooling mode.

(h) Switch on the cooling system by setting the thermostat to a setpoint that is less than the room temperature.

(i) Verify the thermostat activates the indoor unit airflow.

(j) Switch off the cooling system by setting the thermostat to a setpoint that is greater than the room temperature.

(k) Verify the indoor unit air circulation fan does not operate the indoor fan when the compressor is off, except for a fan overrun (fan off delay) of less than 10 minutes that may occur at the end of the compressor on cycle.

If the system does not operate the indoor unit air distribution fan(s) during periods when the spaces served by the system do not require heating or cooling to meet the thermostat setpoint, then the system complies.

APPENDIX C:
Compliance Documents for Installation and Field Verification

When the performance compliance software user inputs specify use of the VCHP compliance option described in this report for one or more systems in the dwelling, the completed certificate of compliance that is generated by the performance compliance software shall require the project to include a registered certificate of installation and a registered certificate of verification for each VCHP system in the dwelling that used the VCHP credit.

Copies of the certificate of installation (CF2R-MCH-33), and certificate of verification (CF3R-MCH-33) compliance documents that will be required follow below. The blank forms shown below are provided for information only. Installers and HERS Raters shall login to one of the Title 24 Data Registries to input the data to complete and register these documents along with the other compliance documents required for the project.

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF2R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 1 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. VCHP System Information

Procedures for verification of VCHP compliance credit eligibility are described on the residential special case compliance webpage at the following URL: https://ww2.energy.ca.gov/title24/2008standards/special_case_appliance/. Each VCHP system requiring verification shall use a separate compliance document.

01	SC System ID/Name from CF1R	
02	SC System Description of Area Served	
03	Conditioned Floor Area Served by the System (ft²)	
04	Status: Refrigerant charge verification from MCH-25	
05	Verification: Is conditioned airflow supplied to all habitable rooms in accordance with the procedure in SC3.1.4.1.7?	

Notes:

B. VCHP Indoor Unit Information

Ducted indoor units are required to be certified to the Energy Commission as low static systems, and included in the list of certified indoor units published on the Energy Commission website at the following URL: https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment.

01	02	03	04	05	06	07	08	09
Indoor Unit Name or Description of Area Served	Installed Indoor Unit Type	Indoor Unit Duct Status	Conditioned Floor Area Served By The Indoor Unit (ft²)	Number of Air Filter Devices on Indoor Unit	Indoor Unit Required Minimum System Airflow Rate (cfm)	Status: Airflow Rate Verification from MCH-23	Is Field Verification of Default Non-Continuous Fan Operation Required?	Verification: Is Ducted Low Static Indoor Unit Certified to CEC?

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

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STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF2R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 2 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

C. Verification: Ducted Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.3.8

Ducted indoor units shall be verified in accordance with the Verified Low Leakage Ducts in Conditioned Space procedure in Section RA3.1.4.3.8.

01	02	03	04
Indoor Unit Name or Description of Area Served	A Visual Inspection Shall Confirm the Space Conditioning Distribution System Location	Measured Duct Leakage to Outside (cfm) Using RA3.1.4.3.4	Compliance Statement:

Notes:

D. Verification: Ductless Indoor Units Located Entirely in Directly Conditioned Space - SC3.1.4.1.8

A visual inspection shall confirm that ductless indoor units are located entirely in conditioned space in accordance with the procedures of SC3.1.4.1.8.

01	02	03
Indoor Unit Name or Description of Area Served	Indoor Unit Installation Location Verification	Compliance Statement:

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

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STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF2R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 3 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

E. Verification: Wall Mounted Thermostats - SC3.4.5

Field verification according to the procedure in SC3.4.5 shall confirm that VCHP space conditioning zones that are greater than 150 ft², are controlled by a permanently installed wall-mounted thermostat.

01	02	03	04	05
Indoor Unit Name or Description of Area Served	Is a Wall-mounted Thermostat Installed in the Zone Served by the Indoor Unit?	Does the Thermostat Control the Zone's Indoor Unit?	Is the Thermostat Mounted Permanently to the Wall?	Compliance Statement:

Notes:

F. Verification: Non-Continuous Fan Operation - SC3.4.6

If the certificate of compliance indicates non-continuous indoor unit fan operation was specified for compliance credit, then the system shall be field verified in accordance with the procedures in SC3.4.6 to confirm that the installed system's indoor unit + outdoor unit combination does not operate the fan continuously when the system thermostat is not calling for conditioning.

