Enertek International

International Consultants In Product Research, Design, Development & Certification

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1 BRIEF

1.1.1 Enertek international Limited (EIL), were contracted to receive, install and commission a production sample, vTherm Thermostatic HIU on behalf of Vital Energi.

1.1.2 To carry out the work involved to evaluate the performance of Domestic Hot Water (DHW) and Space Heating (SH) in accordance with the BESA UK HIU Test regime Technical Specification, Rev-009 requirements, a publicly available online test regime. This is here-on referred to as the Test Regime throughout this document.

1.1.3 To provide a report detailing the tests carried out and generated results in accordance with the Test Regime criteria, including calculations for Volume Weighted Average Return Temperatures (VWART).

2 DEFINITIONS

2.1.1 The following definitions and abbreviations have been used within this report:

Symbol	Description	Unit
P_1	Power, Primary side	kW
P_2	Power, Space Heating side	kW
P_3	Power, Domestic Hot Water	kW
t_{11}	Temperature, Primary Side Supply Connection	°C
t_{12}	Temperature, Primary Side Return connection	°C
t_{21}	Temperature, Space Heating Side Return Connection	°C
t_{22}	Temperature, Space Heating System Supply Connection	°C
t_{31}	Temperature, Cold Water Supply	°C
t_{32}	Temperature, Domestic hot Water Output from HIU	°C
q_1	Volume Flow, Primary side	L/s
q_2	Volume Flow, Space heating side	L/s
q_3	Volume flow, Domestic hot water	L/s
Δp_1	Primary Pressure drop across entire HIU unit	kPa
Δp_2	Pressure Drop, Space heating system across HIU	kPa
Δp_3	Pressure Drop, Domestic Hot Water across HIU	kPa
$VWART_{DHW}$	DHW Volume Weighted Return Temperature	°C
$VWART_{SH}$	Space Heating Volume Weighted Return Temperature	°C
$VWART_{KWH}$	Keep Warm Volume Weighted Return Temperature	°C
$VWART_{HEAT}$	Annual Volume Weighted Return Temperature for Heating Period	°C
$VWART_{NONHEAT}$	Annual Volume Weighed Return Temperature for Non-Heating	°C
$VWART_{HIU}$	Total Annual Volume Weighted Return Temperature	°C
DHW	Domestic Hot Water	–
HIU	Heat Interface Unit	–
SH	Space Heating	–
TMV	Thermostatic mixing Valve	–

3 TEST OBJECT

3.1 Appliance Details

3.1.1 Details of the HIU vTherm Thermostatic HIU appliance are given in Table 3.1. Photograph of the installed appliance is given in Figure 8.2.

Table 3.1 – Appliance Details

Item	Description
Manufacturer	Vital Energi
Model	vTherm Thermostatic HIU
Serial number	44100429
Year of manufacture	2019
DHW priority	No

3.2 Appliance Design Pressures

3.2.1 The maximum design pressures of the vTherm Thermostatic HIU appliance are given for the primary side and the secondary side for both Space Heating and DHW in Table 3.2.

Table 3.2 – Appliance Design Pressures

Item	Value	Unit
Primary Side	10	Bar
Secondary Side space Heating	2.5 (Working Pressure) 3 (Safety Valve)	Bar
Secondary Side DHW	10	Bar

3.3 Appliance Design Temperatures

3.3.1 The maximum design temperatures of the vTherm Thermostatic HIU appliance are given for the primary side and the secondary side for both Space Heating and DHW in Table 3.3

Table 3.3 – Appliance Design Temperatures

Item	Value	Unit
Primary Side	95	°C
Secondary Side space Heating	80	°C
Secondary Side DHW	60	°C

4 TEST METHOD

4.1 Installation of Appliance

4.1.1 The appliance was installed and commissioned (as received) and as defined in the product literature provided. Testing was carried out without further adjustment other than disabling the internal space heating pump and adjusting the setting of the SH and DHW set points through the user interface on the HIU controller to suit the conditions of the HIU test rig. The HIU rig schematic is given in Figure 4.1.

4.2 Test Regime

4.2.1 The testing described in this report was carried out in accordance with the BESA test regime[1]. The Test Regime outlines a series of static and dynamic tests to determine the performance of a HIU's DHW and SH functions. The Regime outlines the test method including the reporting of the results, the performance requirements and the VWART calculations.

4.2.2 The setup of the BESA tests is reproduced in Table 4.1. The basis of reporting the performance of the HIU from the BESA Test Regime is reproduced in Table 4.2.

4.2.3 The Test Regime specifies the testing of two different test temperature packages. The first is the high temperature package, with a district primary supply of 70 °C and the second is the 'low temperature' package, with a district primary supply temperature of 60 °C.

4.2.4 As the Vital Energi, vTherm Thermostatic HIU is suitable for both high and low temperature operation, both test packages were carried out and results recorded within this report.

4.3 Measurement & Uncertainties

4.3.1 All measurements and uncertainties adhere to the requirements stipulated in the BESA Test Regime. All measurements were sampled at a rate of 1 Hz for all tests.

4.3.2 The BESA uncertainties of measurement requirements are as follows: Differential Pressure, ± 1 kPa; Temperature, ± 0.1 °C; Volume Flow, ± 1.5 %. Note: the time constant for the temperature sensors is less than 1.5 s.

4.3.3 EIL's reported uncertainty is based on a standard uncertainty by a coverage factor K=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements. The EIL equipment list and uncertainties are given in Table 8.3, Appendix B.

[1] UK HIU Test Regime Technical Specification, Rev-009 requirements, issued by the Building Engineering Services Association (BESA)

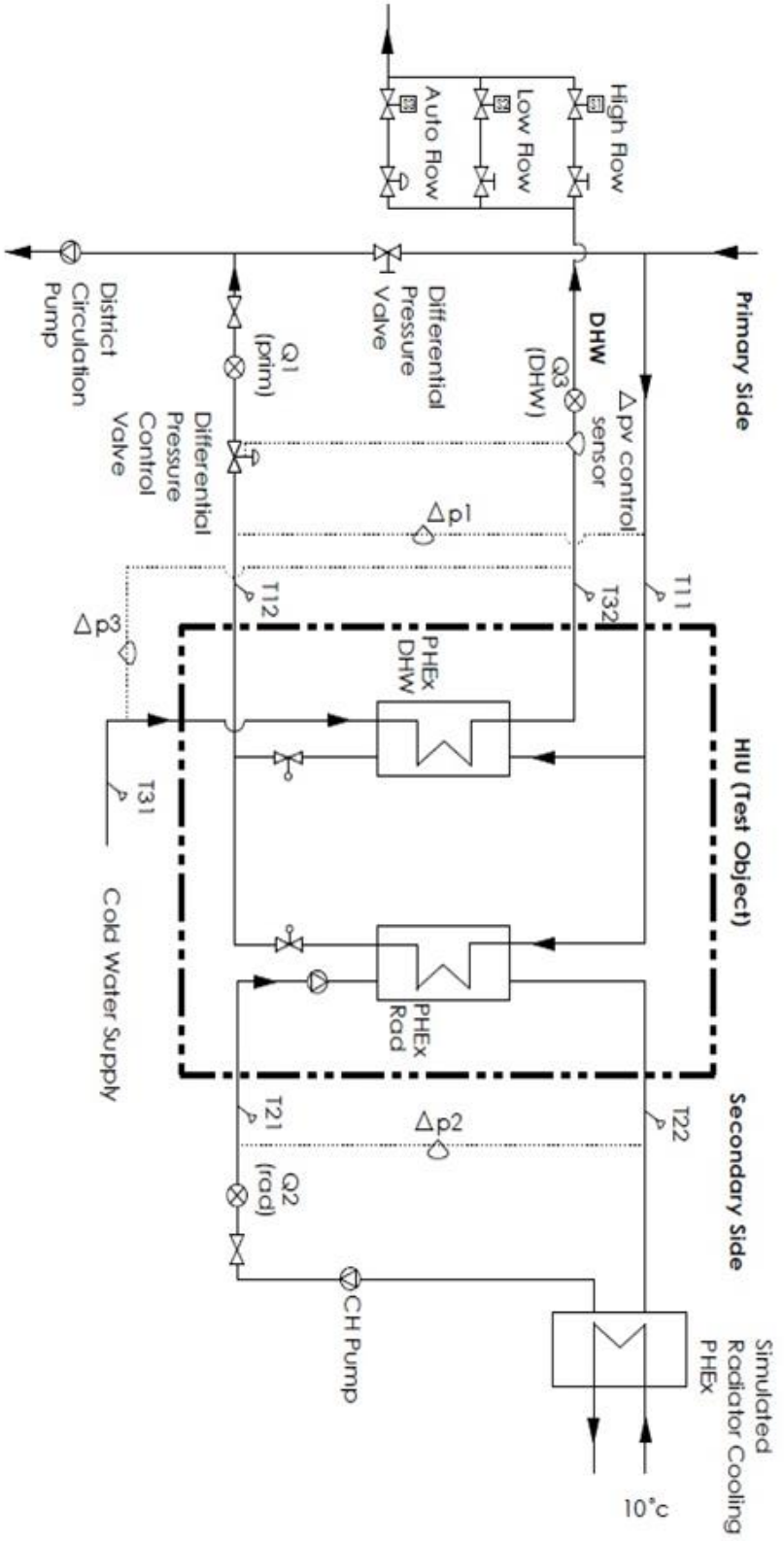

Figure 4.1 – EIL's HIU Test Rig schematic

Table 4.1 – Setup of tests (Based on BESA Test Regime, Table 1: Test Schedule)

		District Circuit			***Domestic Hot Water***			***Space Heating***		
		Static Pressure	Differential Pressure	Flow Temperature	Temperature Set Point	Flow Rate	Heat Load	Flow Temperature	Return Temperature	Heat Load
Symbol		*[p_1]*	*[Δp_1]*	*[t_{11}]*	*[t_{32}]*	*[q_3]*	*[P_3]*	*[t_{22}]*	*[t_{21}]*	*[P_2]*
Units		*[kPa]*	*[kPa]*	*[°C]*	*[°C]*	*[Ls^{-1}]*	*[kW]*	*[°C]*	*[°C]*	*[kW]*
Static Tests										
0a	District Pressure Test	1.43 X Claimed Value	-	-	-	-	-	-	-	-
1a	1kW Space Heating	3.0	0.5	70	-	-	-	60	40	1
1b	2kW Space Heating	3.0	0.5	70	-	-	-	60	40	2
1c	4kW Space Heating	3.0	0.5	70	-	-	-	60	40	4
1d	1kW Space Heating	3.0	0.5	60	-	-	-	45	35	1
1e	2kW Space Heating	3.0	0.5	60	-	-	-	45	35	2
1f	4kW Space Heating	3.0	0.5	60	-	-	-	45	35	4
Dynamic Tests										
2a	Dynamic Tapping	3.0	0.5	70	55	See Test Profile	See Test Profile	-	-	-
2b	Dynamic Tapping	3.0	0.5	60	50			-	-	-
3a	Low Flow	3.0	0.5	70	55	0.02	Record Value.	-	-	-
3b	Low Flow	3.0	0.5	60	50	0.02	Record Value.	-	-	-
4a	Keep-warm	3.0	0.5	70	55	0.00	0	-	-	-
4b	Keep-warm	3.0	0.5	60	50	0.00	0	-	-	-
5a	DHW Response	3.0	0.5	70	55	0.13	Record Value.	-	-	-
5b	DHW Response	3.0	0.5	60	50	0.13	Record Value.	-	-	-

