Enertek International

International Consultants In Product Research, Design, Development & Certification

Project Number:	E4477
Project Title:	BESA testing for Evinox ModuSat XR (Eco)
Client:	Evinox Energy Ltd
Client Address	Unit 37, Barwell Business Park Leatherhead Road, Chessington Surrey KT9 2NY
Date:	22 February 2021
Report Number:	1. Issue 2

Prepared By:

I. Williamson / Project Engineer

Approval By:

Howard Ruston / R&D Manager

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 BRIEF

1.1.1 Enertek international Limited (EIL), were contracted to receive, install and commission a production sample, ModuSat XR (Eco) on behalf of Evinox Energy Ltd.

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 ModuSat XR (Eco) 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	Evinox Energy Ltd
Model	ModuSat XR (Eco)
Serial number	CTPE2B2720A30
Year of manufacture	2020
DHW priority	Yes

3.2 Appliance Design Pressures

3.2.1 The maximum design pressures of the ModuSat XR (Eco) 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	16	Bar
Secondary Side space Heating	3	Bar
Secondary Side DHW	10	Bar

3.3 Appliance Design Temperatures

3.3.1 The maximum design temperatures of the ModuSat XR (Eco) 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 Evinox Energy Ltd, ModuSat XR (Eco) 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)

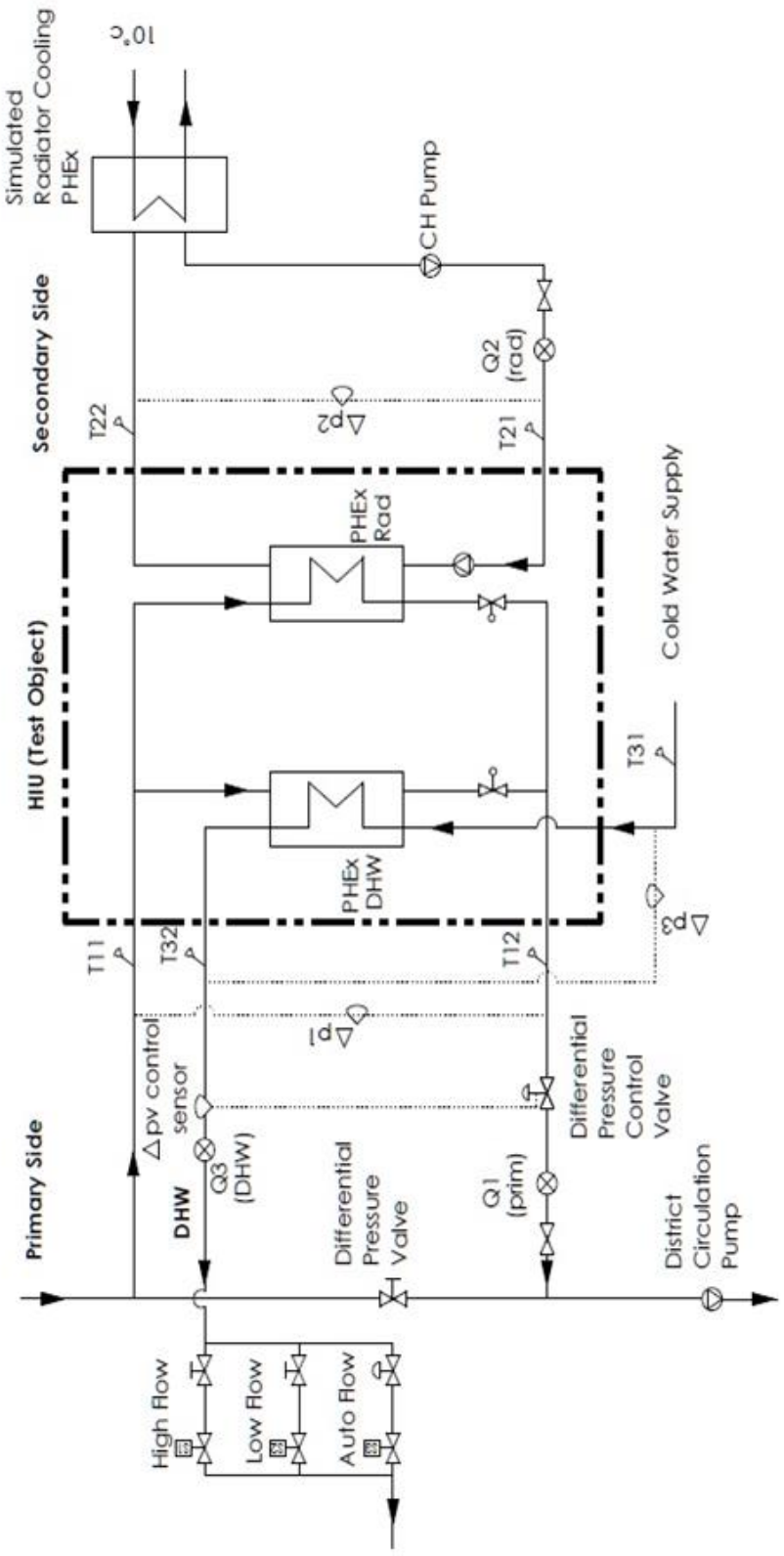

Figure 4.1 – EIL's HIU Test Rig schematic

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 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				
		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)	70.2	39.6	0.009	50.2	1140	40.1	59.8	0.012	1.3	965
1b	- 2 kW Space Heating (DH 70 °C flow)	70.3	40.0	0.017	50.6	2204	39.8	59.8	0.024	1.7	2006
1c	- 4 kW Space Heating (DH 70 °C flow)	70.4	41.2	0.035	49.6	4283	40.1	60.2	0.048	3.6	4021
1d	- Space Heating 1 kW (DH 60 °C flow)	59.8	34.4	0.010	51.2	1062	34.9	44.6	0.024	1.7	975
1e	- Space Heating 2 kW (DH 60 °C flow)	60.2	34.6	0.020	49.8	2094	35.0	44.9	0.048	3.3	2001
1f	- Space Heating 4 kW (DH 60 °C flow)	60.2	35.0	0.039	49.7	4112	35.2	45.2	0.096	9.5	4008

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 59.1°C and 46.6°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 53.3°C and 42.3°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 3c – Low Flow DHW at 70 °C

5.5.1 The HIU met the requirements of test 3a of not exceeding 65°C for more than 10 seconds in accordance with the test method (maximum temperature reached was 61.9°C) The HIU did not provide stable flow temperatures of 55°C +/- 3°C for >60 seconds under the stated conditions.

5.5.2 As the appliance failed to provide stable flow temperatures during test 3a the appliance was retested as test 3c at the manufactures low flow rate. The appliance has passed the requirements of the Low Flow at 70 °C, Test 3c of the BESA Test Regime as:

5.5.3 The manufacturers declared low flow rate was 2.4 l/m which higher than the BESA test rate of 1.2 l/m

5.5.4 The domestic hot water output temperature, t_32 did exceed 65 °C for more than 10 seconds, and;

5.5.5 The appliance did maintain the DHW output temperature, t_32 at 55 ± 3 °C during the last 60 seconds of the test.

5.5.6 The maximum and minimum temperatures of t_32 were 59.5°C and 51.8°C respectively.

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

5.6 Test 3d – Low Flow DHW at 60 °C

5.6.1 The HIU met the requirements of test 3b of not exceeding 65°C for more than 10 seconds in accordance with the test method (maximum temperature reached was 51.5°C) The HIU did not provide stable flow temperatures of 55°C +/- 3°C for >60 seconds under the stated conditions.

5.6.2 As the appliance failed to provide stable flow temperatures during test 3b the appliance was retested as test 3d at the manufactures low flow rate. The appliance has passed the requirements of the Low Flow at 70 °C, Test 3d of the BESA Test Regime as:

5.6.3 The manufacturers declared low flow rate was 2.4 l/m which higher than the BESA test rate of 1.2 l/m

5.6.4 The maximum and minimum temperatures of t_{32} were 55.7°C and 37.3°C respectively.

5.6.5 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 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.

5.7.4 The average heat load on the primary side P_1 is 48 W.

5.7.5 The average electrical consumption was 4.2W.

5.7.6 The average primary flow q_1 over the 8 hour test was 2.8 l/hr.

5.7.7 The Keep-warm control was set to 45°C.

5.7.8 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 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.

