Enertek International

International Consultants In Product Research, Design, Development & Certification

Project Number:	E4322
Project Title:	BESA Testing for Heatlink HL3000-E
Client:	Heatlink
Client Address	2a Baxter Road Sheffield S6 1JF United Kingdom
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1 BRIEF

1.1.1 Enertek international Limited (EIL), were contracted to receive, install and commission a production sample, HL3000-E on behalf of Heat link

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 HL3000-E appliance are given in Table 3.1. Photograph of the installed appliance is given in Figure 8.1.

3.2 Design Pressures

3.2.1 The maximum design pressures of the HL3000-E appliance are given for the primary side and the secondary side for both Space Heating and DHW in Table 3.2.

3.3 Design temperatures

3.3.1 The maximum design temperatures of the HL3000-E appliance are given for the primary side and the secondary side for both Space Heating and DHW in Table 3.3

Table 3.1 – Appliance Details

Item	Description
Manufacturer	Heatlink
Model	HL3000-E
Serial number	696-00003
Year of manufacture	2019
DHW priority	Yes

Table 3.2 – Appliance Design Pressures

Item	Value	Unit
Primary Side	16	Bar
Secondary Side space Heating	2.5	Bar
Secondary Side DHW	9.5	Bar

Table 3.3 – Appliance Design Temperatures

Item	Value	Unit
Primary Side	90	°C
Secondary Side space Heating	85	°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 Heatlink, HL3000-E 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)

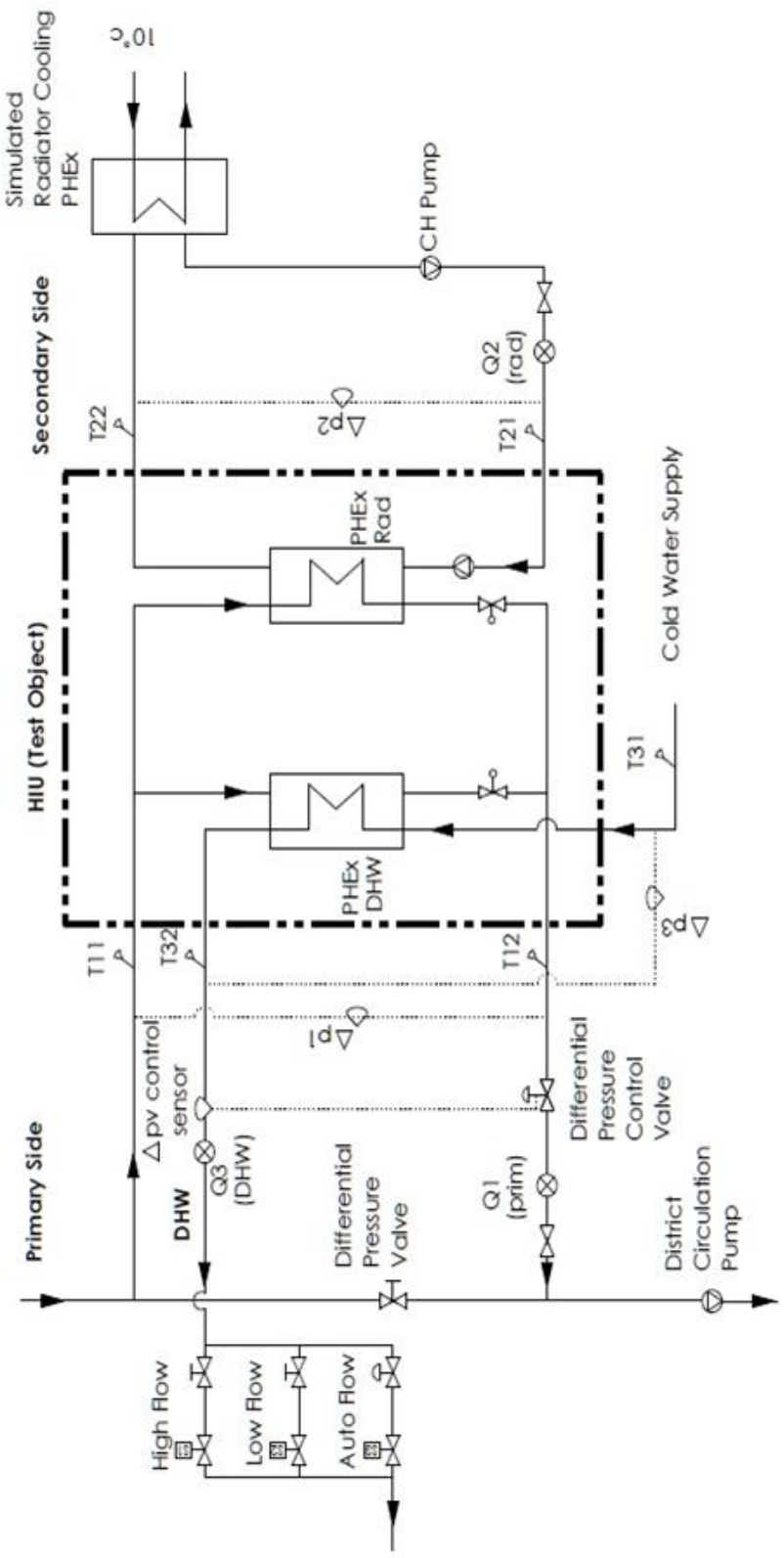

Figure 4.1 – EIL's HIU Test Rig schematic

Table 4.1 – Setup of tests (extracted from BESA Test Regime)

No	Test	static pressure on return	dP across HIU	Primary flow temp	DHW setpoint	DHW flow rate	DHW power	SH output	SH flow temp	SH return temp
		bar	bar	°C	°C	l/s	kW	kW	°C	°C
			dP_1	t_{11}	t_{32}	q_3	P_3	P_2	t_{22}	t_{21}
Static tests										
0a	Static pressure test (same static pressure on both flow and return connections)	1.43 times rated value	1.43 times rated value	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1a	Space Heating 1 kW (DH 70 °C flow)	2.5	0.5	70	55	0	0	1	60	40
1b	Space Heating 2 kW (DH 70 °C flow)	2.5	0.5	70	55	0	0	2	60	40
1c	Space Heating 4 kW (DH 70 °C flow)	2.5	0.5	70	55	0	0	4	60	40
1d	Space Heating 1 kW (DH 60 °C flow)	2.5	0.5	60	50	0	0	1	45	35
1e	Space Heating 2 kW (DH 60 °C flow)	2.5	0.5	60	50	0	0	2	45	35
1f	Space Heating 4 kW (DH 60 °C flow)	2.5	0.5	60	50	0	0	2	45	35
Dynamic tests										
2a	DHW only (DH 70 °C flow)	2.5	0.5	70	55	DHW test profile	DHW test profile	0	n/a	n/a
2b	DHW only (DH 60 °C flow)	2.5	0.5	60	50	DHW test profile	DHW test profile	0	n/a	n/a
3a	Low flow DHW (DH 70 °C flow)	2.5	0.5	70	55	0.02	Record value	0	n/a	n/a
3b	Low flow DHW (DH 60 °C flow)	2.5	0.5	60	50	0.02	Record value	0	n/a	n/a
4a	Keep-warm (DH 70 °C flow)	2.5	0.5	70	55	0	0	0	n/a	n/a
4b	Keep-warm (DH 60 °C flow)	2.5	0.5	60	50	0	0	0	n/a	n/a
5a	DHW response time (DH 70 °C flow)	2.5	0.5	70	55	0.13	Record value	0	n/a	n/a
5b	DHW response time (DH 60 °C flow)	2.5	0.5	60	50	0.13	Record value	0	n/a	n/a

Table 4.2 – Test Reporting, adapted from BESA Test Regime

Test	Description	Reporting
Static Tests		
0	Pressure Tests.	Pass/Fail as to whether HIU manages pressure test without leaks or damage.
1a	Space heating 1 kW, 60/40 °C secondary.	$\mathbf{t_{11}}$ – Primary flow temperature. $\mathbf{t_{12}}$ – 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.	$\mathbf{t_{11}}$ – Primary flow temperature. $\mathbf{t_{12}}$ – 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.	
Dynamic Tests		
2a	DHW only, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at $\boldsymbol{t_{32}}$) 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 $\mathbf{t_{32}}$, $\mathbf{t_{31}}$, $\mathbf{q_3}$, $\mathbf{t_{12}}$, $\mathbf{q_1}$
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. Plot $\mathbf{q_1}$, $\mathbf{q_3}$, $\mathbf{dp_1}$, $\mathbf{dp_3}$ **Note:** Outputs used as input data to 'Low Temperature' Domestic Hot Water Volume Weighted Average Return Temperature calculation.
3a	Low flow DHW, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at $\mathbf{t_{32}}$) 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. Assessment of scaling risk as per criteria detailed in 2.26. 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.
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. 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. Maximum temperature achieved and +/-°C variance around 50.0°C (1 decimal place) to be stated.
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. Plot temperature t_{10}