Table 4.2 – Test Reporting, [Adapted From BESA Test Regime, Table 5]

Test Designation		Reporting
0	District Pressure Test.	Pass/Fail as to whether HIU manages pressure test without leaks or damage.
1a	Space heating 1 kW, 60/40 °C secondary.	t_{11} – Primary flow temperature. t_{12} – Primary return temperature. Plot of key metrics over duration of test. **Note**: Outputs used as input data to 'High Temperature' Space Heating Volume Weighted Average Return Temperature calculation.
1b	Space heating 2 kW, 60/40 °C secondary.	
1c	Space heating 4 kW, 60/40 °C secondary.	
1d	Space heating 1 kW, 45/35 °C secondary.	t_{11} – Primary flow temperature. t_{12} – Primary return temperature. Plot of key metrics over duration of test. **Note**: Outputs used as input data to 'Low Temperature' Space Heating Volume Weighted Average Return Temperature calculation.
1e	Space heating 2 kW, 45/35 °C secondary.	
1f	Space heating 4 kW, 45/35 °C secondary.	
2a	DHW only, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at t_{32}) exceeding 65.0 °C (to 1 decimal point) for more than 10 consecutive seconds. State the maximum and minimum DHW temperatures over the period of the test when there is a DHW flow. Assessment of scaling risk as per the criteria detailed in 2.26. **Note:** Outputs used as input data to 'High Temperature' Space Heating Volume Weighted Average Return Temperature calculation. Plot t_{32}, t_{31}, q_3, t_{12}, q_1
2b	DHW only, DH 60 °C flow; 50 °C DHW.	State the maximum and minimum DHW temperatures over the period of the test when there is a DHW flow. **Note:** Outputs used as input data to 'Low Temperature' Domestic Hot Water Volume Weighted Average Return Temperature calculation. Plot q_1, q_3, dp_1, dp_3
3a	Low flow DHW, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at t_{32}) exceeding 65.0 °C (1 decimal place) for more than 10 consecutive seconds. Comment on ability to deliver DHW at low flow based on DHW temperature reaching at least 45.0 °C (1 decimal place) at the end of the 180 second period of low flow DHW. Comment on the ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 55.0 +/- 3.0 °C (1 decimal place) during the last 60 seconds of the test. Maximum temperature achieved and +/-°C variance around 55.0 °C (1 decimal place) to be stated. Plot of key metrics for 60 seconds of 0.13 l/s flow and the subsequent 180 seconds of 0.02 l/s DHW flow. Assessment of scaling risk as per criteria detailed in 2.26.
3b	Low flow DHW, DH 60 °C flow; 50 °C DHW.	Comment on the ability to deliver DHW at low flow rate based on DHW temperature reaching at least 45 °C (1 decimal place) at the end of the 180 second period of low flow DHW. Comment on the ability to deliver stable DHW flow temperature (at t_{32}), defined as ability to maintain 50.0 +/-3°C (1 decimal place) to be stated. Maximum temperature achieved and +/-°C variance around 50.0°C (1 decimal place) to be stated. Plot of key metrics for 60 seconds of 0.13 l/s flow and the subsequent 180 seconds of 0.02 l/s DHW flow.

Test Designation		Reporting
4a	Keep-warm, DH 70 °C flow; 55 °C DHW.	Assessment of whether valid keep-warm operation, based on 5a response time criteria: Pass/Fail. Comment on HIU keep-warm controls options. Assessment of scaling risk, based on duration of temperatures in excess of 55.0 °C (1 decimal place). State average heat load for the duration of the test. State the average primary flow rate for the duration of the test. Note: Outputs used as input data to 'High Temperature' Keep-warm Volume Weighted Average Return Temperature calculation. Plot of key metrics over duration of test.
4b	Keep-warm, DH 60 °C flow; 50 °C DHW.	Assessment of whether valid keep-warm operation, based on 5a response time criteria: Pass/Fail. Observation on the operation of the HIU during keep-warm. Comment on HIU keep-warm controls options. Assessment of scaling risk based on extent and duration of temperatures in excess of 55.0 °C (1 decimal place). State average heat load for the duration of the test. State the average primary flowrate for the duration of the test. **Note:** Outputs used as input data to 'Low Temperature' Keep-warm Volume Weighted Average Return Temperature calculation. Plot of key metrics over duration of test.
5a	DHW response time, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at t_{32}) exceeding 65.0 °C (1 decimal place) for more than 10 consecutive seconds. State time to achieve 45.0 °C (1 decimal place) and not subsequently drop below 42.0 °C (1 decimal place). Plot t_{32}, t_{31}, t_{12}, q_1 over duration of test.
5b	DHW response time, DH 60 °C flow; 50 °C DHW.	State time to achieve a DHW temperature 45.0 °C (1 decimal place) and not subsequently drop below 42.0 °C (1 decimal place). Comment on stability of DHW temperature. Plot t_{32}, t_{31}, t_{12}, q_1 over duration of test.

5 TEST RESULTS

5.1 Test 0 –Pressure Test

5.1.1 The appliance has passed the requirements of the static pressure test, Test 0 of the BESA Test Regime as:

5.1.2 There was No damage observed during the static pressure test, with the primary flow pressurised to 14.3 bar (1.43 times the rated value), and;

5.1.3 There were No leaks observed during the static pressure test, with the primary flow pressurised to 14.3 bar (1.43 times the rated value).

5.2 Test 1a to 1f – Space Heating 1-4 kW at 70 and 60 °C

5.2.1 The plot of the key metrics of Tests 1a-1f for the space heating 1 - 4 kW at both 70 and 60 °C are displayed in Figure 7.1 to Figure 7.6 respectively. See Table 5.1 for summarised test results including the average primary return temperature, t_{12}.

Table 5.1 - Test Results for Space Heating Tests 1a to 1f

Test	Description	Primary					Secondary				
		Flow Temperature $[t_{11}]$ *[°C]*	*Return Temperature* $[t_{12}]$ *[°C]*	*Flow Rate* $[q_1]$ $[Ls^{-1}]$	*Differential Pressure* $[\Delta p_1]$ *[kPa]*	*Heat Load* $[P_1]$ *[W]*	*Return Temperature* $[t_{21}]$ *[°C]*	*Flow Temperature* $[t_{22}]$ *[°C]*	*Flow Rate* $[q_2]$ $[Ls^{-1}]$	*Differential Pressure* $[\Delta p_2]$ *[kPa]*	*Heat Load* $[P_2]$ *[W]*
1a	- 1 kW Space Heating (DH 70 °C flow)	70.0	38.8	0.010	53.5	1302	40.3	61.8	0.012	-0.8	1081
1b	- 2 kW Space Heating (DH 70 °C flow)	70.1	39.7	0.017	51.7	2141	39.9	60.3	0.012	0.8	2007
1c	- 4 kW Space Heating (DH 70 °C flow)	70.5	40.0	0.032	50.2	4079	39.8	59.5	0.048	-0.5	3959
1d	- Space Heating 1 kW (DH 60 °C flow)	59.6	34.5	0.012	52.7	1275	35.0	47.0	0.024	1.1	1183
1e	- Space Heating 2 kW (DH 60 °C flow)	60.0	34.9	0.022	51.3	2346	35.2	46.5	0.024	-0.1	2253
1f	- Space Heating 4 kW (DH 60 °C flow)	60.5	35.0	0.038	52.7	4103	35.1	45.1	0.097	-4.9	4039

5.3 Test 2a – DHW Dynamic Tapping at 70 °C

5.3.1 The appliance has passed the requirements of the DHW only at 70 °C, Test 2a of the BESA Test Regime as:

5.3.2 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds.

5.3.3 The maximum and minimum temperatures of t_{32} were 57.1°C and 52.5°C respectively.

5.3.4 The plot of the key metrics of the duration of Test 2a is displayed in Figure 7.7, Appendix A.

5.4 Test 2b – DHW Dynamic Tapping at 60 °C

5.4.1 The maximum and minimum temperatures of t_{32} were 52.3°C and 48.1°C respectively.

5.4.2 The plot of the key metrics of the duration of Test 2b is displayed in Figure 7.8, Appendix A.

5.5 Test 3c – Low Flow DHW at 70 °C

5.5.1 The appliance has passed the requirements of the Low Flow at 70 °C, Test 3c of the BESA Test Regime as:

5.5.2 The manufacturers declared low flow rate was 2.1 l/m.

5.5.3 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds, and;

5.5.4 The appliance did maintain the DHW output temperature, t_{32} at 55 ± 3 °C during the last 60 seconds of the test.

5.5.5 The maximum and minimum temperatures of t_{32} were 59.08°C and 37.38°C respectively.

5.5.6 The plot of the key metrics of the duration of Test 3c is displayed in Figure 7.9, Appendix A.

5.6 Test 3d – Low Flow DHW at 60 °C

5.6.1 The appliance did not maintain the DHW output temperature, t_{32} at 50 ± 3 °C during the last 60 seconds of the test.

5.6.2 The maximum and minimum temperatures of t_{32} were 54.05°C and 47.27°C respectively.

5.6.3 The appliance did maintain a steady DHW output temperature during the last 60 seconds of the test, however this was outside of the defined 50 ± 3 °C.

5.6.4 The plot of the key metrics of the duration of Test 3d is displayed in Figure 7.10, Appendix A.

5.7 Test 4a – Keep-warm at 70 °C

5.7.1 The appliance has passed the requirements of the Keep-warm at 70 °C, Test 4a of the BESA Test Regime as:

5.7.2 This is a valid keep-warm operation based on 5a response time criteria, see 5.9.3.

5.7.3 The appliance is not performing keep-warm cycling as the primary flow temperature, t_{11} does not vary by more than ± 3 °C during the final 3 hours of the test.

5.7.4 The average heat load on the primary side P_1 is 26 W.

5.7.5 The average primary flow q_1 over the 8 hour test was 2.3 l/hr.

5.7.6 The Keep-warm control was set to maintain the district return temperature at 40°C..

5.7.7 The plot of the key metrics of the duration of Test 4a is displayed in Figure 7.11, Appendix A.

5.8 Test 4b – Keep-warm at 60 °C

5.8.1 The appliance has passed the requirements of the Keep-warm at 60 °C, Test 4b of the BESA Test Regime as:

5.8.2 This is a valid keep warm operation based on 5b response time criteria, see 5.10.1.

5.8.3 The appliance is not performing keep-warm cycling as the primary flow temperature, t_{11} does not vary by more than ± 3 °C during the final 3 hours of the test.

5.8.4 The average heat load on the primary side P_1 is 39 W.

5.8.5 The average primary flow q_1 over the 8 hour test was 5.0 l/hr.

5.8.6 The Keep-warm control was set to maintain the district return temperature at 42°C..

5.8.7 The plot of the key metrics of the duration of Test 4b is displayed in Figure 7.12, Appendix A.

5.9 Test 5a – DHW Response Time at 70 °C

5.9.1 The appliance has passed the requirements of DHW Response Time at 70°C, Test 5a of the BESA Test Regime as:

5.9.2 The domestic hot water output temperature, t_{32} did not exceed 65 °C for more than 10 seconds.

5.9.3 The DHW response time for t_{32} to reach 45 °C (and not subsequently drop below 42 °C) was 15 seconds; therefore this is a valid keep warm.

