Enertek International

International Consultants In
Product Research, Design,
Development &
Certification

Project Number:	E4096
Project Title:	BESA Test Regime for Albion HIU
Client:	Albion Water Management
Client Address	30/31 Station Close, Potters Bar, Herts, EN6 1TL
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Report Number:	1

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1 BRIEF

1.1.1 Enertek international Limited (EIL), were contracted to receive, install and commission a production sample, MTA TWIN 24-40 on behalf of Albion Water Management.

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 MTA TWIN 24-40 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	Albion Water Management
Model	MTA TWIN 24-40
Serial number	1901137
Year of manufacture	2018
DHW priority	Yes

3.2 Appliance Design Pressures

3.2.1 The maximum design pressures of the MTA TWIN 24-40 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	2.9	Bar
Secondary Side DHW	10	Bar

3.3 Appliance Design Temperatures

3.3.1 The maximum design temperatures of the MTA TWIN 24-40 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	85	°C
Secondary Side space Heating	85	°C
Secondary Side DHW	85	°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 Albion Water Management, MTA TWIN 24-40 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)

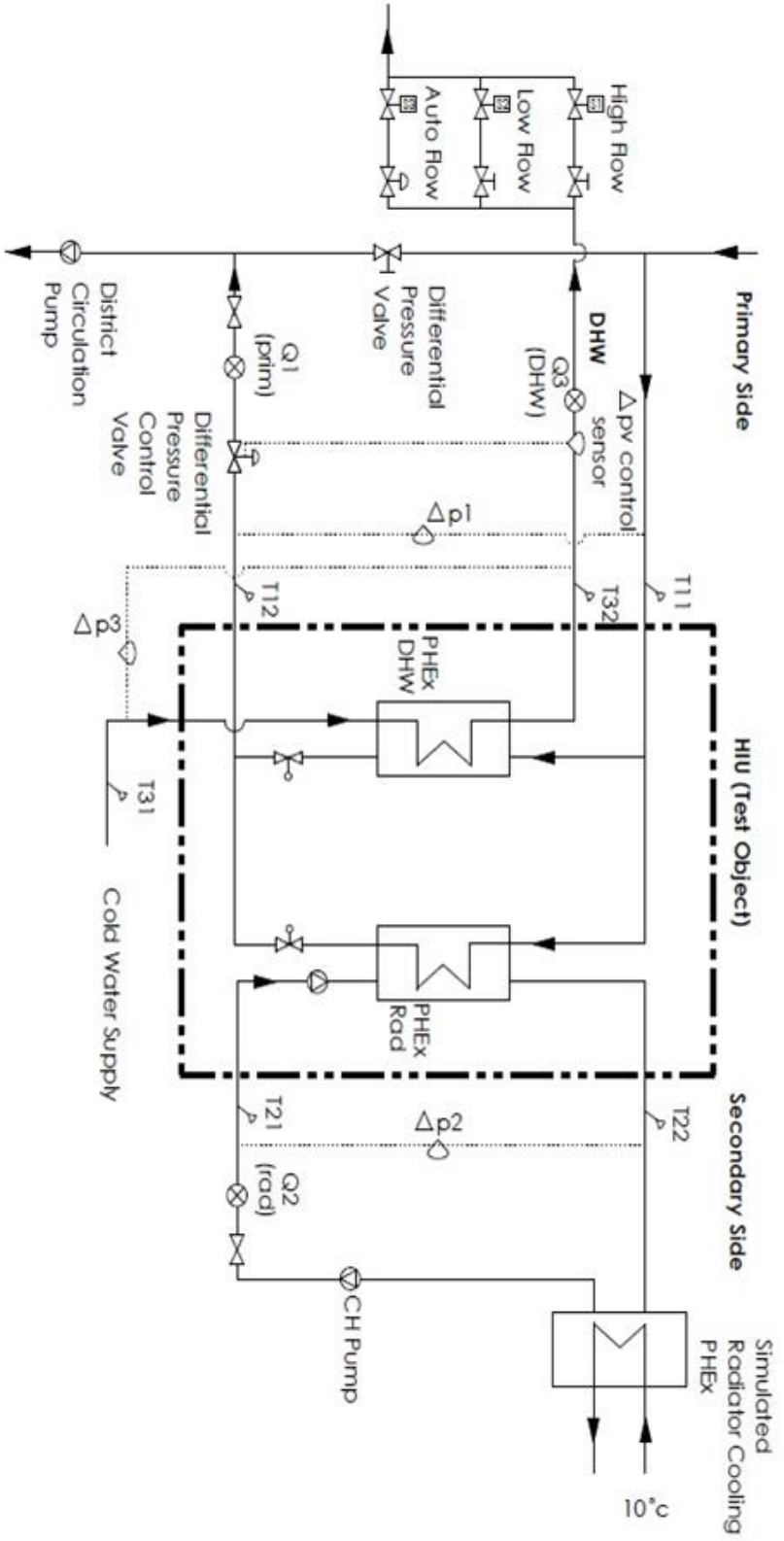

Figure 4.1 – EIL's HIU Test Rig schematic

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)	69.6	40.5	0.010	54.8	1.213	39.9	60.6	0.012	-0.8	1.077
1b	- 2 kW Space Heating (DH 70 °C flow)	69.6	41.1	0.018	53	2.170	40.0	60.3	0.024	-0.3	2.016
1c	- 4 kW Space Heating (DH 70 °C flow)	69.6	42.2	0.036	51.7	4.141	40.0	59.9	0.048	0.3	4.012
1d	- Space Heating 1 kW (DH 60 °C flow)	60.2	34.2	0.010	51.4	1.65	34.7	45.3	0.022	-0.8	0.999
1e	- Space Heating 2 kW (DH 60 °C flow)	59.6	35.2	0.020	53.1	2.035	35.2	45.1	0.047	-0.3	1.95
1f	- Space Heating 4 kW (DH 60 °C flow)	60.2	35.2	0.039	48	4.23	35.0	45.0	0.094	2.4	3.959

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 59.0°C and 43.4°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 Dynamic Tapping at 60 °C

5.4.1 The maximum and minimum temperatures of t_{32} were 51.5°C and 41.6°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 This appliance's declared low flow rate exceeds that of test 3a, therefore test 3c shall be performed instead of 3a at the manufacturer's declared low flow rate of 1.9L/min.

5.6 Test 3b – Low Flow DHW at 60 °C

5.6.1 This appliance's declared low flow rate exceeds that of test 3b, therefore test 3d shall be performed instead of 3b at the manufacturer's declared low flow rate of 1.9L/min.

5.1 Test 3c – Low Flow DHW at 70 °C

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

5.1.2 At the minimum DHW flow rate declared by the manufacturer (1.9 l/min) the unit was able to provide flow temperatures of 55 ± 3 °C during the last 60 seconds of the test.

5.1.3 The domestic hot water output temperature, t_{32} did not exceed 60 °C for more than 5 seconds, and;

5.1.4 The maximum and minimum temperatures of t_{32} were 59.6°C and 52.93°C respectively.

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

5.2 Test 3d – Low Flow DHW at 60 °C

5.2.1 The appliance has passed the requirements of the Low Flow at 60 °C, Test 3d of the BESA Test Regime as:

5.2.2 At the minimum DHW flow rate declared by the manufacturer (1.9 l/min) the unit was able to provide flow temperatures of 50 ± 3 °C during the last 60 seconds of the test.

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

5.2.4 The maximum and minimum temperatures of t_{32} were 54.0°C and 49.6°C respectively.

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

5.3 Test 4a – Keep-warm at 70 °C

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

5.3.2 This is a valid keep warm operation based on 5a response time criteria, see 5.5.3.

5.3.3 The appliance is 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.

5.3.4 The average heat load on the primary side P_1 is 36.1 W.

5.3.5 The average primary flow q_1 over the 8 hour test was 5.37 l/hr.

5.3.6 The Keepwarm control was set to 50°C.

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

5.4 Test 4b – Keep-warm at 60 °C

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

5.4.2 This is a valid keep warm operation based on 5b response time criteria, see 5.6.1.

5.4.3 The appliance is performing keep-warm cycling as the primary flow temperature, t_{11} varies by more than ± 3 °C during the final 3 hours of the test.

5.4.4 The average heat load on the primary side P_1 is 37.3 W.

5.4.5 The average primary flow q_1 over the 8 hour test was 8.04 l/hr.

5.4.6 The Keepwarm control was set to 50°C..

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

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

5.5.1 The appliance has passed the requirements of DHW Response Time at 70°C, Test 5a 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.

5.5.3 The DHW response time for t_{32} to reach 45 °C (and not subsequently drop below 42 °C) was 4 seconds; therefore this is a valid keep warm.

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

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

5.6.1 The DHW response time for t_{32} to reach 45 °C (and not subsequently drop below 42 °C) was 6 seconds; therefore this is a valid keep warm.

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

5.7 Overall Scaling Risk Assessment

5.7.1 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

5.8 Test Summary

5.8.1 See Table 7.1 & Table 7.2 Appendix for the summary of key metrics of all the tests described in this report.

5.9 VWART Calculations

5.9.1 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	$VWART_{SH}$	41	°C
DHW Volume Weighted Return Temperature	$VWART_{DHW}$	19	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	46	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	41	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	38	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	38	°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	$VWART_{DHW}$	19	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	46	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	36	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	39	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	38	°C

6 CONCLUSIONS

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

6.1.2 This appliance's declared low flow rate exceeds that of the low flow tests and was instead tested at the manufacturer's declared low flow rate of 1.9L/min.