		Assessment of scaling risk, based on duration of temperatures in excess of 55.0 °C (1 decimal place). Comment on HIU keep-warm controls options. Plot of key metrics over duration of test. 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.
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. Assessment of scaling risk based on extent and duration of temperatures in excess of 55.0 °C (1 decimal place). Comment on HIU keep-warm controls options. Plot of key metrics over duration of test. 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.
5a	DHW response time, DH 70 °C flow; 55 °C DHW.	Pass/Fail on DHW (at $\mathbf{t_{32}}$) 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 $\mathbf{t_{32}, t_{31}, t_{12}, q_1}$
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 $\mathbf{t_{32}, t_{31}, t_{12}, q_1}$ 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 22.88 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 22.88 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				
		t_{11} *°C*	t_{12} *°C*	q_1 *l/s*	Δp_1 *kPa*	P_1 *W*	t_{21} *°C*	t_{22} *°C*	q_2 *l/s*	Δp_2 *kPa*	P_2 *W*
1a	- 1 kW Space Heating (DH 70 °C flow)	70.1	42.2	0.010	53.9	1167	39.8	59.6	0.012	1.4	959
1b	- 2 kW Space Heating (DH 70 °C flow)	70.1	41.9	0.018	53.3	2115	39.9	59.6	0.024	1.0	1945
1c	- 4 kW Space Heating (DH 70 °C flow)	70.4	42.1	0.034	49.6	4066	40.0	59.8	0.048	0.7	3961
1d	- Space Heating 1 kW (DH 60 °C flow)	60.2	36.3	0.011	57.0	1124	35.0	44.7	0.025	1.0	1013
1e	- Space Heating 2 kW (DH 60 °C flow)	60.3	36.2	0.021	55.7	2093	35.3	45.1	0.050	1.0	2037
1f	- Space Heating 4 kW (DH 60 °C flow)	60.0	36.1	0.040	49.8	3954	35.2	45.1	0.096	5.6	3969

5.3 Test 2a – DHW only 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 57.9°C and 41.2°C respectively.

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

5.4 Test 2b – DHW only at 60 °C

5.4.1 The maximum and minimum temperatures of t_{32} were 51.4°C and 37.7°C respectively.

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

5.5 Test 3a – Low Flow DHW at 70 °C

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

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

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

5.5.4 The maximum and minimum temperatures of t_{32} were 60.97°C and 52.02°C respectively.

5.5.5 The plot of the key metrics of the duration of Test 3a is displayed in Figure 7.9, Appendix.

5.6 Test 3b – Low Flow DHW at 60 °C

5.6.1 The appliance did 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 54.64°C and 47.17°C respectively.

5.6.3 The plot of the key metrics of the duration of Test 3b is displayed in Figure 7.10, Appendix.

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 appliance is not performing keep-warm function as no cycling was observed.

5.7.5 The DHW output temperature, t_{32} was in excess of 55 °C for a total of 0 seconds throughout the duration of the test.

5.7.6 The average heat load on the primary side P_1 is 22 W.

5.7.7 The average primary flow q_1 over the 8 hour test was 1.6 l/hr.

5.7.8 The Keep-warm control was set to 43 on 42 off on the heat interface unit controller.

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

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 appliance is not performing a keep-warm function as no cycling was observed.

5.8.5 The DHW output temperature, t_{32} was in excess of 55 °C for a total of 0 seconds throughout the duration of the test.

5.8.6 The average heat load on the primary side P_1 is 38.1 W.

5.8.7 The average primary flow q_1 over the 8 hour test was 4.579 l/hr.

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

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.

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.

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**	**3a**
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 Table 7.2, Appendix for the 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

Symbol	Description	Value
SH_{PROP}	Annual Heating Period percentage	7.4
NSH_{PROP}	Annual Non-Heating Period percentage	92.6
$VWART_{SH}$	Space Heating Volume Weighted Return Temperature	42
$VWART_{DHW}$	DHW Volume Weighted Return Temperature	16
$VWART_{KWM}$	Keep Warm Volume Weight return Temperature	39
$VWART_{HEAT}$	Annual Volume Weighted Return Temperature For Heating Period	41
$VWART_{NONHEAT}$	Annual Volume Weighted Return Temperature For Non Heating	25
$VWART_{HIU}$	Total Annual Volume Weighted Return Temperature	26

Table 5.4 – Low Temperature VWART Calculations

Symbol	Description	Value
SH_{PROP}	Annual Heating Period percentage	7.1
NSH_{PROP}	Annual Non-Heating Period percentage	92.9
$VWART_{SH}$	Space Heating Volume Weighted Return Temperature	36
$VWART_{DHW}$	DHW Volume Weighted Return Temperature	16
$VWART_{KWM}$	Keep Warm Volume Weight return Temperature	42
$VWART_{HEAT}$	Annual Volume Weighted Return Temperature For Heating Period	36
$VWART_{NONHEAT}$	Annual Volume Weighted Return Temperature For Non Heating	31
$VWART_{HIU}$	Total Annual Volume Weighted Return Temperature	31