5.9.4 The plot of the key metrics of the duration of Test 5a is displayed in Figure 7.13, Appendix A.

5.10 Test 5b – DHW Response Time at 60 °C

5.10.1 The DHW response time for t_{32} to reach 45 °C (and not subsequently drop below 42 °C) was 15 seconds; therefore this is a valid keep warm.

5.10.2 The plot of the key metrics of the duration of Test 5b is displayed in Figure 7.14, Appendix A.

5.11 Overall Scaling Risk Assessment

5.11.1 If any of the below factors occur then the risk of scaling of the DHW plate in hard water areas increases.

Table 5.2 - Overall Scaling Risk Assessment

HIU has a TMV or TRV on the output of the DHW plate heat exchanger.	No	
Test Designation	**2a**	**3c**
t_{32} above 60°C for more than 5 seconds	No	No
t_{12} exceeds 55°C at any point of the test	No	No
Test Designation	**4a**	**4b**
t_{12} exceeds 50°C at any time	No	No

5.12 Test Summary

5.12.1 See Table 7.1 and 7.2, Appendix A for summary of key metrics of all the tests described in this report.

5.13 VWART Calculations

5.13.1 The Volume Weighted Average Return Temperatures (VWART) have been calculated as stipulated in the BESA UK HIU Test Regime document. The calculated VWART values for both the high temperature and low temperature tests described in this report are given below in Table 5.3 and Table 5.4 respectively.

Table 5.3 – High Temperature VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period percentage	SH_{PROP}	7	%
Annual Non-Heating Period percentage	NSH_{PROP}	93	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	40	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	14	°C
Keep-Warm Volume Weight return Temperature	$VWART_{KWM}$	40	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	39	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	26	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	27	°C

Table 5.4 – Low Temperature VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period percentage	SH_{PROP}	7	%
Annual Non-Heating Period percentage	NSH_{PROP}	93	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	35	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	15	°C
Keep-Warm Volume Weight return Temperature	$VWART_{KWM}$	42	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	35	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	31	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	31	°C

6 CONCLUSIONS

6.1.1 The appliance has passed the performance requirements of the BESA HIU Test Regime.

6.1.2 The manufacturers declared low flow rate was 2.1 l/m which is higher than the BESA test rate of 1.2 l/m

6.1.3 The change in q3 (DHW flow rate) during tests 3c and 3b is due to the function of the unit on the HIU test rig.

All conclusions, opinions and interpretations indicated in this report are outside the scope of Enertek's UKAS accreditation.

