



Technical Note		TN-017	
Test: Variable Differential Pressure test		Test no.: all tests	
Assumption: Primary DP during tests		Assumption no: 45 and 61	
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1. Introduction

Current assumption, Test Assumption 45, specifies 50 kPa as primary Differential Pressure (DP) for all tests. However, it also notes that 50 kPa at all times might not be representative of real-life conditions for a HIU. This technical note will propose amendments on the DP of the test.

2. Consideration 1. Real DHN DP

An efficient District Heating Network (DHN) feeding apartments that includes HIUs will operate with variable flow. A variable flow system shall be fed by variable speed pumps, and hence, the Differential Pressure (DP) along the DHN distribution will be also variable. Variable speed pumps are typically used on DHNs to achieve the necessary DP to supply the HIUs located farthest from the plantroom. When there is no demand the flow in the distribution will be small and the pressure drop almost negligible. Therefore, the pumps will be able to reduce their head in the plantroom considerably while achieving the minimum DP at the index point so that the HIUs located farther from the plantroom can cover the corresponding apartment demand. The pumps will increase and decrease speed depending on the system demand, and intermediate HIUs will be exposed to a variable DP. In summary, the HIUs will be exposed to variable pressure during their normal operation within a project specific DP range.

When a HIU is selected for a project the HIU shall operate appropriately in all project conditions. The designer shall design a system that keeps all HIUs within their operating DP range and ensures that the pump is controlled so that the HIU is never exposed to out-of-range DP.

Existing test shows the operation of the HIUs at 50 kPa which is a common DP assigned to HIUs for DHN design. However, it does not show how the HIU would operate when exposed to different DP or changing DP. Hence, it is proposed to include the variable pressure on the test.

3. Considerations for DP range

The BESA HIU test will be based on a "Reference building" see technical note TN-10. According to the calculations used to design the Reference Building, depending on the operating conditions, the distribution pressure drop ranges between 164 and 181 kPa. This is the pressure that the pump should

provide out of the plantroom. These numbers would be necessary to achieve 50 kPa of DP at the index point at peak load and any HIU closer to the plantroom would see higher DP up to 181 kPa.

In order to keep a round number with a reasonable value covering the demand 200 kPa is proposed as the maximum pressure on the test.

In summary, an HIU that is installed in the Reference Building could be exposed to a DP between 50 kPa and 200 kPa.

4. Consideration for DP change

HIUs in the Reference Building will operate between 50 kPa and 200 kPa. The pressure can change between those values, but it will not jump from the lowest value to the highest value suddenly. Experience shows that the DHNs reach maximum demand gradually from lower demands, and therefore, the HIUs will see smaller pressure changes. A sudden DHW demand in the neighbouring HIU is the most common sudden DP change that a HIU would experience.

Using the Reference Building again to value the DP change, the result of a sudden demand of the adjacent HIU was approximately 25 kPa.

Therefore, 25kPa is the proposed variable DP change that the HIUs will be tested to.

5. Proposed Heating test (1a, 1b, 1c, 1d, 1e, 1f)

Due to the technical challenge, low impact on resident comfort, and additional resources that would be required to implement the test, a variable DP heating test is not recommended for the space heating tests (test 1a – 1f). Instead, it is proposed that tests 1b and 1e (1kW heating) are performed with 200 kPa DP, with the other tests remaining at 50 kPa. This approach doesn't provide a challenge for the test houses and the heating operation of the HIU at 200 kPa can be assessed.

6. Proposed DHW Dynamic test (2a & 2b)

Based on previous considerations it is proposed to perform a Dynamic DHW demand test (tests 2a and 2b) with variable DP on the primary. The new test will show the performance of the HIU at different flows with 50 kPa and 200 kPa of DP on the primary. This will show how the HIU would perform in the reference building at maximum and minimum DP.

A 25 kPa fluctuation in DP has also been added to assess the HIU reaction to DP changes during the typically operating conditions. In order to assess the HIUs performance at low (50 kPa) and high (200 kPa), the 25 kPa fluctuation have been introduced within the 180 second low (0.06 l/s), medium (0.10 l/s), and high (0.13 l/s) flow rate tests at both DPs.

Figure 1 shows the proposed test flows and DP values over time.