6 CONCLUSIONS

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

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

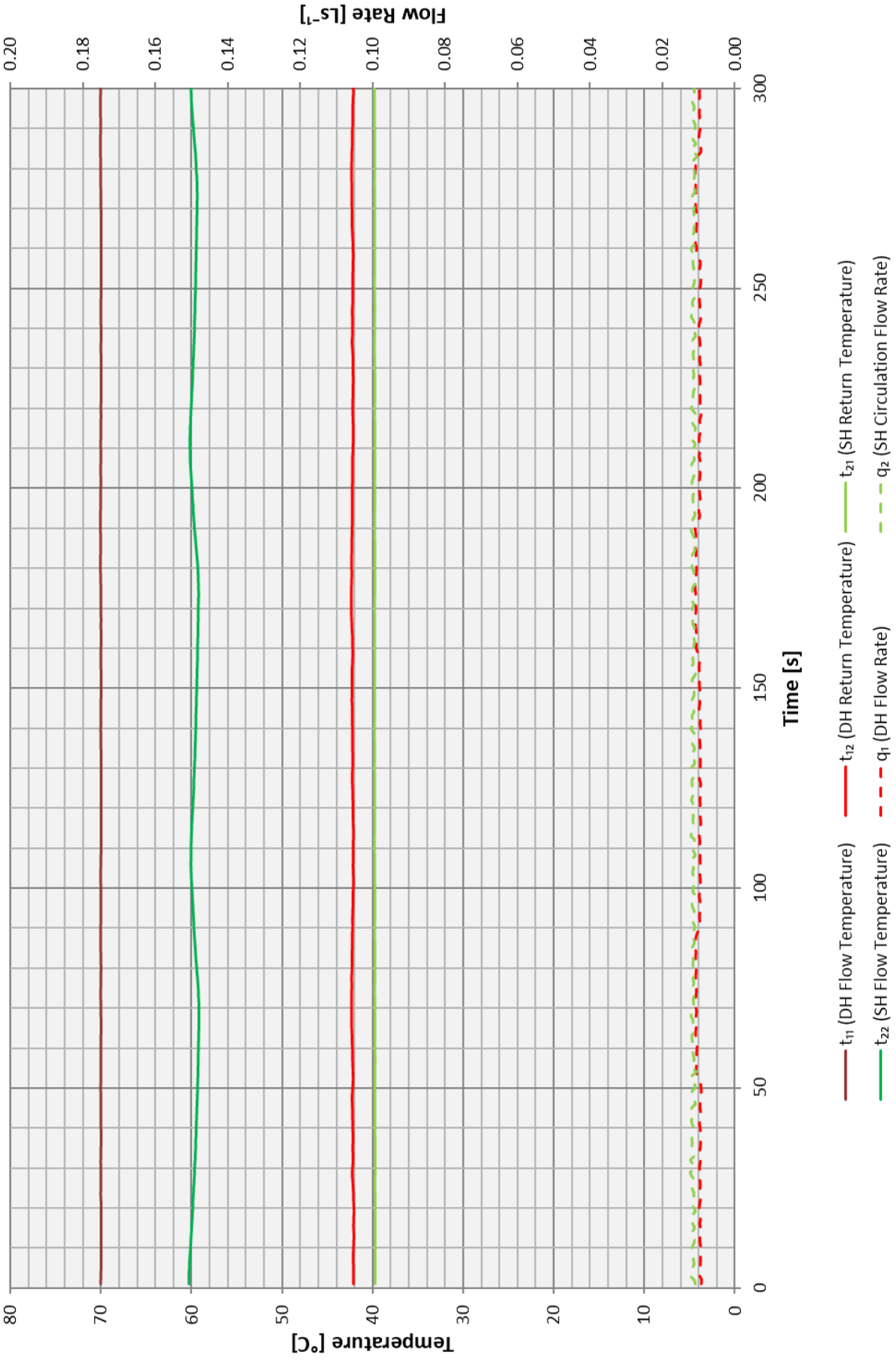

Figure 7.1 - Test 1a – Space Heating 1 kW at 70 °C

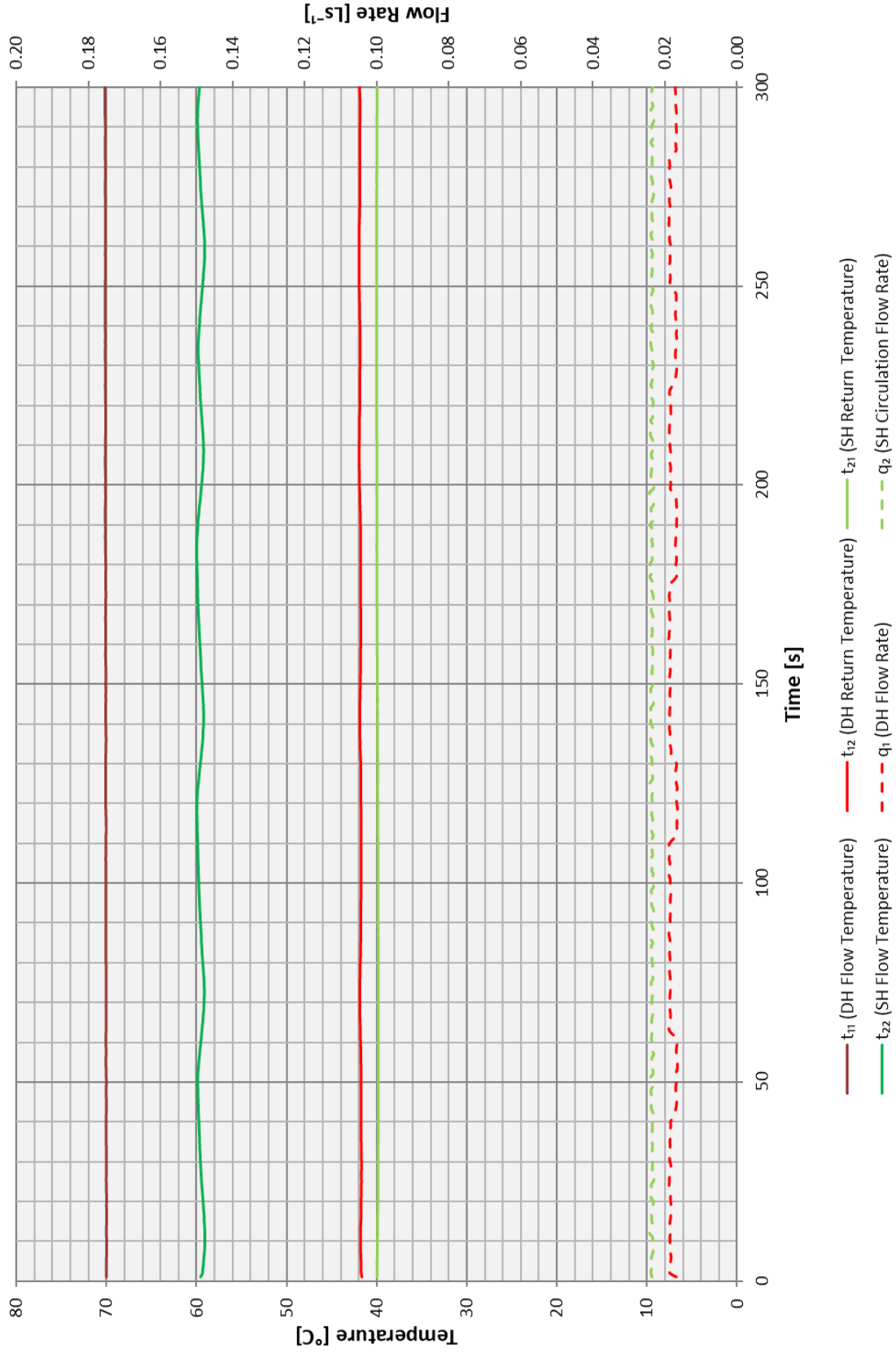

Figure 7.2 - Test 1b – Space Heating 2 kW at 70 °C

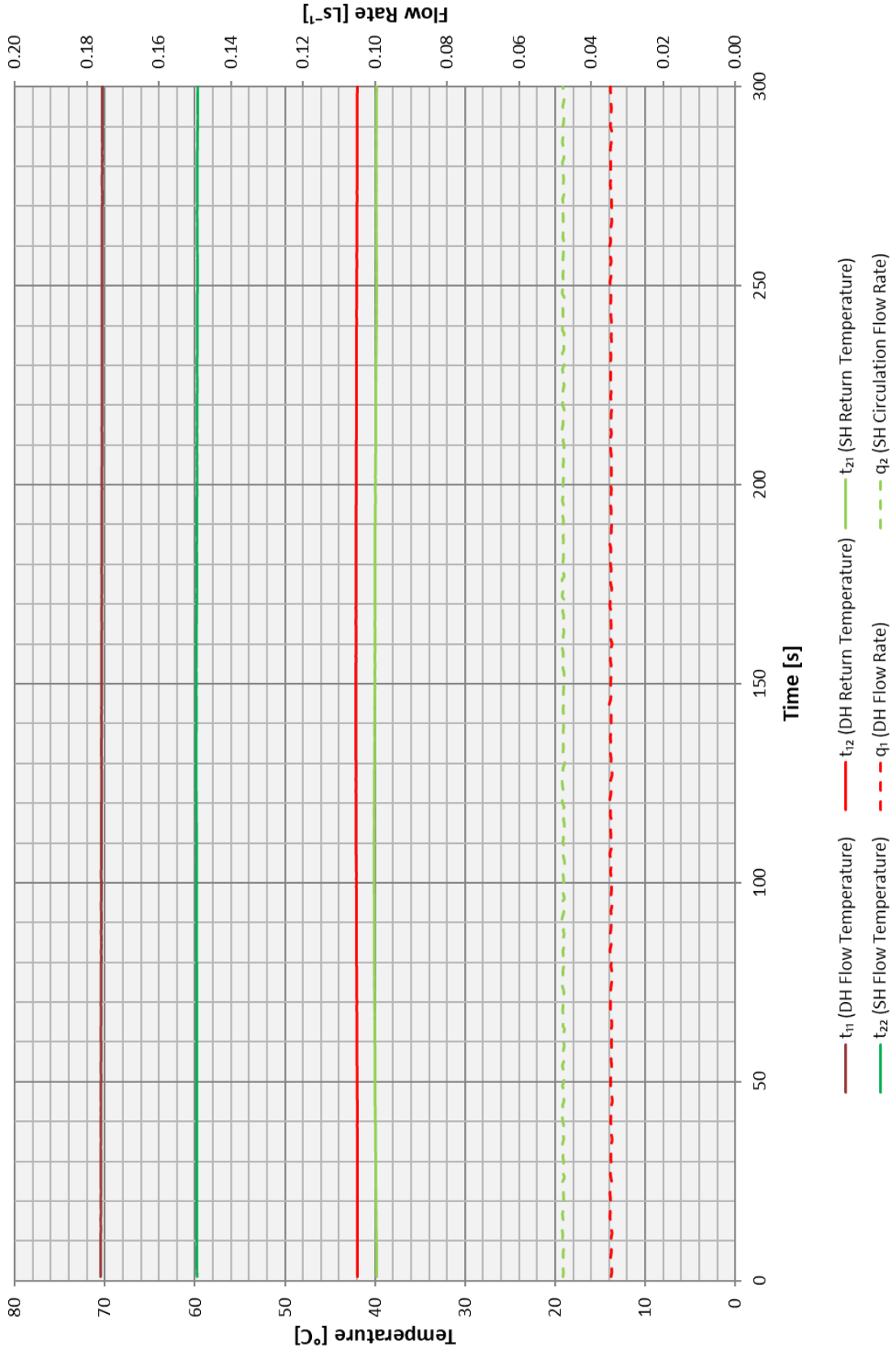

