REQUEST FOR COMMENT

Cold Climate Air Source Heat Pump Specification- Proposed Revisions

This memo serves as a request for comment from interested air-source heat pump (ASHP) stakeholders regarding NEEP's Cold-Climate ASHP Specification ("Spec") and Product List. As detailed in this memo, NEEP proposes a number of changes to the current Specification and would like stakeholder input to inform a final determination of any revisions.

NEEP strongly encourages any interested stakeholder to submit written comments to NEEP via email (ccASHP@neep.org) by **September 25th**. Please note that only written comments will be accepted. Please include "Version 3.0 Proposal Comments" in the subject line to ensure your comments are received and recorded. A list of key questions is in the last section.

Background:
Since 2015, NEEP has managed and housed the Cold Climate Air-Source Heat Pump (ccASHP) Specification and the list of products that meet the specification's requirements. Those requirements include both specific performance levels as well as a series of reporting requirements. The development of the Specification was informed by a market strategy in NEEP's 2014 Northeast/Mid-Atlantic ASHP Market Strategies Report that suggested ASHP stakeholders "Develop standardized Metrics for Cold Climate ASHP Performance" as an opportunity to accelerate adoption of ASHPs. ASHP stakeholders from across the region lacked confidence that the existing heating performance metric (HSPF) for ASHPs provided the necessary information to adequately characterize heating performance generally, and more acutely at low temperatures.

The original purpose of the ccASHP specification is described in the current specification:

> "*The specification was designed to identify air-source heat pumps that are best suited to heat efficiently in cold climates (IECC climate zone 4 and higher). The specification is intended as a model equipment specification to be used broadly by program administrators in cold climates as a minimum requirement for program qualification. It also is intended for engineers, contractors, and other practitioners who need assurance that the equipment they select will have the required heating capacity at design temperature without unnecessary oversizing, and will serve the load efficiently throughout the ambient temperature range.*"

NEEP continues to stress the concepts of differentiation and transparency as core to the specification's purpose going forward. The specification will focus on effectively differentiating those ASHPs that operate efficiently at low temperatures. The Spec also enables greater transparency of system performance of ASHPs across the range of operating conditions, including capacity and efficiency, to the benefit of program administrators, agencies providing incentives, designers, installers, and ultimately consumers.

At NEEP's ASHP Workshop in June of 2017, NEEP presented a status update on the specification, including some analysis of the qualifying units, as well as some of the informal feedback being received related to the specification. Key issues and questions that were discussed are summarized as follows:

- The low number of compact-ducted systems and multi-zone systems meeting the specification criteria. Do we need to reconsider HSPF requirements for these systems?

- The challenge for "cold-climate" ASHPs to meet indirect EER requirement (12.5) that is part of the ENERGY STAR specification. Is high EER an appropriate or necessary component of a cold-climate specification?
- Should the specification include reporting of minimum, rated, and maximum Cooling capacity and input at 82 and 95F, as it currently does with heating performance at 47, 17 and 5F?

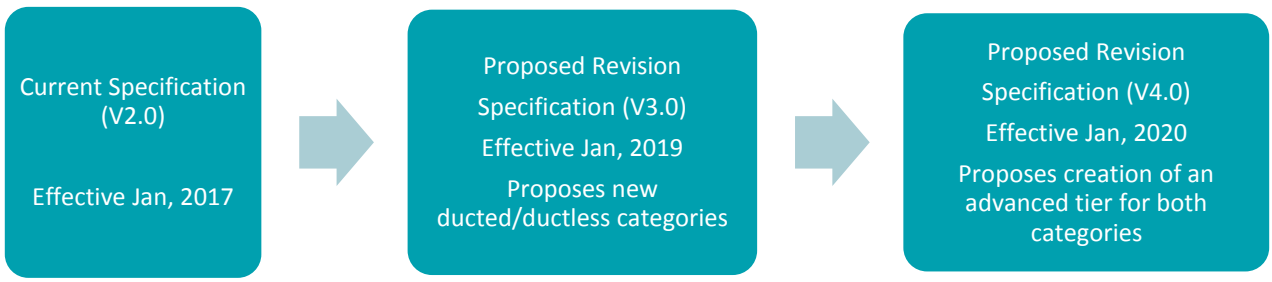
NEEP indicated that it would reconvene the ccASHP Specification Sub-committee following the workshop and discuss opportunities to address these highlighted questions. NEEP began discussing potential revisions to the Spec with the ccASHP Specification sub-committee in the fall of 2017, followed by meetings continuing through the spring of 2018.