7 APPENDIX A

7.1 Key Metric Plots

7.1.1 The graphical plots of the key metrics of the tests described in this report are given in this section.

GRAPHICAL PLOTS START ON NEXT PAGE

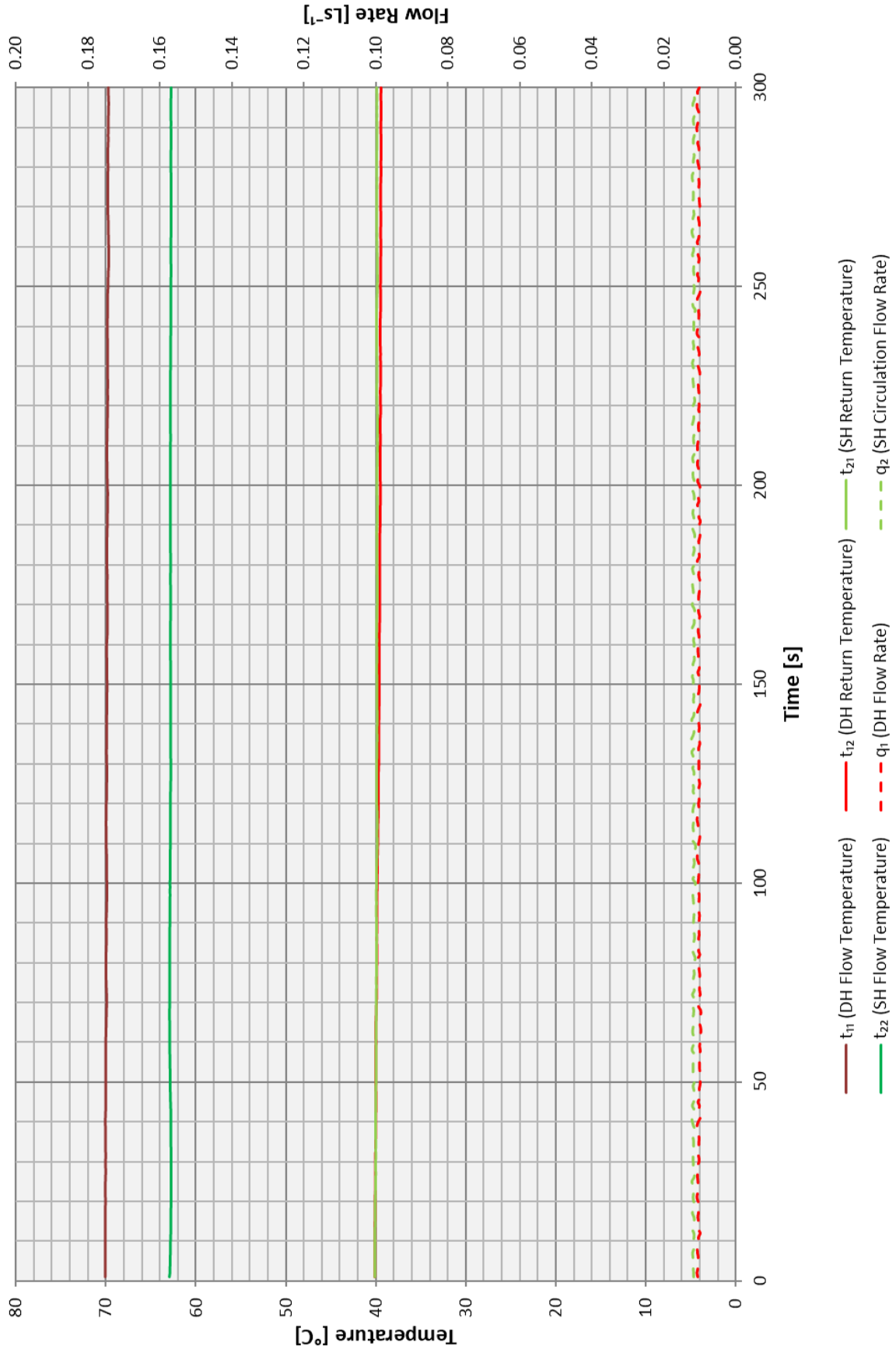

Figure 7.1 - Test 1a – Space Heating 1 kW at 70 °C

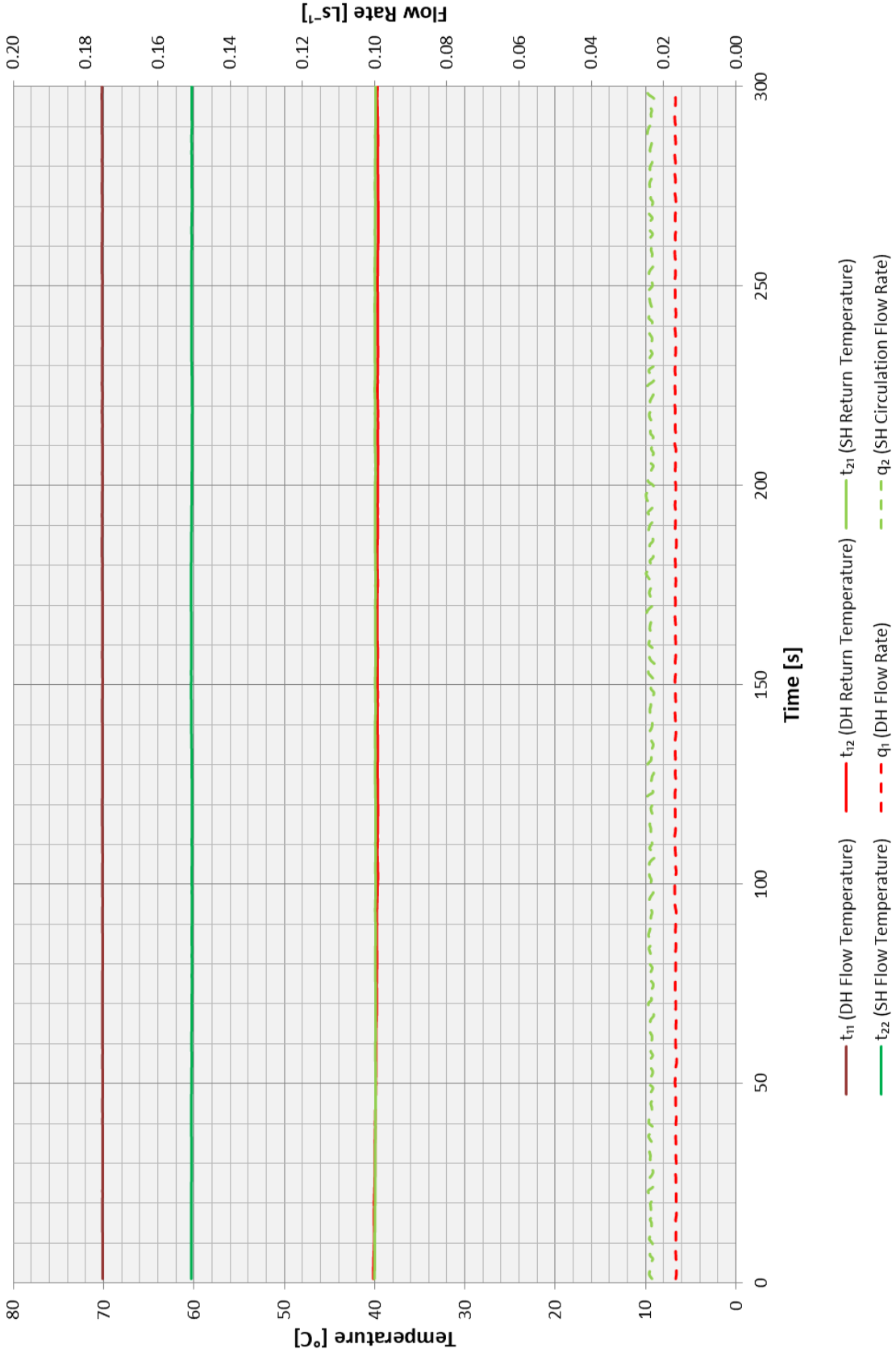

Figure 7.2 - Test 1b – Space Heating 2 kW at 70 °C

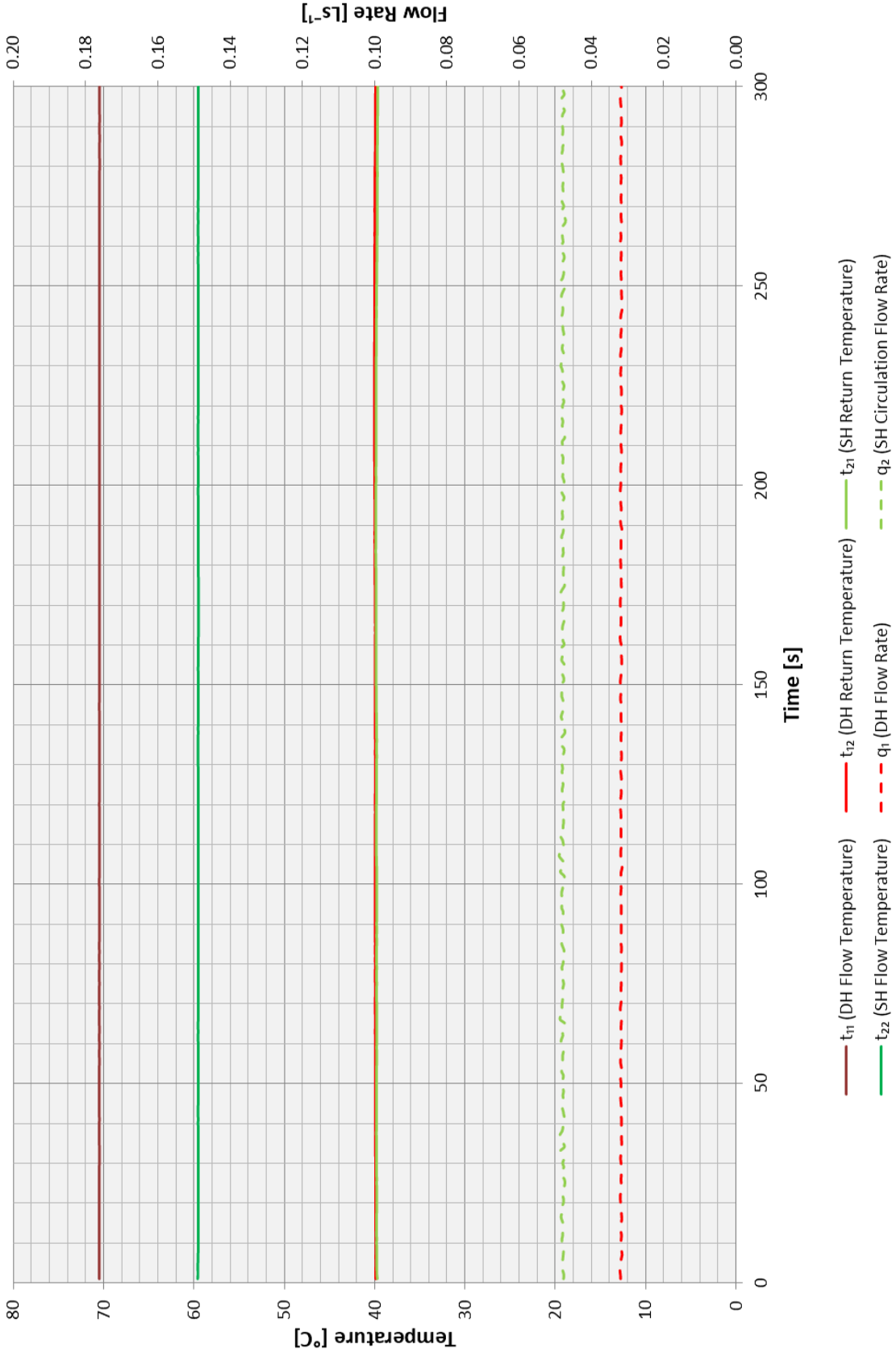

Figure 7.3 - Test 1c – Space Heating 4 kW at 70 °C

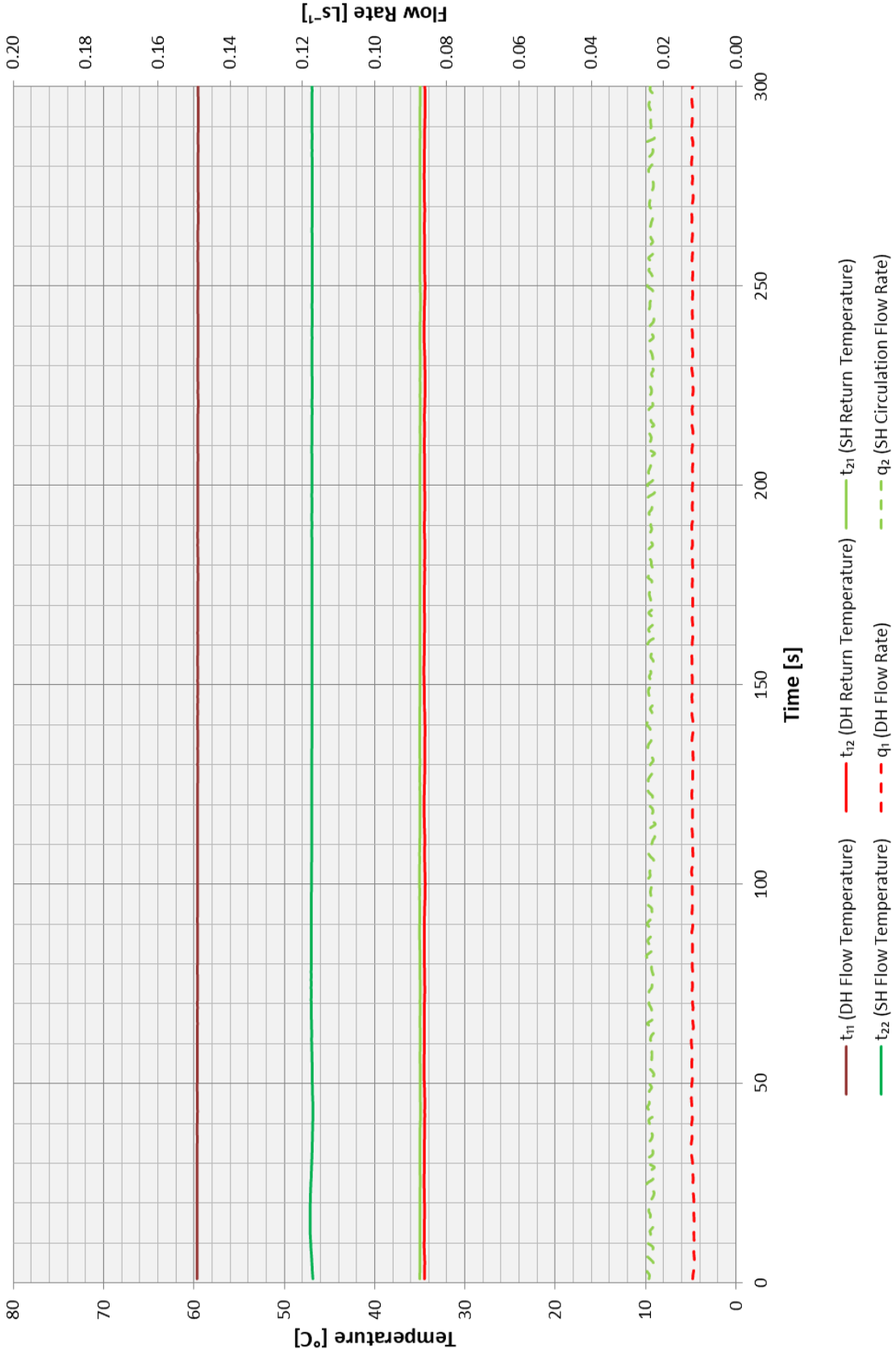

Figure 7.4 - Test 1d – Space Heating 1 kW at 70 °C

Figure 7.5 - Test 1e – Space Heating 2 kW at 60 °C

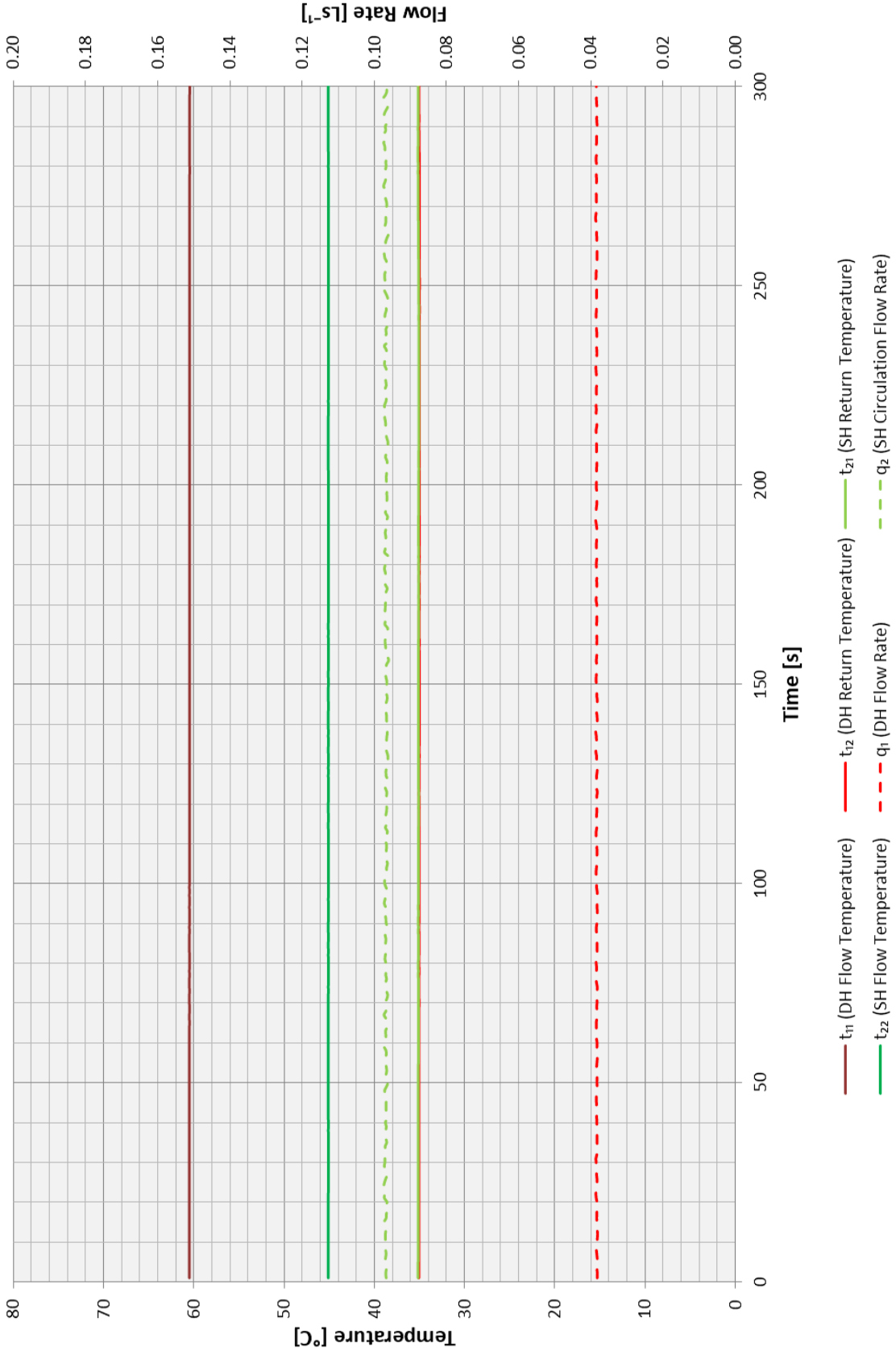

Figure 7.6 - Test 1f – Space Heating 4 kW at 60 °C

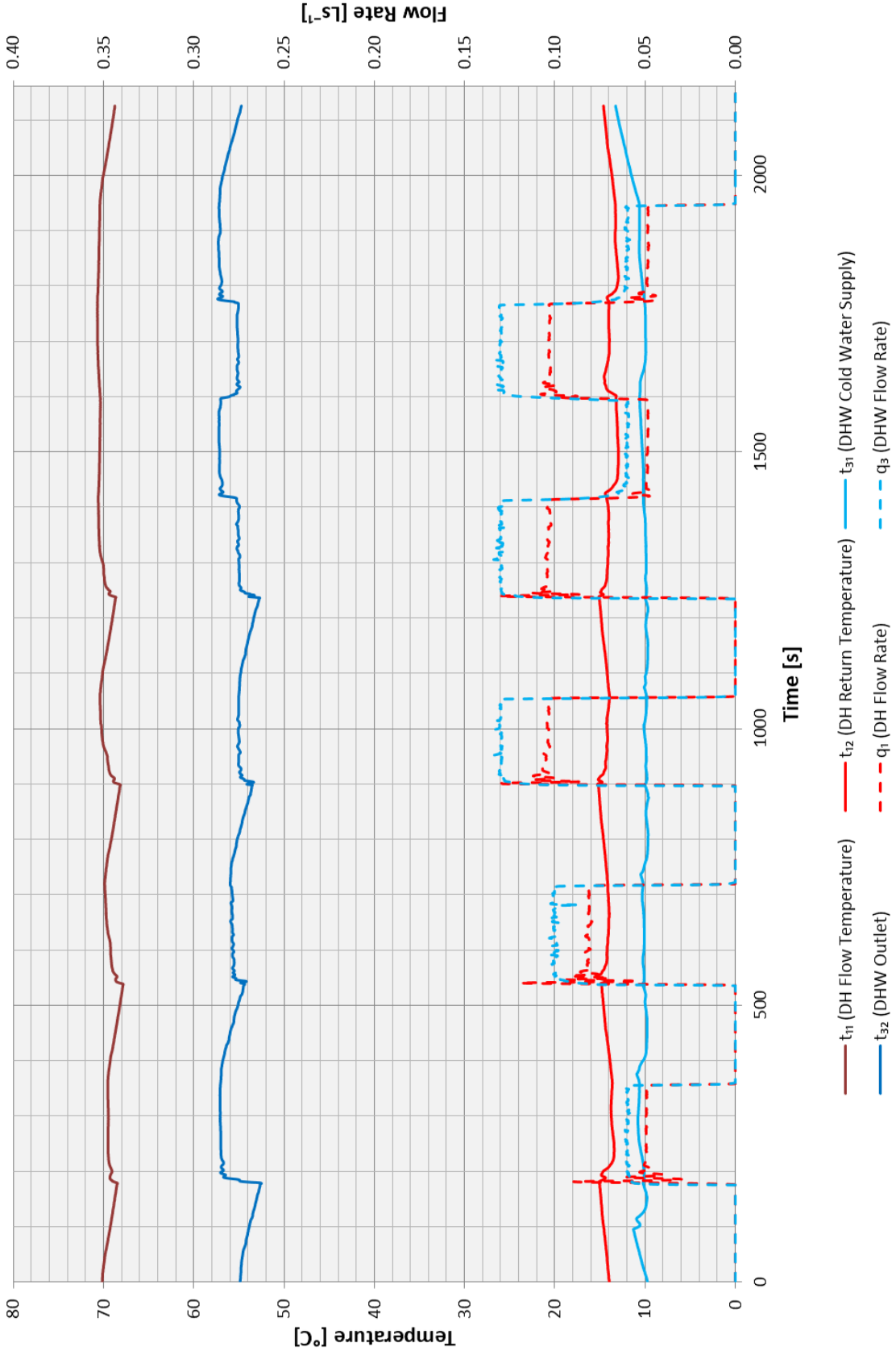

Figure 7.7 - Test 2a – DHW only at 70 °C

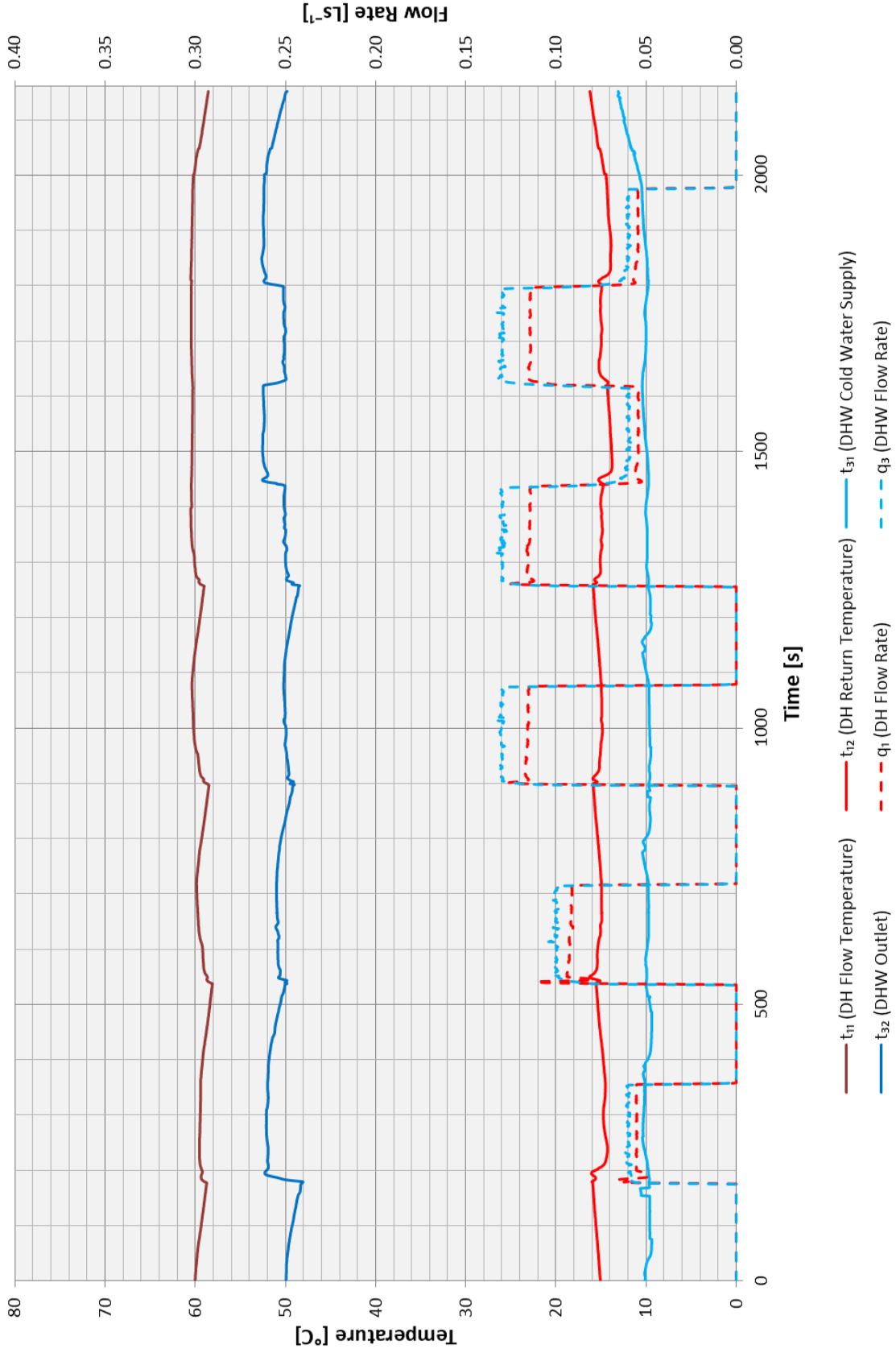

Figure 7.8 - Test 2b – DHW only at 60 °C

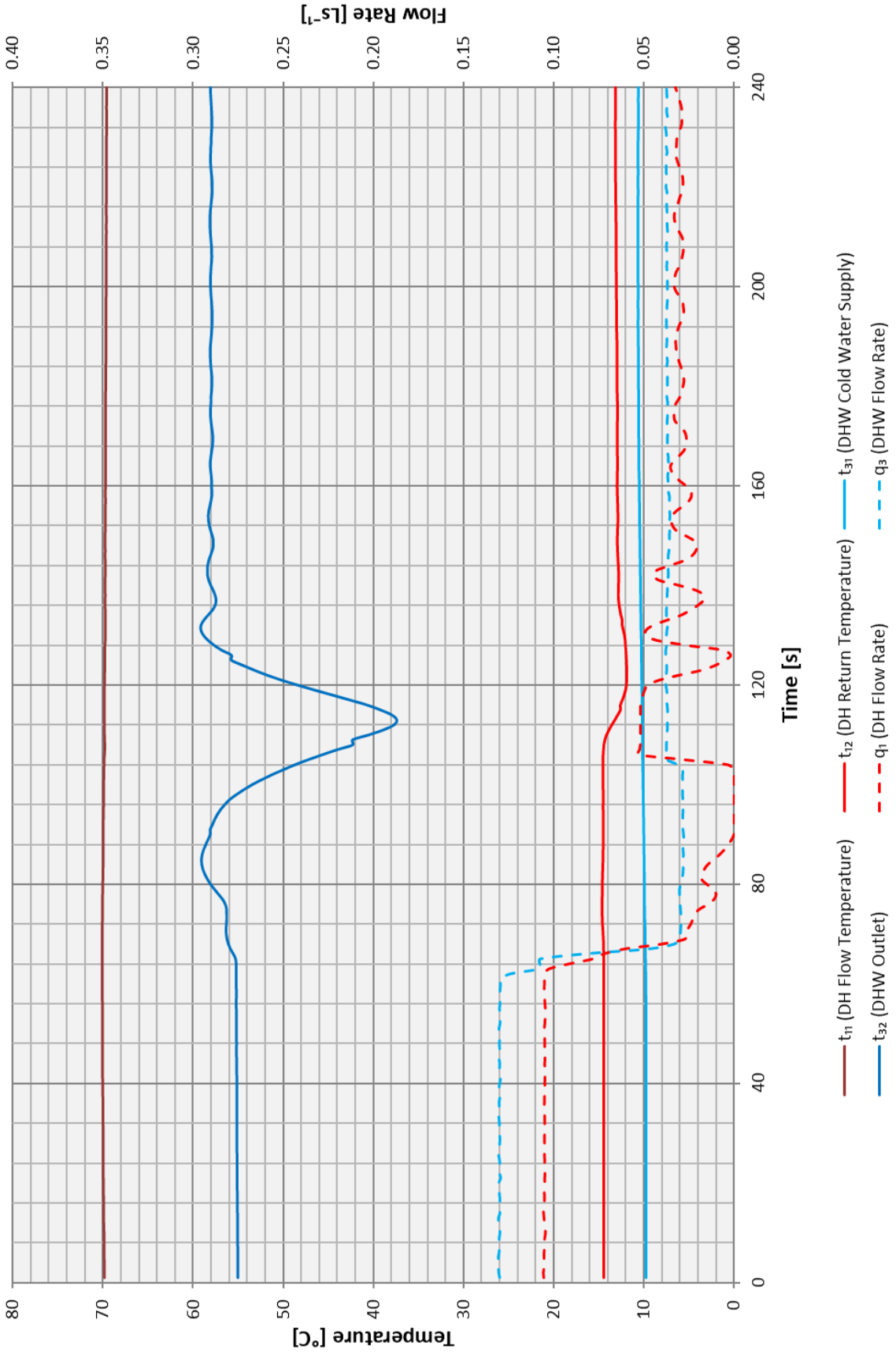