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

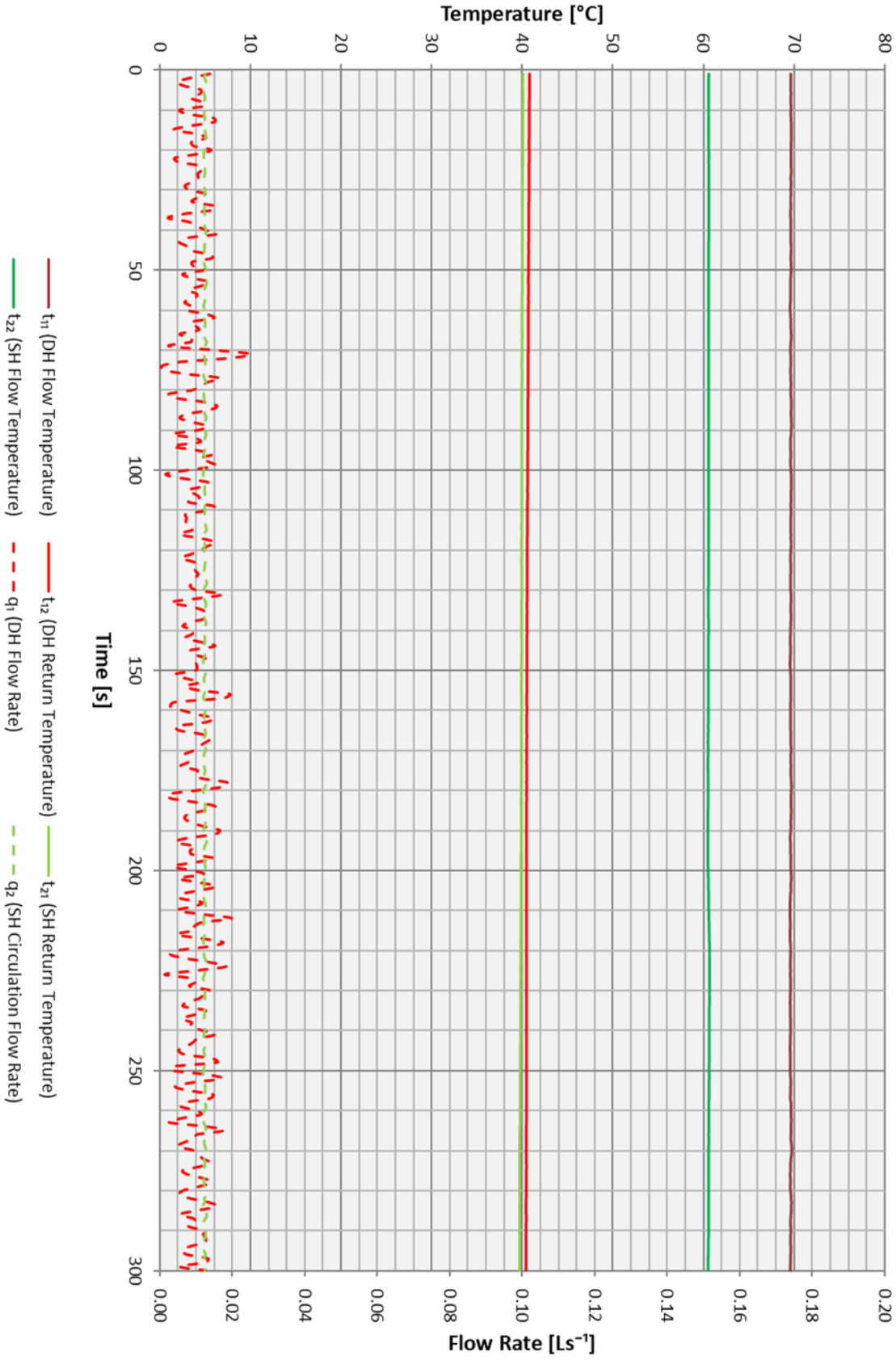

Figure 7.1 - Test 1a – Space Heating 1 kW at 70 °C

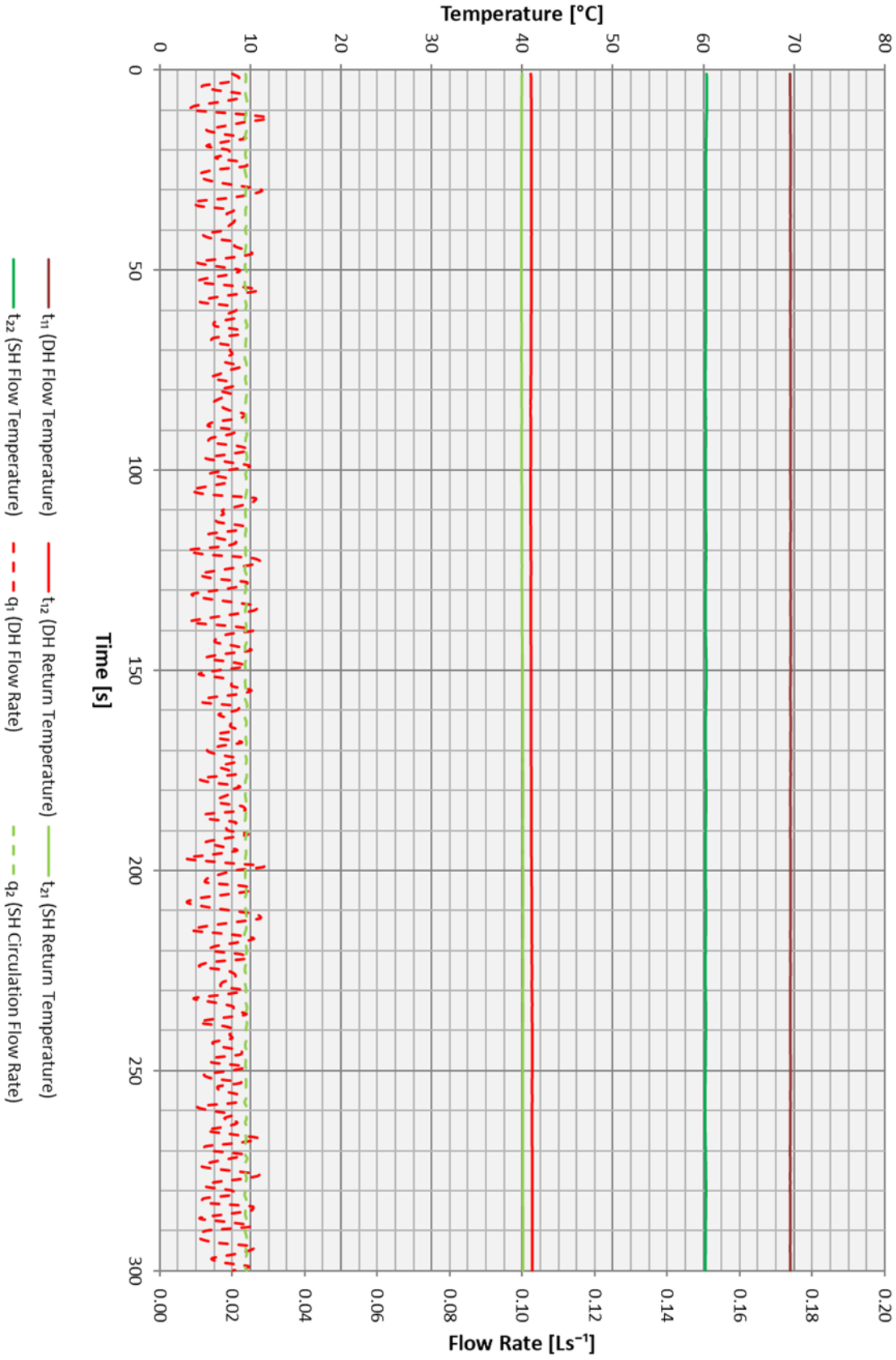

Figure 7.2 - Test 1b – Space Heating 2 kW at 70 °C

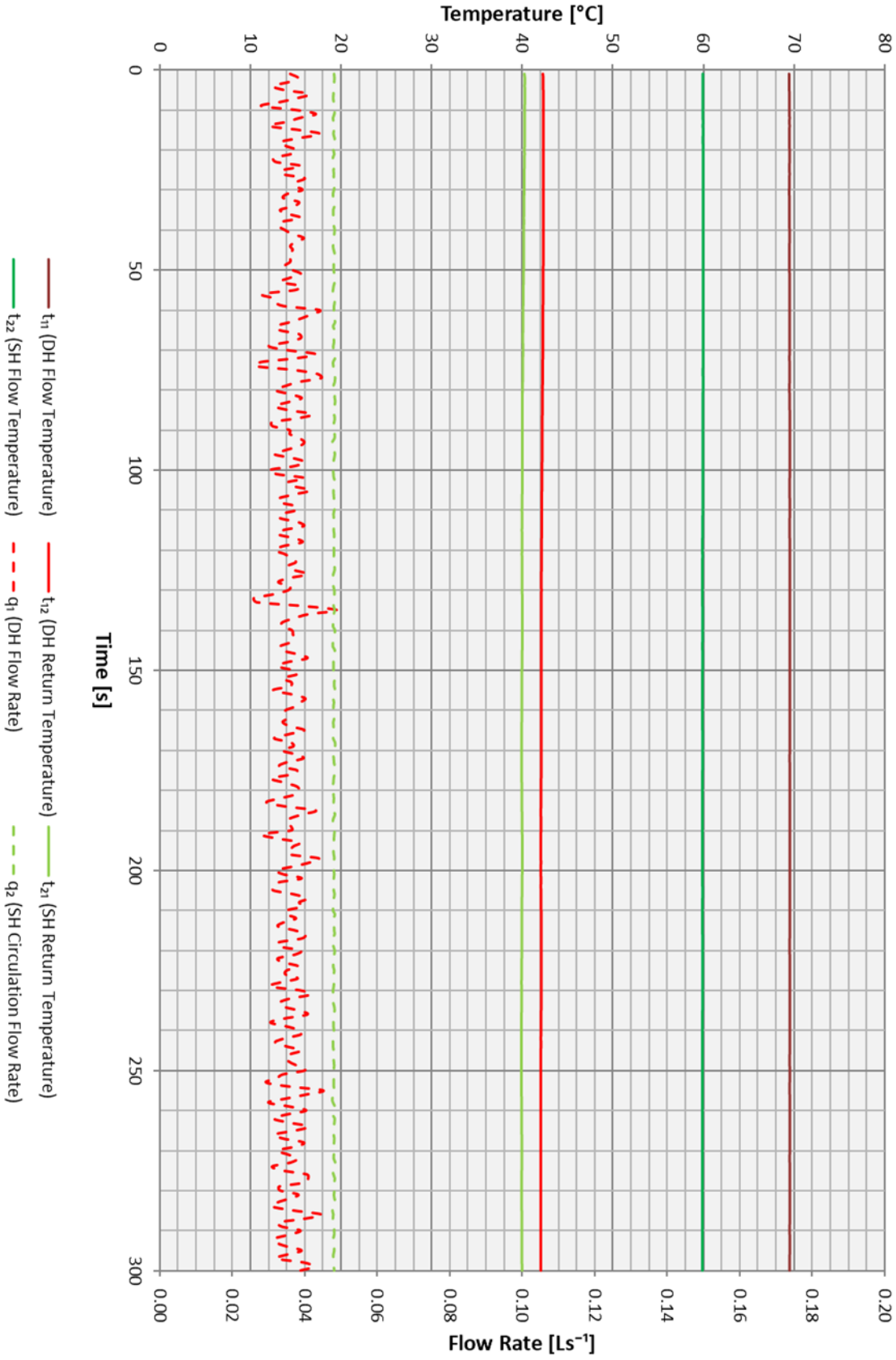

Figure 7.3 - Test 1c – Space Heating 4 kW at 70 °C

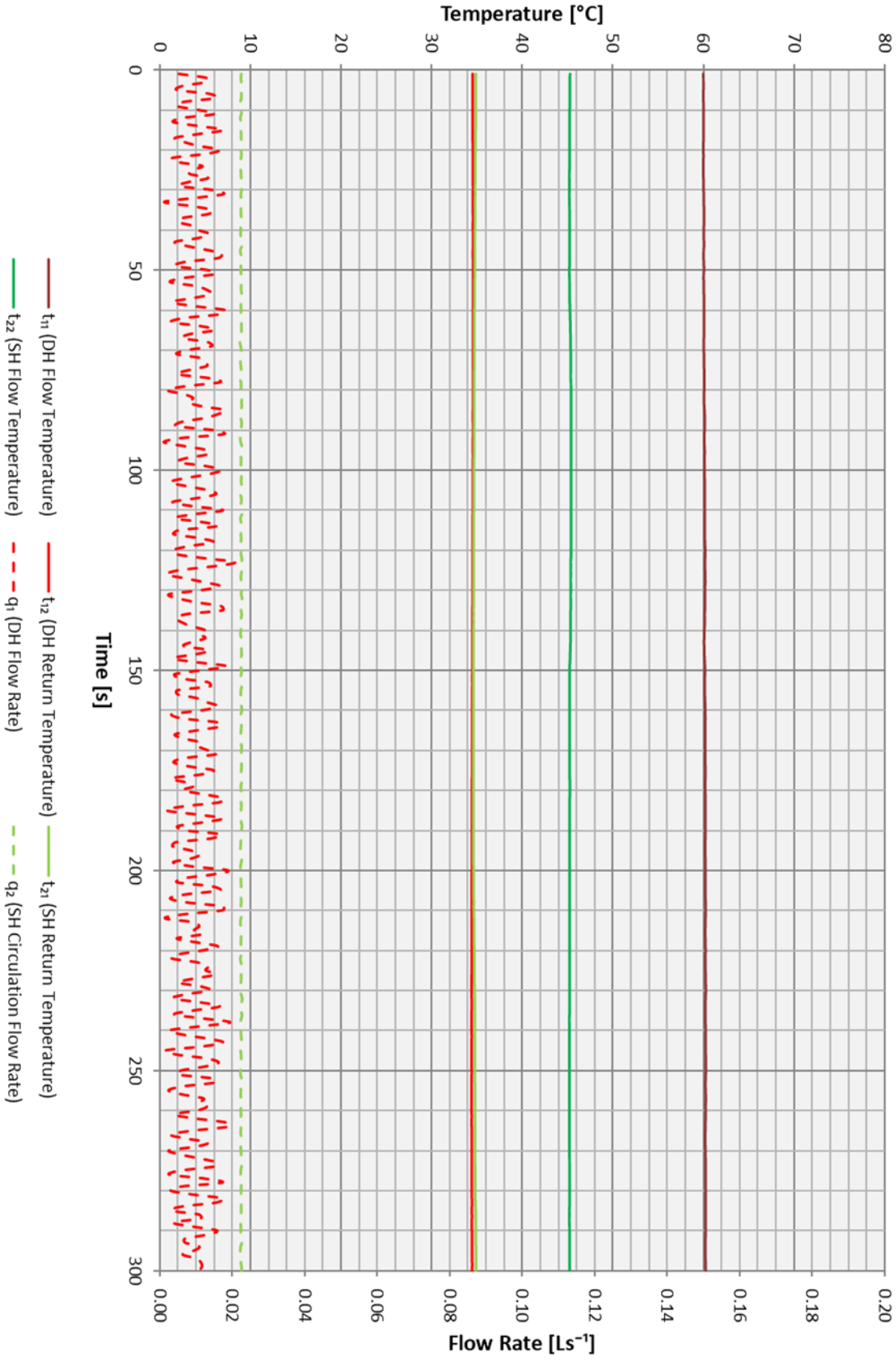

Figure 7.4 - Test 1d – Space Heating 1 kW at 70 °C

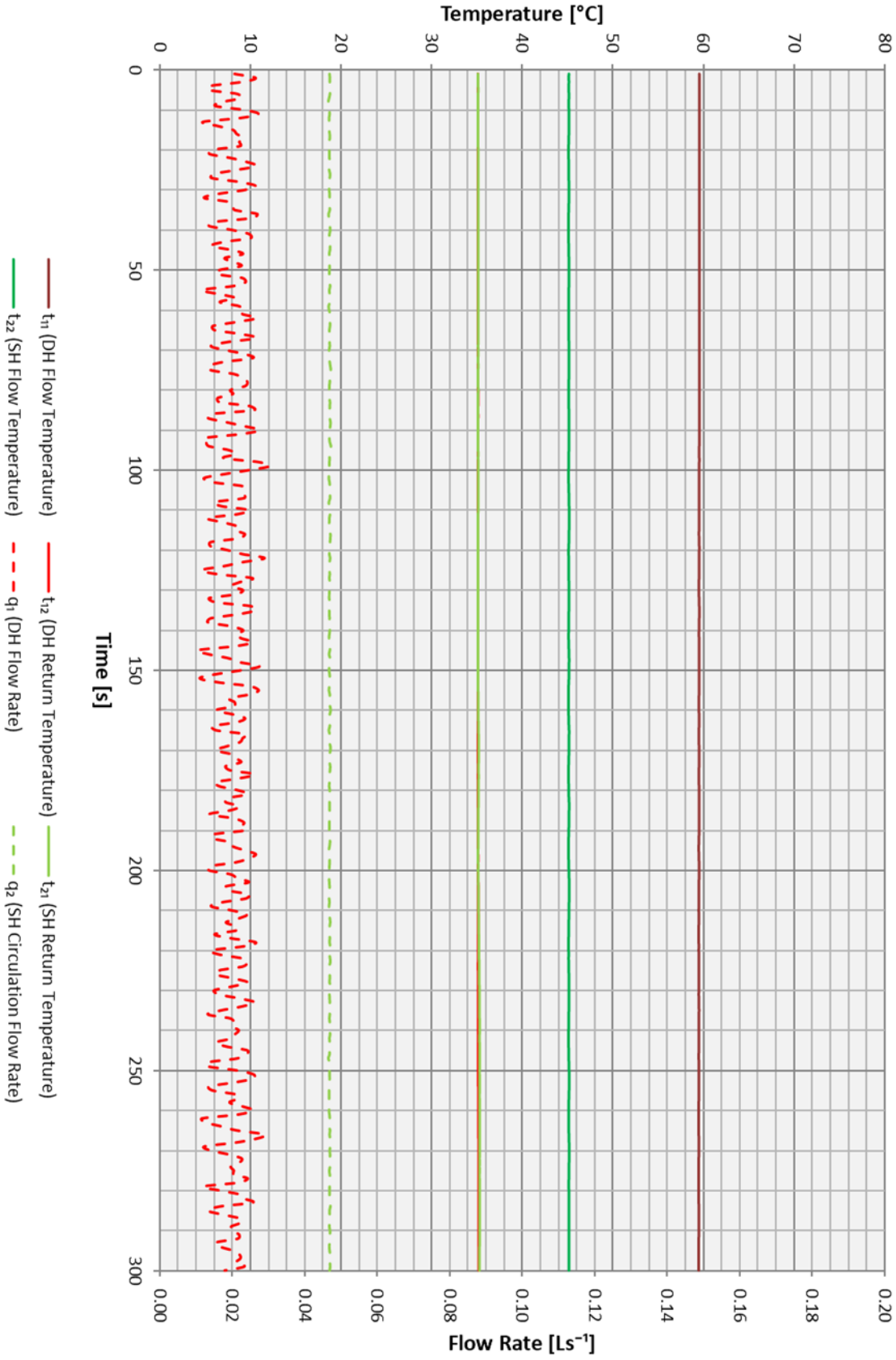

Figure 7.5 - Test 1e – Space Heating 2 kW at 60 °C

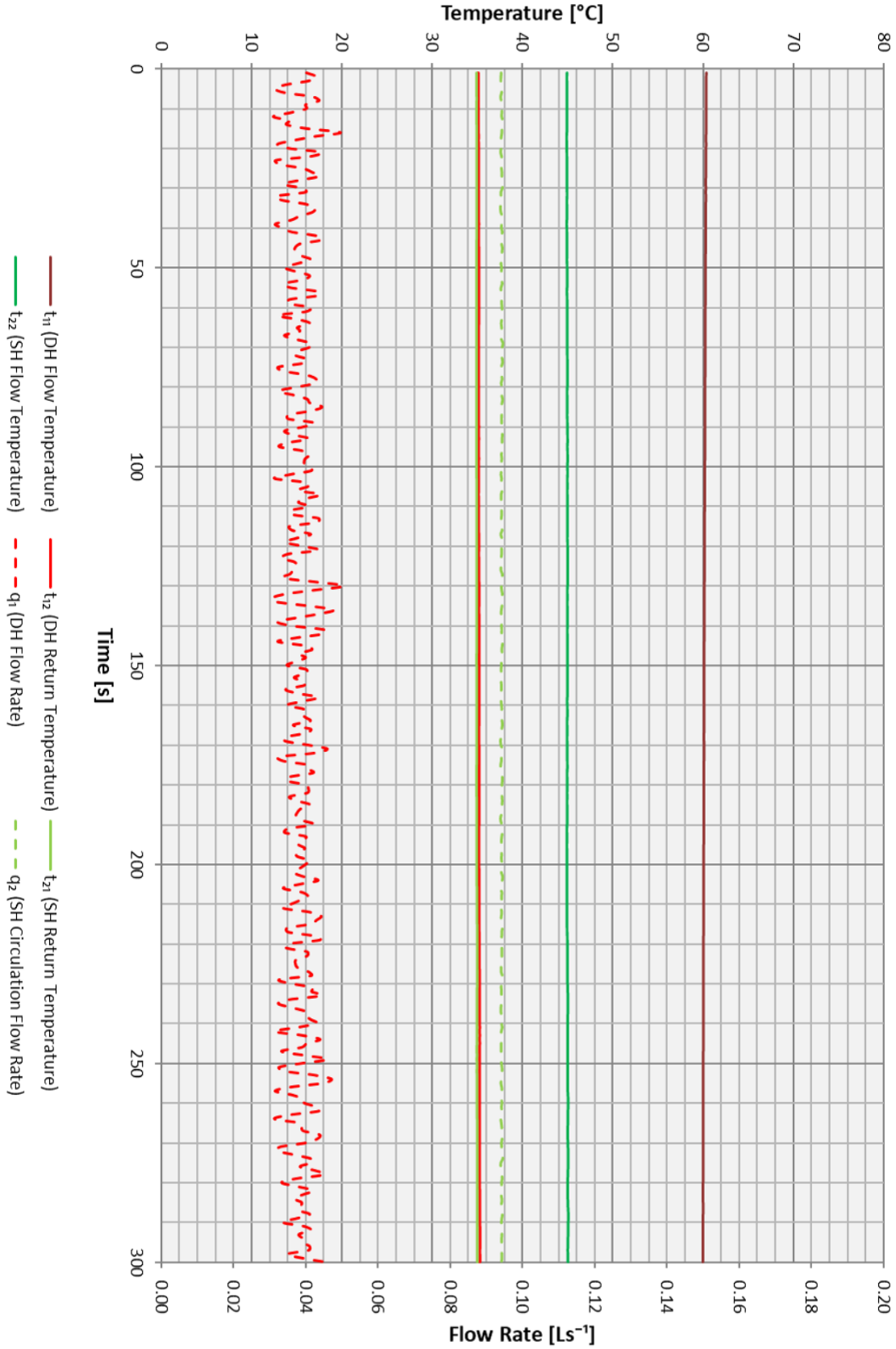

Figure 7.6 - Test 1f – Space Heating 4 kW at 60 °C

