

Technical Note			TN-031
Test: N/A			Test no.: N/A
Assumption: Pass Thresholds			Assumption no: N/A
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1. Introduction

In order to ensure a minimum standard for all HIUs that pass the BESA HIU test, a number of minimum pass thresholds are proposed.

A number of the pass thresholds are retained from the previous test. However, based on a request from the BESA HIU Steering Committee, a new performance threshold based on the VWARD results of the unit is also proposed.

It should be noted that the pass thresholds do not reflect any other compliance test or regime and should not be used for demonstrating compliance with any other guidance or regulations.

The following parameters have pass thresholds:

- DHW maximum temperature
- DHW scaling temperature
- Keep Warm definition
- Space heating, DHW, and Keep Warm VWARDs (all tests)

2. DHW Maximum Temperature Pass Thresholds

The DHW maximum temperature pass thresholds relate to all high temperature DHW tests - 11a, 12a, 12c, 13a, 22a, 31a, and 32a.

The pass threshold for all these tests is less or equal to 1 second at a temperature measured at t32 of equal to or greater than 60 °C. For clarity, a unit will have deemed to have failed if a temperature of over 60 °C measured at t32 is recorded for more than 1 second.

The technical justifications for these pass thresholds are detailed and presented in Technical Note 8 (TN_BESA_HIU_008_Assumption_27&28_DynamicDHWtest-PassFailCriteriaScaldingLimits_WE_Rev2_01).

3. DHW Scaling Temperature Pass Thresholds

There are two DHW scaling temperature pass thresholds.

The first relates to the dynamic DHW tests 11a, 12a, 12c, 13a, 22a, 31a, 32a. The pass threshold for these tests is that the temperature measured at t12, doesn't exceed 55°C for more than 5 seconds during the tests.

The second relates to the Keep Warm test 21a. The pass threshold for these tests is that the temperature measured at t12, doesn't exceed 55°C at any point during the test.

The technical justifications for these pass thresholds are detailed and presented in Technical Note 29 (TN_BESA_HIU_029_Assumption_68_ScalingAssessment_DM_Rev1_03).

4. Keep Warm Definition

The Keep Warm definition pass threshold relates to the Keep Warm DHW response time tests – 22a and 22b.

In order to be considered as a functioning Keep Warm HIU, the HIU must be able to provide DHW at t32 within 15 seconds.

The technical justifications for these pass thresholds are detailed and presented in Technical Note 19 (TN_BESA_HIU_019_Assumption_44_PerformanceRequirementsOfKWF_GJ_Rev1_02).

5. VWARD Pass Thresholds

5.1. Analysis

In order to determine the suitable pass VWARD thresholds for the new test, analysis was carried out on the 29 HIU tests carried out since 2018.