Figure 7.9 - Test 3c – Low Flow DHW at 70 °C

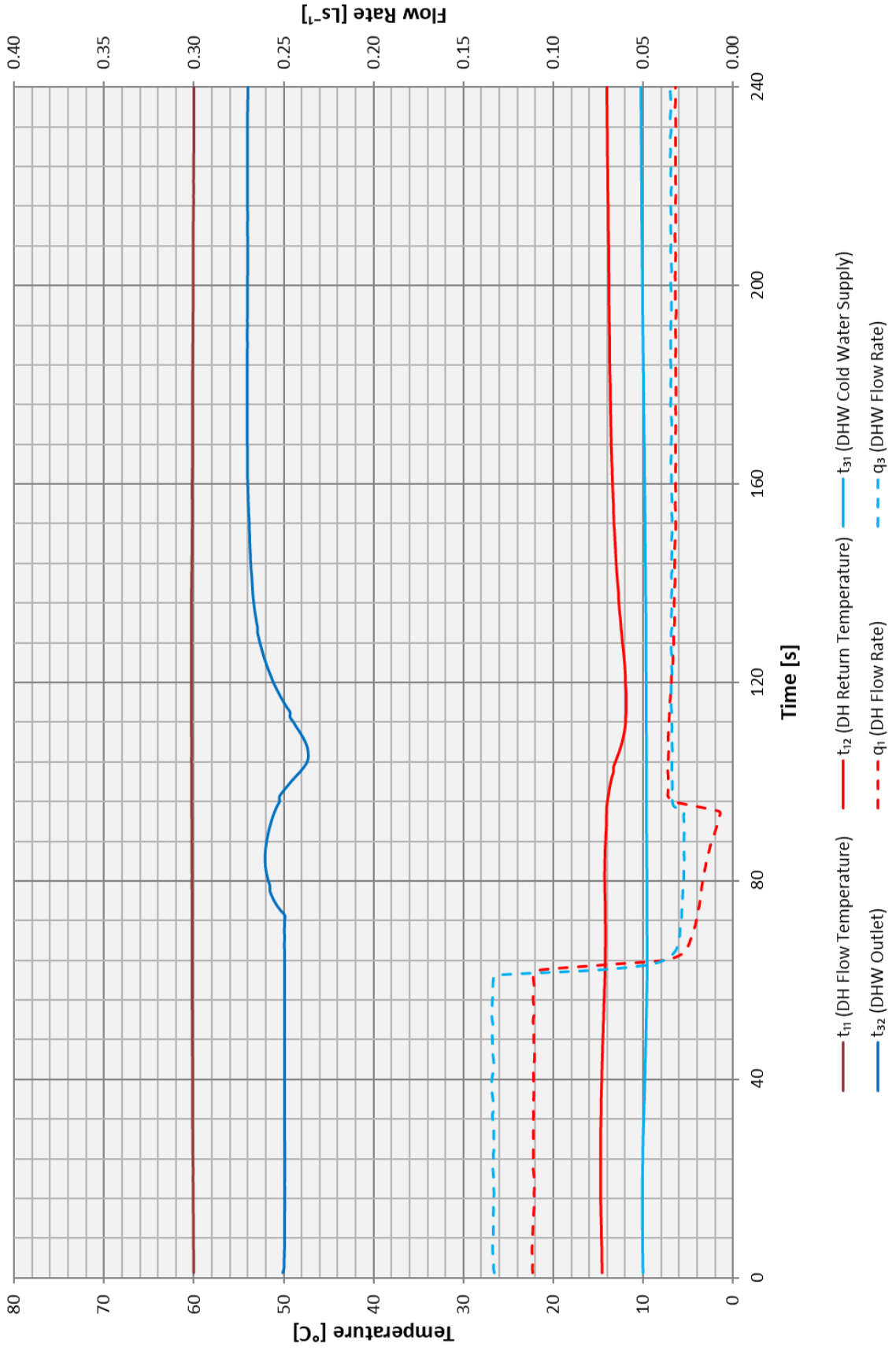

Figure 7.10 - Test 3d – Low Flow DHW at 60 °C

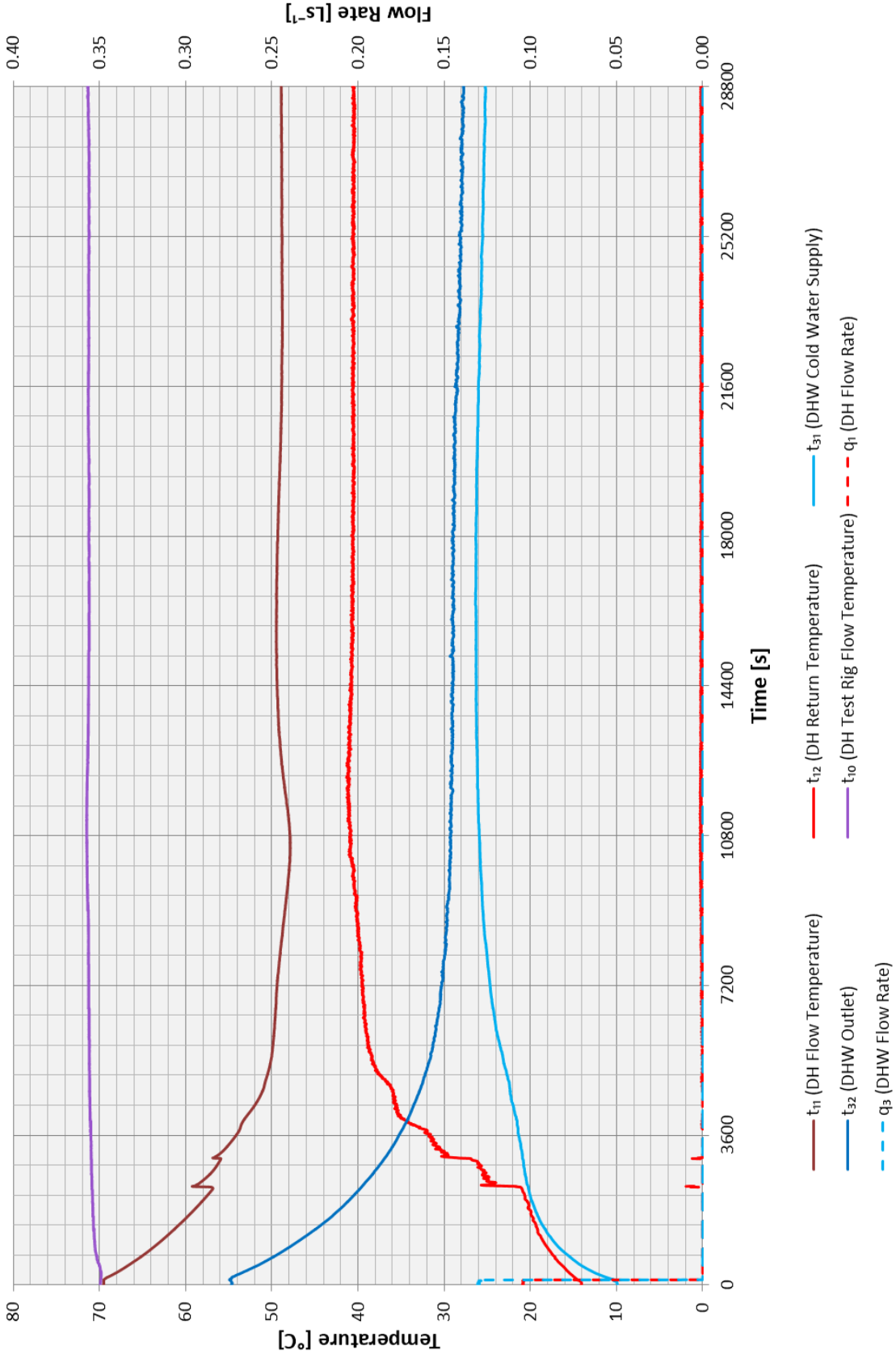

Figure 7.11 - Test 4a – Keep-warm at 70 °C

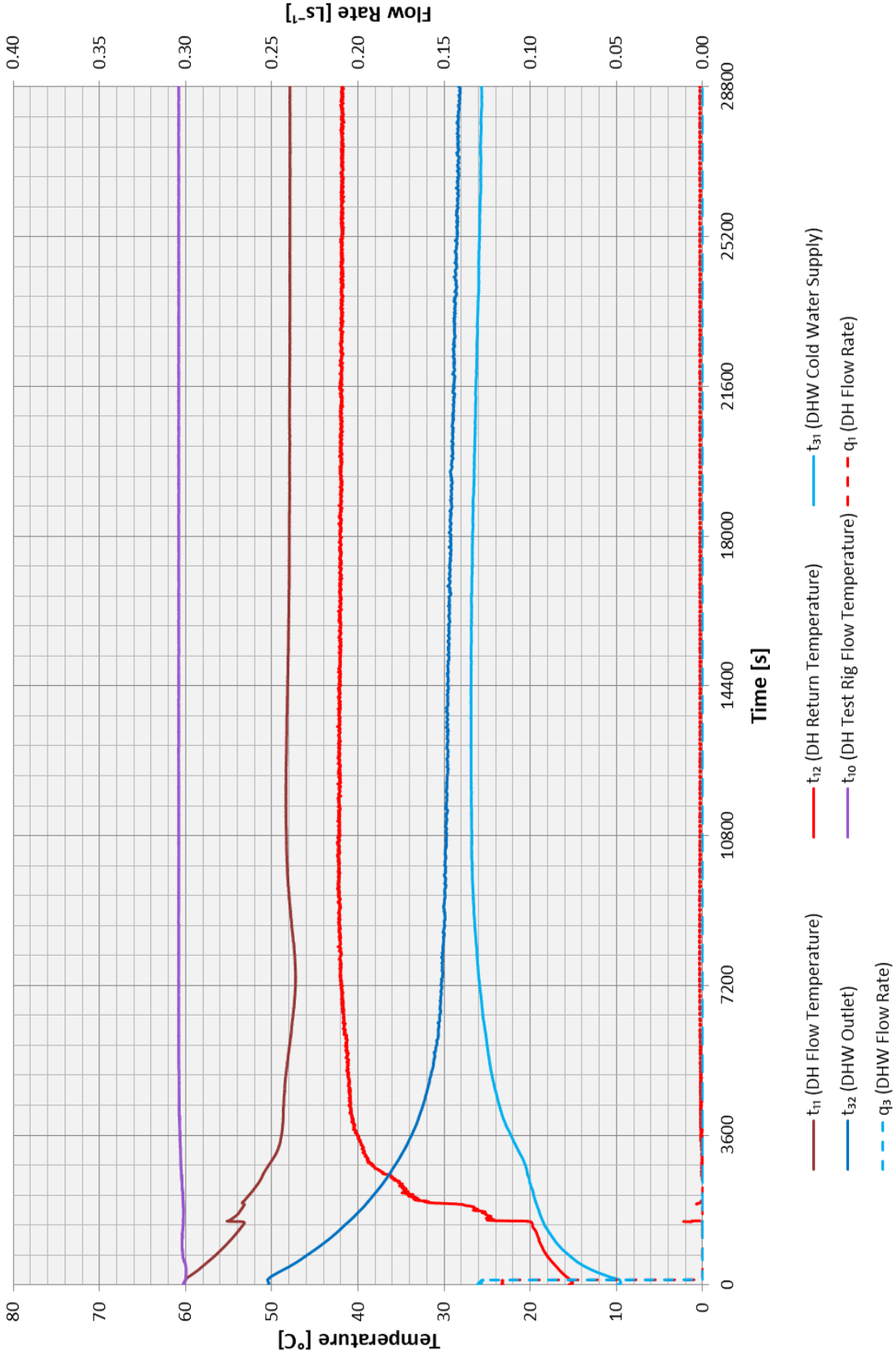

Figure 7.12 - Test 4b – Keep-warm at 60 °C

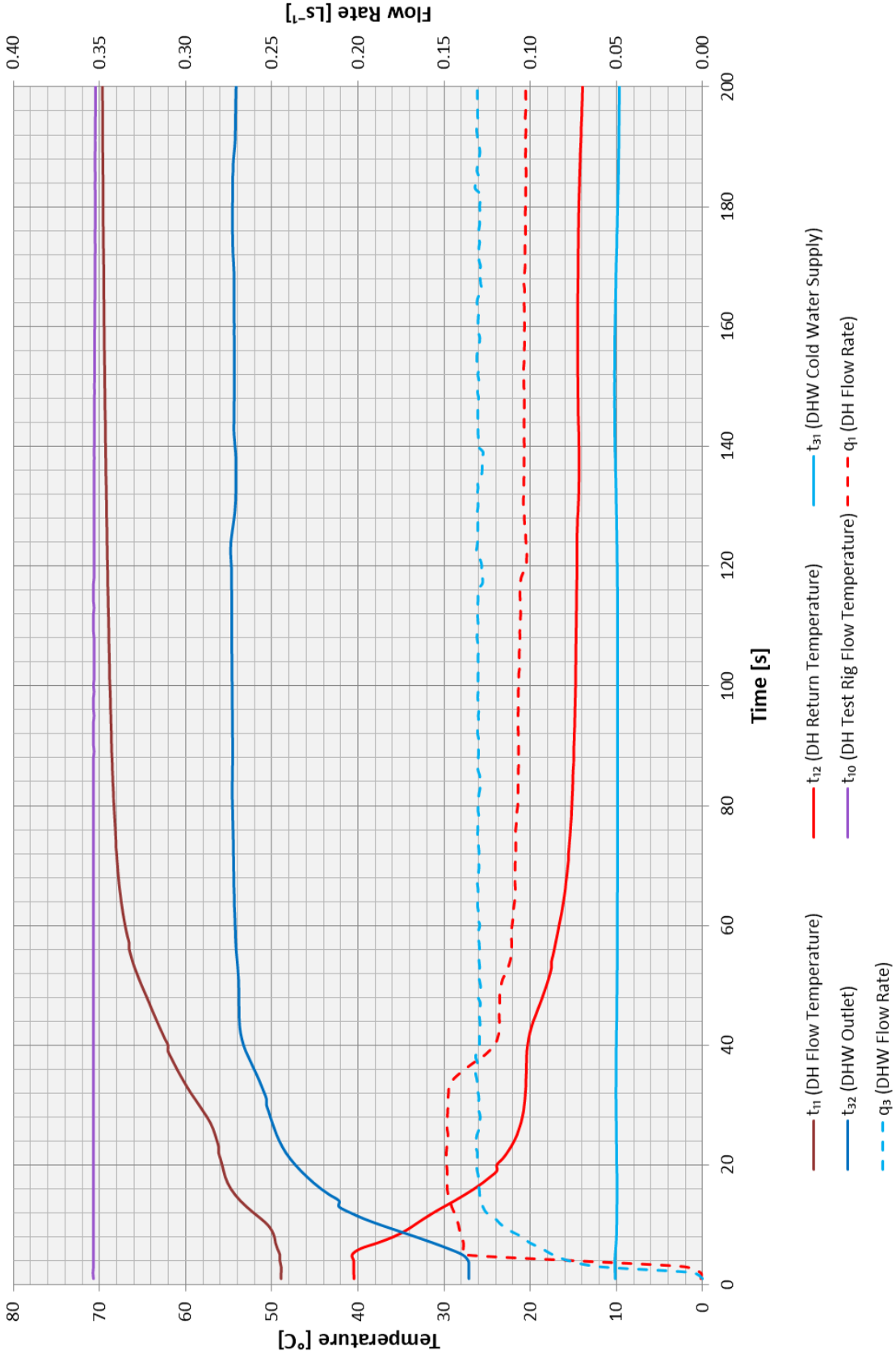

Figure 7.13 - Test 5a – DHW Response Time at 70 °C

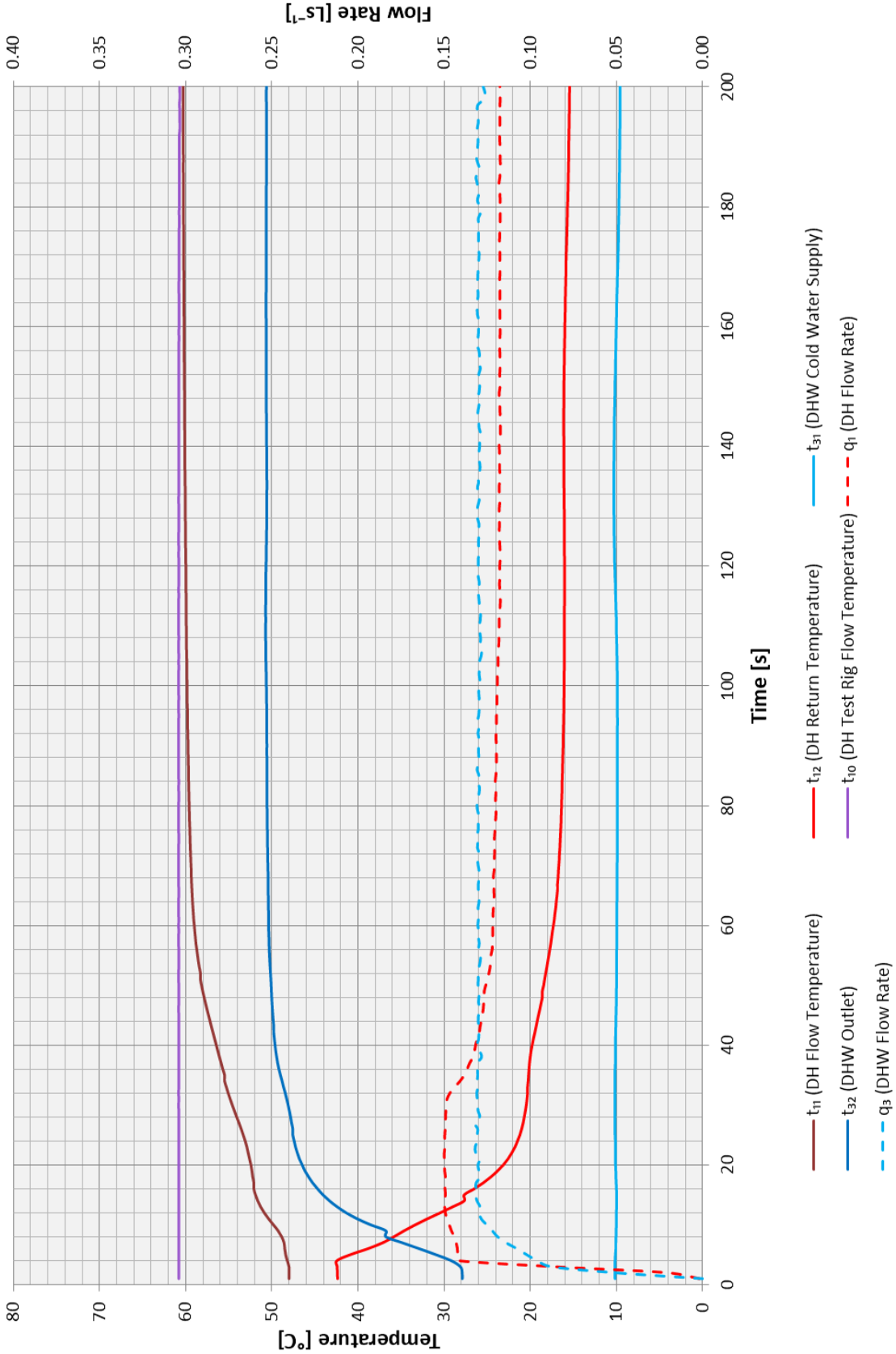

Figure 7.14 - Test 5b – DHW Response Time at 60 °C

7.2 Key Metric and VWART Summary

7.2.1 The summary tables of the key metrics and VWARTs of the tests described in this report are given in this section.

SUMMARY TABLES START ON NEXT PAGE

Enertek International

High Temperature VWART Calculation for vTherm Theromostatic
Primary flow temperature: 70°C; DHW set point: 55°C; Space heating temerpatures: 60°C/40°C
Test carried out by Enertek International for HIGH Temperature BESA Tests