5.8.4 The average heat load on the primary side P_1 is 59 W.

5.8.5 The average primary flow q_1 over the 8 hour test was 5.3 l/hr.

5.8.6 The average electrical consumption was 4.2 W.

5.8.7 The Keep-warm control was set to 45°C .

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 Choose an item. 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	Yes
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 VWART Calculations

5.12.1 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	$VWART_{DHW}$	13	°C
Keep Warm Volume Weight return Temperature	$VWART_{KWM}$	43	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	40	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	28	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	29	°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	$VWART_{KWM}$	44	°C
Annual Volume Weighted Return Temperature For Heating Period	$VWART_{HEAT}$	35	°C
Annual Volume Weighted Return Temperature For Non Heating	$VWART_{NONHEAT}$	33	°C
Total Annual Volume Weighted Return Temperature	$VWART_{OVERALL}$	33	°C

6 CONCLUSIONS

6.1.1 The appliance has passed 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

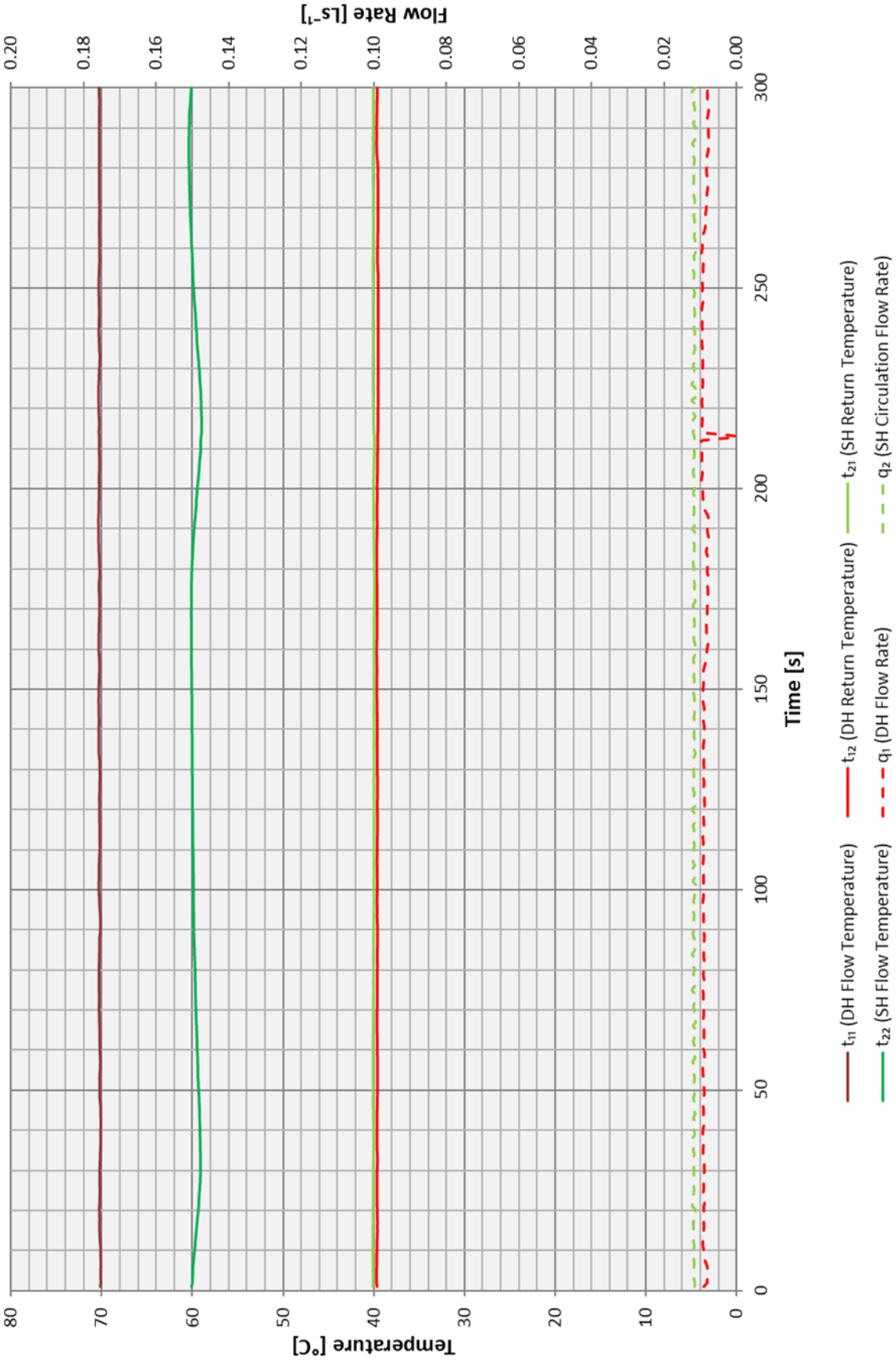

Figure 7.1 - Test 1a – Space Heating 1 kW at 70 °C

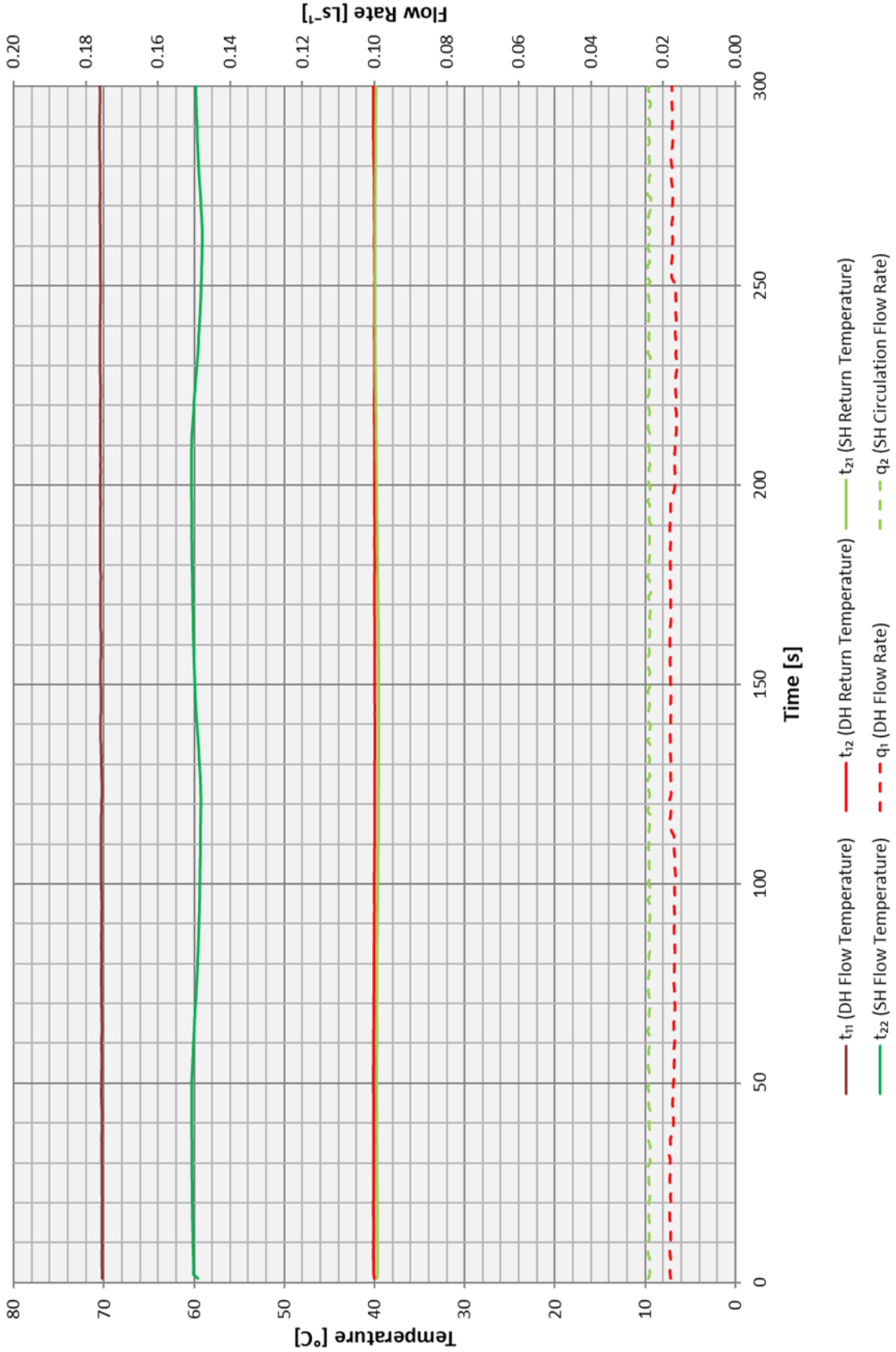

Figure 7.2 - Test 1b – Space Heating 2 kW at 70 °C