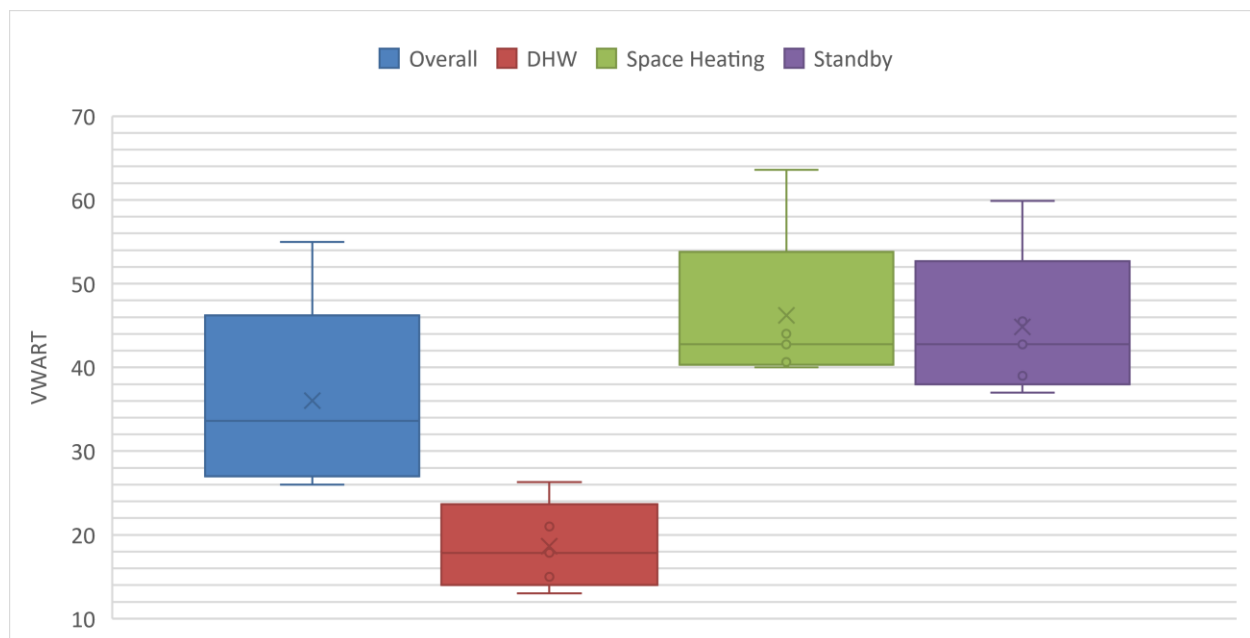


Figure 1 Overall, DHW, space heating, and Keep Warm VWARD results for the 29 high temperature tests

Figure 1 above shows the highest, lowest, 25% percentile, 75% percentile and mean VWARD for the overall, DHW, space heating, and Keep Warm tests. It can be seen that there is a significant variation between all tests

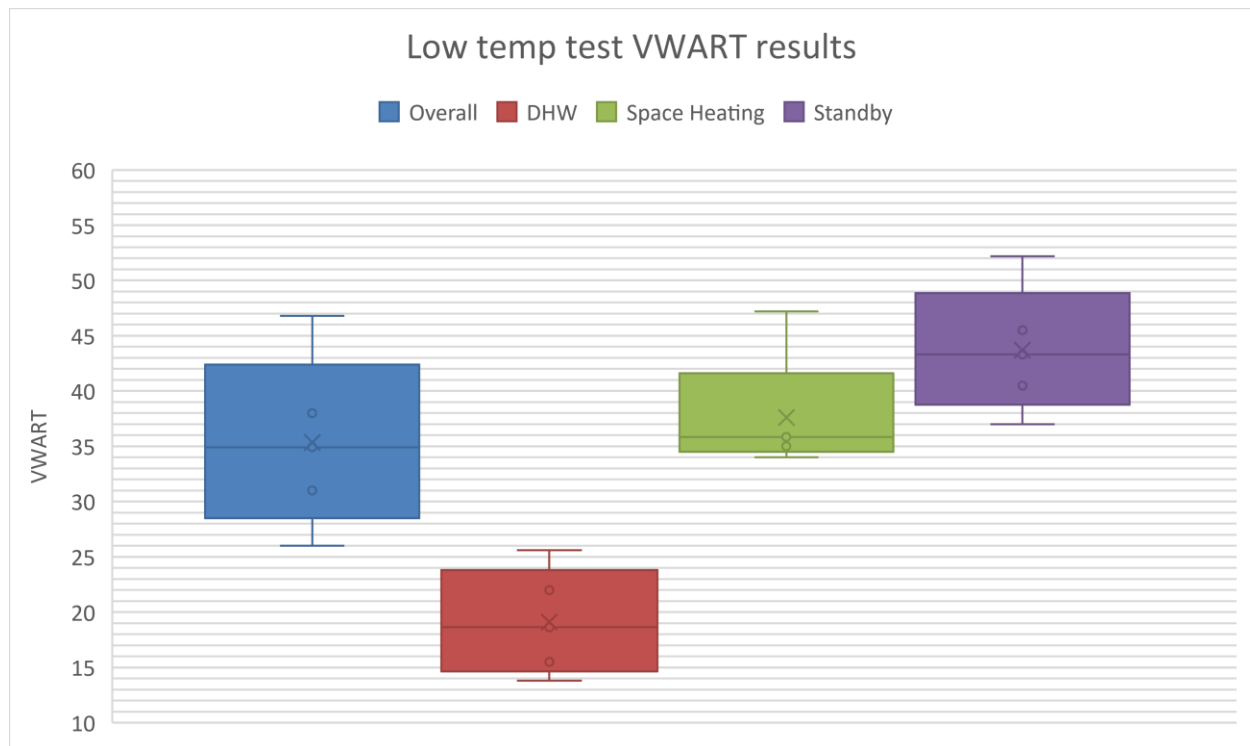


Figure 2 Overall, DHW, space heating, and Keep Warm VWARD results for the 29 low temperature tests

As with the high temperature tests, it can be seen in Figure 2 that there is a significant variation in all four VWARD reported values in the low temperature tests.