The NEEP ccASHP product list continues to include very few systems that utilize low- or mid-static, compact-ducted indoor units. There are only 21 single-zone systems and 19 multi-zone systems (8 using all ducted indoor units, 11 having mixed configuration of non-ducted and ducted) on the list of over 1200 products. The consensus of the regional working group is that consumer interest in these types of ASHP configuration is growing and there is concern that low availability of program rebates for these types of systems may discourage otherwise interested consumers from moving forward with ASHP technology. Systems that utilize compact ducts may also enable more appropriate sizing, in particular for multiple small rooms with small loads, as compared with multiple ductless zones. Reducing the number of zones should increase net system efficiency and value to consumers, but the structure of the current spec acts to discourage consideration of this product class. There has been general interest from stakeholders over the past year to explore changes to the specification that would allow more of these systems to qualify.

NEEP is also cognizant of the fact that there continues to be a variety of technical requirements from across the region's incentive programs. This revision is also seen as an opportunity to make revisions that lead to greater consistency in program qualification requirements. There is broad agreement that regional market transformation towards high performance ASHPs would be accelerated by less diversity in program requirements. The following proposal has been designed with this additional goal in mind.

Based on sub-committee meetings and additional input received over the past year, NEEP proposes the following revisions as a proposed ccASHP Specification Version 3.0, as well as a proposed future Version 4.0.

Proposed High level Specification Evolution



Version 3.0 Proposal

NEEP is proposing the following changes to become effective on **January 1, 2019**:

Existing ccASHP Specification Performance Requirements (V2.0)	**Proposed Specification Performance Requirements (V3.0) Proposed changes highlighted in RED**
Compressor must be variable capacity	Compressor must be variable capacity
Indoor and outdoor units must be part of an AHRI matched system	Indoor and outdoor units must be part of an AHRI matched system
HSPF ≥10	HSPF ≥ 9 for all ducted systems, including: • Single-zone systems with ducted indoor unit (compact-ducted) • Multi-zone systems that include at least one ducted indoor unit • Centrally ducted systems
HSPF >10	HSPF ≥10 for all non-ducted systems including: • Single-zone systems with non-ducted indoor unit • Multi-zone systems that utilize all non-ducted indoor units
ENERGY STAR Certified includes: • SEER > 15 • EER > 12.5	Cooling Rating requirements: • SEER ≥ 15 • EER ≥ 10.0 (ENERGY STAR Certification no longer required)
COP 5° F >1.75 (at maximum capacity operation)	COP 5°F > 1.75 (at maximum capacity operation)
Lab testing results or engineering data for each system must be reported through the attached "*Cold Climate Air-Source Heat Pump Performance Information Tables*". Incomplete tables will not be considered. Data includes (but is not limited to) min/max/rated heating performance at 5F, 17F and 47F.	Lab testing results or engineering data for each system must be reported through the attached "*Cold Climate Air-Source Heat Pump Performance Information Tables*". Incomplete tables will not be considered. Data includes (but is not limited to) min/max/rated heating performance at 5F, 17F and 47F, and cooling performance at 82F and 95F.[1]

[1] Maximum and minimum performance (capacity and input power) are defined as describing the highest and lowest capacity that can be sustained without cycling of the compressor, under normal operating conditions at the prescribed outdoor temperatures, respectively.

Rationale for Proposed changes

Creating new categories (Ducted and Ductless) with different HSPF levels

We believe there is justification for reducing required HSPF levels for products that utilize compact ducts and centrally ducted products, due to differences in testing conditions used to test these systems (per AHRI 210/240).

Ducted systems require more energy than ductless systems to deliver the same amount of space conditioning through the ducts, because of the additional friction of the duct system. Although the ratings of similar ductless products (units that otherwise have the same ratings, controls, and utilize the same outdoor models) would seem to indicate that they are 20-25% more efficient than ducted models, researchers from NREL/PNNL estimate the real differences in performance from the added fan energy to be about 4%[2]. This value was confirmed independently by Proctor Engineering Group[3]. Subtracting 4% from the 20-25% ratings difference still leaves a 15-20% gap in the efficiency ratings between ductless and ducted systems that are otherwise nearly identical.