01	02	03	04	05
Indoor Unit Name or Description of Area Served	Is Non-Continuous Default Fan Operation Shown in CEC Certification Listings?	Does Indoor Unit Air Distribution Fan Operate When There Is No Call For Heating?	Does Indoor Unit Air Distribution Fan Operate When There Is No Call For Cooling?	Compliance Statement:

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF2R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 4 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

G. Verification: Installed Air Filter Sizing and Pressure Drop - SC3.1.4.7 and SC3.1.4.8

Nominal 2-inch or greater depth air filters shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch w.c at the air filter's design airflow rate as verified according to the procedures in SC3.1.4.8. Nominal one-inch minimum depth air filters shall be allowed if the filter face area is sized based on a maximum face velocity of 150 ft per minute at the air filter design airflow rate according to the procedures in SC3.1.4.7. In order to inform the occupant of the airflow and clean filter pressure drop performance required for replacement air filters, the installer shall place a sticker in or near the filter grille displaying the air filter design airflow rate and the maximum allowed clean filter pressure drop at the design airflow rate as required by Standards Section 150.0(m)12Biv.

01	02	03	04	05	06	07	08	09	10	11	12
Indoor Unit Name or Description of Area Served	Air Filter Name or Description of Location	Air Filter Device Type	Design Airflow Rate for Air Filter Device (cfm)	Air Filter Nominal Depth (inch)	Air Filter Nominal Length (inch)	Air Filter Nominal Width (inch)	Air Filter Calculated Nominal Face Area ($inch^2$)	Air Filter Required Minimum Face Area ($inch^2$)	Face Area Compliance	Air Filter Rated Pressure Drop at Design Airflow Rate (inch W.C.)	Air Filter Pressure Drop Compliance

Notes:

H. VCHP System Compliance Statement

01	

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF2R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		CF2R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 5 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT	
1. I certify that this Certificate of Installation documentation is accurate and complete.	
Documentation Author Name:	Documentation Author Signature:
Documentation Author Company Name:	Date Signed:
Address:	CEA/HERS Certification Identification (if applicable):
City/State/Zip:	Phone:

RESPONSIBLE PERSON'S DECLARATION STATEMENT

I certify the following under penalty of perjury, under the laws of the State of California:

1. The information provided on this Certificate of Installation is true and correct.
2. I am either: a) a responsible person eligible under Division 3 of the Business and Professions Code in the applicable classification to accept responsibility for the system design, construction, or installation of features, materials, components, or manufactured devices for the scope of work identified on this Certificate of Installation and attest to the declarations in this statement, or b) I am an authorized representative of the responsible person and attest to the declarations in this statement on the responsible person's behalf.
3. The constructed or installed features, materials, components or manufactured devices (the installation) identified on this Certificate of Installation conforms to all applicable codes and regulations and the installation conforms to the requirements given on the Certificate of Compliance, plans, and specifications approved by the enforcement agency.
4. I understand that a HERS rater will check the installation to verify compliance and if such checking determines the installation fails to comply, I am required to offer any necessary corrective action at no charge to the building owner.
5. I will ensure that a registered copy of this Certificate of Installation shall be posted, or made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a registered copy of this Certificate of Installation is required to be included with the documentation the builder provides to the building owner at occupancy.

Responsible Builder/Installer Name:	Responsible Builder/Installer Signature:	
Company Name: (Installing Subcontractor or General Contractor or Builder/Owner)	Position With Company (Title):	
Address:	CSLB License:	
City/State/Zip:	Phone:	Date Signed:
Third Party Quality Control Program (TPQCP) Status:	Name of TPQCP (if applicable):	

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

CF2R-MCH-33-H User Instructions

Section A. VCHP System Information

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. This field is filled out automatically. It is referenced from the CF2R-MCH-25 which must be completed prior to this document.
5. Perform the verification specified by RSC3.1.4.1.7 and select the value that describes the result of the verification.