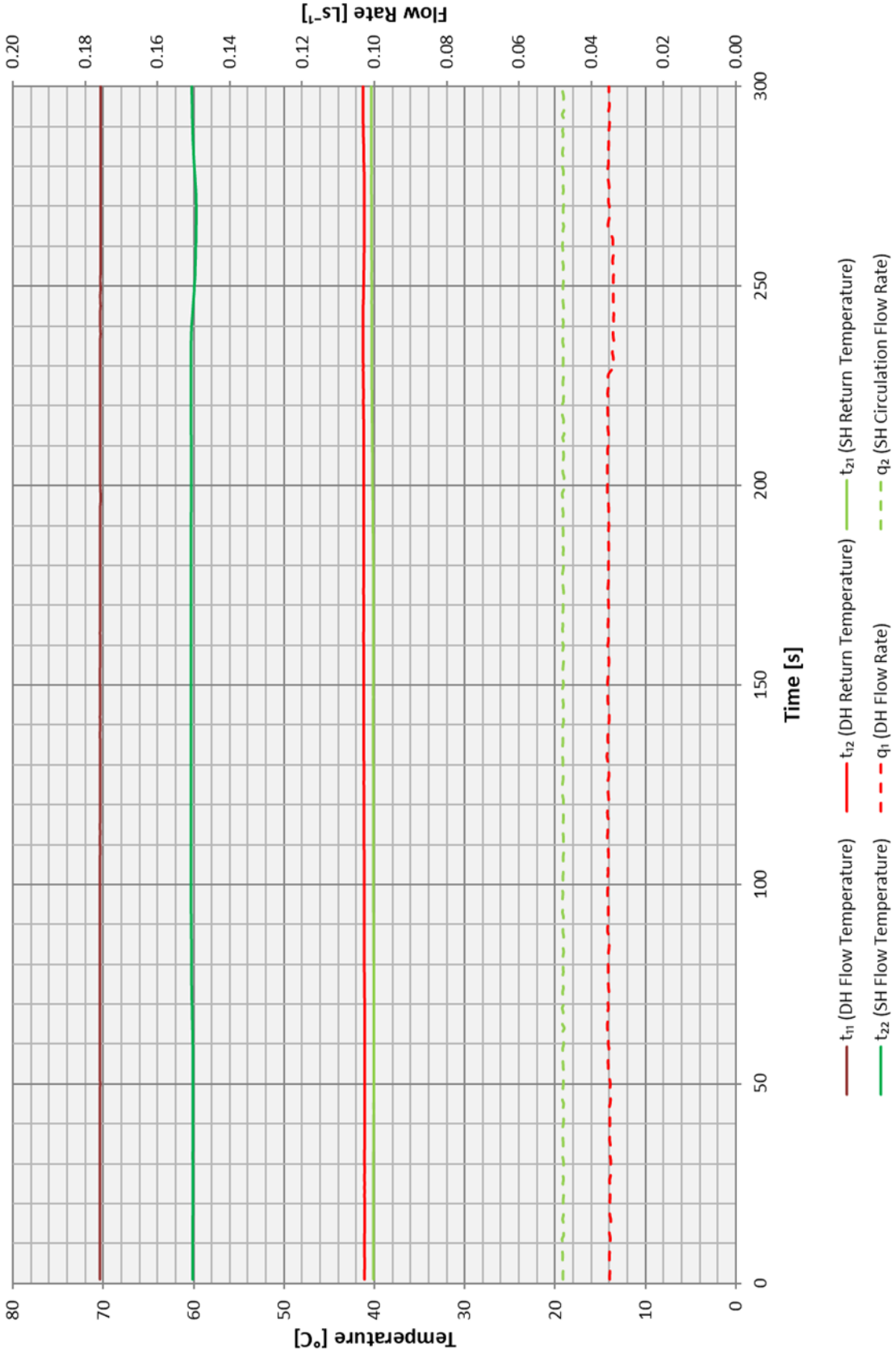

Figure 7.3 - Test 1c – Space Heating 4 kW at 70 °C

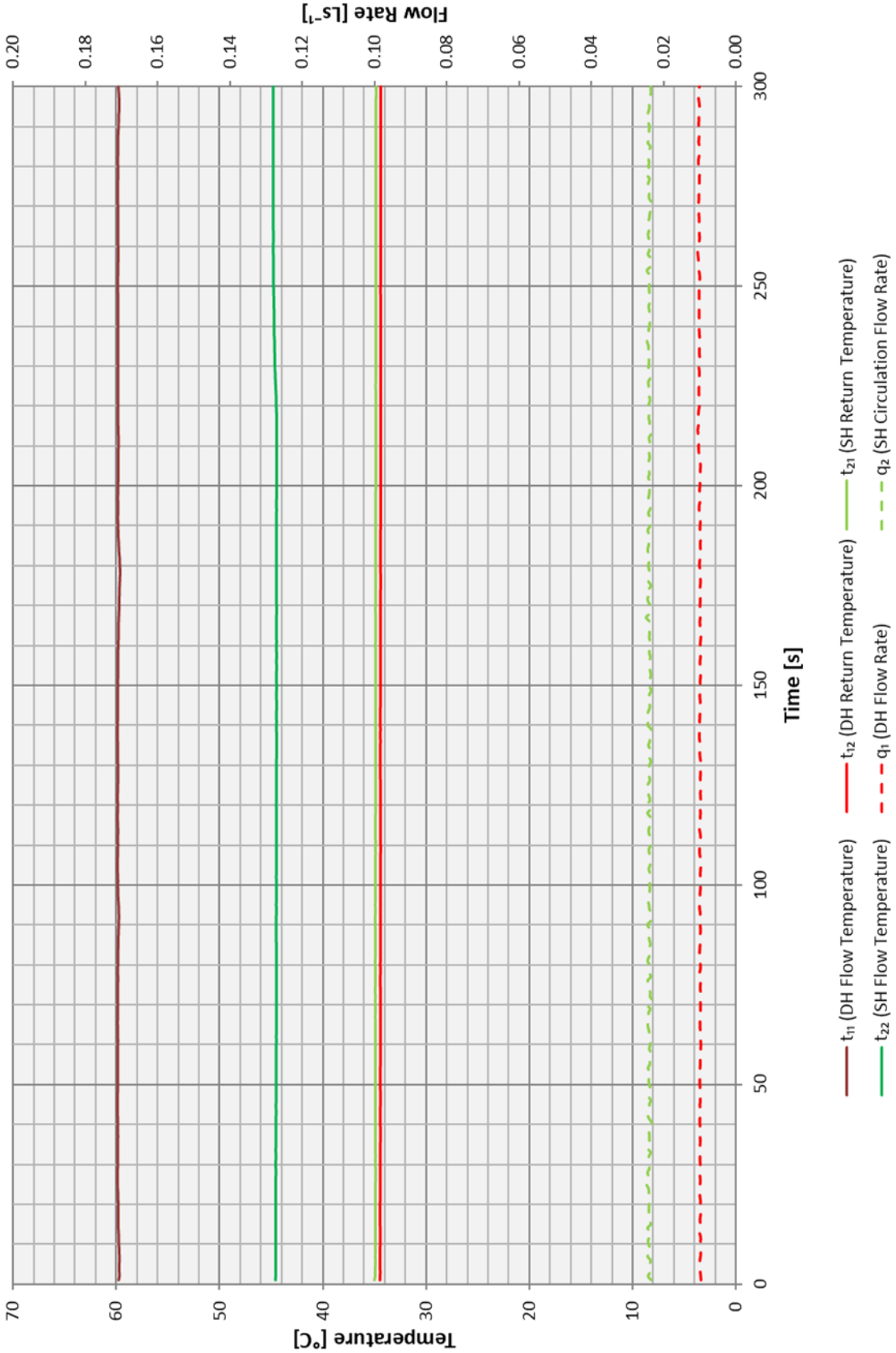

Figure 7.4 - Test 1d – Space Heating 1 kW at 60 °C

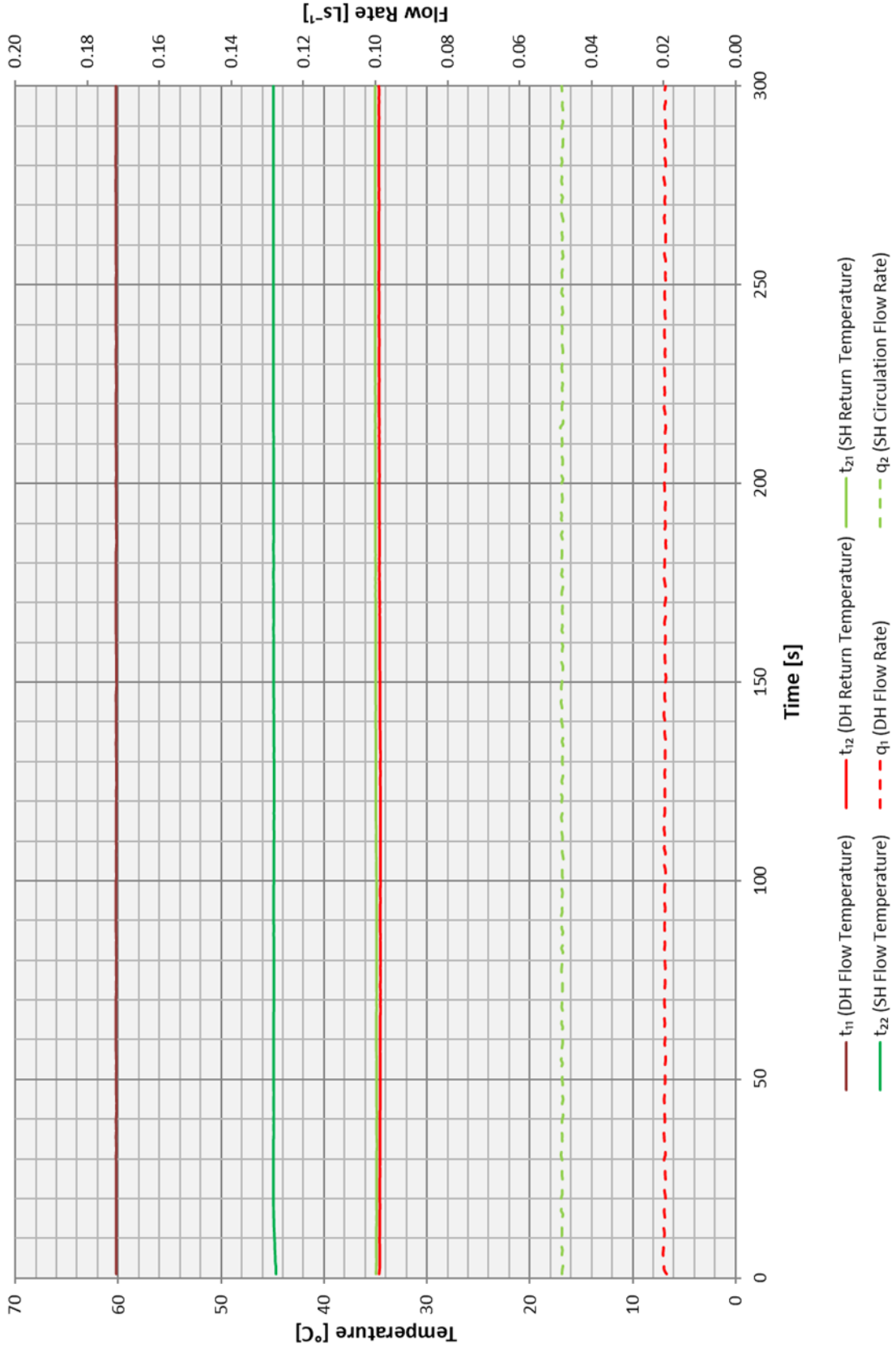

Figure 7.5 - Test 1e – Space Heating 2 kW at 60 °C

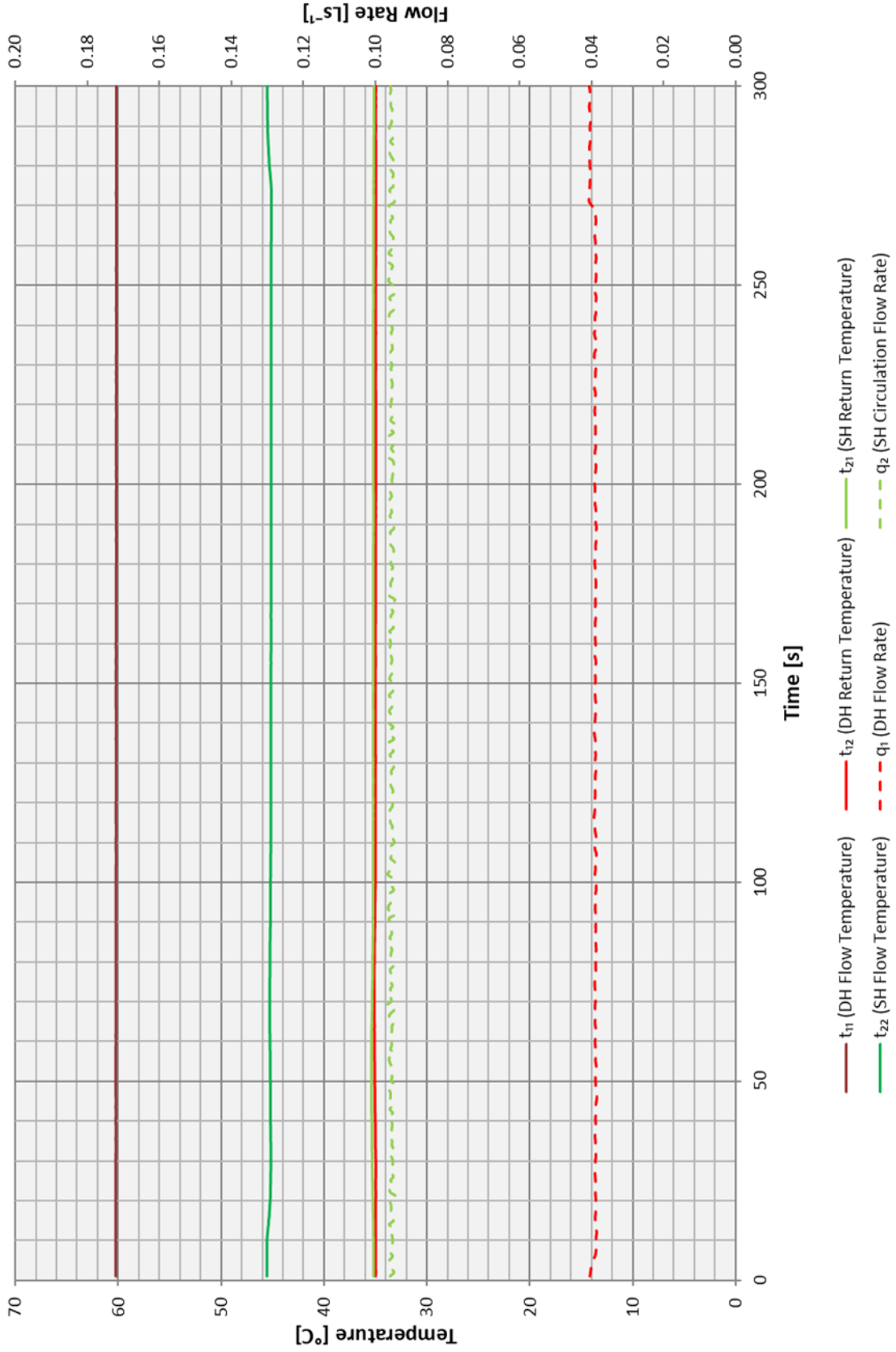

Figure 7.6 - Test 1f – Space Heating 4 kW at 60 °C

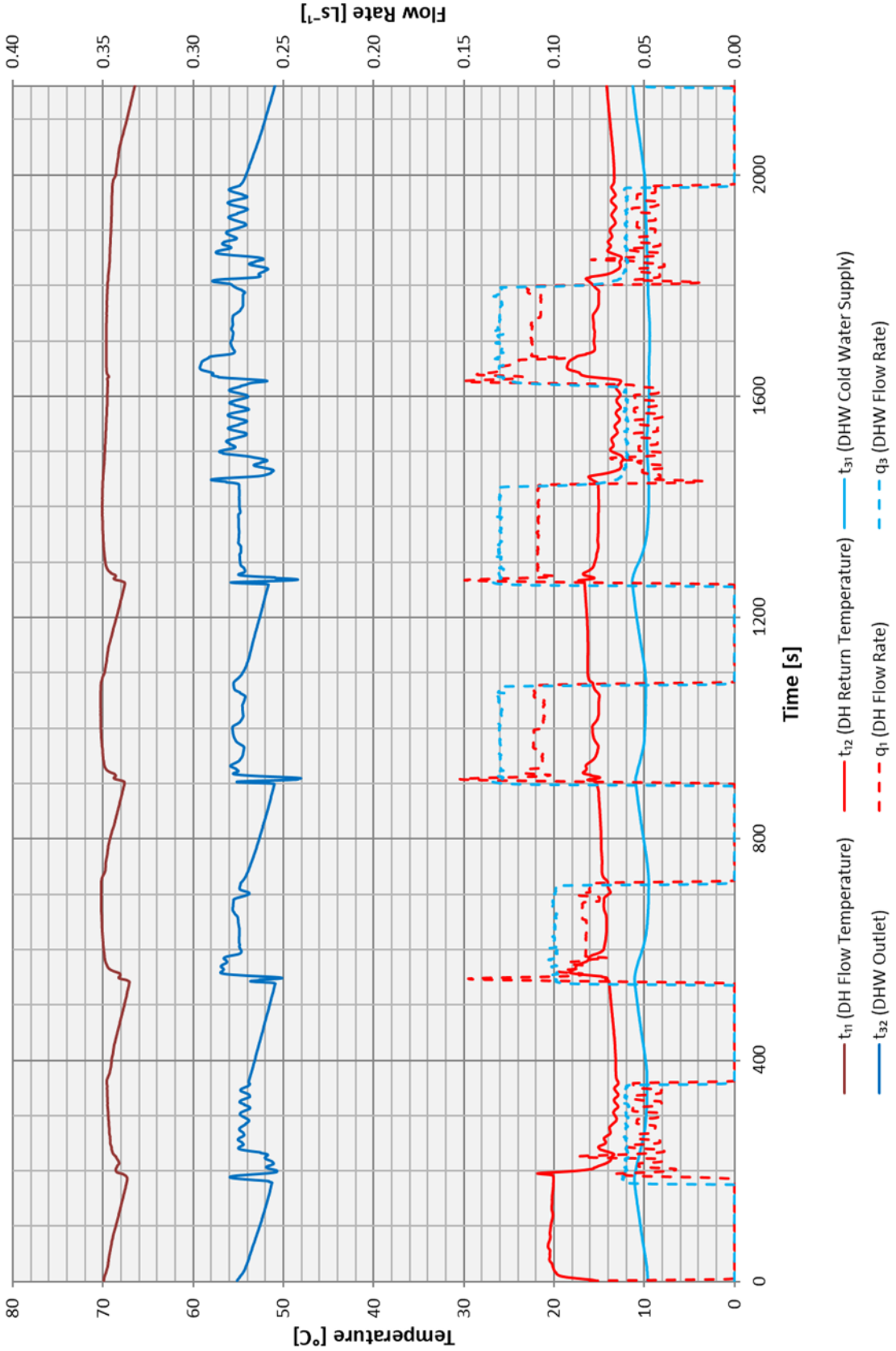

Figure 7.7 - Test 2a – DHW only at 70 °C