Non-ducted systems are tested under conditions that appear to report performance differently compared to those that have ducts, because the ductless systems can be operated at higher fan speeds during the rating tests. While there is a maximum air flow specified in the test procedure for ducted systems (equivalent to 444 CFM/ton), there is no maximum specified for ductless systems during the test. The increased fan power during testing is small compared to the increased capacity (and therefore efficiency) produced by higher flow rates, even though ductless fan coils would never be run at "test mode" fan speeds during normal operation. This test condition would result in a larger discrepancy in rated performance results that are not borne out in the field.

In addition, we believe there is significant, cost-effective savings to consumers by encouraging compact-ducted systems (typically mid-static air handlers with ducts leading to 2-4 small rooms) over multi-zone individual ductless in each room. Though the installation cost would typically be similar, installing multiple zones that are oversized into multiple rooms with small loads exacerbates excessive compressor cycling and lower efficiencies under lower-load conditions. Each zone installed in a small room that is oversized leads to a larger and larger outdoor unit, yet the larger outdoor units have smaller turn-down ratios. Under part-load conditions the minimum capacity of the unit may exceed the total house load by several times, leading to excessive cycling. Two likely solutions to improve performance would be by installing more single-zone systems (that each have larger individual turn-down ratios), and by combining several small rooms into a shared zones by using a compact-ducted system. The option to offer fewer wall-mounted ductless terminals and/or fewer outdoor units provides more options for designers and installers to offer alternative solutions that can meet customers' needs.

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[2] C.E. METZGER, J. ZHANG, PH.D., J. MAGUIRE; J. WINKLER, Are Ducted Mini-Splits Worth It? , ASHRAE Journal, February 2018

[3] Personal communication from Abram Conant, Proctor Engineering Group, 10/18/2017: "… the EER difference due to higher fan energy for the ducted head would be on the order of ~4% for the units we tested last year."

Having ducted cold-climate systems that are listed (and that may in the long run by as efficient, if not more so, than their ductless counterparts) will become a key component of the specification moving forward.

For these reasons, we propose a reduced HSPF requirement of 9 for all systems that utilize ducts (whether centrally ducted, mixed or ducted-only), while maintaining the current HSPF level for those systems that exclusively utilize ductless indoor heads. Considering that this decrease is only 10%, it should be conservative in comparison to the roughly 15-20% gap in the HSPF ratings caused by the test procedure.

Lowering required EER levels

The proposed reduction of the required EER levels reflects a recognition that the specification should focus on differentiating systems optimized for heating performance and efficiency. The proposed reduction represents an intentional pivot away from requiring top-tier efficiency in all conditions, and towards a stronger focus on heating efficiency (steady state and seasonal).

Based on supplemental specifications we have obtained for approximately 40 multi-zone systems that meet the COP@5F requirement but fail other requirements, moving to 10 EER would allow the majority of the systems to meet the specification that otherwise meet the requirements, but are not listed due to their lower EER rating. We believe these systems demonstrate high heating performance and that they belong on a list of cold-climate ASHP products, while still maintaining adequate cooling performance.

ASHPs use energy during the cooling season and we want to ensure that cooling efficiencies are not completely sacrificed, so the proposal continues to include SEER and EER requirements; only the EER level is proposed to be reduced. The previous EER requirement was driven by the ENERGY STAR specification that is a uniform spec for the entire United States and does not differentiate by climate. The ENERGY STAR HSPF requirement is 8.5, 4% better than the code minimum of 8.2, yet the SEER requirement of 15 is more than 15% higher than the code minimum of 13. This may make sense for a nationwide program, but it is heavily biased towards cooling performance; such a bias does not support a spec for climates where heating loads dominate by a large margin. There is not a code minimum EER rating, and we believe that allowing more flexibility with the EER requirements better serves the goal of providing a focus on products with high performance in cold climates.

Version 4.0 Proposal
NEEP is proposing the following changes to become effective on **January 1, 2020**

Note that Version 3.0 becomes Tier 1 of a new Version 4.0, with the introduction of an advanced Tier 2.

