Comparison of H/ERV Certification Standards

For: North American Passive House Network
Prepared on: 04 March 2021
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1. Introduction

The Heating and Ventilating Institute (HVI), Energy Star (ES) and Passive House Institute (PHI) are three residential H/ERV certification programs recognized within the North American market. The growth of application of the Passive House Building Standard on the continent has increased the demand for PHI certified H/ERVs. Unfortunately, there are few certified devices on the market. This has prompted Passive House project proponents to consider specifying non-PHI certified systems. Unfortunately, proponents often mistake the performance ratings listed in HVI or ES databases as equivalent to PHI ratings. This is a natural conclusion as, at the surface, the programs require verification of similar performance data. However, Passive House practitioners with deeper knowledge of H/ERV performance requirements have recognized that the data are not necessarily comparable.

The main goal of this report is to identify what additional testing, if any, is required for Non-PHI certified equipment to produce the data necessary for Passive House ventilation component certification. This is meant to aid industry stakeholders (test labs, manufacturers, HVI, Passive House practitioners, policy makers etc) in establishing the necessary processes to facilitate this additional testing in North American accredited laboratories. It is envisioned that these data would be published in an appendix to the CSA439 test reports. The outcomes would be a more streamlined, cost effective process for manufacturers to obtain Passive House component certification and a more robust Passive House products market. A byproduct of this process is that manufacturers who don't quite meet all of the rigorous certification requirements would still obtain the performance data that Passive House practitioners require. In this way, Passive House Consultants can reliably and accurately assess the suitability of non-PHI certified H/ERVs for their projects. This would substantially decrease the risk of manufacturers committing to the process without obtaining a meaningful outcome.

To be clear, the intention of the report is not to assess the validity or reliability of any of the programs for particular purposes. In other words, no claim is being made that one program is better than the other. Rather, it seeks to create a more robust market of certified Passive House ventilation components and increase the number of buildings achieving Passive House certification.

2. Definitions and Abbreviations

ODA = Outdoor air
SUP = Supply air
EXT = Extract air
EXH = exhaust air
ODAT = ODA temperature
Critical Temperature = Frost protection limit: temperature at which frost protection mechanism is activated

3. Assessed Parameters

The energy performance of H/ERVs is generally the focus when comparing products and test results, often to the complete disregard of other parameters. However, as the primary purpose of the technology is to ventilate indoor spaces, other parameters such as air quality, comfort and resiliency are important to consider. In reviewing the standards, a few things became clear:

1) The definitions are not consistent across the programs. Comparing these definitions for consistency is a non-trivial task.
2) How each parameter is assessed is not consistent across the programs/underlying test standards
3) Not all parameters assessed and reported by PHI are assessed/reported by the HVI and ES programs or the underlying test standard, CSA439.
4) The HVI and ES standards do not set minimum performance requirements for most of the parameters

The PHI standard describes thirteen parameters that are assessed in its certification (Table 1):

Table 1: Parameters that are considered in PHI H/ERV certification

Parameter	Background
Operational Range	The air flow range (minimum and maximum) over which the performance results are valid.
Air leakage	A measure of how much air leakage the machine exhibits. This may or may not include internal leakage (between air streams), external leakage (leakage across the casing) and cross leakage (trapped in regenerative heat exchanger during transition between air streams).
Air quality	The degree of filtration required. The primary purpose of an H/ERV is to provide fresh air. In order to protect the occupants as well as the heat exchanger from dust and other pollutants, a minimal level of filtration should be employed.
Heat (Sensible) Recovery Efficiency	A measure of how efficiently the H/ERV transfers heat from one airstream to the other. This may or may not account for parasitic losses (e.g. air leakage).
Moisture (Latent) Recovery Efficiency	A measure of how efficiently the machine transfers moisture from one airstream to the other. This may or may not account for parasitic losses (e.g. air leakage).
Power consumption – operation	The amount of electrical power per volume air flow (W/CFM) required to operate the H/ERV as a ventilator (motors and controls). This excludes energy used for all other purposes, such as frost protection.
Power consumption – standby	The amount of electrical power (W) required when the H/ERV is in standby.
Case heat loss	The amount of heat lost to/gained from the environment through the H/ERV casing. This loss represents heat that cannot be recovered, which decreases the sensible heat recovery efficiency
Thermal Comfort	The minimum supply air temperature guaranteed by the H/ERV. If the air entering a room is too cold, occupants may feel uncomfortable (low air temperature, draughts). Building codes often stipulate this minimum temperature. Establishing the minimum supply temperature is essential for determining whether the supply air must be conditioned before being supplied to the building.