Section B. VCHP Indoor Unit Information

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. Enter the conditioned floor area served by the indoor unit - a value in ft^2.
5. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
6. This field is filled out automatically. It is referenced from the CF2R-MCH-23 which must be completed prior to this document.
7. This field is filled out automatically. It is referenced from the CF2R-MCH-23 which must be completed prior to this document.
8. This field is filled out automatically. It is referenced from the Certificate of Compliance which must be completed prior to this document.
9. Navigate to the URL for the Manufacturer certification listings and determine whether the installed system is included in the CEC listing, then select the value that describes the result of the verification.

Section C. Verification: Ducted Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.3.8

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the statement that best describes the location of the ducted distribution system.
3. Enter the leakage to outside airflow determined from the RA3.1.4.3.8
4. This field is filled out automatically

Section D. Verification: Ductless Indoor Units Located Entirely in Directly Conditioned Space - SC3.1.4.1.8

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the statement that best describes the indoor unit installation location as determined according to SC3.1.4.1.8.
3. This field is filled out automatically

Section E. Verification: Wall Mounted Thermostats - SC3.4.5

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Answer yes or no to the question: Is a wall-mounted thermostat installed in the zone served by the indoor unit?
3. Answer yes or no to the question: Does the thermostat control the zone's indoor unit?
4. Answer yes or no to the question: Is the thermostat mounted permanently to the wall?
5. This field is filled out automatically

Section F. Verification: Non-Continuous Fan Operation SC3.4.6

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the best response to the question: Is non-continuous default fan operation shown in CEC certification listings?
3. Select the best response to the question: Does indoor unit air distribution fan operate when there is no call for heating?
4. Select the best response to the question: Does indoor unit air distribution fan operate when there is no call for cooling?
5. This field is filled out automatically

Section G. Verification: Installed Air Filter Sizing and Pressure Drop - SC3.1.4.7 and SC3.1.4.8

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. This field is filled out automatically. It is referenced from another section on this document, or from the CF2R-MCH-01 which must be completed prior to this document.
5. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
6. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
7. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
8. This field is filled out automatically by calculating the product of air filter length and air filter width.
9. This field is filled out automatically based on the depth of the filter.
10. This field is filled out automatically
11. Input the pressure drop at the design airflow rate from the performance data information published on the air filter label.
12. This field is filled out automatically

Section H. VCHP System Compliance Statement

1. This field is filled out automatically.

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF3R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 1 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. VCHP System Information

Procedures for verification of VCHP compliance credit eligibility are described on the residential special case compliance webpage at the following URL: https://ww2.energy.ca.gov/title24/2008standards/special_case_appliance/. Each VCHP system requiring verification shall use a separate compliance document.

01	SC System ID/Name from CF1R	
02	SC System Description of Area Served	
03	Conditioned Floor Area Served by the System (ft^2)	
04	Status: Refrigerant charge verification from MCH-25	
05	Verification: Is conditioned airflow supplied to all habitable rooms in accordance with the procedure in SC3.1.4.1.7?	

Notes:

B. VCHP Indoor Unit Information

Ducted indoor units are required to be certified to the Energy Commission as low static systems, and included in the list of certified indoor units published on the Energy Commission website at the following URL: https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment.

01	02	03	04	05	06	07	08	09
Indoor Unit Name or Description of Area Served	Installed Indoor Unit Type	Indoor Unit Duct Status	Conditioned Floor Area Served By The Indoor Unit (ft^2)	Number of Air Filter Devices on Indoor Unit	Indoor Unit Required Minimum System Airflow Rate (cfm)	Status: Airflow Rate Verification from MCH-23	Is Field Verification of Default Non-Continuous Fan Operation Required?	Verification: Is Ducted Low Static Indoor Unit Certified to CEC?

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF3R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 2 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

C. Verification: Ducted Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.3.8

Ducted indoor units shall be verified in accordance with the Verified Low Leakage Ducts in Conditioned Space procedure in Section RA3.1.4.3.8.