Existing ccASHP Specification Performance Requirements (for reference)	**Proposed Specification Performance Requirements V3.0 (Becomes Tier 1 of proposed Version 4.0)** **Proposed changes from current spec highlighted in RED**	**Proposed Version 4.0, Tier 2** **Proposed Tier 2 changes highlighted in GREEN**
Compressor must be variable capacity	Compressor must be variable capacity	Compressor must be variable capacity
Indoor and outdoor units must be part of an AHRI matched system	Indoor and outdoor units must be part of an AHRI matched system	Indoor and outdoor units must be part of an AHRI matched system
HSPF >10	HSPF ≥ 9 for all Ducted Systems including: • Single-zone systems with ducted indoor unit ("mini-ducted") • Centrally ducted systems • Multi-zone systems that include at least one ducted indoor unit	HSPF ≥ 11 for all Ducted Systems including: • Single-zone systems with ducted indoor unit ("mini-ducted") • Centrally ducted systems • Multi-zone systems that include at least one ducted indoor unit
HSPF >10	HSPF >10 for all non-ducted systems including: • Single-zone systems with non-ducted indoor unit • Multi-zone systems that utilize all non-ducted indoor units	HSPF ≥12 for all non-ducted systems including: • Single-zone systems with non-ducted indoor unit • Multi-zone systems that utilize all non-ducted indoor units
ENERGY STAR Certified includes: • SEER > 15 • EER > 12.5	Cooling Rating requirements: • SEER ≥ 15 • EER ≥ 10.0 • (ENERGY STAR Certification no longer required)	Cooling Rating requirements: • SEER ≥ 15 • EER ≥ 10.0 (ENERGY STAR Certification no longer required)
COP 5° F ≥1.75 (at maximum capacity operation)	COP 5°F ≥ 1.75 (at maximum capacity operation)	COP 5°F ≥ 2.0 (at maximum capacity operation)

Lab testing results or engineering data for each system must be reported through the attached "*Cold Climate Air-Source Heat Pump Performance Information Tables*". Incomplete tables will not be considered. Data includes (but is not limited to) min/max/rated heating performance at 5F, 17F and 47F.	Lab testing results or engineering data for each system must be reported through the attached "*Cold Climate Air-Source Heat Pump Performance Information Tables*". Incomplete tables will not be considered. Data includes (but is not limited to) min/max/rated heating performance at 5F, 17F and 47F, and cooling performance at 82F and 95F.[4]	Lab testing results or engineering data for each system must be reported through the attached "*Cold Climate Air-Source Heat Pump Performance Information Tables*". Incomplete tables will not be considered. Data includes (but is not limited to) min/max/rated heating performance at 5F, 17F and 47F, and cooling performance at 82F and 95F.

Rationale for Proposed changes

Moving to a two-tiered Specification

NEEP and regional stakeholders share an interest in seeing performance of ASHPs improve over time, particularly low temperature performance. NEEP is interested in helping to drive performance improvement in the ASHP market, optimized for low-temperature heating operation while giving the market sufficient lead time to respond to a new advanced tier. By raising the bar, we believe we are helping to send signals to the marketplace that ASHP stakeholders in the Northeast are interested in seeing progression in cold-climate heat pump technology.

An important benefit of adding a second tier is our ability to simultaneously "raise the bar" as well as maintain the significant amount of valuable information that we have collected through the specification and listing since 2015. Simply raising the bar would sacrifice much of this performance information, so we've proposed to carry Version 3.0 over to become tier 1 of the Version 4.0 specification.

To this end, we are proposing to create an advanced tier as part of the Version 4.0 that requires higher levels of COP@5F and HPSF, allowing newer and even more efficient products to be further differentiated from the rest of the cold-climate models.

NEEP conducted a quantitative analysis of the 1263 systems on the current List (7.30.18) to inform the proposed levels of Tier 2. We were interested in proposing levels that reflected fairly small percentages today with the expectation that the spec will serve as a driver to performance improvements (in both COP@5F and HSPF), and higher qualification rates, by the time version 4.0 takes effect (proposed for January 2020). Based on the analysis, NEEP is proposing increases in HSPF and COP@5F for both the ductless and ducted categories.

[4] Maximum and minimum performance (capacity and input power) are defined as describing the highest and lowest capacity that can be sustained without cycling of the compressor, under normal operating conditions at the prescribed outdoor temperatures, respectively.