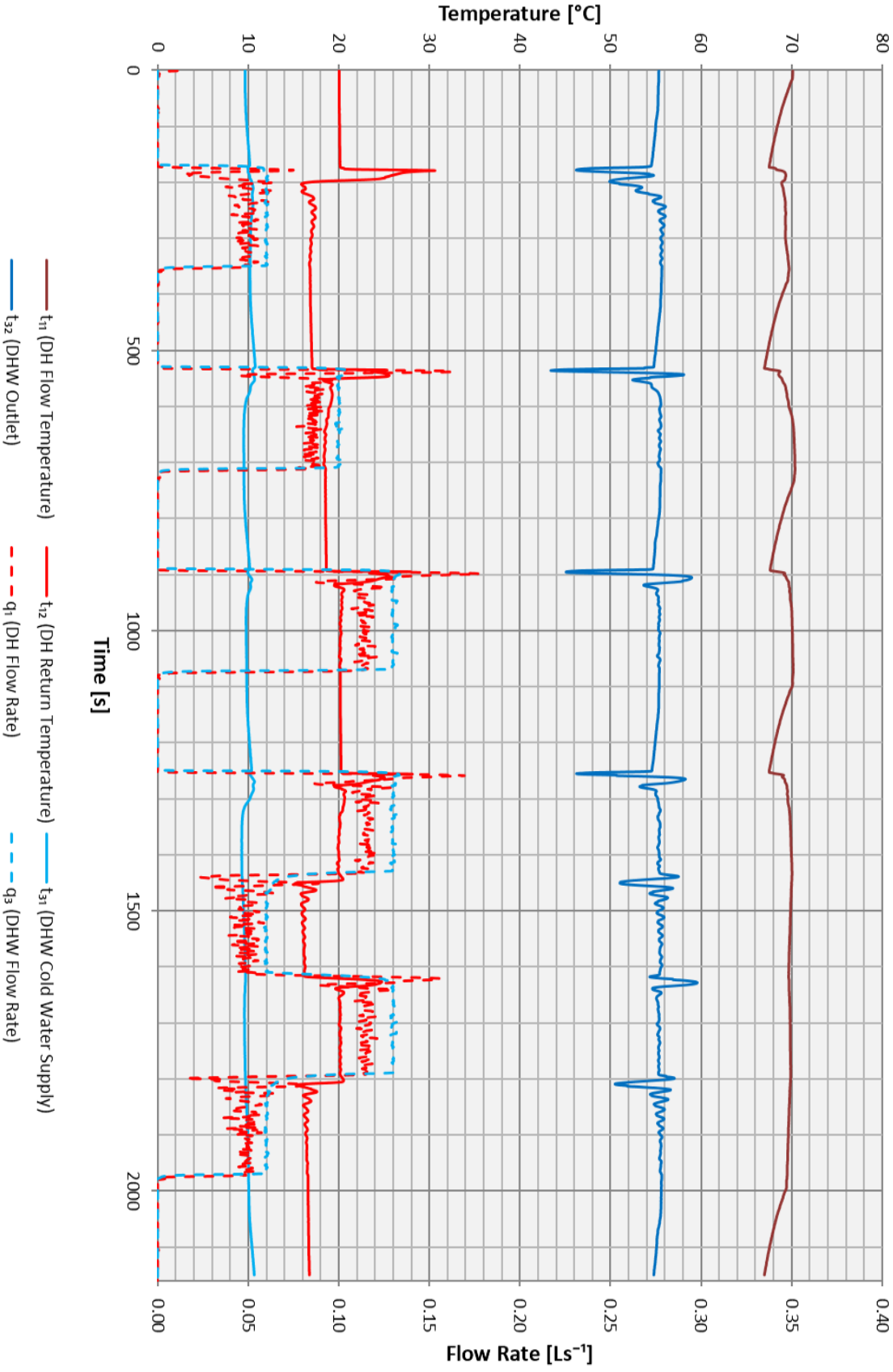

Figure 7.7 - Test 2a – DHW only at 70 °C

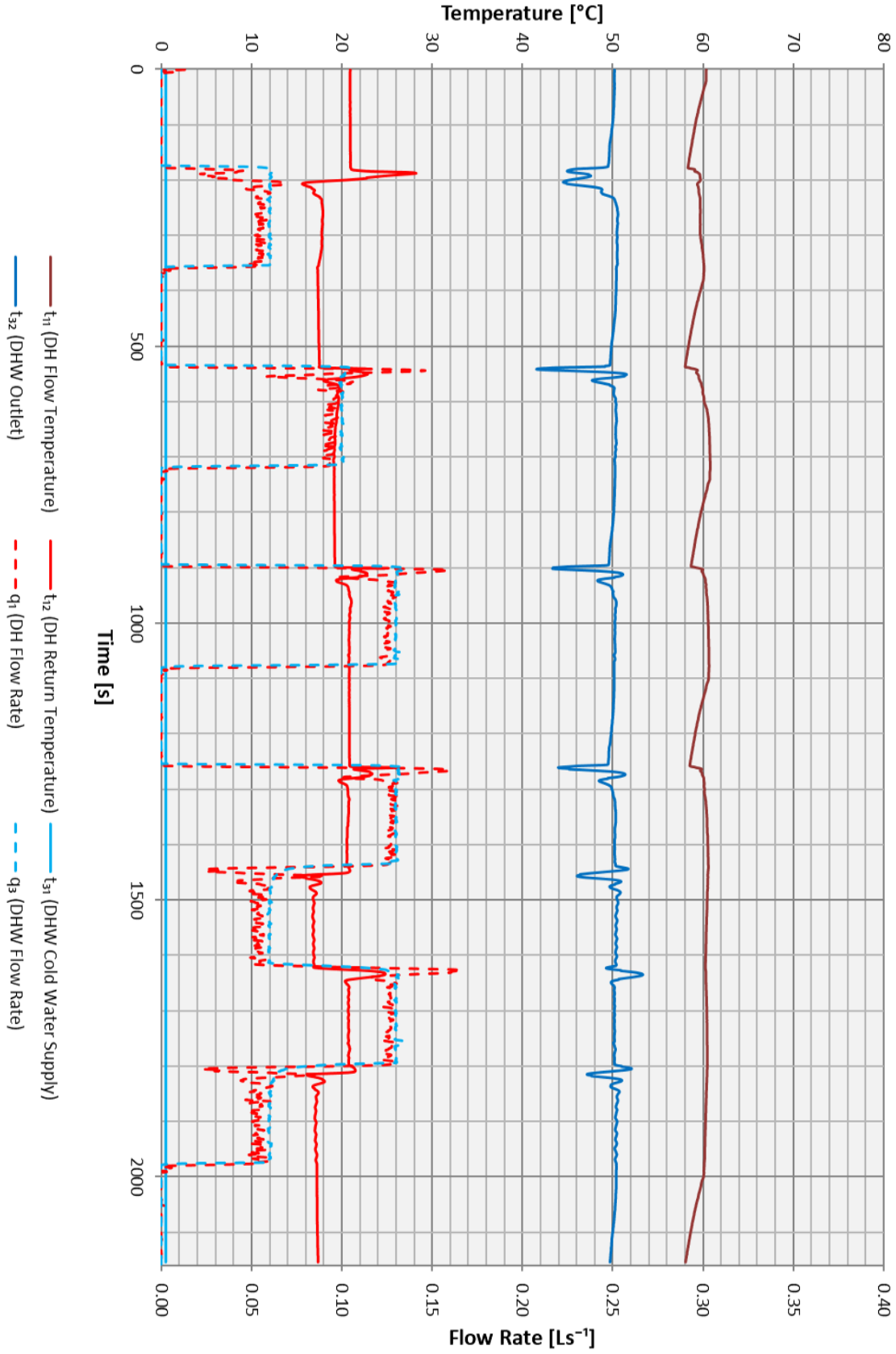

Figure 7.8 - Test 2b – DHW only at 60 °C

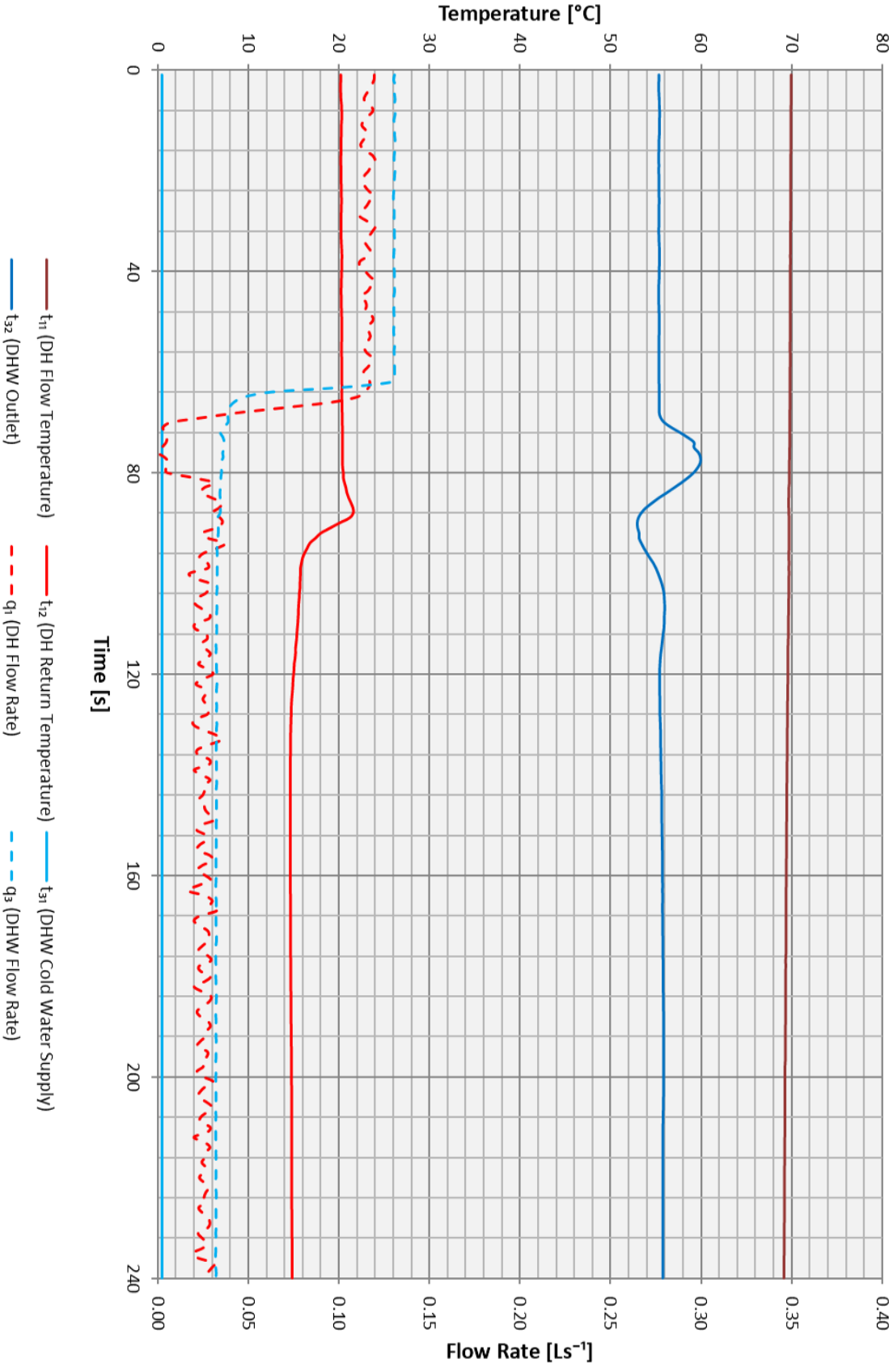

Figure 7.9 - Test 3a – Low Flow DHW at 70 °C

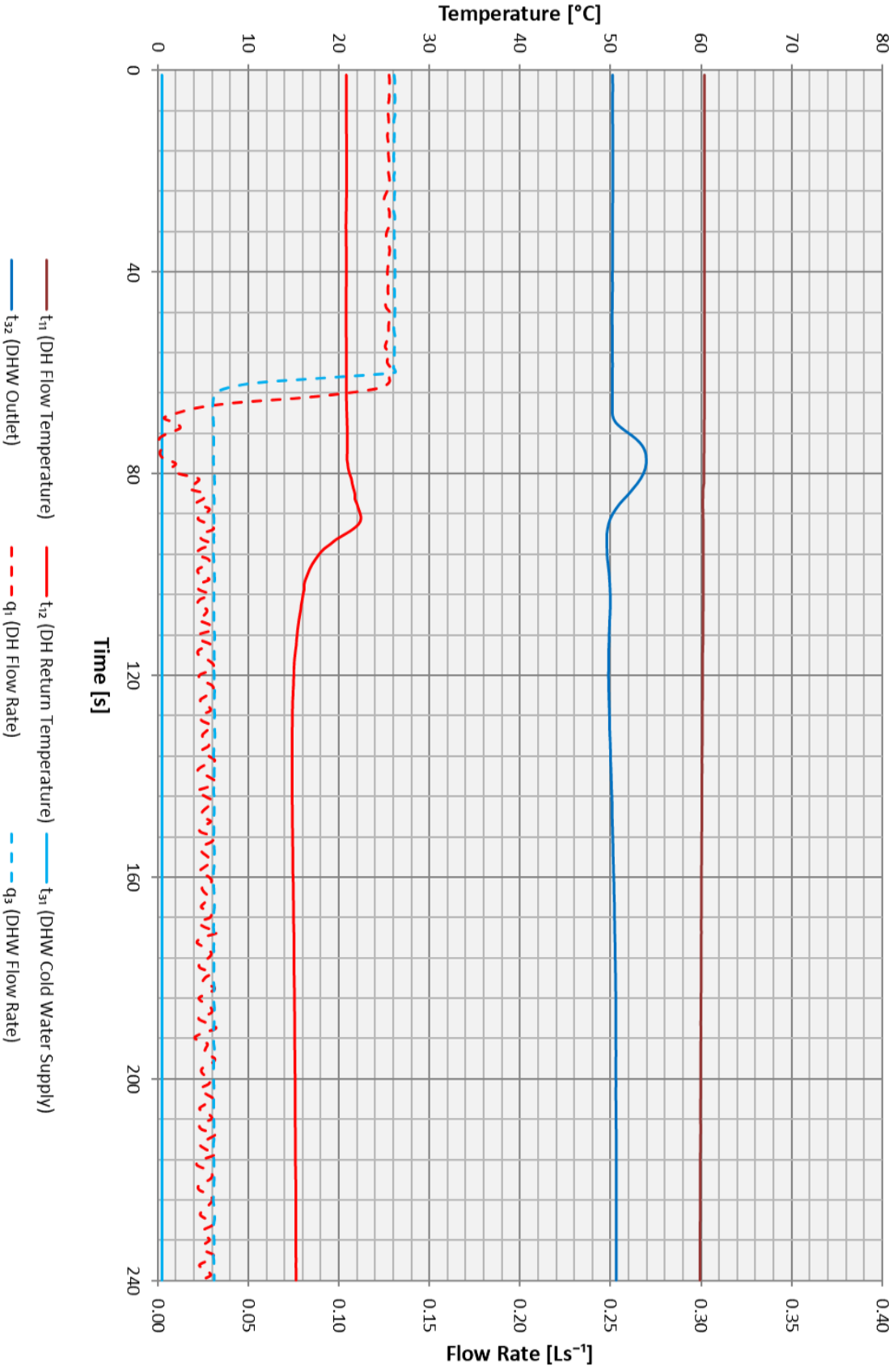

Figure 7.10 - Test 3b – Low Flow DHW at 60 °C

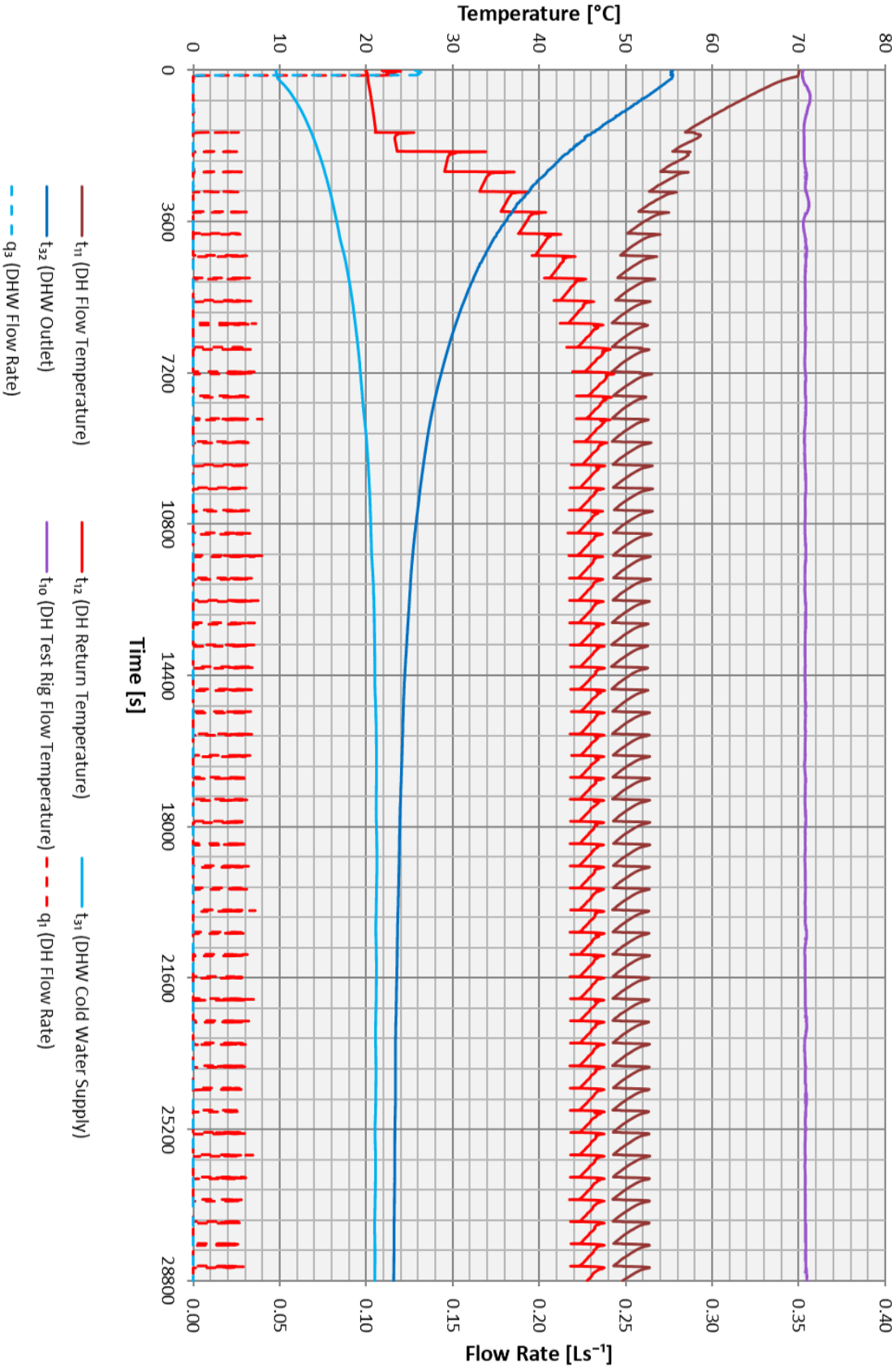

Figure 7.11 - Test 4a – Keep-warm at 70 °C

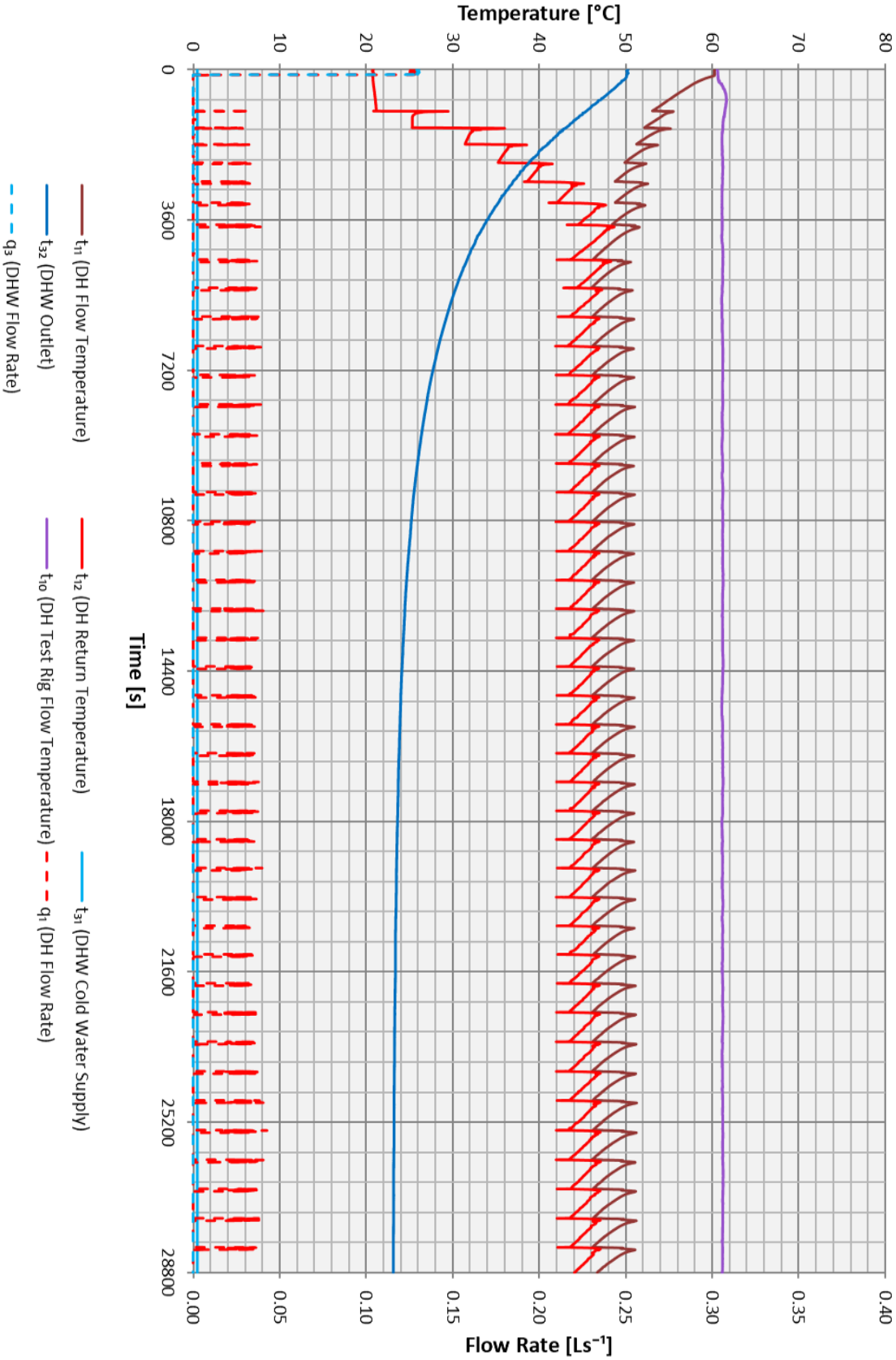

Figure 7.12 - Test 4b – Keep-warm at 60 °C

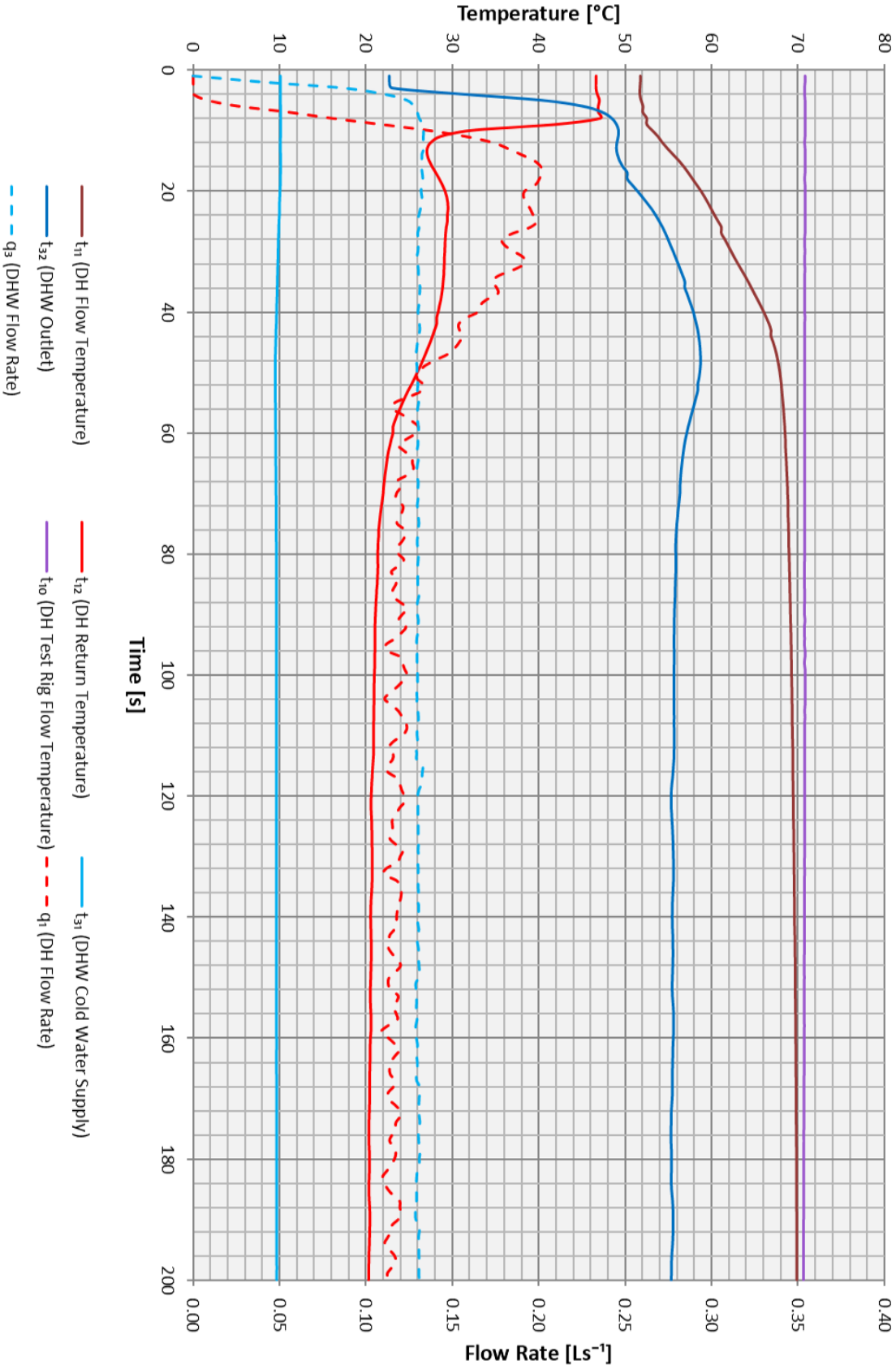

Figure 7.13 - Test 5a – DHW Response Time at 70 °C