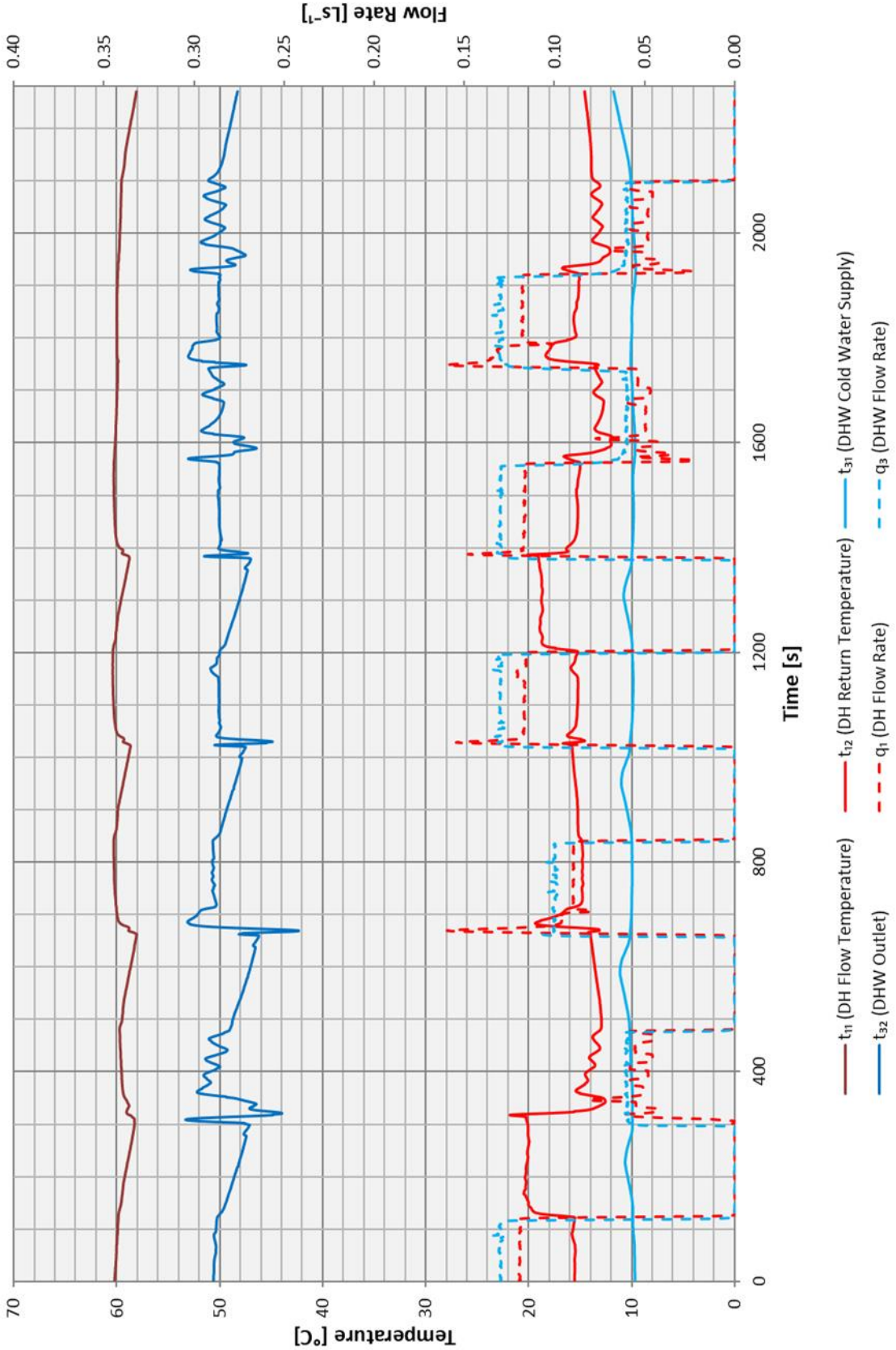

Figure 7.8 - Test 2b – DHW only at 60 °C

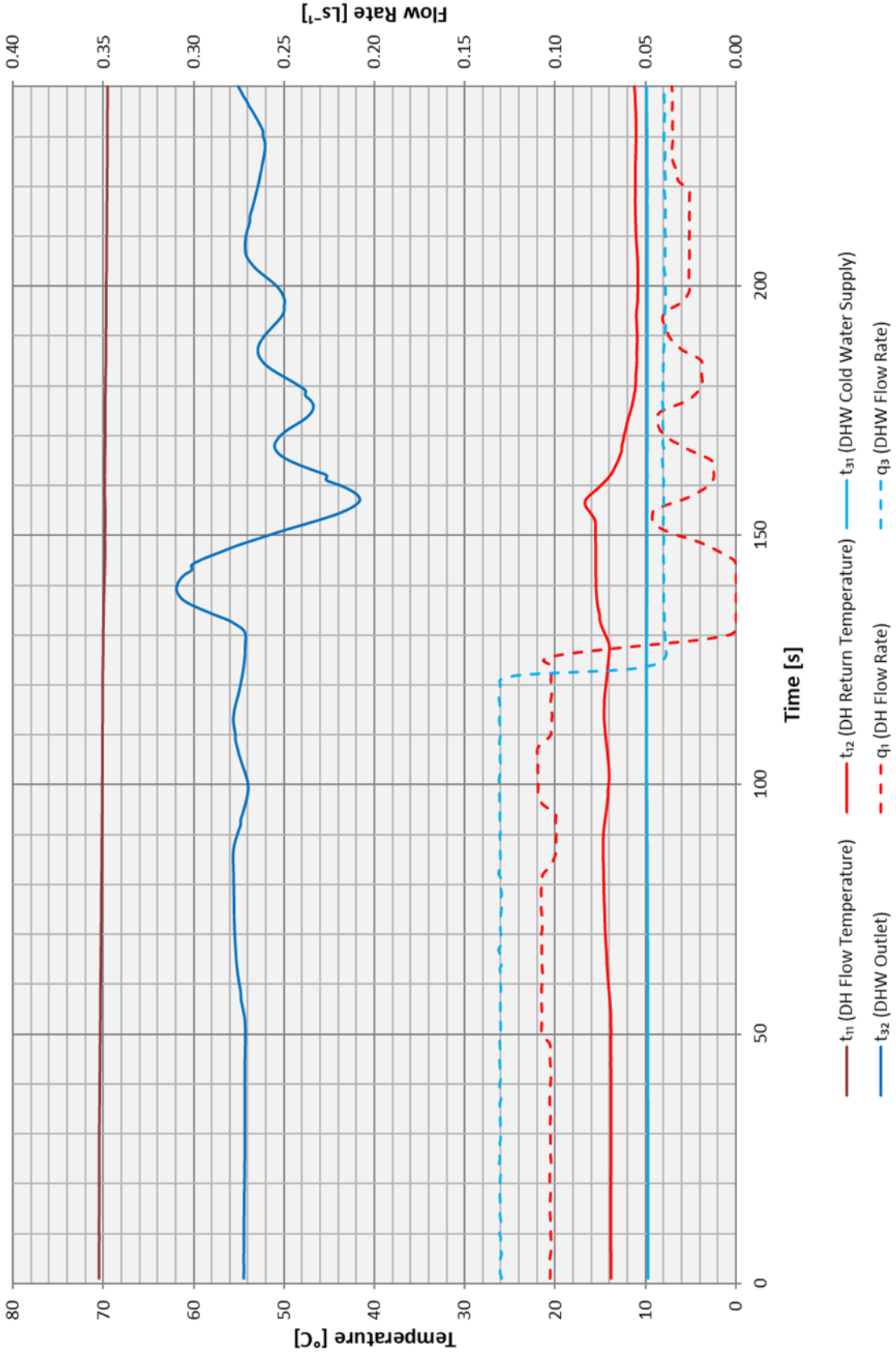

Figure 7.9 - Test 3c – Low Flow DHW at 70 °C

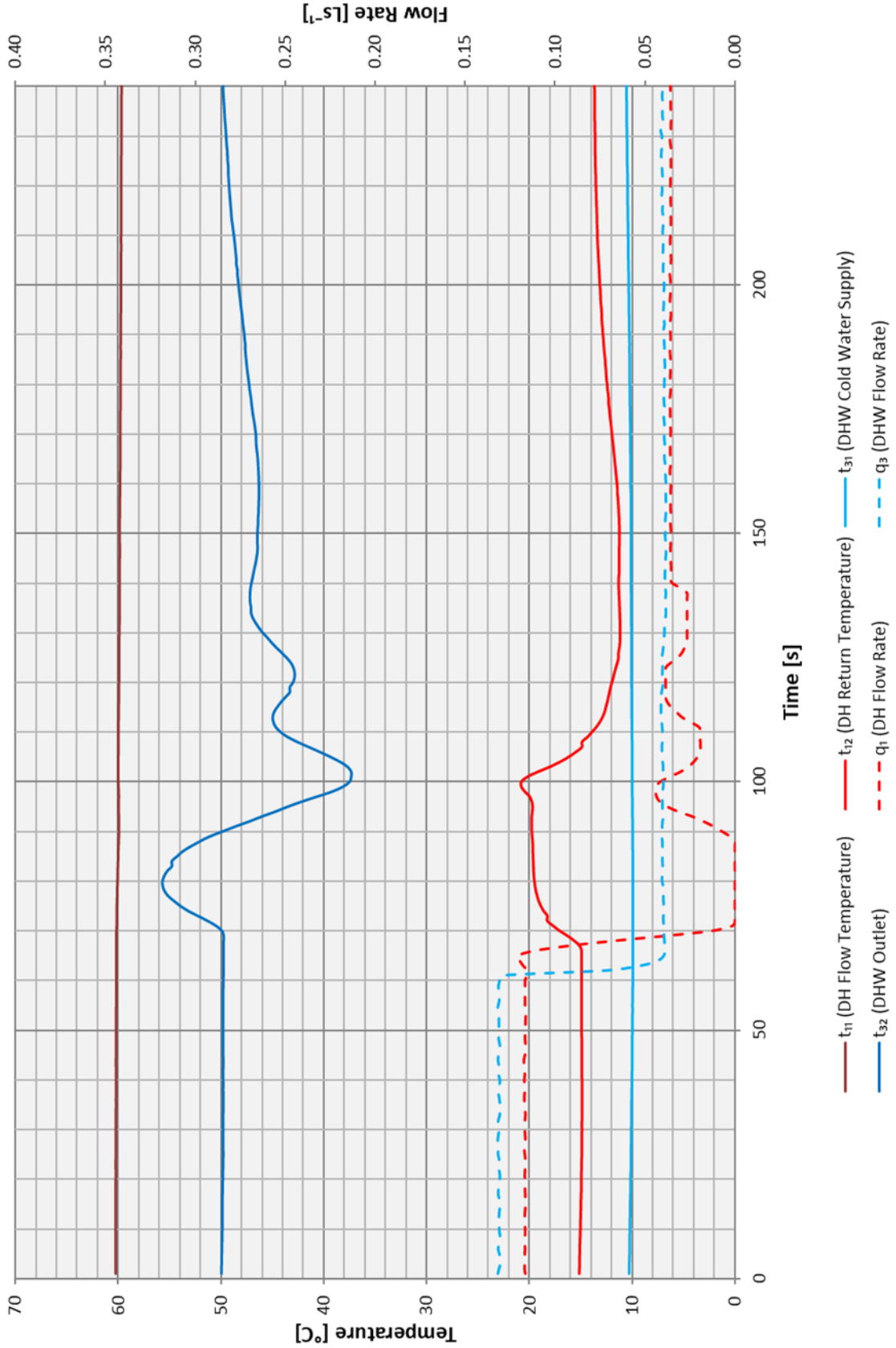

Figure 7.10 - Test 3d – Low Flow DHW at 60 °C

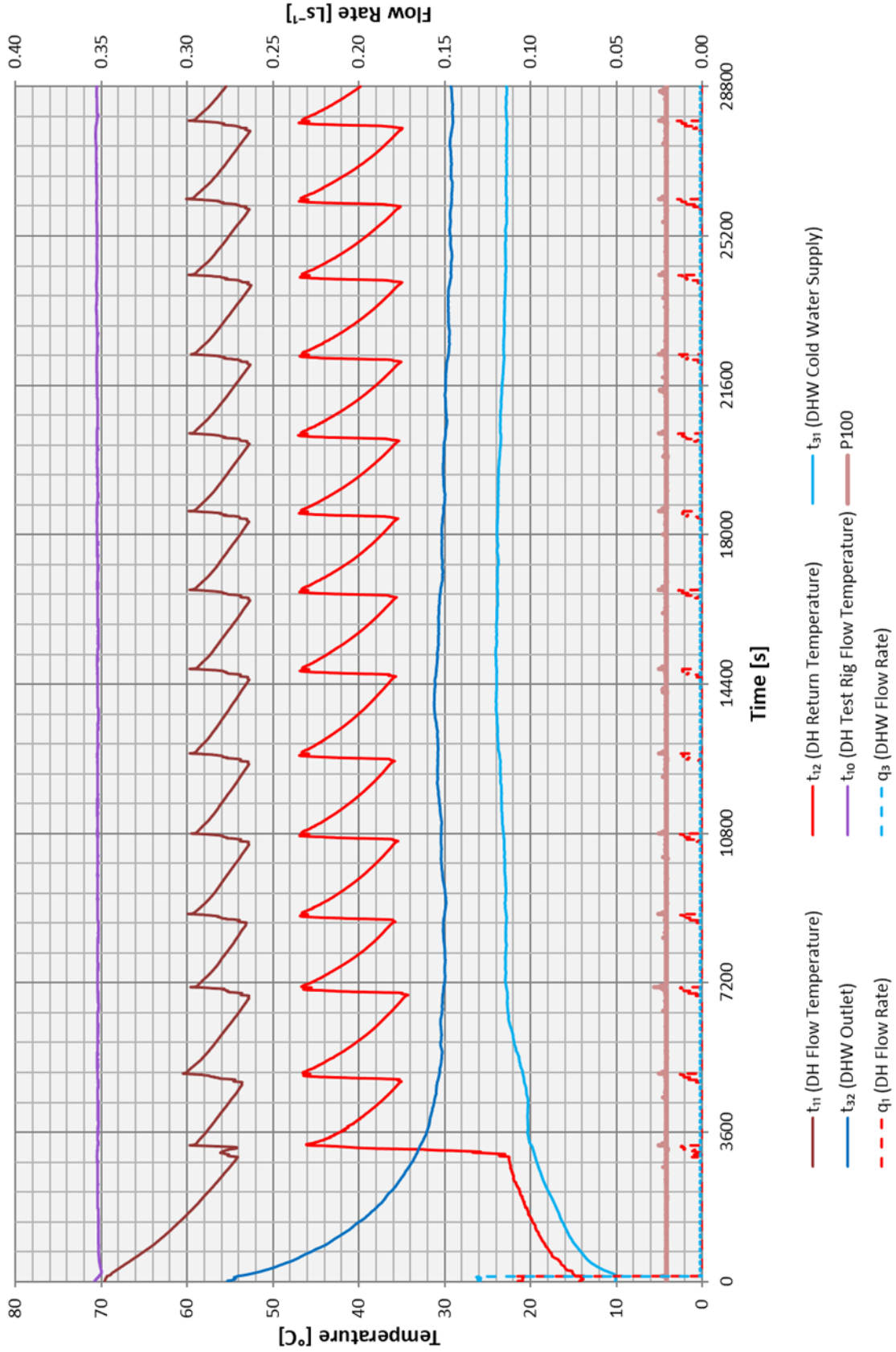

Figure 7.11 - Test 4a – Keep-warm at 70 °C

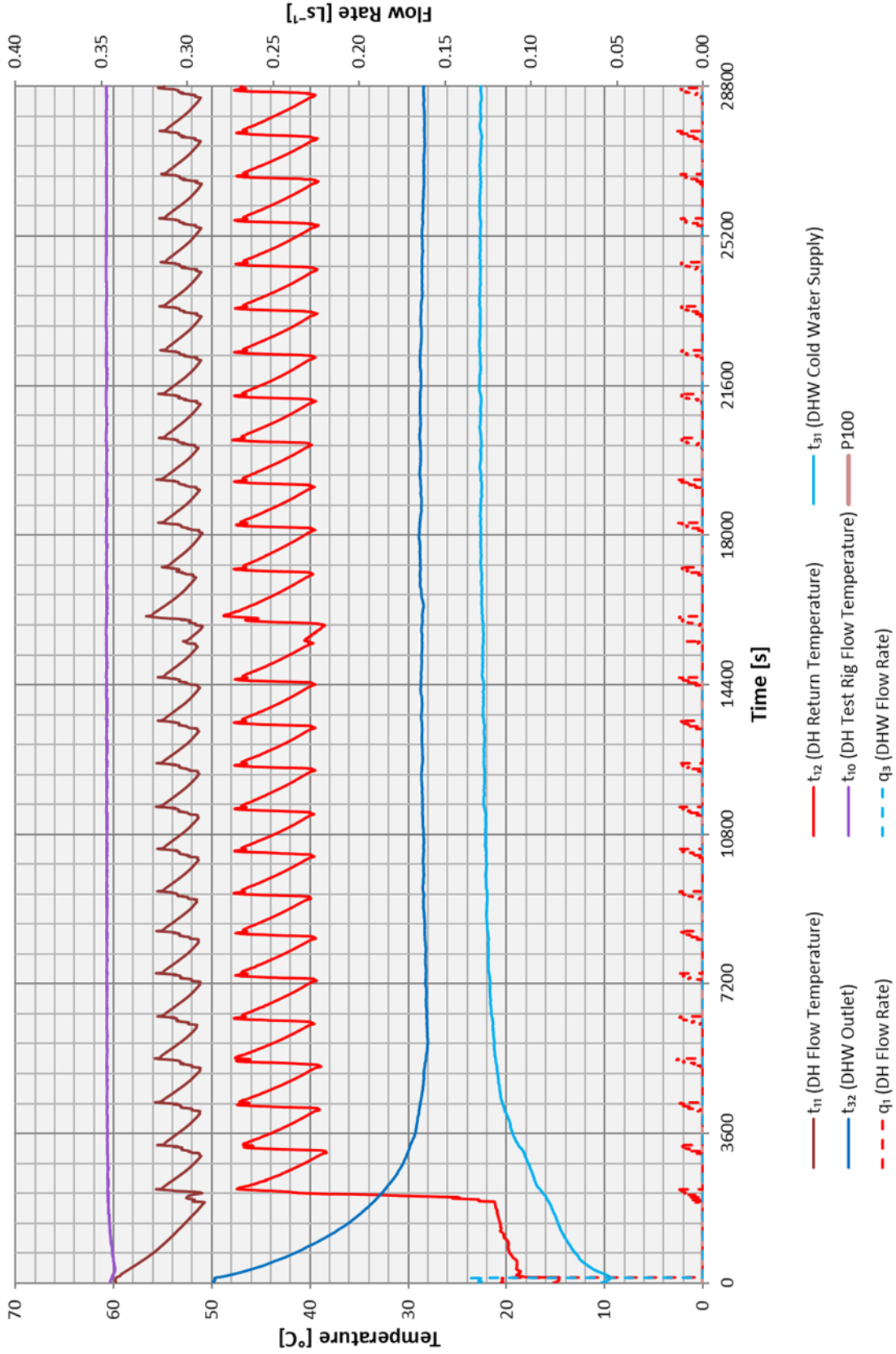

Figure 7.12 - Test 4b – Keep-warm at 60 °C

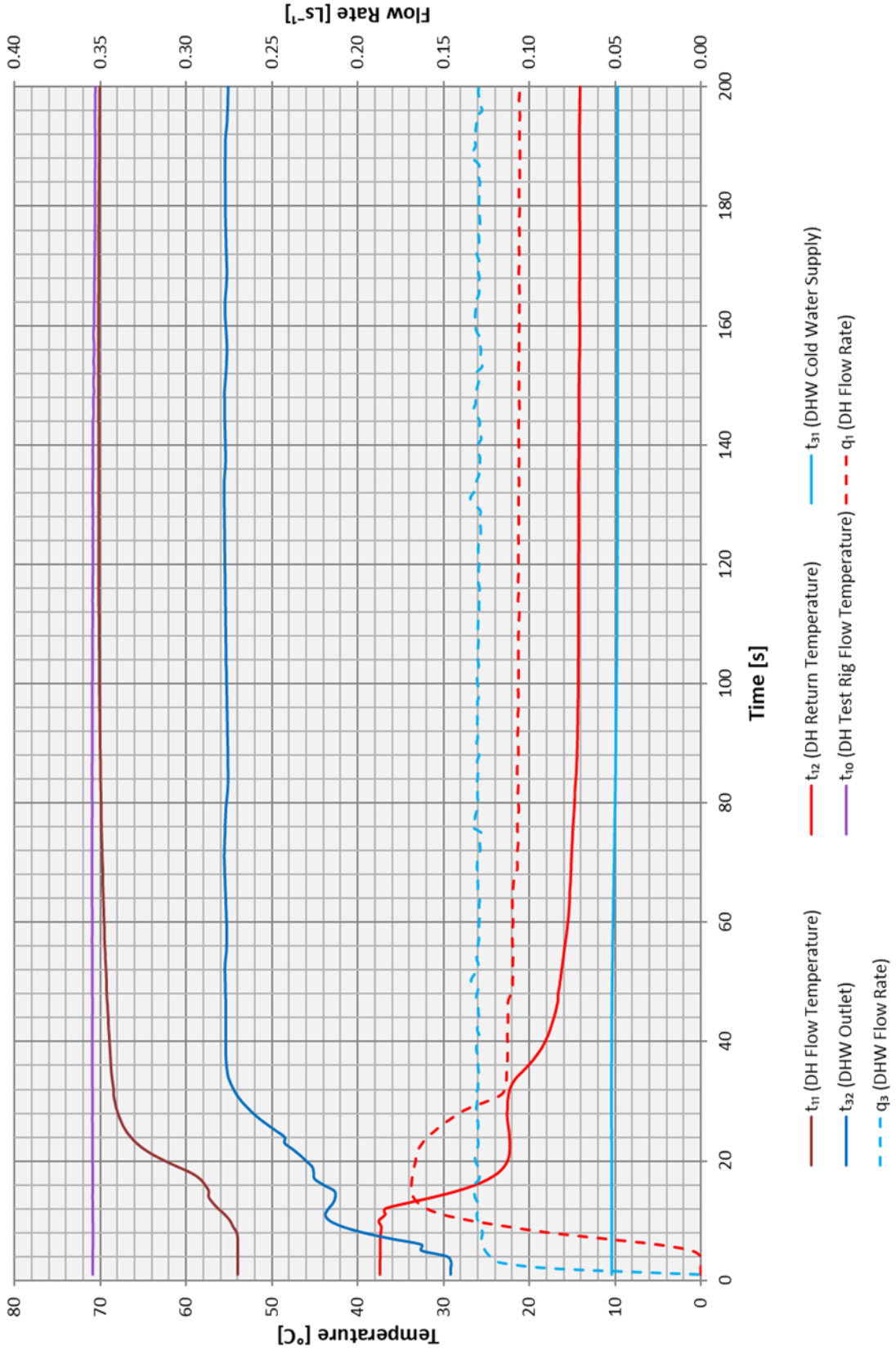

