



Technical Note		TN-018	
Test: <b>Definition of Cyclical Data</b>		Test no.: 1 (SH Load), 4 (Keep Warm)	
Assumption: 98			
Rev: 1.0	Date: 7 <sup>th</sup> June 2021	Author: Steffan Cook	Checked: Robert Hunter

The aim of this Technical Note is to describe to test houses when data may be considered as cyclical so as to meet test criteria or to decide when to launch further tests from cycling temperatures.

## 1. Introduction

In tests, the outputs (i.e., temperature, flow) measured may vary with time in a consistent and repeatable pattern. Usually, the repeated pattern in the data will trend towards or around a point or value (typically a set point) with time but never settle at that value. This type of data set and behaviour is called cyclical data. Cyclical results in test data can sometimes be acceptable as a pass result or can be analysed to understand when a subsequent test should be launched.

The aim of this Technical Note is to describe the conditions where data may be considered cyclical.

## 2. Impact

For the space heating tests (test:1); clauses 4.9 and 4.15 of the HIU standard already allow for variation in the space heating output. There are no hard limits on MAX and MIN temperature for either the flow or return, instead the average flow and average return temperatures *over the duration of the test* are to be within  $\pm 0.5^{\circ}\text{C}$  of the stated set point. Therefore, temperature MAX and MIN values can vary up and down with time as long as the average is close to the desired set point.

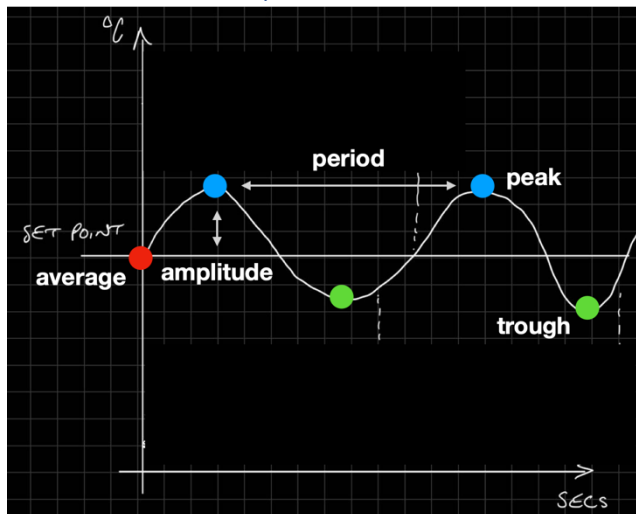
The space heating tests therefore don't directly specify that test data needs to be 'stable' (no discernible change in value with time). *However*, for the sample test data to be considered *valid* for use in a report there is an assumption that the sample data is 'stable' and would be repeatable and continue forever beyond the test duration. However, test results that show unstable output cannot be assumed to be repeatable or continuous and therefore are not acceptable, with the exception being where the data can be described as cyclical. A definition of when data can be described as cyclical is therefore necessary.

*Note: The HIU Standard does not directly state that sample test data should be typical of the HIU output. This is a general assumption that is taken to be true (if it were not true then there would be no purpose to standard testing.)*

For the keep warm test (test:4); the keep-warm function provides periodic bursts of heat to keep the HIU 'preheated' and therefore able to deliver hot water more rapidly. For HIUs that have long cycle periods between each keepwarm operation, clause 4.42 states that the time at which the DHW response test (test 5) should be launched is at 75% of the cycle time (period) since the last peak (also by inference the last draw in heat).

The definition of cyclical data and a data peak and period so as to identify the point at which the cycle is 75% of its way through a period is therefore necessary.

### 3. Parts of a Cycle



A cycle will have:

- A peak to peak period
- A period MAX value (peak/crest)
- A period MIN value (trough)
- An average value (time-averaged over the period)

### 4. Cycle tolerances

Data is said to be cyclical in the test data when;

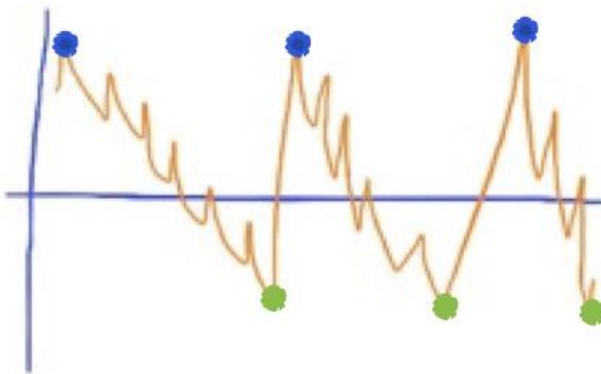
- All cycle periods have a variation within  $\pm 10\%$  of the average period time
- All peaks are within  $\pm 1^\circ\text{C}$
- All troughs are within  $\pm 1^\circ\text{C}$

### 5. Conclusions

Data found in HIU Standard tests may be described as cyclical if the data meets the tolerances above. The definition of peak, trough, period and average value are stated.

### 6. Keep Warm Data – Example

Especially seen in keep warm data, sometimes the cyclical nature of the data is not clear. In this example we see several peaks and troughs in the data among many other smaller peaks and troughs.



However, this data set is cyclical following the definition above. Each high peak has the same time separation (period) and have the same value. Each trough also has the same value (within tolerances – see Section 4 Cycle Tolerances).

### 7. Queries or exceptions

There may be circumstances where a test house or manufacturer believes that test data is valid for meeting test criteria under the definition of cyclical data but is outside the parameters given here. In such

cases, test houses or manufacturers may ask the HIU Technical Lead for a review and/or the data can be presented to the BESA HIU Technical Committee for a formal review.