01	02	03	04
Indoor Unit Name or Description of Area Served	A Visual Inspection Shall Confirm the Space Conditioning Distribution System Location	Measured Duct Leakage to Outside (cfm) Using RA3.1.4.3.4	Compliance Statement:

Notes:

D. Verification: Ductless Indoor Units Located Entirely in Directly Conditioned Space - SC3.1.4.1.8

A visual inspection shall confirm that ductless indoor units are located entirely in conditioned space in accordance with the procedures of SC3.1.4.1.8.

01	02	03
Indoor Unit Name or Description of Area Served	Indoor Unit Installation Location Verification	Compliance Statement:

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF3R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 3 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

E. Verification: Wall Mounted Thermostats - SC3.4.5

Field verification according to the procedure in SC3.4.5 shall confirm that VCHP space conditioning zones that are greater than 150 ft², are controlled by a permanently installed wall-mounted thermostat.

01	02	03	04	05
Indoor Unit Name or Description of Area Served	Is a Wall-mounted Thermostat Installed in the Zone Served by the Indoor Unit?	Does the Thermostat Control the Zone's Indoor Unit?	Is the Thermostat Mounted Permanently to the Wall?	Compliance Statement:

Notes:

F. Verification: Non-Continuous Fan Operation - SC3.4.6

If the certificate of compliance indicates non-continuous indoor unit fan operation was specified for compliance credit, then the system shall be field verified in accordance with the procedures in SC3.4.6 to confirm that the installed system's indoor unit + outdoor unit combination does not operate the fan continuously when the system thermostat is not calling for conditioning.

01	02	03	04	05
Indoor Unit Name or Description of Area Served	Is Non-Continuous Default Fan Operation Shown in CEC Certification Listings?	Does Indoor Unit Air Distribution Fan Operate When There Is No Call For Heating?	Does Indoor Unit Air Distribution Fan Operate When There Is No Call For Cooling?	Compliance Statement:

Notes:

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF3R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 4 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

G. Verification: Installed Air Filter Sizing and Pressure Drop - SC3.1.4.7 and SC3.1.4.8

Nominal 2-inch or greater depth air filters shall be sized by the system designer to accommodate a maximum allowable clean-filter pressure drop of 0.1 inch w.c at the air filter's design airflow rate as verified according to the procedures in RSC3.1.4.8. Nominal one-inch minimum depth air filters shall be allowed if the filter face area is sized based on a maximum face velocity of 150 ft per minute at the air filter design airflow rate according to the procedures in RSC3.1.4.7. In order to inform the occupant of the airflow and clean filter pressure drop performance required for replacement air filters, the installer shall place a sticker in or near the filter grille displaying the air filter design airflow rate and the maximum allowed clean filter pressure drop at the design airflow rate as required by Standards Section 150.0(m)12Biv.

01	02	03	04	05	06	07	08	09	10	11	12
Indoor Unit Name or Description of Area Served	Air Filter Name or Description of Location	Air Filter Device Type	Design Airflow Rate for Air Filter Device (cfm)	Air Filter Nominal Depth (inch)	Air Filter Nominal Length (inch)	Air Filter Nominal Width (inch)	Air Filter Calculated Nominal Face Area ($inch^2$)	Air Filter Required Minimum Face Area ($inch^2$)	Face Area Compliance	Air Filter Rated Pressure Drop at Design Airflow Rate (inch W.C.)	Air Filter Pressure Drop Compliance

Notes:

H. VCHP System Compliance Statement

01	

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

STATE OF CALIFORNIA

Variable Capacity Heat Pump Compliance Credit

CEC-CF3R-MCH-33-H (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H
Variable Capacity Heat Pump (VCHP) Compliance Credit		(Page 5 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT	
1. I certify that this Certificate of Installation documentation is accurate and complete.	
Documentation Author Name:	Documentation Author Signature:
Documentation Author Company Name:	Date Signed:
Address:	CEA/HERS Certification Identification (if applicable):
City/State/Zip:	Phone:

RESPONSIBLE PERSON'S DECLARATION STATEMENT

I certify the following under penalty of perjury, under the laws of the State of California:

1. The information provided on this Certificate of Installation is true and correct.
2. I am either: a) a responsible person eligible under Division 3 of the Business and Professions Code in the applicable classification to accept responsibility for the system design, construction, or installation of features, materials, components, or manufactured devices for the scope of work identified on this Certificate of Installation and attest to the declarations in this statement, or b) I am an authorized representative of the responsible person and attest to the declarations in this statement on the responsible person's behalf.
3. The constructed or installed features, materials, components or manufactured devices (the installation) identified on this Certificate of Installation conforms to all applicable codes and regulations and the installation conforms to the requirements given on the Certificate of Compliance, plans, and specifications approved by the enforcement agency.
4. I understand that a HERS rater will check the installation to verify compliance and if such checking determines the installation fails to comply, I am required to offer any necessary corrective action at no charge to the building owner.
5. I will ensure that a registered copy of this Certificate of Installation shall be posted, or made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a registered copy of this Certificate of Installation is required to be included with the documentation the builder provides to the building owner at occupancy.

Responsible Builder/Installer Name:	Responsible Builder/Installer Signature:	
Company Name: (Installing Subcontractor or General Contractor or Builder/Owner)	Position With Company (Title):	
Address:	CSLB License:	
City/State/Zip:	Phone:	Date Signed:
Third Party Quality Control Program (TPQCP) Status:	Name of TPQCP (if applicable):	

Registration Number: Registration Date/Time: HERS Provider:

CA Building Energy Efficiency Standards - 2019 Residential Compliance

January 2020

CF3R-MCH-33-H User Instructions

Section A. VCHP System Information

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. This field is filled out automatically. It is referenced from the CF2R-MCH-25 which must be completed prior to this document.
5. Perform the verification specified by RSC3.1.4.1.7 and select the value that describes the result of the verification.

Section B. VCHP Indoor Unit Information

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. Accept the default value from the CF2R, otherwise enter the conditioned floor area served by the indoor unit - a value in ft^2.
5. Accept the default value from the CF2R, otherwise enter the number of air filter devices on this indoor unit.
6. This field is filled out automatically. It is referenced from the CF2R-MCH-23 which must be completed prior to this document.
7. This field is filled out automatically. It is referenced from the CF2R-MCH-23 which must be completed prior to this document.
8. This field is filled out automatically. It is referenced from the Certificate of Compliance which must be completed prior to this document.
9. Navigate to the URL for the Manufacturer certification listings and determine whether the installed system is included in the CEC listing, then select the value that describes the result of the verification.

Section C. Verification: Ducted Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.3.8

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the statement that best describes the location of the ducted distribution system.
3. Enter the leakage to outside airflow determined from the RA3.1.4.3.8
4. This field is filled out automatically

Section D. Verification: Ductless Indoor Units Located Entirely in Directly Conditioned Space - SC3.1.4.1.8

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the statement that best describes the indoor unit installation location as determined according to SC3.1.4.1.8.
3. This field is filled out automatically

Section E. Verification: Wall Mounted Thermostats - SC3.4.5

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Answer yes or no to the question: Is a wall-mounted thermostat installed in the zone served by the indoor unit?
3. Answer yes or no to the question: Does the thermostat control the zone's indoor unit?
4. Answer yes or no to the question: Is the thermostat mounted permanently to the wall?
5. This field is filled out automatically

Section F. Verification: Non-Continuous Fan Operation SC3.4.6

1. This field is filled out automatically. It is referenced from a different section of this document.
2. Select the best response to the question: Is non-continuous default fan operation shown in CEC certification listings?
3. Select the best response to the question: Does indoor unit air distribution fan operate when there is no call for heating?
4. Select the best response to the question: Does indoor unit air distribution fan operate when there is no call for cooling?
5. This field is filled out automatically

Section G. Verification: Installed Air Filter Sizing and Pressure Drop - SC3.1.4.7 and SC3.1.4.8

1. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
2. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
3. This field is filled out automatically. It is referenced from the CF2R-MCH-01 which must be completed prior to this document.
4. This field is filled out automatically. It is referenced from another section on this document, or from the CF2R-MCH-01 which must be completed prior to this document.
5. Enter the nominal depth of the air filter in inches.
6. Enter the nominal length of the air filter in inches.
7. Enter the nominal width of the air filter in inches.
8. This field is filled out automatically by calculating the product of air filter length and air filter width.
9. This field is filled out automatically based on the depth of the filter.
10. This field is filled out automatically
11. Input the pressure drop at the design airflow rate from the performance data information published on the air filter label.
12. This field is filled out automatically