Figure 7.13 - Test 5a – DHW Response Time at 70 °C

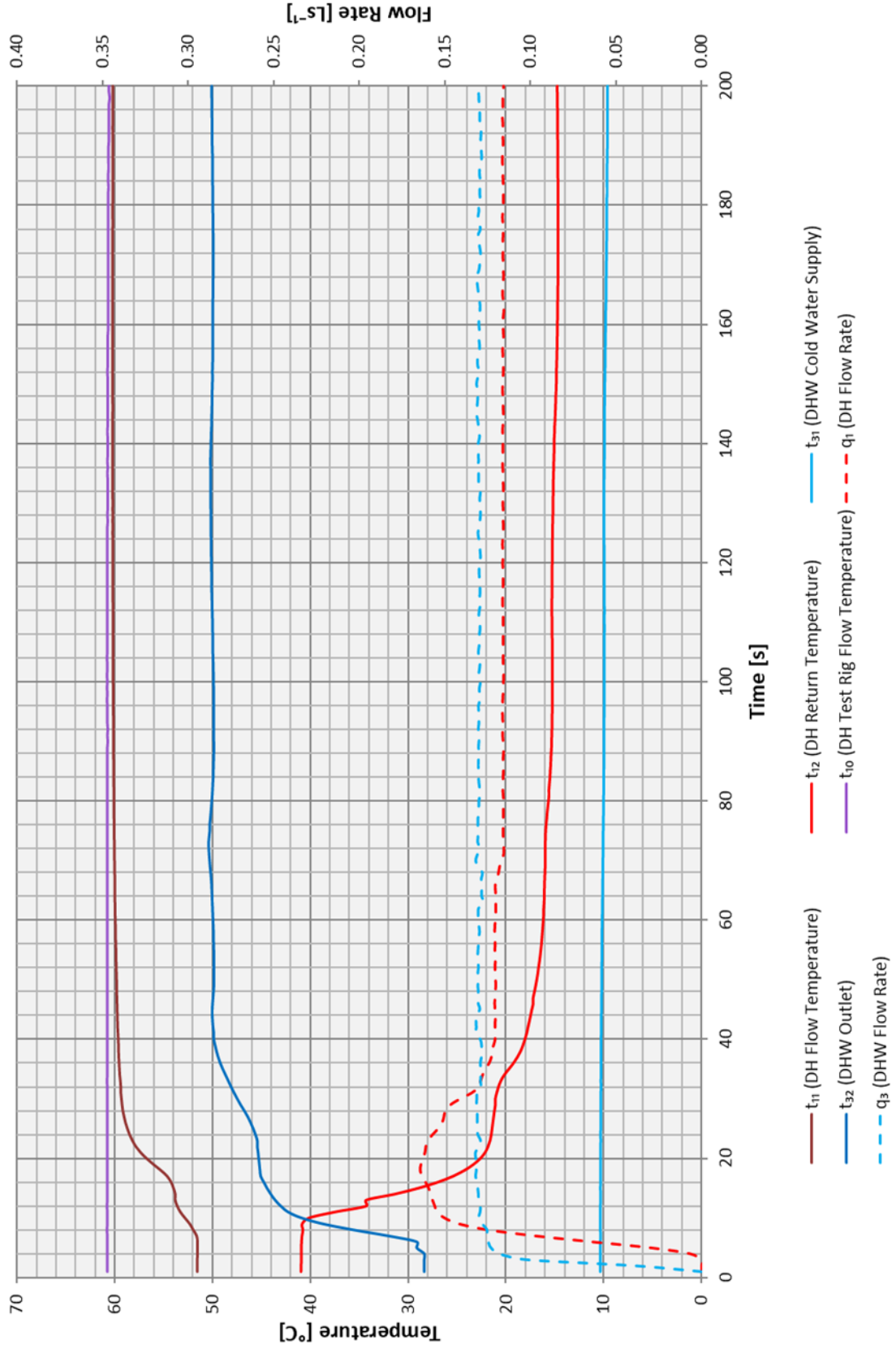

Figure 7.14 - Test 5b – DHW Response Time at 60 °C

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

VWART Calculation with Keep Warm

Test carried out by Enertek International for High Temperature BESA Tests

Manufacturer:	Evinox
Model:	ModuSat XR (Eco)
Serial number:	CTPE2B2720A30
Calculation performed by I.Williamson of Enertek on:	08/09/2020