Figure 7.3 - Test 1c – Space Heating 4 kW at 70 °C

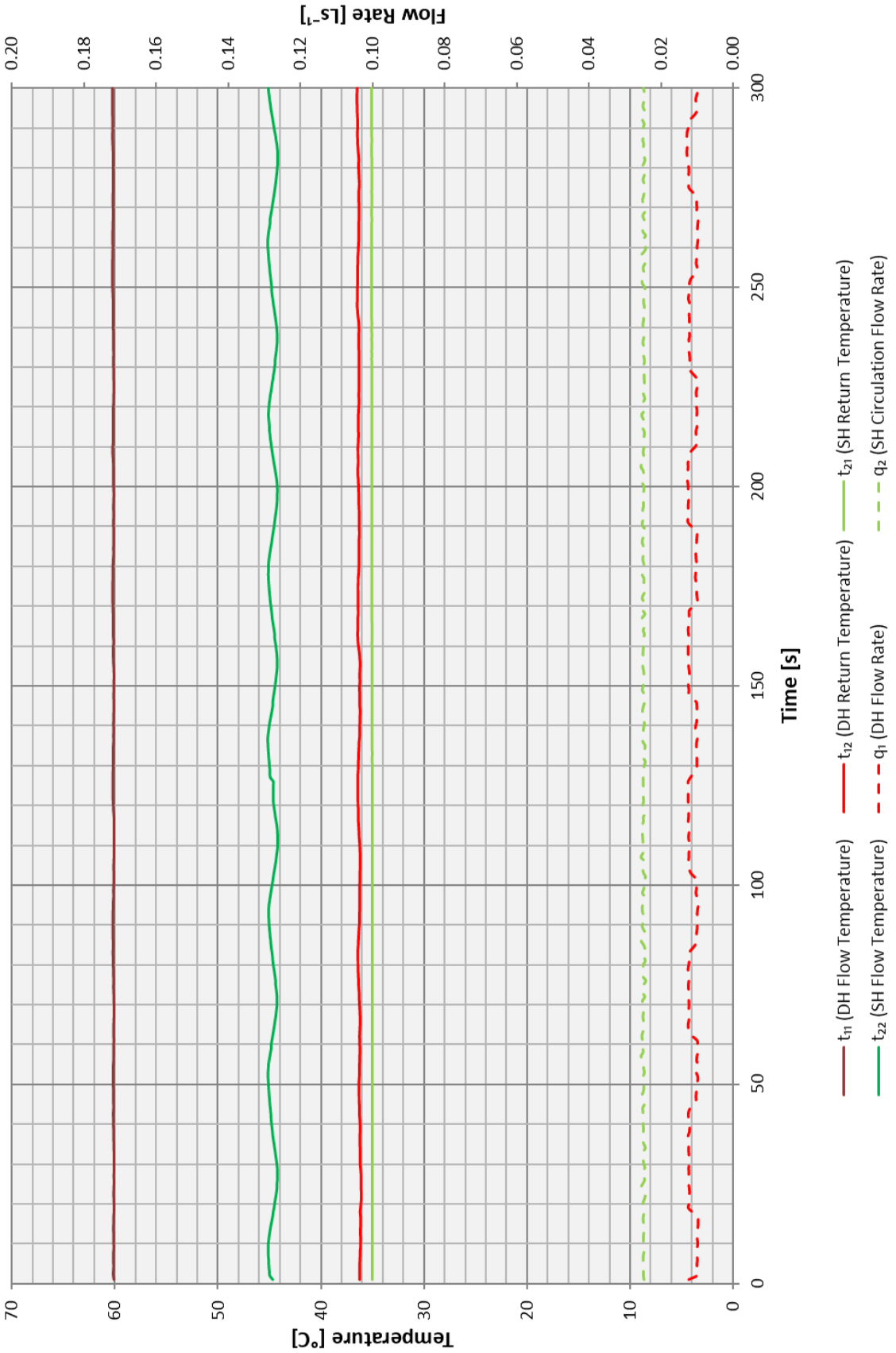

Figure 7.4 - Test 1d – Space Heating 1 kW at 60 °C

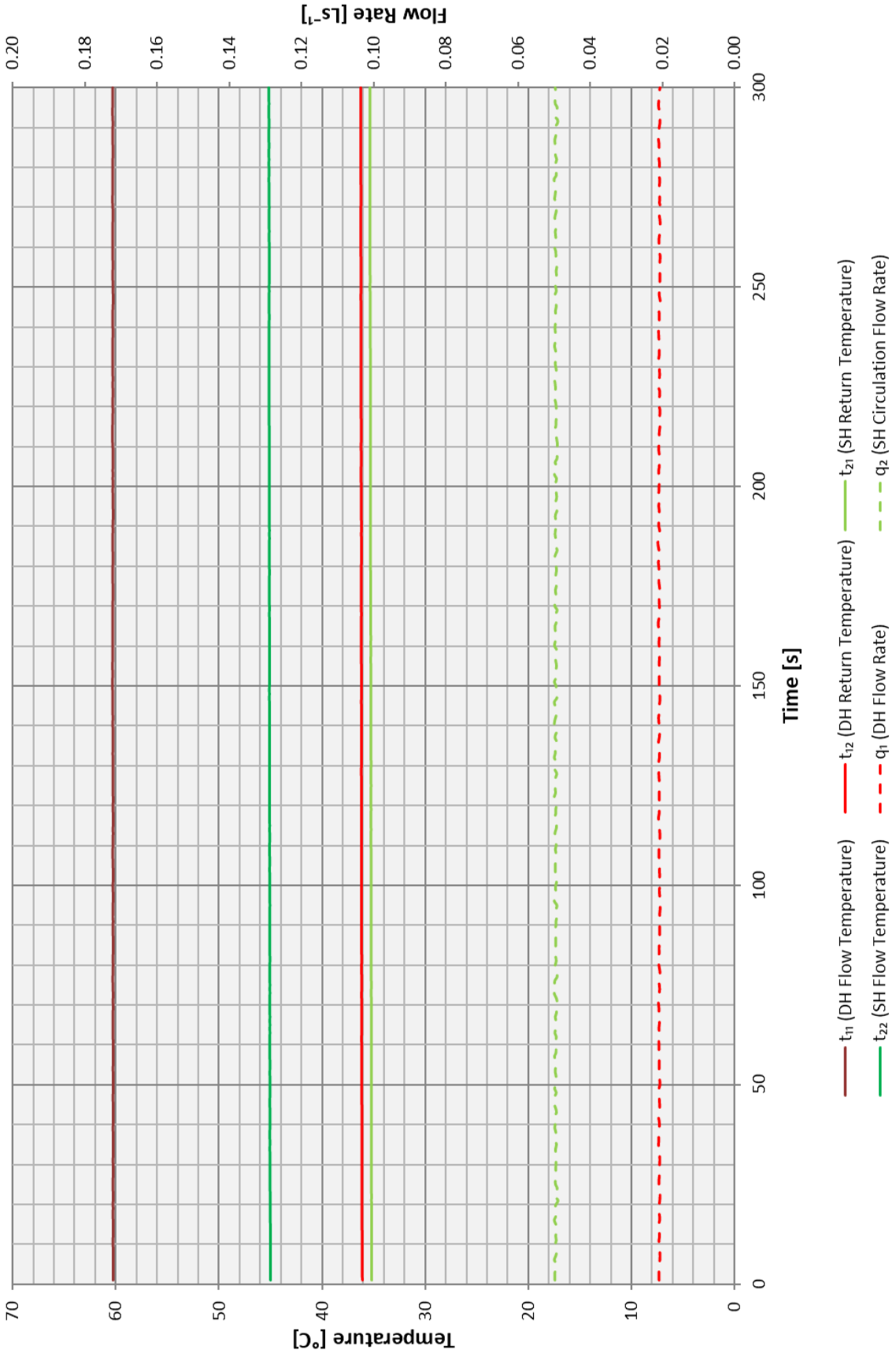

Figure 7.5 - Test 1e – Space Heating 2 kW at 60 °C

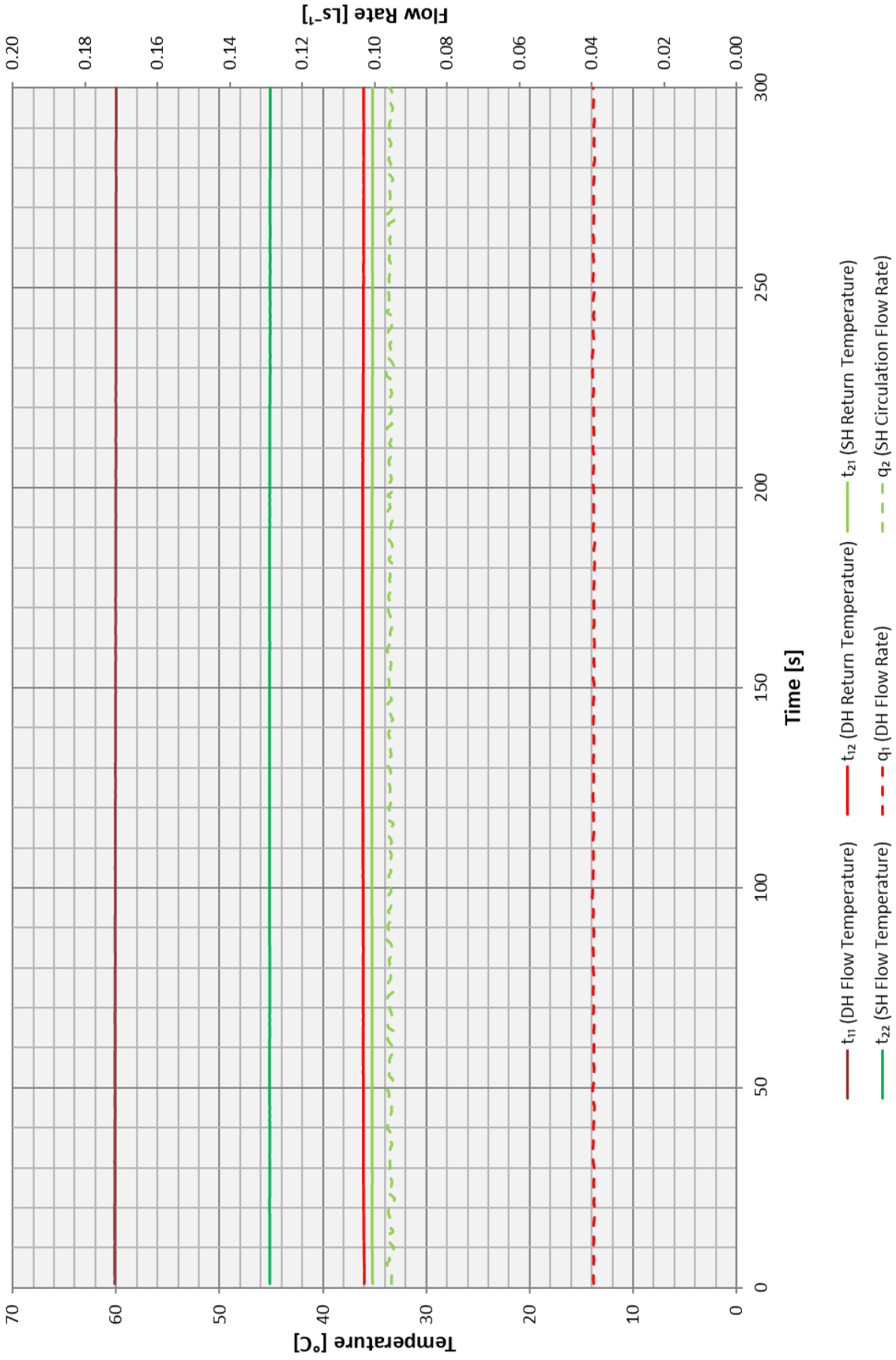

Figure 7.6 - Test 1f – Space Heating 4 kW at 60 °C