Section H. VCHP System Compliance Statement

1. This field is filled out automatically

APPENDIX D:
Certification Documentation for Ducted VCHP Systems

The performance certificate of compliance for the dwelling shall require the installed ducted single-split systems and ducted multiple-split systems for which the compliance option credit was claimed to be models that have been certified to the Energy Commission. Certification shall be submitted to the Energy Commission by the original equipment manufacturer to confirm the VCHP systems meet the low-static eligibility requirement, and optionally to confirm the indoor unit + outdoor unit system combination does not operate the indoor unit fan continuously by default.

Low-static system certification.

If the VCHP compliance option credit is claimed on the performance certificate of compliance for a building project, then the installed ducted single-split or multiple-split VCHP systems for which the compliance option credit was claimed shall be equipment models that have been certified to the Energy Commission by the original equipment manufacturer to confirm the VCHP systems meet the definition for a low-static pressure system as defined in 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017). https://www.federalregister.gov/documents/2017/01/05/2016-30004/energy-conservation-program-test-procedures-for-central-air-conditioners-and-heat-pumps

A listing of manufacturers' certified VCHP system model numbers shall be published on the California Energy Commission's website.

- *A low-static blower coil system* produces greater than 0.01 in. wc. and a maximum of 0.35 in. wc. external static pressure when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling.
- *Single-split system* means a split system that has one outdoor unit and one indoor unit connected with a single refrigeration circuit.
- *Multiple-split (or multi-split) system* means a split system that has one outdoor unit and two or more coil-only indoor units and/or blower coil indoor units connected with a single refrigerant circuit.

Default non-continuous fan operation certification.

The original equipment manufacturer may also elect to certify to the Energy Commission that a ducted low-static indoor unit + outdoor unit system combination does not operate the indoor unit fan continuously by default. This certification is required in order to receive credit for the fan energy component of the VCHP compliance option credit. "Default" operation is how the system operates when the system is purchased and installed without making any changes to any control settings. In order for the system to receive the fan energy credit, the fan shall not operate continuously by default during times when the system is not providing any cooling or

heating. When non-continuous fan operation credit is claimed, field verification shall confirm the non-continuous fan operation.

Submittal to the Energy Commission.

Original equipment manufacturers shall submit VCHP system certification information to the Energy Commission electronically using the form shown below. Indoor unit + outdoor unit combinations shall be shown in the same row in the table below. Use additional rows/pages as needed when submitting data for multiple system models. A signed/scanned pdf format copy of the completed form shall also be submitted to the Energy Commission.

Air handler fan configuration settings documentation

Ducted VCHP systems are required to meet a minimum airflow rate target, however default indoor unit fan configuration settings may require modification in order for the installed fan airflow to meet the required rate. Therefore the manufacturer shall also submit an electronic copy of the model's published product documentation that provides direction for configuring the indoor unit fan for operation at airflow rates equal to or greater than the minimum rates required for compliance. The required airflow rates are as follows:

- For single-split systems, and packaged systems the minimum airflow rate is 350 cfm per nominal ton of outdoor unit cooling capacity.
- For multiple-split systems, the minimum airflow rate is 350 cfm per nominal ton of indoor unit cooling capacity.

The Ducted Variable Capacity Heat Pump Declaration documentation shown below shall be completed and submitted electronically to CertifiedtoCEC@energy.ca.gov.

Ducted Variable Capacity Heat Pump (VCHP) System - Certification to the California Energy Commission

Low-static system certification. If the VCHP compliance option credit is claimed on the performance certificate of compliance for a building project, then the installed ducted single-split or multiple-split VCHP systems for which the compliance option credit was claimed shall be equipment models that have been certified to the Energy Commission by the original equipment manufacturer to confirm the VCHP systems meet the definition for a low-static pressure system as defined in 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017).
https://www.federalregister.gov/documents/2017/01/05/2016-30004/energy-conservation-program-test-procedures-for-central-air-conditioners-and-heat-pumps

A listing of manufacturers' certified VCHP system model numbers shall be published on the California Energy Commission's website.