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

	VWART (°C)	Volume (m3)
DHW	13	21.7
Standby	43	22.3
Space Heating	40	45.7

	VWART with keep warm active	
Period	**VWART (°C)**	**% Time**
No Heating	28	93%
Heating	40	7%
Overall	29	

		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	1140	0.032	40	116	101.5	3.26	-	-
2kW Space Heating	1b	2204	0.063	40	865	392.4	24.67	-	-
4kW Space Heating	1c	4283	0.127	41	602	140.5	17.79	-	-
DHW Low Flow Rate	2a	11094	0.158	13	682	65.7	10.38	-	-
DHW Medium Flow Rate	2a	18601	0.284	14	296	16.0	4.53	-	-
DHW High Flow Rate	2a	24119	0.370	14	442	18.4	6.80	-	-
DHW Post Low Flow Rate	2a	-	0.000	0	-	-	0.00	10000	30
DHW Post Medium Flow Rate	2a	-	0.000	13	-	-	0.00	660	70
DHW Post High Flow Rate	2a	-	0.000	14	-	-	0.00	300	145
DHW Keep Warm Standby	4a	-	0.003	43	-	8025.5	22.32	-	-

Table 7.1 - Key Metrics of High Temperature Package

Enertek International

VWART Calculation with Keep Warm

Test carried out by Enertek International for Low Temperature BESA Tests

Manufacturer:	Evinox
Model:	ModuSat XR (Eco)
Serial number:	CTPE2B2720A30
Calculation performed by I.Williamson of Enertek on:	08/09/2020

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

	VWART (°C)	Volume (m3)
DHW	15	27.0
Standby	44	42.8
Space Heating	35	51.3

	VWART with keep warm active	
Period	**VWART (°C)**	**% Time**
No Heating	33	93%
Heating	35	7%
Overall	33	

		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	1062	0.036	34	107	100.5	3.63	-	-
2kW Space Heating	1e	2094	0.071	35	823	393.3	27.80	-	-
4kW Space Heating	1f	4112	0.141	35	579	140.8	19.83	-	-
DHW Low Flow Rate	2b	9941	0.175	14	672	73.3	12.85	-	-
DHW Medium Flow Rate	2b	16916	0.327	15	298	17.6	5.75	-	-
DHW High Flow Rate	2b	21672	0.412	15	440	20.5	8.44	-	-
DHW Post Low Flow Rate	2b	-	0.000	0	-	-	0.00	10000	30
DHW Post Medium Flow Rate	2b	-	0.000	15	-	-	0.00	660	70
DHW Post High Flow Rate	2b	-	0.001	16	-	-	0.00	300	145
DHW Keep Warm Standby	4b	-	0.005	44	-	8014.0	42.78	-	-

Table 7.2 - Key Metrics of Low Temperature Package

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	Swep E8LAS (Max70plates)
2	Domestic Hot Water Heat Exchanger	Y	Swep E8LAS
3	Controller for Space Heating	Y	Argus Vision 882MS20_2Rb3c
4	Control Valve and Actuator for Space Heating	Y	Frese 53-1304 PICV, 53-1183 Actuator
5	Space Heating Strainer	NA	NA
6	Controller for Domestic Hot Water	Y	Argus Vision 882MS20_2Rb3c
7	Control Valve and Actuator for Domestic Hot Water	Y	Frese OEM DN20 PICV, 53-1183 Actuator
8	Temperature Sensors	Y	Tasseron TSB0AI
9	Domestic Hot Water Isolating Valve	NA	NA
10	Primary Side Strainer	NA	NA
11	Drain Valves	Y	Rastelli 25008
12	Vent Valves	NA	NA
13	Circulation Pump set with AAV & PRV	Y	Wilo Yonos Para 15/7.0
14	Heat Meter	Y	Ploumeter RC15 DN15
15	Domestic Hot Water Flow Sensor	Y	Sika VTY10
16	Pipes	Y	Hecapo 4503419000
17	Connections	Y	Hecapo 4503416500
18	Joints	NA	NA
19	Gaskets	Y	Donit Tesnit BA-U
20	Expansion Vessel	Y	Aquasystems VRP220-8
21	Insulation	Y	Bautech 75-0, Armaflex AC,
22	Pressure Sensors	Y	Huba OEM 505
A1	'O' Ring	NA	NA
A2	Commissioning guide.	Y	TP 2019 Modusat XR Installation Manual Draft 2551868AB
A3	Operation guides with a function description / description of operation and care instructions as suited to the intended user category.	Y	ViewSmart Temperature Control Instructions 2551851A
A4	Declaration of Conformity for CE-marked HIUs.	Y	2020-05-01_EC Declaration
A5	Full parameter list for electrically controlled HIUs.	Y	Control Parameters
A6	Maximum primary static operating differential pressure.	NA	Static - 16 bar, Diffrential - 4 bar
A7	Deactivation procedure of the internal SH pump.	NA	SH Pump was unplugged
	Model name and type number	NA	ModuSat XR ECO TP-55-20R
	Serial number	NA	CTPE2B2720A30

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

ModuSat XR (Eco)	
Appliance Serial Number	CTPE2B2720A30
Space Heating Heat Exchanger	Swep E8LAS
Domestic Hot Water Heat Exchanger	Swep E8LAS
Controller for Space Heating	Argus Vision 882MS20_2Rb3c
Control Valve & Actuator for Space Heating	Frese 53-1304 PICV, 53-1183 Actuator
Controller for Domestic Hot Water	Argus Vision 882MS20_2Rb3c
Temperature Sensors	Tasseron TSB0AI
Circulation Pump	Wilo Yonos Para 15/7.0
Heat Meter	Ploumeter RC15
Domestic Hot Water Flow Sensor	Sika VTY10
Pipes	Hecapo 4503419000
Connections	Hecapo 4503416500
Gaskets	Donit Tesnit BA-U
Expansion Vessel	Aquasystems VRP220-8
Pressure Sensors	Huba OEM 505
Insulation	Bautech 75-0, Armaflex AC,

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	26/06/2021
Flow Meter [DHW Flow Rate]	FM 602	U98515-19	±0.00305	l/s	26-06-2019	26/06/2021
Flow Meter [SH Flow Rate]	FM 603	U98530-19	±0.04871	l/s	27-06-2019	27/06/2021
Flow Meter [DHW Flow Rate]	FM 605	U98539-19	±0.00576	l/s	28-06-2019	28-06-2021
Pressure Transducer [Primary Supply]	PT 086	U98458-19	±6.82	kPa	22-06-2019	22/06/2021
Pressure Transducer [Primary Return]	PT 085	U98460-19	±7.88	kPa	22-06-2019	22/06/2021
Pressure Transducer [DHW Output Pressure]	PT 083	U98469-19	±7.73	kPa	23-06-2019	23/06/2021
Pressure Transducer [DHW Cold Water Supply]	PT 084	U98468-19	±7.31	kPa	23-06-2019	23/06/2021
Pressure Transducer [SH Flow]	PT 087	U98463-19	±7.26	kPa	22-06-2019	22/06/2021
Pressure Transducer [SH Return]	PT 088	U98461-19	±7.30	kPa	22-06-2019	22/06/2021
PRT Probe [Primary Supply Temp]	PRT 4709	EIL 439991	±0.4	°C	18/06/2020	18/06/2021
PRT Probe [Primary Return Temp]	PRT 4708	EIL 439991	±0.6	°C	18/06/2020	18/06/2021
PRT Probe [DHW Output Temp]	PRT 4711	EIL 439992	±0.4	°C	18/06/2020	18/06/2021
PRT Probe [Cold Water Supply Temp]	PRT 4710	EIL 439992	±1.9	°C	18/06/2020	18/06/2021
PRT Probe [SH Supply Temp]	PRT 4707	EIL 439991	±0.4	°C	18/06/2020	18/06/2021
PRT Probe [SH Return Temp]	PRT 4706	EIL 439991	±1.0	°C	18/06/2020	18/06/2021
Pressure Transducer [Static Pressure Test]	PT 090	U100553-19	±50	kPa	21/11/2019	20/11/2020
Power Meter [Electrical consumption]	PM1022	U103585-20	±1.03	W	27/07/2020	27/07/2021
Software	VERSION – LabVIEW, Version 5, Service pack 1					

Report Issue No	Reason for Report Update
1	Original Issue
2	Calibration data updated in table 8.3.1 for PRTs - 4706,4707,4708,4709,4710,4711

1 Malmo Road
Sutton Fields
Kingston upon Hull, HU7 0YF

+44 (0) 1482 877500
enertekinternational.com
Registered in England No. 2262638

EUA energy&utilities alliance HHIC HEATING & HOTWATER INDUSTRY COUNCIL