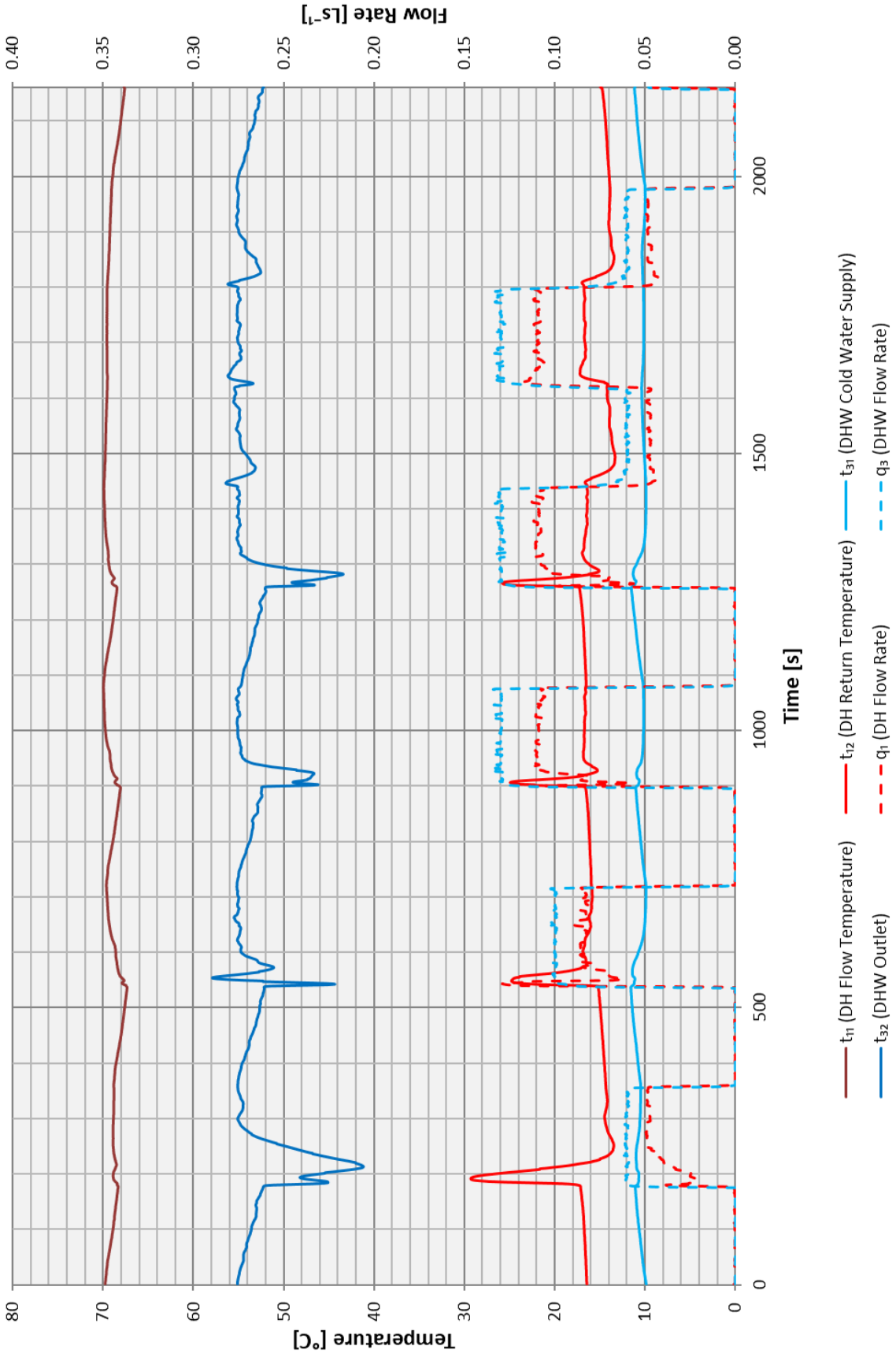

Figure 7.7 - Test 2a – DHW only at 70 °C

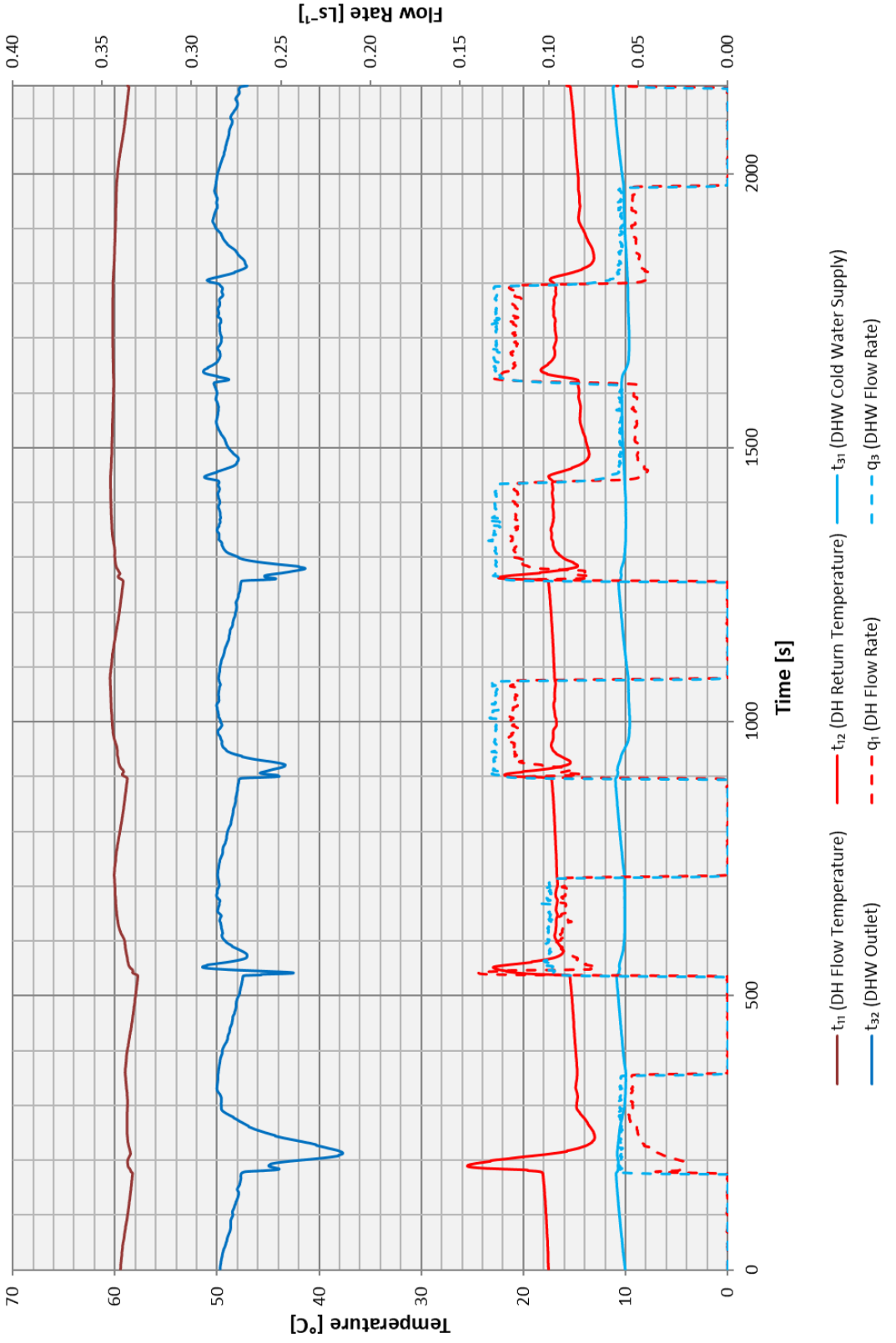

Figure 7.8 - Test 2b – DHW only at 60 °C

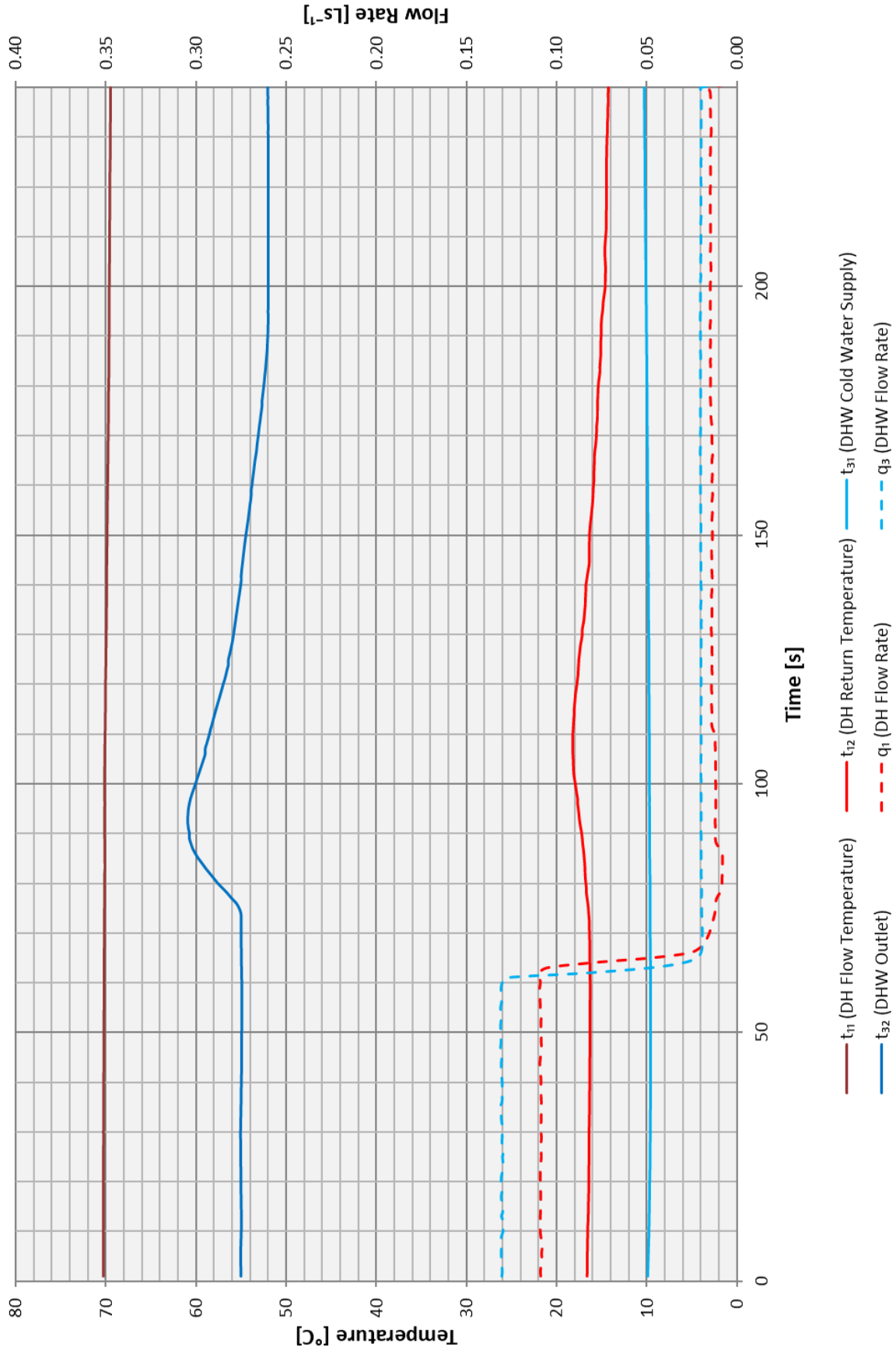

Figure 7.9 - Test 3a – Low Flow DHW at 70 °C

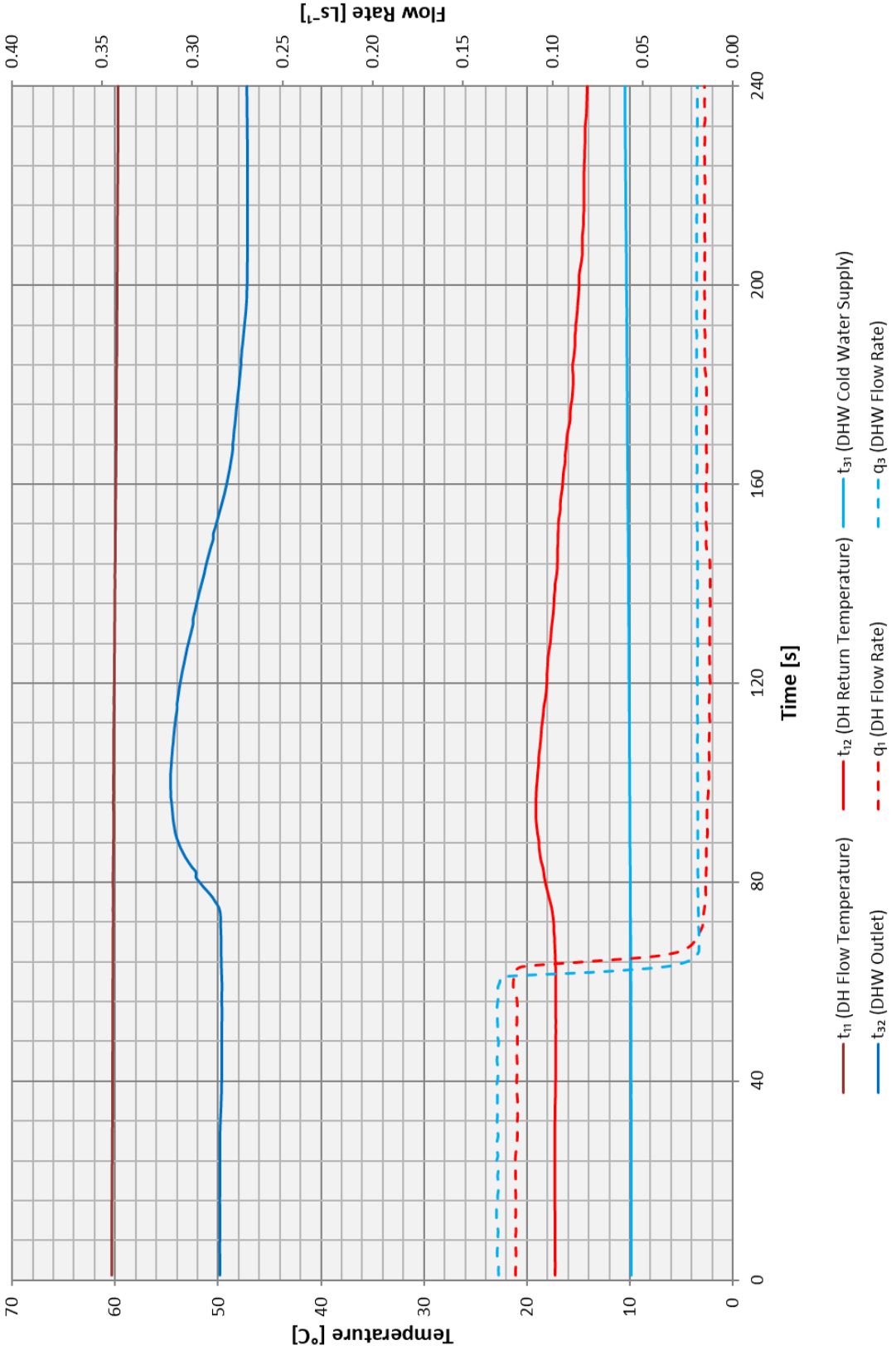

Figure 7.10 - Test 3b – Low Flow DHW at 60 °C