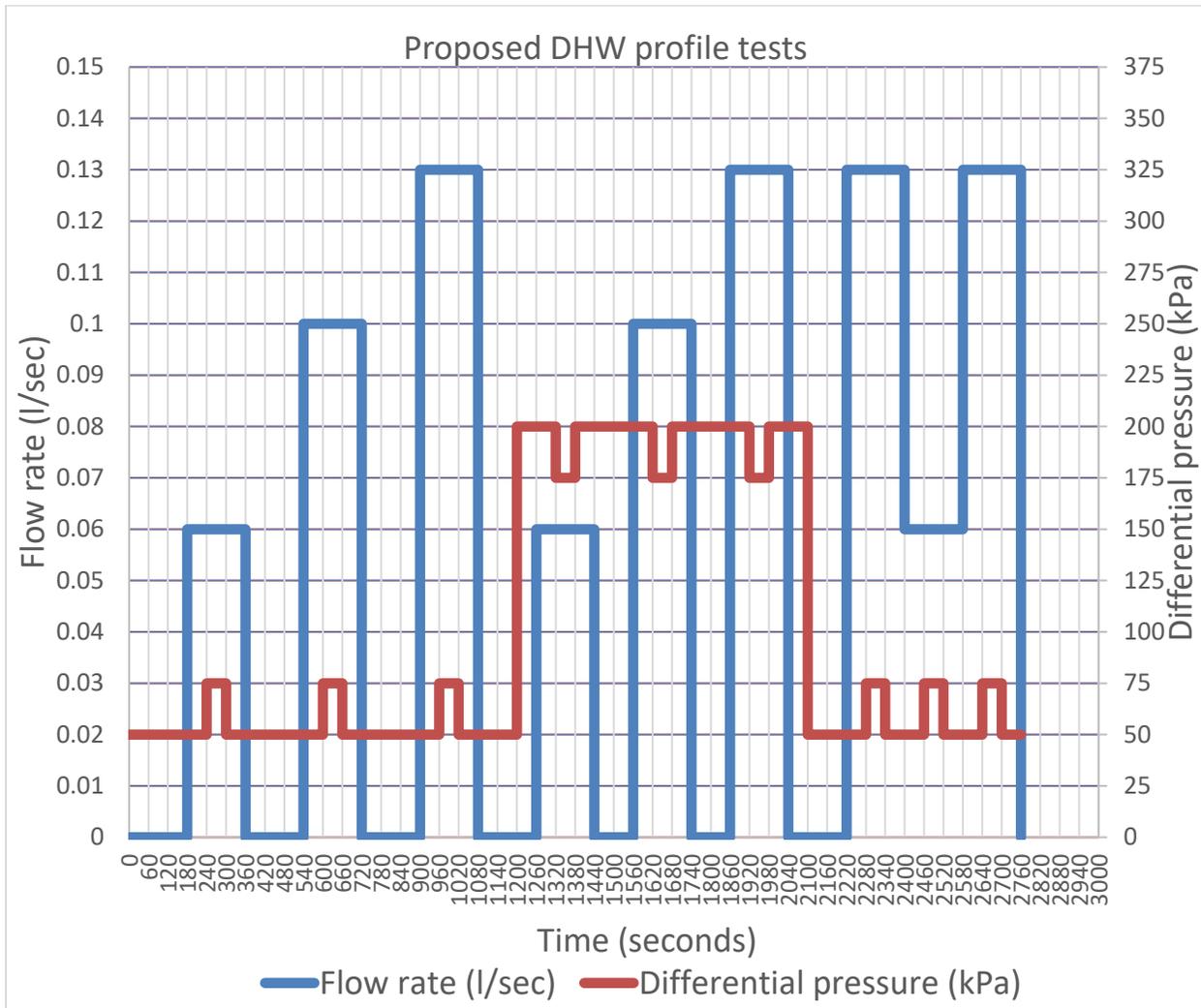


Figure 1: Proposed secondary flows and DP for DHW dynamic test (2a &2b)

7. Low flow DHW test (3a and 3b, test 3c and 3d are added)

Previous low flow tests show that the output of a HIU may fluctuate at low flow conditions. High DP challenges the authority of the control valve at low flows and might increase DHW outlet temperatures fluctuations that could represent a health and safety risk. It is recommended to test low flow at minimum and maximum pressure. This would add test 3c and 3d to the test regime. 3a and 3b would remain as the existing (high temperature) HT and (low temperature) LTs test at 50 kPa. Tests 3c and 3d would be introduced as the HT and LT test with the higher 200 kPa DP.

8. Keep-warm and DHW response time (4a, 4b, 5a, 5b)

As variable DP would not be expected to significantly affect the performance of a HIU during the keep-warm and DHW response time tests, undertaking multiple tests at different DP would increase considerably the test time and the cost of the test without adding much value to the test. It is recommended to keep performing the test with 50 kPa constant.

9. Conclusions

This test modification will provide more information about the HIU behavior under real life conditions and impact to resident comfort.

10. Recommendation

It is recommended to analyse the feasibility of performing this test with adequate repeatability. As the DP will be controlled by a pump, it is recommended that pump model, internal control PID parameters and external PID parameters are set equal in all test houses to ensure that the test is comparable in different test rigs.