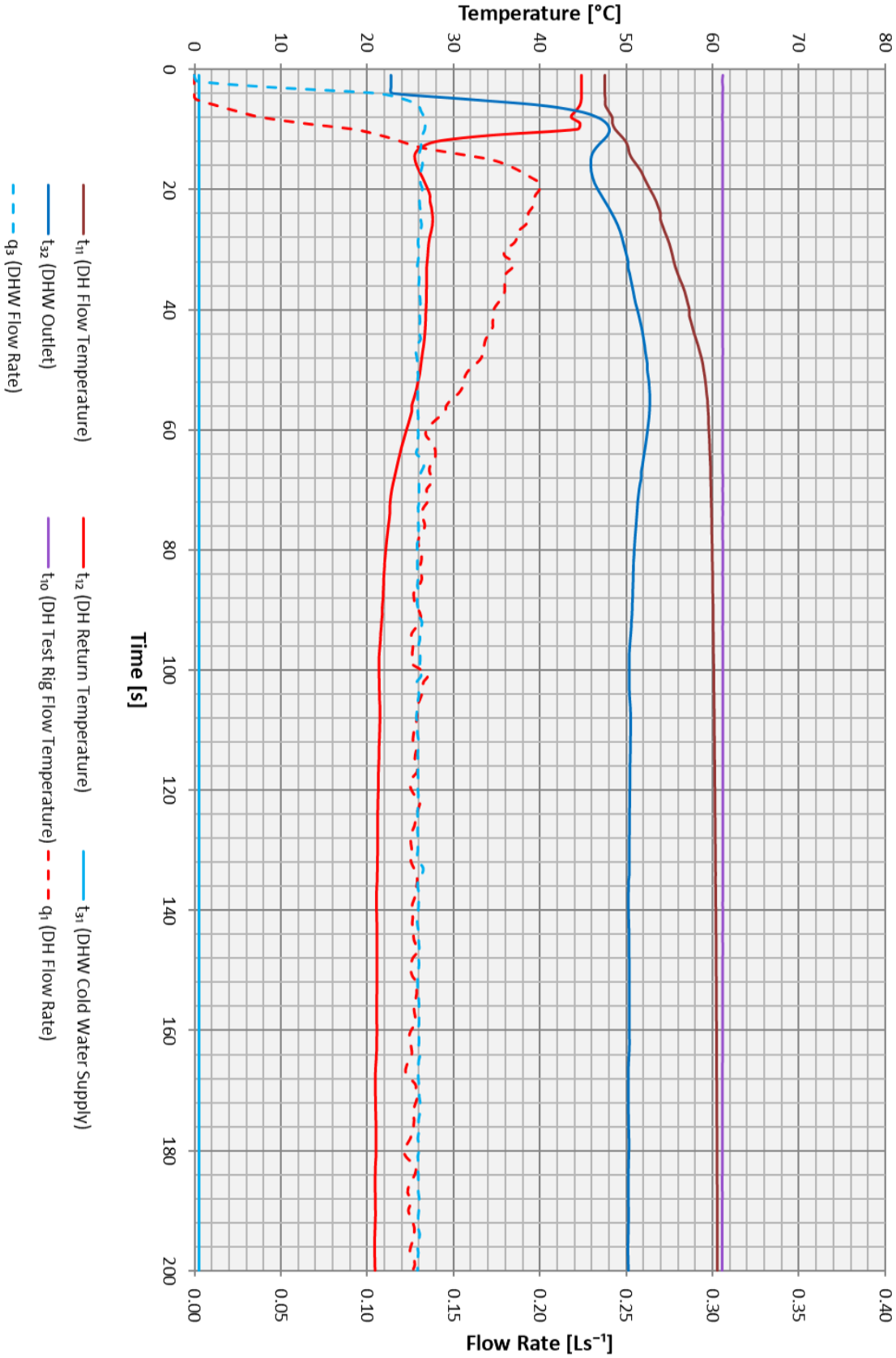

Figure 7.14 - Test 5b – DHW Response Time at 60 °C

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

			Space Heating			Dynamic Domestic Hot Water						Keep Warm
			1kW	2kW	4kW	Low Flow	Post Low Flow	Med Flow	Post Med Flow	High Flow	Post High Flow	
Parameter	**Symbol**	**Units**	1d	1e	1f	2b	2b	2b	2b	2b	2b	4b
Volume Weighted Avg. Return Temp	*[VWART]*	*[°C]*	40.54	41.07	42.17	17.8	16.8	19.3	18.5	20.8	20.2	45.8
Annual Hours of Operation	*[h]*	*[hrs]*	91	390	141	54	-	13	-	15	-	8056
Annual Primary Volume	*[V]*	*[m^3]*	3.3	25.6	18.3	9.2	0.0	4.0	0.0	6.1	0.0	43.3