Acoustic Comfort	The maximum acoustic levels generated by the H/ERV. An H/ERV can transmit noise to occupied rooms through its air ports, its casing, or through the building's structure. If noise emanating from the H/ERV is too loud, occupants may find it disruptive. Establishing the maximum acoustic levels generated by the machine provides essential information for mechanical designers.
Frost protection	The energy required for frost protection and/or to defrost the heat exchanger. During cold periods, condensation can build up on the heat exchanger and freeze, reducing the airflow and transfer efficiency. An H/ERV must be able to either prevent freezing or periodically defrost the exchanger to avoid performance degradation.
Controls	The minimum level of user control required. The degree of controllability can influence occupant satisfaction and operational energy demand.
Resiliency	The capability of the H/ERV to protect itself and the building's occupants from harm during and after operational disruptions.

Table 2 shows which parameters are captured in the testing procedures/certification reports for each of the certification standards. It also lists the relevant test standards on which the certification standards are based. "PHI" indicates that the test procedures is defined by the PHI. For reference, the PHI residential standard applies to devices < 353 CFM (600 m3/h), while the Energy Star standard applies to devices < 500 CFM (850 m3/h).

Table 2: Parameters Captured/Reported and Underlying Test Standards

Parameter	Captured in Testing/Report			Test Standards	
	PHI	**HVI**	**ES**	**PHI**	**HVI/ES**
Operational Range	yes	yes	yes	NT VVS 022 and 023	CSA439
Air leakage	yes	yes	yes	PHI	CSA439
Air quality	no	no	no	PHI	CSA439
Sensible Heat Recovery Efficiency	yes	yes	yes	PHI	CSA439
Moisture Recovery Efficiency	yes	yes	yes	PHI	CSA439
Power consumption - operation	yes	yes	yes	PHI	CSA-C62301
Power consumption - standby	yes	yes	yes	PHI	CSA439
Case heat loss	yes	yes	yes	PHI	CSA439
Thermal Comfort	yes	no	no	ISO 3743 and 5136	N/A
Acoustic Comfort	yes	no	rec*	PHI	CSA439
Frost protection	yes	yes	yes	PHI	N/A
Controls	yes	no	rec*	PHI	N/A
Resiliency	yes	no	no	PHI	CSA439

*Rec = recommended

4. Performance Requirements

As the parameters assessed vary between the programs, the performance requirements naturally do as well. Table 3 summarizes the key requirements.