Manufacturer: Vital Energi; Model: vTherm Thermostatic; Serial number: 44100395;
VWART calculation prepared by Ian Williamson of Enertek International on 28 Aug 2019

	VWART(°C)	Volume (m3)
DHW	14	22.6
Standby	40	18.4
Space Heating	40	43.0

	VWART with Keep warm active	
Period	**VWART(°C)**	**% Time**
No Heating	26	93%
Heating	39	7%
Overall	**27**	

	VWART with Keep warm inactive	
Period	**VWART**	**% Time**
No Heating	14	93%
Heating	39	7%
Overall	**16**	

	DHW Draw test results			Post DHW Draw (60 seconds)	
	Power (W)	Primary flow (ls)	VWART (°C)	Primary flow (m^3/hr)	VWART (°C)
Low	11403	0.049	14	0.000	14
Medium	18534	0.081	14	0.000	14
High	21173	0.092	14	0.000	14

DHW Draw Volumes pa		
kWh pa	Hours	Volume pa (m^3)
729	63.93	11.20
297	16.02	4.60
444	20.97	6.90

Post DWH Draw Volumes pa		
Events pa	Average duration (secs)	Volume pa (m^3)
10000	30	-
660	75	-
300	145	-

	Standy test results	
	Primary flow (m^3/hr)	VWART (°C)
Standby	0.002300	40

Standby Volumes pa	
Hours	Volume pa (m^3)
8,033	18.40

	Space Heating test results		
	Power (W)	Primary flow (m^3/hr)	VWART (°C)
1kWp	1296	0.010	40
2kWp	2141	0.017	40
4kWp	4079	0.032	40

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m^3)
98	91.00	3.20
787	392.00	23.70
565	143.00	16.40

Table 7.1 - Key Metrics of High Temperature Package

Low Temperature VWART Calculation for vTherm Theromostatic
Primary flow temperature: 60°C; DHW set point: 50°C; Space heating temerpatures: 45°C/35°C
Test carried out by Enertek International for HIGH Temperature BESA Tests
Manufacturer: Vital Energi; Model: vTherm Thermostatic; Serial number: 44100395;
VWART calculation prepared by Ian Williamson of Enertek International on 28 Aug 2019

	VWART(°C)	Volume (m3)
DHW	15	28.1
Standby	42	40.5
Space Heating	35	50.9

	VWART with Keep warm active	
Period	**VWART(°C)**	**% Time**
No Heating	31	93%
Heating	35	7%
Overall	**31**	