5.2. Initial proposed VWARD pass threshold values

High temperature test

Based on the analysis, the following VWARD pass thresholds were initially proposed for the high temperature tests. It should be noted that an HIU is considered to have failed the test if it fails any one of the four VWARD results.

Parameter	Criteria ($\leq^{\circ}\text{C}$)	No. failed	Comment
DHW	22	2	
Space Heating	45	1	As per CP1 guidance
Keep Warm	44	8	

Table 1 Initial proposed VWARD thresholds for high temperature test based on current temperature regime

Every HIU that failed any of the individual parameters also failed the Overall test as can be seen in Figure 3 below. However, two HIUs pass all of the three independent tests (DHW, space heating and Keep Warm VWARDS).

HIU Name	Overall VWARD	DHW VWARD	Space heating VWARD	Standby VWARD	Test passed	Pass/Fail
HIU3	55	26.3	63.6	59.9	0	FAIL
HIU9	44	16	40	51	2	FAIL
HIU11	42	23	44	51	1	FAIL
HIU4	40	18.6	41.8	48.9	2	FAIL
HIU10	40	20	44	49	2	FAIL
HIU20	40	19	41	40	3	FAIL
HIU2	37.9	18.6	40.3	47.7	2	FAIL
HIU28	37	22	45	45	2	FAIL
HIU29	36	21	45	43	3	FAIL

Figure 3 HIUs that would fail the proposed high temperature VWARD thresholds

Overall percentage of failures for these pass thresholds would be 31% (9 of 29 units fail). It should be noted that this analysis doesn't currently consider the impact of the new temperature regime (see Table 3).

Low temperature test

Based on the analysis presented in Section 2, the following VWARD pass thresholds were proposed for the low temperature tests.

Parameter	Criteria ($\leq^{\circ}\text{C}$)	No. failed	Comment
DHW	23	4	
Space Heating	40	1	As per CP1 guidance
Keep Warm	45	7	Has significant impact on overall HIU performance

Table 2 Initial proposed VWARD thresholds for low temperature test based on current temperature regime

Unlike the high temperature tests, there were several HIUs that failed individual tests (DHW and Keep Warm) but passed the Overall test result.

HIU Name	Overall VWARD	DHW VWARD	Space heating VWARD	Standby VWARD	Test passed	Pass/Fail
HIU3	46.8	25.6	47.2	52.2	0	FAIL
HIU11	44	23	36	51	2	FAIL
HIU10	43	21	36	50	2	FAIL
HIU20	42	20	35	48	2	FAIL
HIU2	41.6	16.4	34.9	49.9	2	FAIL
HIU4	39	19.7	35.2	46.2	2	FAIL
HIU16	38	21	35	46	3	FAIL
HIU27	38	25	38	45	3	FAIL
HIU18	34	24	36	42	3	FAIL
HIU25	32	25	36	40	3	FAIL

Figure 4 HIUs that would fail the proposed low temperature VWARD thresholds

Overall percentage of failures for these pass thresholds would be 34% (10 of 29 units fail). It should be noted that this analysis doesn't currently consider the impact of the new temperature regime (see Table 4).

5.3. Final proposed VWARD pass threshold values

High temperature test

The temperature changes proposed in for the high temperature test is a reduction in the DHW flow temperature from 55 to 50 °C and the space heating profile to change from 60/40 °C to 55/35 °C.

Criteria	Current test value (°C)	Proposed test value (°C)
DH flow temperature	70	70
DHW flow temperature	55	50
Space heating flow temperature	60	55
Space heating return temperature	40	35

Table 3 Current and proposed temperature test values for the high temperature test

It is considered that this will have a minimal impact on the DHW VWARD and an even smaller impact on the Keep Warm VWARD. As there will be a larger forward approach temperature (20 °C compared with 15 °C) during the DHW test, it is likely that HIUs will perform slightly better than current tests.