Table 3: Performance Requirements of the certification programs

Parameter	PHI	HVI	ES
Operational Range	ODA and EXH streams must be balanceable (<10%) at rated flow rate	no	Climate Zones ≥6: Net air flow at 32oF (0oC) and -13oF (-25oC) must be within 10% of each other Climate Zones 1,2A, and 3A Net air flow at 32oF (0oC) and 95oF (35oC) must be within 10% of each other
Air leakage	Internal leakage ≤ 3% @mid flow rate of the operational range External leakage ≤ 3% @mid flow rate of the operational range Crossflow leakage ≤ 3% @mid flow rate of the operational range (regenerative HX devices only)	no	no
Air quality	Filter Performance ODA ≥ MERV13 (F7), EXT ≥ MERV8 (G4) Inspection and cleaning of the central apparatus including the heat exchanger should be easy It must be possible for the user to change the filters themselves. A description for this procedure and suppliers for spare filters should be documents in the handbook. Service life of filter should be limited to one year Manufacturer must ensure proliferation of microorganisms and entry of endotoxins is prevented permanently by providing either components or obligatory attachments for the device	no	no
Sensible Heat Recovery Efficiency	Between 5oF (-15oC) and 50oF (10oC): HRE ≥75%	CSA439 sets SRE ≥ 55% Permits imbalance in ODA/EXH	Climate Zones ≥6: 32oF (0oC): SRE ≥ 65% -13oF (-25oC): SRE ≥ 60% For other climate zones, no requirements are yet set
Moisture Recovery Efficiency	The method of regulating airflow to ensure excessive humidity levels are prevented should be explained	no	no

Power consumption - operation	≤ 0.45 Wh/m3 (1.31 CFM/W)	no	Climate Zones ≥ 6, Canada SRE < 75%: 1.2 CFM/W SRE ≥ 75%: 0.8 CFM/W
Power consumption - standby	< 1 W, otherwise device must provide possibility of a complete disconnection from the electrical supply as default	no	no
Case heat loss	no	no	no
Thermal Comfort	@ODAT = 14oF (-10oC): SUPT ≥ 61.7oF (16.5oC) Can be achieved with inbuilt heater	no	no
Acoustic Comfort	device noise ≤ 35 db(A) (if not installed in separate mechanical room) living spaces ≤ 25 db(A) extract rooms ≤ 30 db(A) Suggestions for appropriate silencers for the supply air and air extract air ducts are to be made on the basis of measured emissions.	no	Manufacturer shall indicate in Installation Instructions of proper installation of vibration deadening materials such as short pieces of flexible duct. Must include in produce literature following statement: "Each product should be installed using sound attenuation techniques appropriate for the installation."
Frost protection	Frost free after 12 hours @ ODAT = 5oF (-15oC) Frost protection mechanism must switch on at EXHT ≤ 26.6oF (-3oC). The approach for the manual readjustment of the frost protection limit Determination of critical temperature. It must be possible to set this so that no frost can occur in the heat exchanger No supply air interruption during defrost is permitted	no	-13oF (-25oC): SRE ≥60% Allows recirculated air for defrost H/ERVs with electric resistance heaters are ineligible for ENERGY STAR qualification

Controls	At least 3 flow rate settings controllable by occupant: Basic (70-80%) standard: (100%) increased: (130%)	no	Manufacturer must include in product literature following statement: “Installation of a user-accessible control with your product will improve comfort and may significantly reduce the product’s energy use.”
Resiliency	Device must restart after power loss and operation must continue at the same setting as before the power failure Emergency shutdown: supply temp < 41oF (5oC). For the user, a clearly perceptible corresponding error message should be issued at the control unit.	no	no

5. Test Procedures

An exhaustive review of the test procedures of each standard is beyond on the scope of this report. However, a summary of relevant observations is listed in Table 4.

Table 4: Relevant info on test procedures referenced by the certification programs

Parameter	PHI	HVI/ES	Comments
Operational Range	The device's upper and lower limits are determined based on manufacturers highest and lowest speeds	The devices maximum rated airflow is determined For multi-speed devices the airflows and static pressures shall be obtained: a) for units with fixed speeds, at each fixed speed; or b) for units with adjustable speeds, at the upper and lower limits of adjustment.	The applied pressures differ between the standards. If the PHI applied pressures are used, the test labs should be able to perform this test.
Air leakage	The device is pressurized by blocking certain ports and the resultant airflow to measure Pressures up to 300 Pa are applied.	The concentration of a tracer gas injected into the testing setup is measured at all four parts to determine air leakage.	The two procedures are fundamentally different. WIthout a deeper comparison, HVI’s method cannot be assessed for suitability. The very high applied pressure under PHI protocols may not be achievable the test rig of all test labs
Air Quality	No test required	N/A	No test required
Sensible Heat	This test is undertaken at an EXH temperature that ensures no condensation is formed	Condensation is permitted to form in the device during the test	Both standards require measurement of mass flow, temperature, and humidity at