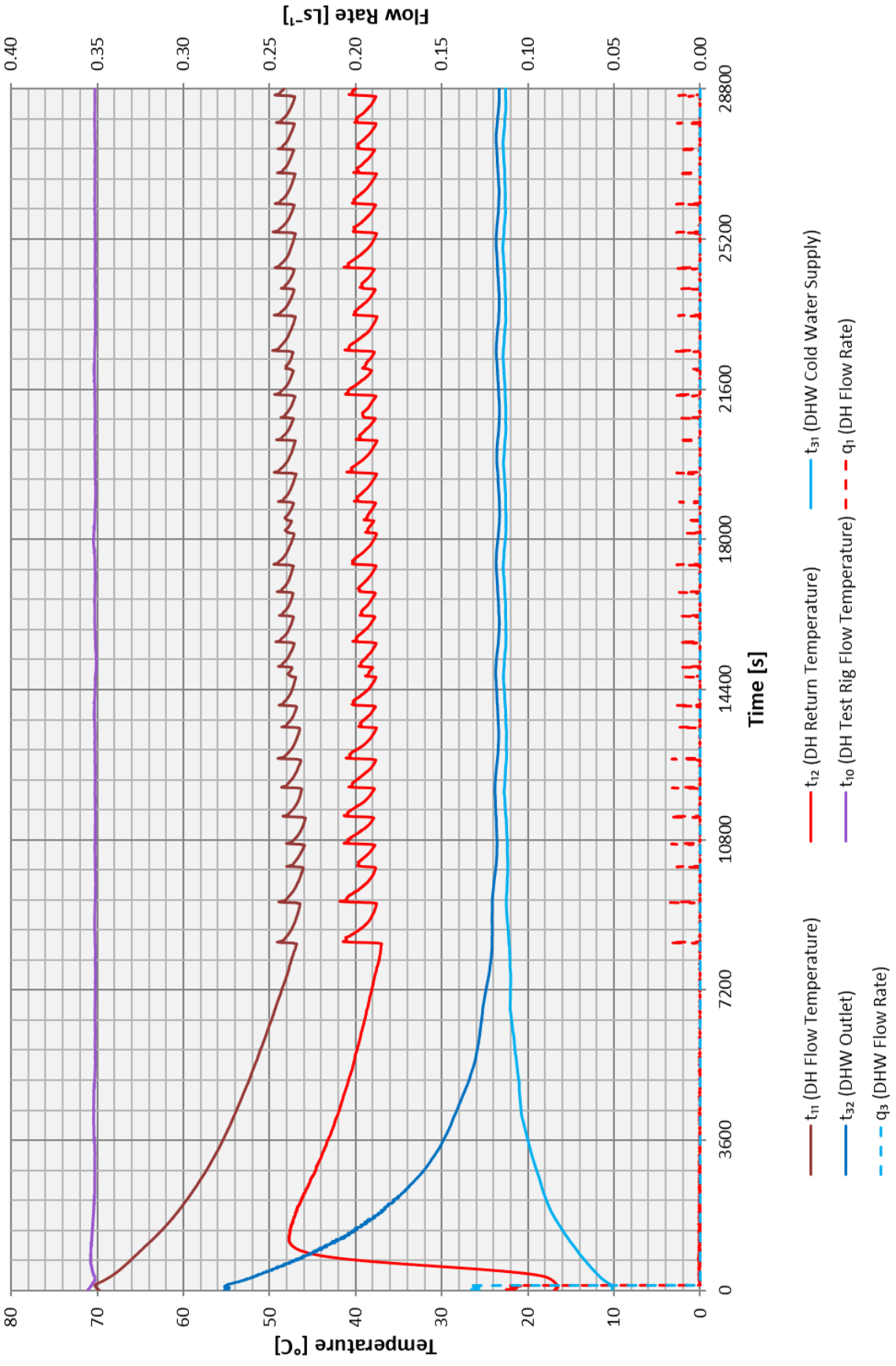

Figure 7.11 - Test 4a – Keep-warm at 70 °C

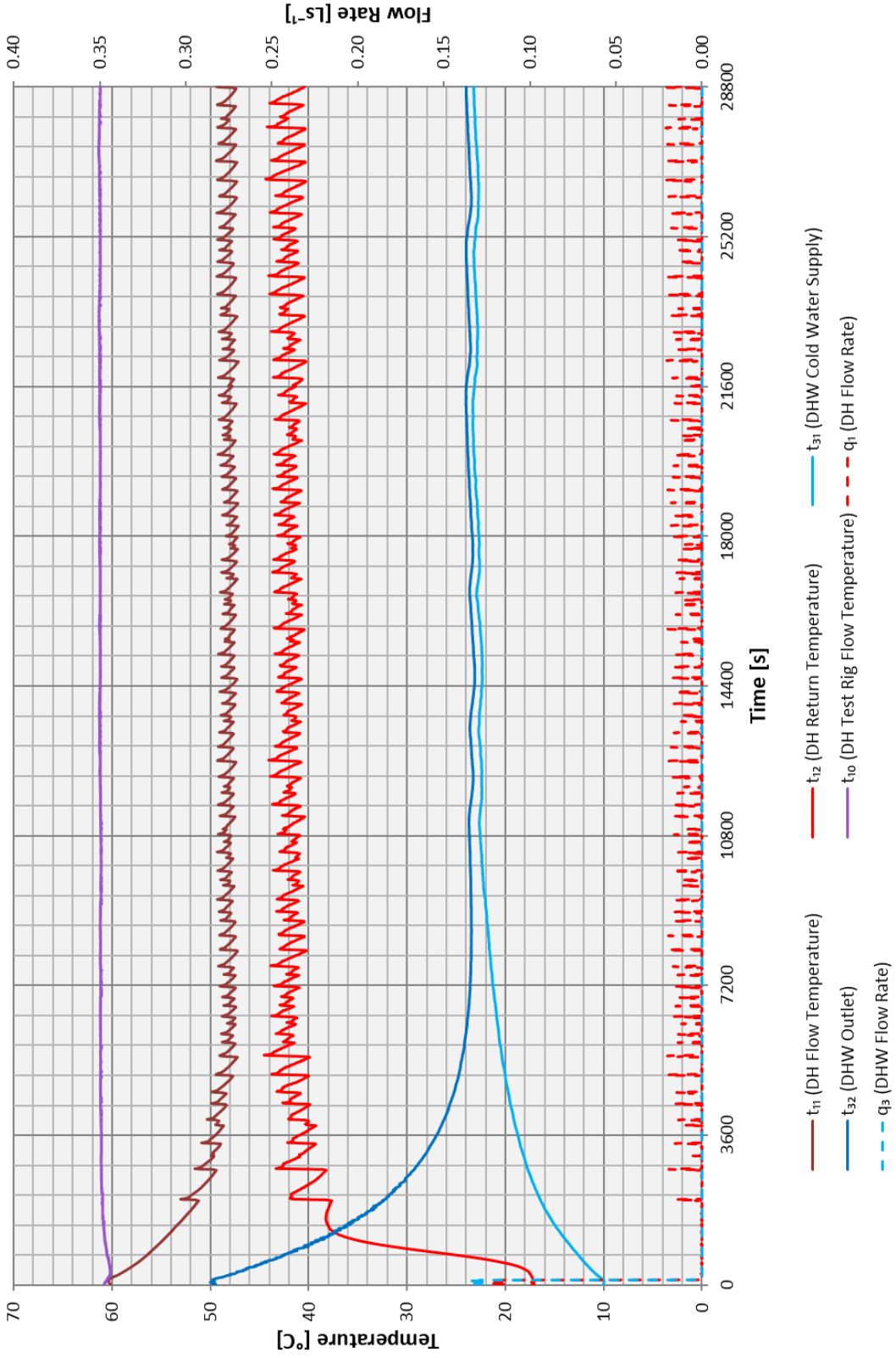

Figure 7.12 - Test 4b – Keep-warm at 60 °C

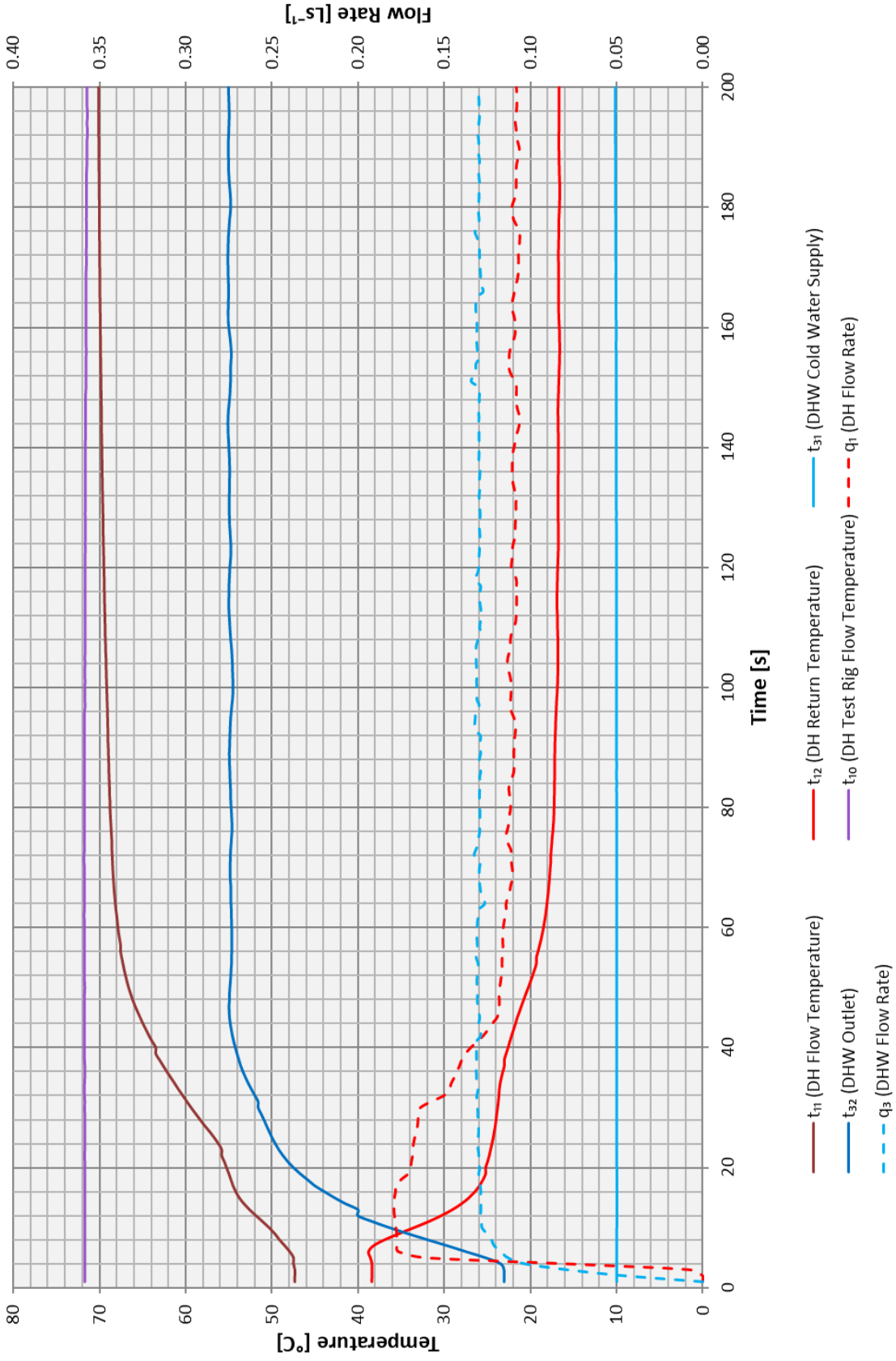

Figure 7.13 - Test 5a – DHW Response Time at 70 °C

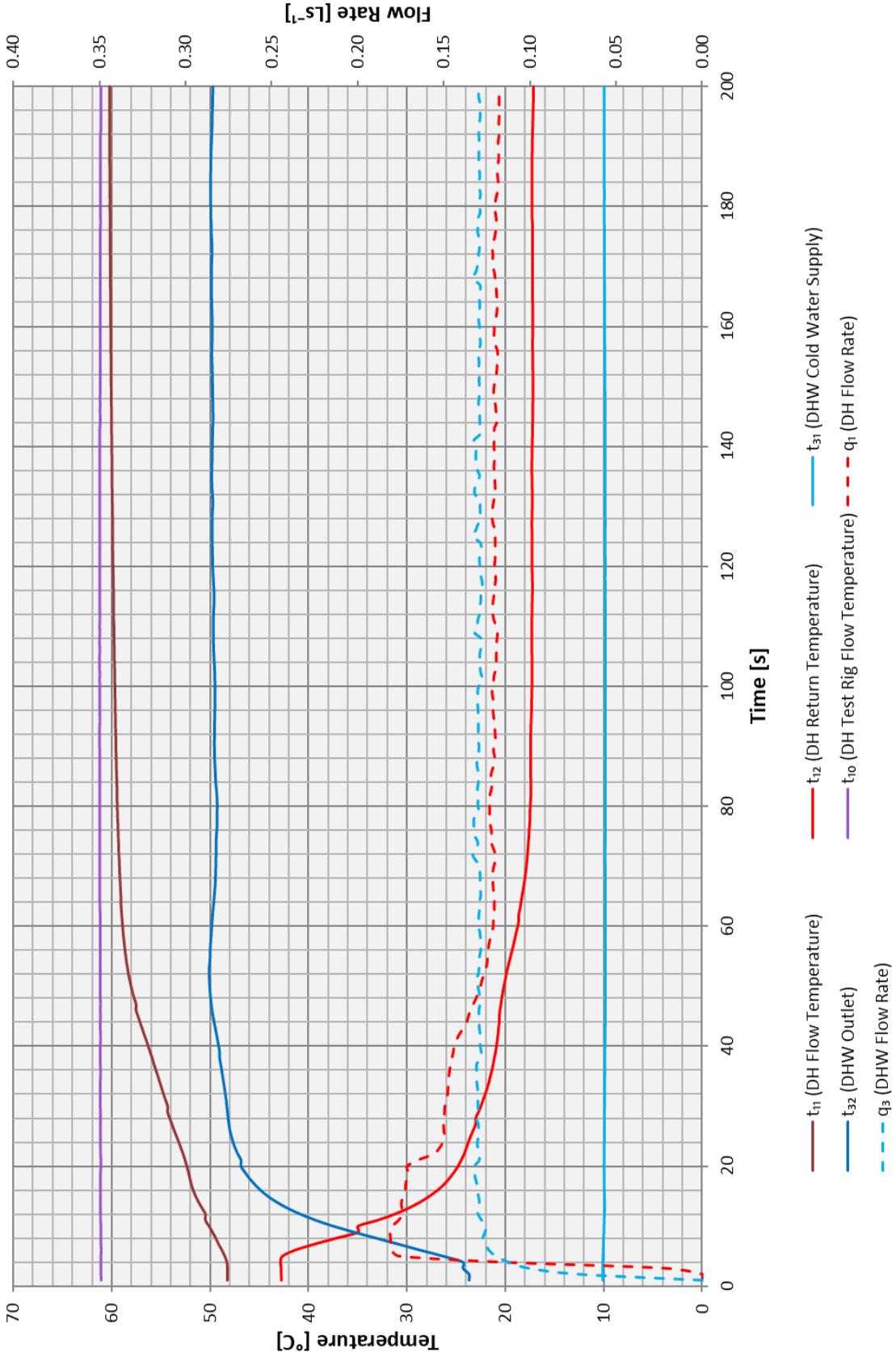

Figure 7.14 - Test 5b – DHW Response Time at 60 °C

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

Low Temperature VWART Calculation for Heatlink HL3000-E HIU

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: Taconova Group; Model: HL3000-E; Serial number: 696-00003;
VWART calculation prepared by Ian Williamson of Enertek International on 27 March 2020