Primary Power	*[P_1]*	*[W]*	1213	2170	4141	10218	25	17973	23	23295	23	36.1
Secondary Power	*[P_2]*	*[W]*	1077	2016	4012	-	-	-	-	-	-	-
DHW Power	*[P_3]*	*[W]*	-	-	-	13503	0	22749	0	29562	0	-
Primary Flow Temperature	*[t_{11}]*	*[°C]*	69.6	69.6	69.6	69.3	69.2	69.8	69.9	69.9	69.8	51.3
Primary Return Temperature	*[t_{12}]*	*[°C]*	40.5	41.1	42.2	18.1	16.9	19.2	18.5	20.7	20.2	43.4
Sceondary Return Temperature	*[t_{21}]*	*[°C]*	39.9	40.0	40.0	-	-	-	-	-	-	-
Secondary Flow Temperature	*[t_{22}]*	*[°C]*	60.6	60.3	59.9	-	-	-	-	-	-	-
DHW Supply Temperature	*[t_{31}]*	*[°C]*	-	-	-	10.3	10.2	9.8	9.6	9.9	9.9	-
DHW Outlet Temperature	*[t_{32}]*	*[°C]*	-	-	-	54.5	55.6	55.0	55.5	55.2	55.4	-
Primary Flow Rate	*[q_1]*	*[Ls^{-1}]*	0.010	0.018	0.036	0.047	0.000	0.085	0.000	0.113	0.000	0.001
Secondary Flow Rate	*[q_2]*	*[Ls^{-1}]*	0.012	0.024	0.048	-	-	-	-	-	-	-
DHW Flow Rate	*[q_3]*	*[Ls^{-1}]*	-	-	-	0.060	0.000	0.100	0.000	0.129	0.000	0.000
Primary Pressure Differential	*[Δp_1]*	*[kPa]*	54.8	53.0	51.7	51	63	51	64	50	66	89
Secondary Pressure Differential	*[Δp_2]*	*[kPa]*	-0.8	-0.3	0.3	-	-	-	-	-	-	-
DHW Pressure Differential	*[Δp_3]*	*[kPa]*	-	-	-	2	2	6	2	9	2	-
Ambient Temp	*[t_a]*	*[°C]*	20.8	21.0	21.3	21.0	21.0	21.0	21.0	21.0	21.0	20.7