- *A low-static blower coil system* produces greater than 0.01 in. wc. and a maximum of 0.35 in. wc. external static pressure when operated at the cooling full-load air volume rate not exceeding 400 cfm per rated ton of cooling.
- *Single-split system* means a split system that has one outdoor unit and one indoor unit connected with a single refrigeration circuit.
- *Multiple-split (or multi-split) system* means a split system that has one outdoor unit and two or more coil-only indoor units and/or blower coil indoor units connected with a single refrigerant circuit.

Default non-continuous fan operation certification. The original equipment manufacturer may also elect to certify to the Energy Commission that a ducted low-static indoor unit + outdoor unit system combination does not operate the indoor unit fan continuously by default. This certification is required in order to receive credit for the fan energy component of the VCHP compliance option credit. "Default" operation is how the system operates when the system is purchased and installed without making any changes to any control settings. In order for the system to receive the fan energy credit, the fan shall not operate continuously by default during times when the system is not providing any cooling or heating. When non-continuous fan operation credit is claimed, field verification shall confirm the non-continuous fan operation.

Air handler fan configuration settings documentation. Ducted VCHP systems are required to meet a minimum airflow rate target, however default indoor unit fan configuration settings may require modification in order for the installed fan airflow to meet the required rate. Therefore the manufacturer shall also submit an electronic copy, or a URL link to an electronic copy of the model's published product documentation that provides direction for configuring the indoor unit fan for operation at airflow rates equal to or greater than the minimum rates required for compliance. The required airflow rates are as follows:

- For single-split systems, and packaged systems the minimum airflow rate is 350 cfm per nominal ton of outdoor unit cooling capacity.
- For multiple-split systems, the minimum airflow rate is 350 cfm per nominal ton of indoor unit cooling capacity.

Submittal to the Energy Commission. Original equipment manufacturers shall submit VCHP system certification information to the Energy Commission electronically using this form. Indoor unit + outdoor unit combinations shall be shown in the same row in the table below. Use additional rows/pages as needed. A signed/scanned pdf format copy of the completed form shall also be submitted to the Energy Commission.

Complete and submit electronically to CertifiedtoCEC@energy.ca.gov.

List of low-static VCHP systems offered for certification (insert additional rows as needed)

Outdoor Unit Manufacturer Name	Outdoor Unit Brand Name	Outdoor Unit Model Number	Indoor Unit Manufacturer Name	Indoor Unit Brand Name	Indoor Unit Model Number	Does Indoor Unit + Outdoor Unit Combination Operate the Fan Continuously by Default? (yes or no)	URL Link to Manufacturer's Published Technical Documentation for this Model

When providing the information below, be sure to enter complete mailing addresses, including postal/zip codes.

Certifying Company

Contact Person Name *	Phone 1
Certifying Company Name **	Phone 2
Address	Fax
(Address)	E-mail
(Address)	Company Website (URL)

* If the contact person named above is NOT the person whose signature is on the Declaration, then the full contact information for the person whose signature is on the Declaration must also be provided on a separate page.
** If the company named above is: A) a parent entity filing on behalf of a subsidiary entity; B) a subsidiary entity filing on behalf of a parent entity; or C) an affiliate entity filing on behalf of an affiliate entity, the above contact information must be provided for any additional entities on a separate page.

Manufacturer (if different from Certifying Company)

Contact Person Name	Phone 1
Manufacturing Company Name	Phone 2
Address	Fax
(Address)	E-mail
(Address)	Company Website (URL)

Declaration

I declare under penalty of perjury under the laws of the State of California that:

(1) All the information in this statement and in any attachment(s) is true, complete, accurate,

(2) The systems listed on this document meet the qualifications for low-static system types as defined in 10 CFR Parts 429 and 430, Docket No. EERE–2016–BT–TP–0029, Federal Register Vol. 82, No. 3, January 5, 2017);

(3) If so indicated in the List of low-static VCHP systems offered for certification above, the system also qualifies as a system that does not operate continuously by default when heating or cooling is not required.

(4) [If the party submitting this statement is a corporation, partnership, or other business entity] I am authorized to make this declaration, and to file this statement, on behalf of the company named below.

Certifying Company Name _____ Date _____

Name/Title (please print) _____ Signature _____