	VWART with Keep warm inactive	
Period	**VWART**	**% Time**
No Heating	15	93%
Heating	34	7%
Overall	**16**	

	DHW Draw test results			Post DHW Draw (60 seconds)	
	Power (W)	Primary flow (ls)	VWART (°C)	Primary flow (m^3/hr)	VWART (°C)
Low	10249	0.055	15	0.000	15
Medium	16739	0.091	15	0.000	15
High	21317	0.115	15	0.000	15

DHW Draw Volumes pa		
kWh pa	Hours	Volume pa (m^3)
729	70.00	13.90
297	18.00	5.80
444	21.00	8.50

Post DWH Draw Volumes pa		
Events pa	Average duration (secs)	Volume pa (m^3)
10000	30	-
660	75	-
300	145	-

	Standy test results	
	Primary flow (m^3/hr)	VWART (°C)
Standby	0.005000	40

Standby Volumes pa	
Hours	Volume pa (m^3)
8,079	40.50

	Space Heating test results		
	Power (W)	Primary flow (m^3/hr)	VWART (°C)
1kWp	1277	0.012	34
2kWp	2346	0.022	35
4kWp	4103	0.038	35

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m^3)
98	83.00	3.60
787	349.00	27.90
565	140.00	19.40

Table 7.2 - Key Metrics of Low Temperature Package

VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period Percentage	SH_{PROP}	7.1	%
Annual Non-Heating Period Percentage	NSH_{PROP}	92.9	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	40	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	14	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	40	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	39	°C
Annual Volume Weighted Return Temperature For Non-Heating	$VWART_{NONHEAT}$	26	°C
Total Annual Volume Weighted Return Temperature	$VWART_{HIU}$	27	°C

Clause 5.13.1, Table 5.3

Table 7.3 – High Temperature VWART Calculations

VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period Percentage	SH_{PROP}	6.5	%
Annual Non-Heating Period Percentage	NSH_{PROP}	93.5	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	35	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	15	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	42	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	35	°C
Annual Volume Weighted Return Temperature For Non-Heating	$VWART_{NONHEAT}$	31	°C
Total Annual Volume Weighted Return Temperature	$VWART_{HIU}$	31	°C

Clause 5.13.1, Table 5.4

Table 7.4 – Low Temperature VWART Calculations

8 APPENDIX B

8.1 Appliance Documentation

8.1.1 The details of the appliance documentation are given in Table 8.1 below.

Table 8.1 – Documentation Supplied

	Component:	Document Submitted (Y/N):	Manufacturer and type:
1	Space Heating Heat Exchanger	Yes	SWEP E8 LAS
2	Domestic Hot Water Heat Exchanger	Yes	SWEP E8 LAS
3	Controller for Space Heating	Yes	Frese Compact DN15 2.5
4	Control Valve and Actuator for Space Heating	Yes	Frese Thermostatic Actuator
5	Space Heating Strainer	Yes	Strainer 0.5mm
6	Controller for Domestic Hot Water	n/a	n/a
7	Control Valve and Actuator for Domestic Hot Water	Yes	Danfoss ABQM and QT Actuator
8	Temperature Sensors	n/a	n/a
9	Domestic Hot Water Isolating Valve	Yes	Bonomi PN40 DN20 Ball Valve
10	Primary Side Strainer	Yes	Strainer 0.5mm
11	Drain Valves	Yes	Tongsheng Brass Co. ½" PN16
12	Vent Valves	n/a	n/a
13	Circulation Pump set with AAV & PRV	Yes	Grundfos pump UPM3 15-70, 130 Auto
14	Heat Meter	Yes	Sharky 775 heat meter DN15
15	Domestic Hot Water Flow Sensor	n/a	n/a
16	Pipes	Yes	SS 304 – Primary & Heating / SS 316 MCW & DHW
17	Connections	Yes	Brass
18	Joints	Yes	Brass
19	Gaskets	Yes	Non-WRAS Approved: Klingersil C-4500 fibre washer WRAS Approved: Centellen HD 3820 fibre washer
20	Expansion Vessel	Yes	Cimm RP220 550 10
21	Insulation	Yes	ARPRO 5135 EPP Casing
22	Pressure Sensors	n/a	n/a
A1	'O' Ring	n/a	n/a
A2	Commissioning guide.	No	
A3	Operation guides with a function description / description of operation and care instructions as suited to the intended user category.	No	
A4	Declaration of Conformity for CE-marked HIUs.	Yes	
A5	Full parameter list for electrically controlled HIUs.		n/a
A6	Maximum primary operating differential pressure.		2 bar
A7	Deactivation procedure of the internal SH pump.		n/a
	Model name and type number		vTherm Thermostatic
	Serial number		44100429

8.2 Appliance Components

8.2.1 Details of the main appliance components are given in Table 8.2.

Table 8.2 – Appliance Components details

vTherm Thermostatic HIU	
Appliance Serial Number	44100429
Space Heating Heat Exchanger	SWEP E8 LAS
Domestic Hot Water Heat Exchanger	SWEP E8 LAS
Controller for Space Heating	Frese Compact DN15 2.5
Control Valve & Actuator for Space Heating	Frese Compact DN15 2.5 and Thermostatic Actuator
Controller for Domestic Hot Water	n/a
Temperature Sensors	n/a
Domestic Hot Water Isolating valve	Bonomi PN40 DN20 Ball Valve
Primary Side Strainer	Strainer 0.5mm
Circulation Pump	Grundfos pump UPM3 15-70, 130 Auto
Heat Meter	Sharky 775 heat meter DN15
Domestic Hot Water Flow Sensor	n/a
Pipes	SS 304 – Primary & Heating / SS 316 MCW & DHW
Connections	Brass
Gaskets	Non-WRAS Approved: Klingersil C-4500 fibre washer WRAS Approved: Centellen HD 3820 fibre washer
Expansion Vessel	CIMM RP220x550 10 Litre
Pressure Sensors	n/a
Insulation	ARPRO 5135 EPP Casing

8.3 Appliance Photographs

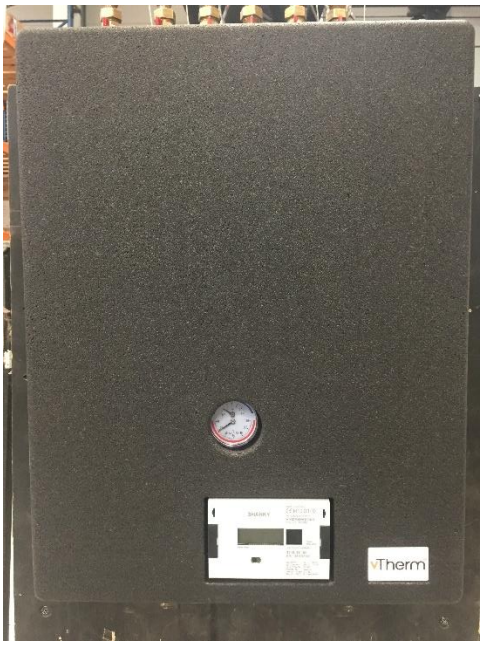

Figure 8.1 – Photograph of Appliance [Case Fitted]

Figure 8.2 – Photograph of Appliance [Case Removed]

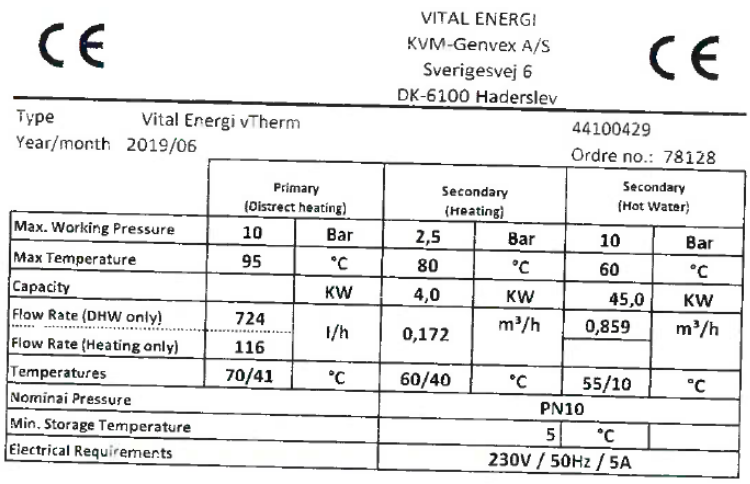

Figure 8-3 – Appliance Data Label

8.4 Calibrations and uncertainties

8.4.1 A list of equipment, their calibrations and uncertainties are given in Table 8.3 below.

Table 8.3 - EIL Equipment Calibration and Uncertainties

Equipment Name	ID Number	Calibration Certificate	Measurement Uncertainty K=2 $\frac{U}{\sqrt{20}}$	Units	Calibration Date	Calibration Due
Flow Meter [Primary Flow Rate]	FM 601	U99513-19	±0.0004	l/s	26-06-2019	26/06/2020
Flow Meter [DHW Flow Rate]	FM 602	U98515-19	±0.00305	l/s	26-06-2019	26/06/2020
Flow Meter [SH Flow Rate]	FM 603	U98530-19	±0.04871	l/s	27-06-2019	27/06/2020
Flow Meter [DHW Flow Rate]	FM 605	U98539-19	±0.00576	l/s	28-06-2019	28-06-2020
Pressure Transducer [Primary Supply]	PT 086	U98458-19	±6.82	kPa	22-06-2019	22/06/2020
Pressure Transducer [Primary Return]	PT 085	U98460-19	±7.88	kPa	22-06-2019	22/06/2020
Pressure Transducer [DHW Output Pressure]	PT 083	U98469-19	±7.73	kPa	23-06-2019	23/06/2020
Pressure Transducer [DHW Cold Water Supply]	PT 084	U98468-19	±7.31	kPa	23-06-2019	23/06/2020
Pressure Transducer [SH Flow]	PT 087	U98463-19	±7.26	kPa	22-06-2019	22/06/2020
Pressure Transducer [SH Return]	PT 088	U98461-19	±7.30	kPa	22-06-2019	22/06/2020

Equipment Name	ID Number	Calibration Certificate	Measurement Uncertainty K=2 $\frac{U}{\sqrt{20}}$	Units	Calibration Date	Calibration Due
PRT Probe [Primary Supply Temp]	PRT 4709	EIL 436771	±0.4	°C	31/07/2019	31/07/2020
PRT Probe [Primary Return Temp]	PRT 4708	EIL 436771	±0.4	°C	31/07/2019	31/07/2020
PRT Probe [DHW Output Temp]	PRT 4711	EIL 436772	±0.4	°C	31/07/2019	31/07/2020
PRT Probe [Cold Water Supply Temp]	PRT 4710	EIL 436771	±2.2	°C	31/07/2019	31/07/2020
PRT Probe [SH Supply Temp]	PRT 4707	EIL 436771	±0.4	°C	31/07/2019	31/07/2020
PRT Probe [SH Return Temp]	PRT 4706	EIL 436771	±0.5	°C	31/07/2019	31/07/2020
Pressure Transducer [Static Pressure Test]	PT 078	K41178P	±9.31	kPa	25/05/2018	25/08/2019
Software	VERSION – LabVIEW, Version 5 , Service pack 1					

Report Issue No	Reason for Report Update
1	Original Issue

Report Template Issue No	Reason for Report Update
1	Original Issue
1.1	Formatting changes, updates to meet new BESA requirements

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