Table 7.1 - Key Metrics of High Temperature Package

Parameter	Symbol	Units	Space Heating			Dynamic Domestic Hot Water						Keep Warm
			1kW 1d	2kW 1e	4kW 1f	Low Flow 2b	Post Low Flow 2b	Med Flow 2b	Post Med Flow 2b	High Flow 2b	Post High Flow 2b	4b
Volume Weighted Avg. Return Temp	[VWART]	[°C]	34.53	35.17	35.23	18.0	17.3	19.6	19.2	20.9	20.8	45.6
Annual Hours of Operation	[h]	[hrs]	98	404	143	59	-	14	-	17	-	8025
Annual Primary Volume	[V]	[m^3]	3.5	29.0	19.8	10.9	0.0	4.8	0.0	7.3	0.0	64.5
Primary Power	[P_1]	[W]	1065	2035	4023	8910	65	15818	85	20279	46	37.3
Secondary Power	[P_2]	[W]	999	1950	3959	-	-	-	-	-	-	-
DHW Power	[P_3]	[W]	-	-	-	12258	0	20606	0	26723	0	-
Primary Flow Temperature	[t_{11}]	[°C]	60.2	59.6	60.2	59.7	59.9	60.3	60.5	60.4	60.4	48.8
Primary Return Temperature	[t_{12}]	[°C]	34.5	35.2	35.2	18.4	17.4	19.5	19.2	20.9	20.8	43.8
Sceondary Return Temperature	[t_{21}]	[°C]	34.7	35.2	35.0	-	-	-	-	-	-	-
Secondary Flow Temperature	[t_{22}]	[°C]	45.3	45.1	45.0	-	-	-	-	-	-	-
DHW Supply Temperature	[t_{31}]	[°C]	-	-	-	10.6	9.9	10.0	10.0	10.2	10.3	-
DHW Outlet Temperature	[t_{32}]	[°C]	-	-	-	49.5	50.4	49.9	50.2	49.9	50.2	-
Primary Flow Rate	[q_1]	[Ls^{-1}]	0.010	0.020	0.039	0.051	0.000	0.093	0.000	0.123	0.000	0.002
Secondary Flow Rate	[q_2]	[Ls^{-1}]	0.022	0.047	0.094	-	-	-	-	-	-	-
DHW Flow Rate	[q_3]	[Ls^{-1}]	-	-	-	0.060	0.000	0.100	0.000	0.129	0.000	0.000
Primary Pressure Differential	[Δp_1]	[kPa]	51.4	53.1	48.0	48	60	48	60	47	62	94
Secondary Pressure Differential	[Δp_2]	[kPa]	-0.8	-0.3	2.4	-	-	-	-	-	-	-
DHW Pressure Differential	[Δp_3]	[kPa]	-	-	-	3	1	6	1	9	1	-
Ambient Temp	[t_a]	[°C]	21.1	20.6	21.3	20.2	20.2	20.2	20.2	20.2	20.2	20.7

Table 7.2 - Key Metrics of Low Temperature Package

VWART Calculation with Keep Warm

Test carried out by Enertek International for High Temperature BESA Tests

Manufacturer:	Albion
Model:	MTA TWIN 24-40
Serial number:	1901137
Calculation performed by B Meekin of Enertek on:	10/08/2019

Primary Flow Temperature:	70°C
DHW Setpoint:	55°C
Space Heating Temperature:	60/40°C

	VWART (°C)	Volume (m3)
DHW	19	19.3
Standby	46	43.3
Space Heating	44	50.9

VWART with keep warm active

Period	VWART (°C)	% Time
No Heating	38	93%
Heating	41	7%
Overall	**38**	

Table 7.3 – High Temperature VWART Calculations

		Test Results							
		Power [W]	Primary flow [m³/hr]	VWART [°C]	Energy Used [kWh]	Annual Operation [Hours]	Volume [m³]	Events [Per Year]	Average duration [Seconds]
1kW Space Heating	1a	1229	0.040	44	111	90.5	3.60	-	-
2kW Space Heating	1b	2155	0.074	45	841	390.5	28.75	-	-
4kW Space Heating	1c	4040	0.130	43	577	142.7	18.54	-	-
DHW Low Flow Rate	2a	13503	0.171	18	552	54.0	9.21	-	-
DHW Medium Flow Rate	2a	22749	0.306	19	235	13.1	3.99	-	-
DHW High Flow Rate	2a	29562	0.408	21	350	15.0	6.12	-	-
DHW Post Low Flow Rate	2a	-	0.000	17	-	-	0.01	10000	30
DHW Post Medium Flow Rate	2a	-	0.000	19	-	-	0.00	660	70
DHW Post High Flow Rate	2a	-	0.000	20	-	-	0.00	300	145
DHW Keep Warm Standby	4a	-	0.005	46	-	8055.7	43.28	-	-

VWART Calculation with Keep Warm

Test carried out by Enertek International for Low Temperature BESA Tests

Manufacturer:	0
Model:	0
Serial number:	0
Calculation performed by B Meekin of Enertek on:	10/08/2019

Primary Flow Temperature:	60°C
DHW Setpoint:	50°C
Space Heating Temperature:	45/35°C

	VWART (°C)	Volume (m3)
DHW	19	23.1
Standby	46	64.5
Space Heating	35	52.3

	VWART with keep warm active	
Period	**VWART (°C)**	**% Time**
No Heating	39	93%
Heating	36	7%
Overall	**38**	

Table 7.4 – Low Temperature VWART Calculations

		Test Results							
		Power [W]	Primary flow [m³/hr]	VWART [°C]	Energy Used [kWh]	Annual Operation [Hours]	Volume [m³]	Events [Per Year]	Average duration [Seconds]
1kW Space Heating	1d	1065	0.036	35	105	98.1	3.50	-	-
2kW Space Heating	1e	2035	0.072	35	821	403.6	28.97	-	-
4kW Space Heating	1f	4023	0.139	35	574	142.7	19.81	-	-
DHW Low Flow Rate	2b	12258	0.184	18	530	59.5	10.93	-	-
DHW Medium Flow Rate	2b	20606	0.334	20	228	14.4	4.81	-	-
DHW High Flow Rate	2b	26723	0.441	21	337	16.6	7.33	-	-
DHW Post Low Flow Rate	2b	-	0.001	17	-	-	0.03	10000	30
DHW Post Medium Flow Rate	2b	-	0.002	19	-	-	0.01	660	70
DHW Post High Flow Rate	2b	-	0.001	21	-	-	0.01	300	145
DHW Keep Warm Standby	4b	-	0.008	46	-	8025.1	64.54	-	-

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		SWEP E8AS x 24 Plates
2	Domestic Hot Water Heat Exchanger		SWEP E8AS x 40 Plates
3	Controller for Space Heating and Hot Water Heating		Vergne Innovation Electronic Board 121090-0416, Firmware version 2.0
4	Control Valve and Actuator for Space Heating		Vergne Innovation NMB Stepper Motor
5	Space Heating Strainer		N/A
6	Control Valve and Actuator for Hot Water Heating		Vergne Innovation NMB Stepper Motor
7	Temperature Sensors		Tasseron NTC TSD00E5
8	Domestic Hot Water Isolating Valve		LA B&G di Bardini Enrico & C. s.r.l. Brass Ball
9	Primary Side Strainer		Stainless Steel Mesh 316L 0.8mm
10	Drain Valves		Brass with EP856 O-Ring
11	Vent Valve		Kramer GE10/P Automatic Air Vent
12	Circulation Pump		Wilo Para MS/8-75 PWM1
13	Heat Meter		Itron Ultramaxx
14	Domestic Hot Water Flow Sensor		Huba Type 201.910121 Paddle Switch
15	Pipes		Brass
16	Connections		Brass
17	Joints		N/A
18	Gaskets		EP856
19	O Rings		EP856
20	Pressure Sensor		Vergne Innovation Proportional DC signal sensor
21	Expansion Vessel		CIMM RP250 10L
22	Insulation		Made from PLASTYROBEL – Expanded Polystyrene
A1			
A2	Commissioning Guide		Provided with Unit and attached
A3	Operation Guide		Provided with Unit and attached
A4	Declaration of Conformity		LVD, EMC
A5	Full Parameter List		Provided with Unit and attached
A6	Maximum Primary Static Operating Differential Pressure		3 Bar
A7	Deactivation procedure of the internal SH Pump		Disconnect electrical tab on Pump
	Model name and type number		MTA Twin 24-40
	Serial number		1901137 / 1003

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

MTA TWIN 24-40	
Appliance Serial Number	
Space Heating Heat Exchanger	
Domestic Hot Water Heat Exchanger	
Controller for Space Heating	
Control Valve & Actuator for Space Heating	
Controller for Domestic Hot Water	
Temperature Sensors	
Domestic Hot Water Isolating valve	
Primary Side Strainer	
Circulation Pump	
Heat Meter	
Domestic Hot Water Flow Sensor	
Pipes	
Connections	
`O` Rings	
Gaskets	
Expansion Vessel	
Pressure Sensors	
Insulation	