Analysis of qualification rates (under different HSPF/COP@5F combinations)

Tier 1 Proposed levels/qualification rates

Tier 2 Proposed levels/qualification rates

1263 total units

Qualification rates under different possible spec combination levels

		1.75		2		2.25		2.5	
Ducted (out of 765 total units)		# of systems meeting both conditions	% all of Ducted	# of systems meeting both conditions	% of all Ducted	# of systems meeting both conditions	% of all Ducted	# of systems meeting both conditions	% of all Ducted
	9	765	100%	558	73%	231	30%	12	1.5%
	10	765	100%	558	73%	231	30%	12	1.5%
	11	222	29%	216	28%	163	21%	0	0%
Ductless (out of 498 total units)		# of systems meeting both conditions	% of all Ductless	# of systems meeting both conditions	% of all Ductless	#	% of all Ductless	#	% of all Ductless
	10	498	100%	278	56%	117	23%	59	12%
	11	270	54%	157	32%	60	12%	25	5%
	12	138	28%	82	16%	41	8%	19	4%

Current policy regarding variable capacity requirement:

NEEP intends on continuing to require variable capacity as an element of meeting the ccASHP Specificaiton. The genesis of this requirement stems from the inherent advantage of operating in part load compared to the higher cycling behavior of single and two speed system. While efficiencies are achieved through this part load operation, the current metric/test procedure (HSPF/AHRI 210/240) does not fully capture these benefits. NEEP is monitoring the development of a new voluntary test procedure being developed by CSA Group that we believe has potential to more fully capture these benefits. We encourage manufacturers who have single- or two-speed systems that believe their systems are high performing cold-climate systems to explore opportunities to have these systems tested using the voluntary test procedure (expected to be finalized in 2018). NEEP will be assessing on an ongoing basis if and when it might be appropriate to incorporate the CSA test procedure into the ccASHP Specification.

Vision for Future Specification Revision (Version 5.0)

From the launch of the ccASHP specification over three years ago, there has been an acknowledgement that the lack of a standardized test procedures for all the required performance data has been a key deficiency that all of the stakeholders are interested in overcoming. The CSA test procedure noted above represents a potential pathway to include a voluntary, load-based test and rating procedure for ASHP efficiencies at a wide range of temperatures and load conditions. It is expected to provide a test procedure and performance metrics that are generally more reflective of field performance, and reflective of meaningful differences between equipment ratings in all climates, but particularly for cold climates.

Assuming the CSA test procedure is finalized in 2018 to a point where significant lab testing can take place in 2019, NEEP will monitor testing results and continue to consult the ccASHP Specification sub-committee, as well as stakeholders from the US and Canada to inform possible future use of the test procedure as part of this specification. NEEP will communicate with stakeholders as developments arise.

Key Questions that we are interested in feedback on;

1. Do you support the creation of separate categories for Ducted/Ductless ASHPs products proposed in Version 3.0?
2. Do you support how we have "defined" these two categories?
3. Do you support the proposed reduction of HSPF levels for ducted products in Version 3.0?
4. Do you support the proposed reduction in EER level for both ductless and ducted products (and subsequent elimination of ENERGY STAR certification)?
5. Do you support the creation of an advanced tier in Version 4.0?
6. Do you support the specific performance level changes proposed for tier 2 as part of Version 4.0?
7. Do you support the effective dates of Version 3.0 and Version 4.0?
8. Is it important to maintain the requirement for systems to be "variable capacity"?
9. Would you suggest including some requirement for "Turn-down ratio" to ensure cycling is avoided in higher temperature heating conditions (i.e. 47F)?
10. Would you suggest including some requirement for Capacity maintenance (i.e. capacity@5/capacity@47 has to meet a certain percent)? If so, how could we effectively ensure that systems are not purposefully "de-rated" at 47F to increase capacity maintenance?
11. The impact of defrost cycles is not currently captured in the COP@5F measurement. How important is trying to include the impacts? Suggested methods are welcome.
12. Would there be any value in including refrigerant used as an element of the reporting requirement?
13. Should the reporting requirement include onboard diagnostic capabilities?
14. Are there other changes that would make the specification more useful/relevant to your organization's or company's interests (i.e. program administrators, manufacturers, installers, local/state/federal agencies, etc.)?