	VWART(°C)	Volume (m3)
DHW	16	28.4
Standby	42	36.7
Space Heating	36	53.2

	VWART with Keep warm active	
Period	**VWART(°C)**	**% Time**
No Heating	31	93%
Heating	36	7%
Overall	**31**	

Table 7.1 - key metrics of Low Temperature Package

	DHW Draw test results			Post DHW Draw (60 seconds)	
	Power (W)	Primary flow (ls)	VWART (°C)	Primary flow (m^3/hr)	VWART (°C)
Low	8469	0.047	15	0.000	15
Medium	16016	0.091	17	0.000	17
High	20595	0.114	17	0.000	17

DHW Draw Volumes pa		
kWh pa	Hours	Volume pa (m^3)
729	81.00	13.60
297	18.00	6.00
444	21.00	8.70

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 (Ls^{-1})	VWART (°C)
Standby	0.001000	42

Standby Volumes pa	
Hours	Volume pa (m^3)
8,002	36.60

	Space Heating test results		
	Power (W)	Primary flow (Ls^{-1})	VWART (°C)
1kWp	1013	0.011	36
2kWp	2037	0.021	36
4kWp	3969	0.040	36

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m^3)
98	97.00	3.90
787	386.00	29.00
565	142.00	20.30

High Temperature VWART Calculation for Heatlink HL3000-E HIU

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: Taconova Group; Model: HL3000-E; Serial number: 696-00003;
VWART calculation prepared by Ian Williamson of Enertek International on 26 March 2020

	VWART(°C)	Volume (m3)
DHW	16	23.1
Standby	39	13.0
Space Heating	42	47.6

	VWART with Keep warm active	
Period	**VWART(°C)**	**% Time**
No Heating	25	93%
Heating	41	7%
Overall	**26**	

Table 7.2 - key metrics of High Temperature Package

	DHW Draw test results			Post DHW Draw (60 seconds)		DHW Draw Volumes pa			Post DWH Draw Volumes pa		
	Power (W)	Primary flow (ls)	VWART (°C)	Primary flow (m^3/hr)	VWART (°C)	kWh pa	Hours	Volume pa (m^3)	Events pa	Average duration (secs)	Volume pa (m^3)
Low	10013	0.042	16	0.000	15	729	73.00	11.10	10000	30	-
Medium	18220	0.083	17	0.000	16	297	16.00	4.90	660	75	-
High	23265	0.103	17	0.000	17	444	19.00	7.10	300	145	-

	Standy test results	
	Primary flow (Ls^{-1})	VWART (°C)
Standby	0.000500	39

Standby Volumes pa	
Hours	Volume pa (m^3)
8,008	13.00

	Space Heating test results		
	Power (W)	Primary flow (Ls^{-1})	VWART (°C)
1kWp	959	0.010	42
2kWp	1945	0.018	42
4kWp	4066	0.034	42

Space Heating Volumes pa		
kWh pa	Hours	Volume pa (m^3)
98	102.00	3.70
787	405.00	26.20
565	143.00	17.70

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	$VWART_{SH}$	36	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	16	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	42	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	36	°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 7.3 – Low Temperature VWART calculations

VWART Calculations

Description	Symbol	Value	Unit
Annual Heating Period Percentage	SH_{PROP}	7.4	%
Annual Non-Heating Period Percentage	NSH_{PROP}	92.6	%
Space Heating Volume Weighted Return Temperature	$VWART_{SH}$	42	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	16	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	39	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	41	°C
Annual Volume Weighted Return Temperature For Non-Heating	$VWART_{NONHEAT}$	25	°C
Total Annual Volume Weighted Return Temperature	$VWART_{HIU}$	26	°C

Clause 5.13.1, Table 5.3

Table 7.4 – High 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	Y	Danfoss XB06H+-1-26
2	Domestic Hot Water Heat Exchanger	Y	Danfoss XB06H+-1-50
3	Controller for Space Heating	Y	TacoControl Z1
4	Control Valve and Actuator for Space Heating	Y	ESBE Control valve SLB122
5	Space Heating Strainer	Y	ITAP DN20 IG-IG 3/4" L=70mm
6	Controller for Domestic Hot Water	Y	TacoControl Z1
7	Control Valve and Actuator for Domestic Hot Water	Y	ESBE Control valve SLB122
8	Temperature Sensors	Y	Titec NTC 10K ø5mm
9	Domestic Hot Water Isolating Valve	Y	ITAP Ballvalve DN20 AG-IG 3/4" grün Griff WRAS
10	Primary Side Strainer	Y	ITAP DN20 IG-IG 3/4" L=70mm
11	Drain Valves	Y	SCE Technology Co.Ltd. KFE 1/2"
12	Vent Valves	Y	Taconova ER 40 VENT 6 1/8"
13	Circulation Pump set with AAV & PRV	Y	Taconova: TacoFlow2 C 15-60/130 – UK -AAV ER 40 VENT 6 1/8" - PRV Galeffi 3Bar IG-IG 1/2" 311430
14	Heat Meter	Y	Engelmann SensoStar U (mit M-Bus)
15	Domestic Hot Water Flow Sensor	Y	SIKA VTY 20 Flowsensor 0-60l/min
16	Pipes	Y	Stainless steel 1.4404 18mm
17	Connections	Y	¾" and 1" with paper seal
18	Joints	Y	O-ring nut sealing system
19	Gaskets	Y	REINZ AFM34/2 and AFM34 And EPDM O-Rings
20	Expansion Vessel	Y	CIMM Exp. Vessel RP 250x438x105 - 3/8"
21	Insulation	Y	EPP
22	Pressure Sensors	N/A	none
A1	'O' Ring	Y	EPDM
A2	Commissioning guide.	Y	see instructions/manual
A3	Operation guides with a function description / description of operation and care instructions as suited to the intended user category.	Y	see instructions/manual
A4	Declaration of Conformity for CE-marked HIUs.	Y	N/A
A5	Full parameter list for electrically controlled HIUs.	Y	N/A
A6	Maximum primary static operating differential pressure.	N/A	4bar
A7	Deactivation procedure of the internal SH pump.	Y	N/A
	Model name and type number		HL 3000-E
	Serial number		696-00003

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

HL3000-E	
Appliance Serial Number	696-00003
Space Heating Heat Exchanger	Danfoss XB06H+-1-26
Domestic Hot Water Heat Exchanger	Danfoss XB06H+-1-50
Controller for Space Heating	TacoControl Z1
Control Valve & Actuator for Space Heating	ESBE Control valve SLB122
Controller for Domestic Hot Water	TacoControl Z1
Temperature Sensors	Titec NTC 10K ø5mm
Domestic Hot Water Isolating valve	ITAP Ballvalve DN20 AG-IG 3/4" grün Griff WRAS
Primary Side Strainer	ITAP DN20 IG-IG 3/4" L=70mm
Circulation Pump	Taconova: TacoFlow2 C 15-60/130 – UK
Heat Meter	Engelmann SensoStar U (mit M-Bus)
Domestic Hot Water Flow Sensor	SIKA VTY 20 Flowsensor 0-60l/min
Pipes	Stainless steel 1.4404 18mm
Connections	¾” and 1” with paper seal
`O` Rings	EPDM
Gaskets	REINZ AFM34/2 and AFM34 And EPDM O-Rings
Expansion Vessel	CIMM Exp. Vessel RP 250x438x105 - 3/8"
Pressure Sensors	N/A
Insulation	EPP

8.3 Appliance Photographs

Figure 8.1 – Photograph of appliance with case off

Figure 8.2 – Photograph of appliance with case on

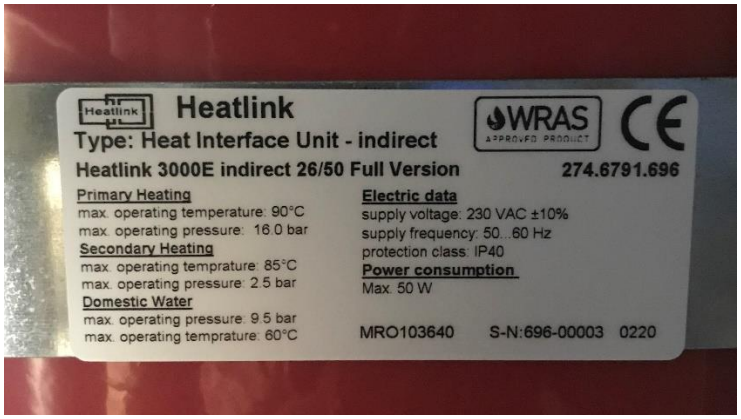

Figure 8-3 – Data Label

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
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

Equipment Name	ID Number	Calibration Certificate	Measurement Uncertainty K=2 $\frac{U}{\sqrt{20}}$	Units	Calibration Date	Calibration Due
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 090	K41178P	±9.31	kPa	21/11/2019	20/11/2020
Software	VERSION – LabVIEW, Version 5 , Service pack 1					

Report Issue No	Reason for Report Update
1	Original Issue

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