Therefore, it is proposed that the initial VWARD pass thresholds as outlined in Table 1 are used.

Likewise with the reduction of space heating temperatures, it is expected that the reduction of VWARD will scale linearly with the reduction in the return temperature, i.e. if the heating circuit return temperature drops from 40 °C to 35 °C, the primary return temperature expected will also drop by 5 °C, therefore, as above it is proposed that the initial VWARD pass thresholds as outlined in Table 1 are used.

Low temperature test

There is only one temperature changed proposed in the low temperature test. However, this is much more significant than the high temperature test changes as it is a reduction in the primary flow temperature. This will have a significant impact on the DHW VWARD as the forward approach temperature is being reduced from 10 °C to 5°C. It is expected that DH primary return temperatures will be higher for the same HIU and DHW plate heat exchanger (PHE).

Criteria	Current test value (°C)	Proposed test value (°C)
DH flow temperature	60	55
DHW flow temperature	50	50
Space heating flow temperature	45	45
Space heating return temperature	35	35

Table 4 Current and proposed temperature test values for the low temperature test

In order to estimate the impact of the temperature change, SWEP provided the theoretical return temperatures for two common HIU plates at the three DHW power level tests (approximately 8, 15 and 20 kW). It is understood that other major PHE manufacturers have comparable performance.

Heat Load (kW)	DH Flow Temp (°C)	Return Temp (°C)	Increase in DH Return Temp (°C)
8	60	14.82	3.95
	55	18.77	
15	60	17.73	4.94
	55	22.67	
20	60	19.31	5.38
	55	24.69	

Table 5 Calculated return temperatures for SWEP E8LASN-Wx20 PHE at 50 °C secondary flow temperature (provided by SWEP)

From a selection of previous tests, the approximate impact that each heat load test has on the final DHW VWARD is approximately:

- 8 kW – 50%
- 15 kW – 20%
- 20 kW – 30%

Therefore, the approximate impact of reducing the primary DH flow temperature from 60 °C to 55 °C on the DHW VWARD for this specific PHE would be a **4.6 °C** increase.

A second PHE which has a higher performance and is used on several HIUs that have been tested under the existing BESA HIU test regime was also modelled.

Heat Load (kW)	DH Flow Temp (°C)	Return Temp (°C)	Increase in DH Return Temp (°C)
8	60	11.84	2.45
	55	14.29	
15	60	13.89	3.64
	55	17.53	
20	60	15.19	4.06
	55	19.25	

Table 6 Calculated return temperatures for SWEP E8LASN-Wx40 PHE at 50 °C secondary flow temperature (provided by SWEP)

The SWEP E8LASN-Wx40 PHE results in much lower return temperatures under all conditions and a smaller increase in return temperature when compared with the first plate heat exchanger (SWEP E8LASN-Wx20).

The approximate impact of reducing the primary DH flow temperature from 60 °C to 55 °C on the DHW VWARD for this specific PHE would be a **3.2 °C** increase.

Considering these two modelled PHE, it is recommended that the VWARD increase is 4 °C, which would result in a DHW VWARD from 23 °C to 27 °C (see Table 2).

Regarding the other VWARDS:

- Space Heating – the selected VWARD is already extremely permissive (based on CP1 2020) and the vast majority of HIUs do not have issue with achieving the 40 °C target.

The reduction in primary DH flow temperature also have a much smaller impact as the forward approach temperature is still 10 °C (55 °C / 45 °C).

- Keep Warm – the reduction in primary DH flow temperature is likely to have a comparatively small impact on the VWART. Due to the lower DH flow temperature, the DH return temperature is expected to be lower, but a greater volume of water will be required to maintain the PHE temperature.

5.4. Recommendation

The following values are recommended as the VWART pass thresholds for the proposed low and high temperature tests.

Due to the significant changes to the testing parameters and Overall VWART calculation methodology, an Overall VWART is not currently proposed. This will be reviewed and implemented in future test regimes.

High Temperature test

Parameter	Criteria (\leq °C)
DHW	22
Space Heating	40
Keep Warm	44

Low Temperature test

Parameter	Criteria (\leq °C)
DHW	27
Space Heating	40
Keep Warm	45