Recovery Efficiency	during the test. This is to ensure the dry heat recovery efficiency can be determined Mass flow, temperature, and humidity at all four air ports are measured	ODA and EXH airflows are permitted to be imbalanced during test Mass flow, temperature, and humidity at all four air ports are measured	all four air ports, so the necessary data is being collected. If the PHI boundary conditions are adopted, all test labs should be able to perform this test.
Moisture Recovery Efficiency	The necessary data can be obtained during the heat recovery efficiency testing.	The necessary data can be obtained during the heat recovery efficiency testing.	If the PHI boundary conditions are adopted, all test labs should be able to perform this test.
Power consumption - operation	This is determined using a separate test	This is determined using a separate test	If the PHIs protocols are followed, all test labs should be able to perform this test.
Power consumption - standby	This is a straight forward test	This is a straight forward test	If the PHIs protocols are followed, all test labs should be able to perform this test.
Case heat loss	This is captured implicitly in the heat recovery test	This is measured explicitly in the heat recovery test	No separate measurement is required for PHI.
Thermal Comfort	This is a specific test that has no equivalent in HVI testing	No such test is performed	If the PHIs protocols are followed, all test labs should be able to perform this test.
Acoustic Comfort	This is a specific test that has no equivalent in HVI testing	No such test is performed	Labs that test airflow and energy performance likely do not also test acoustic performance
Frost protection	During this test, the mass flow balance of the ODA/EXH must be maintained and the mass flow must not decrease No frost should be visible on the heat exchanger at the end of the test	Frost is permitted to build up during the test, which impacts the determination of net outdoor air, supply, and exhaust flows Tests at ODATs lower than PHI boundary conditions are routinely performed	If the PHIs protocols are followed, all test labs should be able to perform this test.
Controls	No test required	No test required	No test required
Resiliency	The frost protection test involves closing the extract air duct and in parallel decreasing the ODAT The emergency shutdown test involved unplugging and plugging back in the device	No such test is performed	If the PHIs protocols are followed, all test labs should be able to perform these tests.

6. Recommendations

Based on the review undertaken, the following recommendations can be made to achieve the outcomes of a streamlined, cost effective process for manufacturers to obtain Passive House component certification, a more robust Passive House products market, and production of performance data that Passive House practitioners require for correctly specifying non-PHI certified products in their Passive House projects.

1. The operational range should be determined according to PHI protocols
2. The dry heat recovery efficiency and moisture recovery efficiency tests should be undertaken according to PHI protocols
3. The internal, external, and (where relevant) cross leakage tests should be undertaking accordingly to to the PHI protocols
4. The thermal comfort test should be undertaken according to PHI protocols.
5. The acoustic comfort tests should be undertaken according to PHI protocols. The main challenge here is that the existing HVI certified test labs are likely not set up for acoustic testing. This may require the unit to be sent to a different lab, which would increase the testing costs.
6. The resiliency tests should be undertaken according to PHI protocols
7. The frost protection tests should be undertaken according to PHI protocols
8. The requirements that do not require testing should be separately verified by the test lab or PHI. These include filtration level, user controls, method of regulating moisture levels for ERVs,

For reference, the PHI standard notes the following: "If, due to the available facilities in a certain laboratory, individual air conditions cannot be achieved, after early agreement with the PHI an arrangement should be made which approximates the intentions of the requirements as much as possible." Therefore, if there are laboratories in North American that may not be able to provide all the testing, they could still potentially be considered for testing to PHI protocols and are encouraged to discuss this opportunity with PHI.

7. References

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