8.3 Appliance Photographs

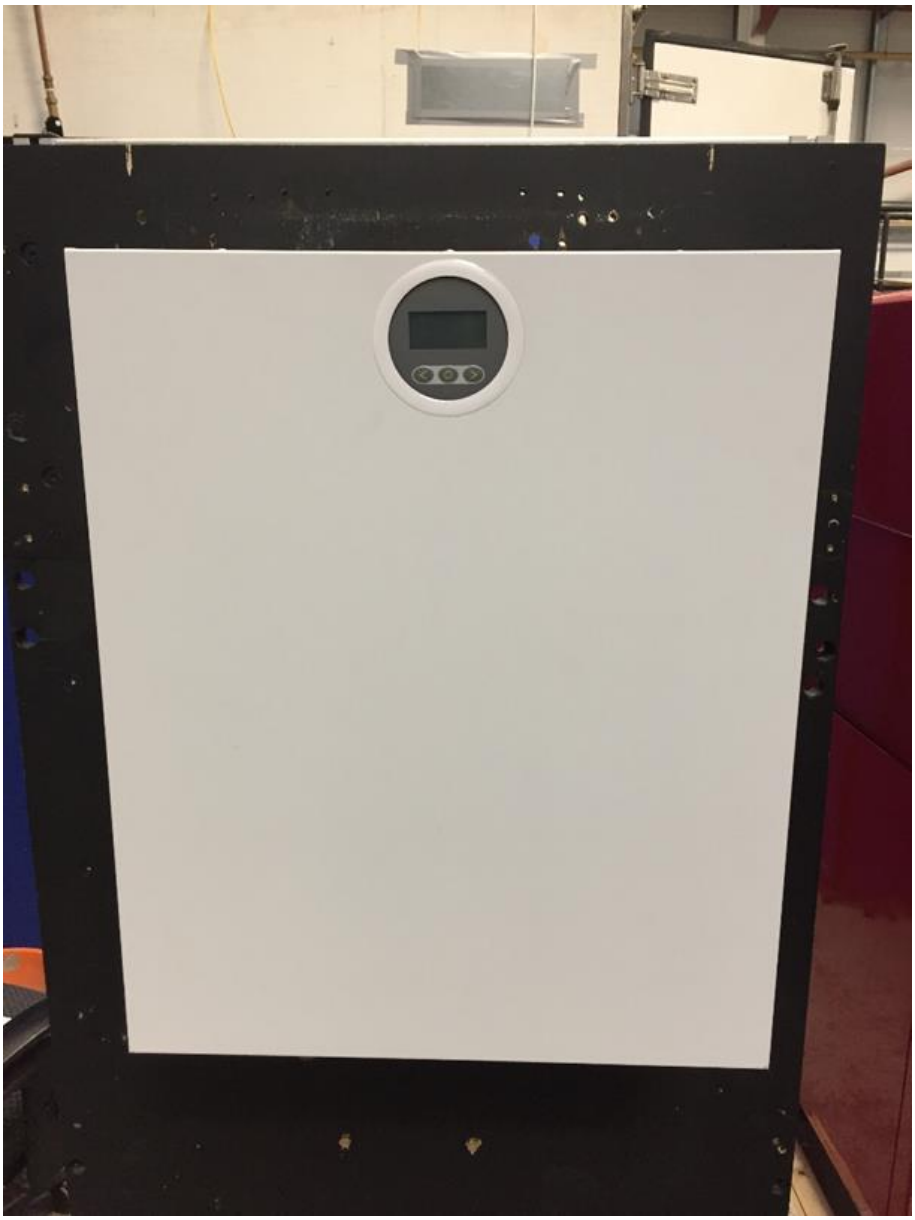

Figure 8.1 – Photograph of Appliance [Case Fitted]

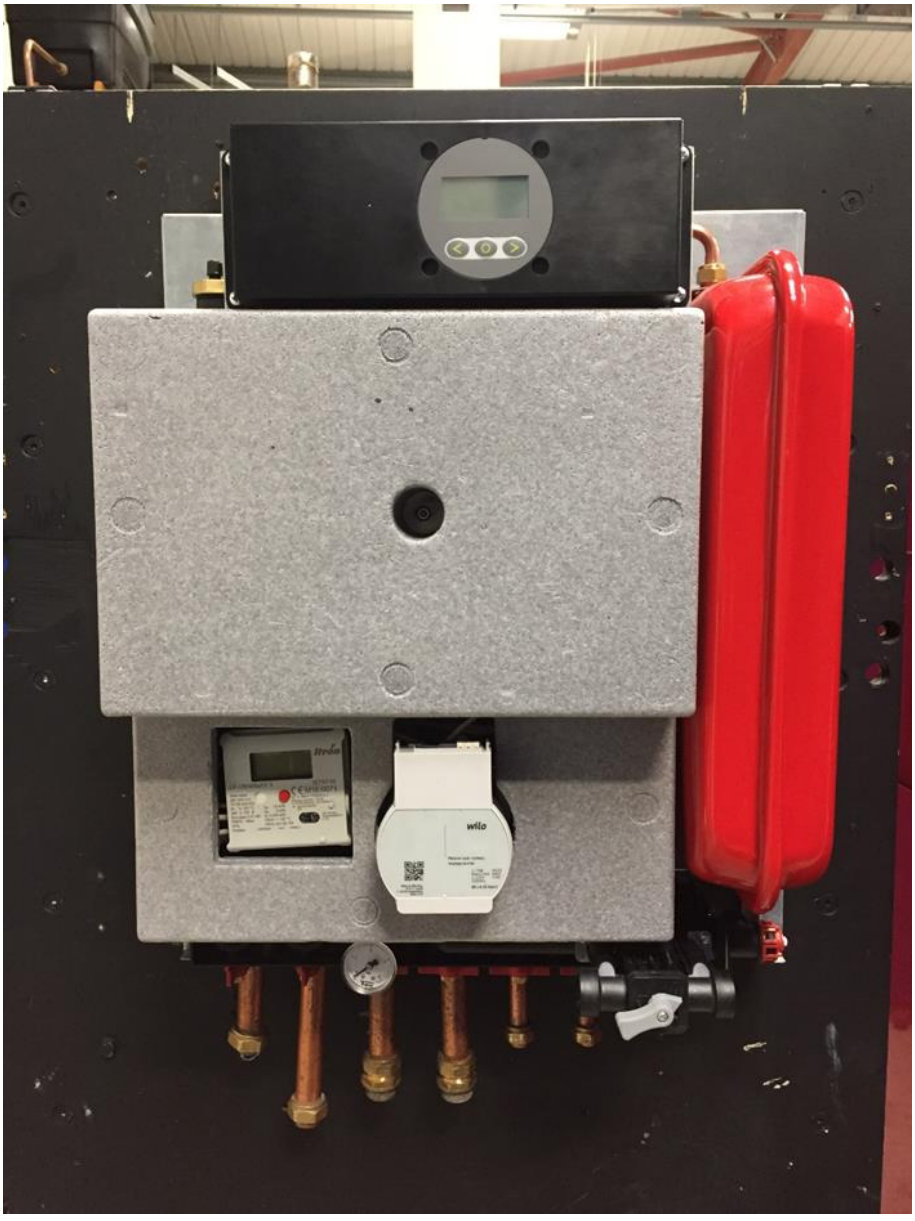

Figure 8.2 – Photograph of Appliance [Case Removed]

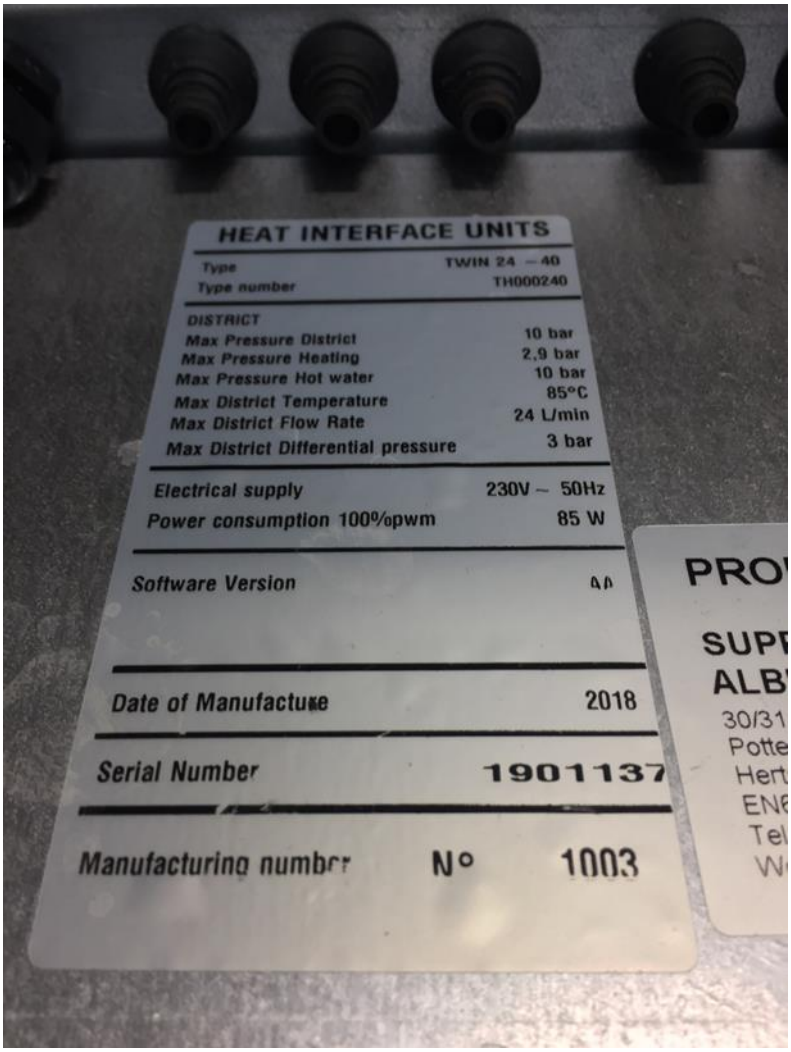

Figure 8-3 – Appliance Data Label

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	U92491-18	±0.0004	l/s	23-05-2018	23/05/2019
Flow Meter [DHW Flow Rate]	FM 602	U92511-18	±0.00305	l/s	24-05-2018	24/05/2019
Flow Meter [SH Flow Rate]	FM 603	U92467-18	±0.04871	l/s	22-05-2018	22/05/2019
Pressure Transducer [Primary Supply]	PT 086	K41132P	±6.82	kPa	22-05-2018	22/05/2019
Pressure Transducer [Primary Return]	PT 085	K41131P	±7.88	kPa	22-05-2018	22/05/2019
Pressure Transducer [DHW Output Pressure]	PT 083	K41129P	±7.73	kPa	22-05-2018	22/05/2019
Pressure Transducer [DHW Cold Water Supply]	PT 084	K41130P	±7.31	kPa	22-05-2018	22/05/2019
Pressure Transducer [SH Flow]	PT 087	K41127P	±7.26	kPa	22-05-2018	22/05/2019
Pressure Transducer [SH Return]	PT 088	K41128P	±7.30	kPa	22-05-2018	22/05/2019
PRT Probe [Primary Supply Temp]	PRT 4611	EIL 432360	±0.4	°C	16/05/2018	16/05/2019
PRT Probe [Primary Return Temp]	PRT 4612	EIL 432360	±0.4	°C	16/05/2018	16/05/2019
PRT Probe [DHW Output Temp]	PRT 4615	EIL 432360	±0.4	°C	16/05/2018	16/05/2019
PRT Probe [Cold Water Supply Temp]	PRT 4705	EIL 432360	±2.2	°C	16/05/2018	16/05/2019
PRT Probe [SH Supply Temp]	PRT 4613	EIL 432360	±0.4	°C	16/05/2018	16/05/2019
PRT Probe [SH Return Temp]	PRT 4608	EIL 433000	±0.5	°C	19/07/2018	19/07/2019
Pressure Transducer [Static Pressure Test]	PT 078	K41178P	±9.31	kPa	25/05/2018	25/05/2019
Software	VERSION – LabVIEW, Version 5 , Service pack 1					

Report Issue No	Reason for Report Update
1	Original Issue.
2	Formatting changes and additional comments added.
3	Updated to new report format.

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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