

## Soot load vs DP characteristic measurement on the DPG

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### Introduction

Measurement of backpressure as a function of soot load is an important application for the DPG, both in development and production QA applications.

The DPG allows the measurement of such characteristics with good reproducibility, with several advantages over engine testing and other rigs:

- Soot output rate is constant without any effect from the variable backpressure of the DPF.
- Low levels of NO<sub>2</sub> avoid any uncertainty in the soot level due to passive regeneration effects.
- The system can be operated with the burner on but with no soot generation, to distinguish the effect on the backpressure of warming up and pore filling.
- Uncanned filters can be tested easily in the Filter Test Housing.
- The multi-stage test required can run automatically, with manual intervention only required for weighing the filter.
- The flow rate and temperature are independently controlled, and the system automatically corrects for variations in atmospheric pressure.

In the standard loading test, the filter is loaded to a little higher than the soot load of interest, and is weighed at the start and end of loading to determine the actual soot load: therefore any day to day variability in the soot load rate does not affect the data. The backpressure is logged continuously, and the backpressure at the load of interest is read from the logged data. These calculations, and the checking against part-type specific limits, is automated by the DPG software.

### Summary/ typical data

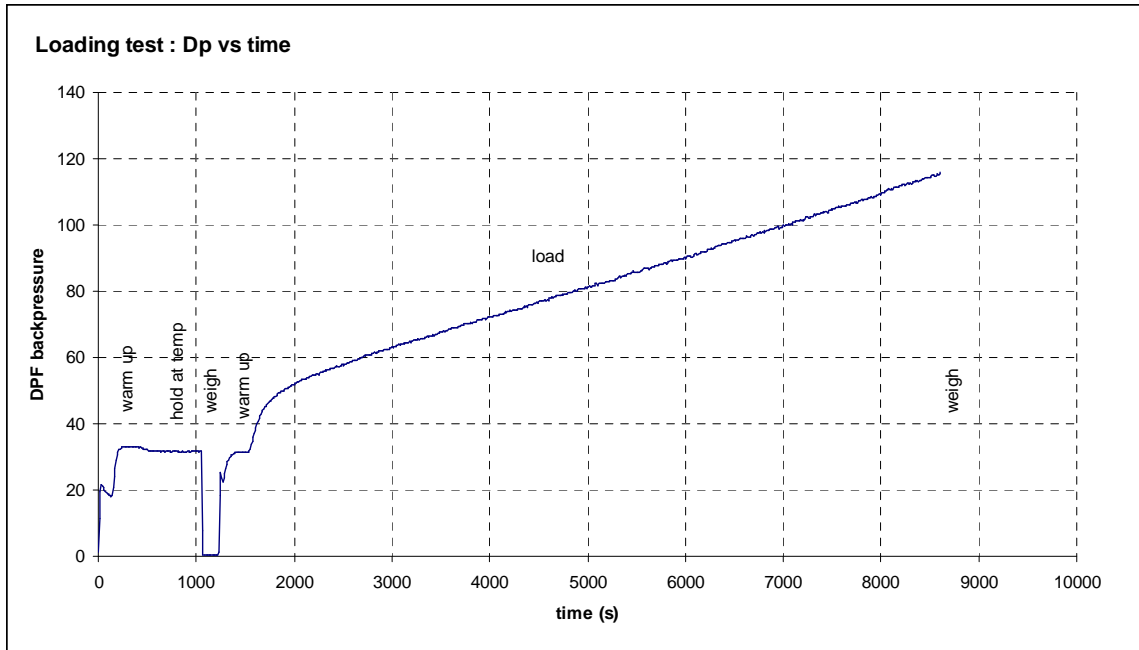
The following conditions are recommended for backpressure testing:

	DPF volume	DPF flow	DPF temperature
Light duty systems	up to ~ 5l	250 kg/h	240°C
Medium duty systems	above ~5l	400 kg/h	240°C

The procedure (described in detail below) can be summarised as:

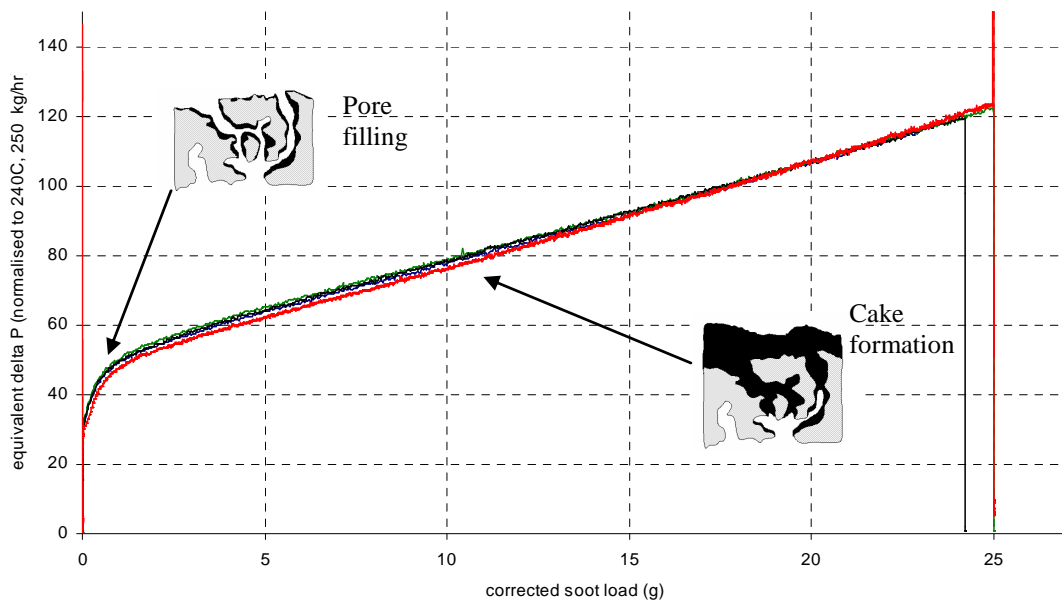
1. Stabilise airflows/ warmup fuel nozzle
2. Light burner and warm DPF under test without soot
3. Hold DPF at temperature until operator is ready for zero weight
4. Weigh DPF
5. Relight burner and warm DPF back up
6. Switch to soot loading condition and load for prescribed period
7. Switch to no soot condition and hold DPF at temperature for weighing
8. Weigh DPF

The diagram below shows a typical characteristic for the DPF pressure drop plotted vs time.



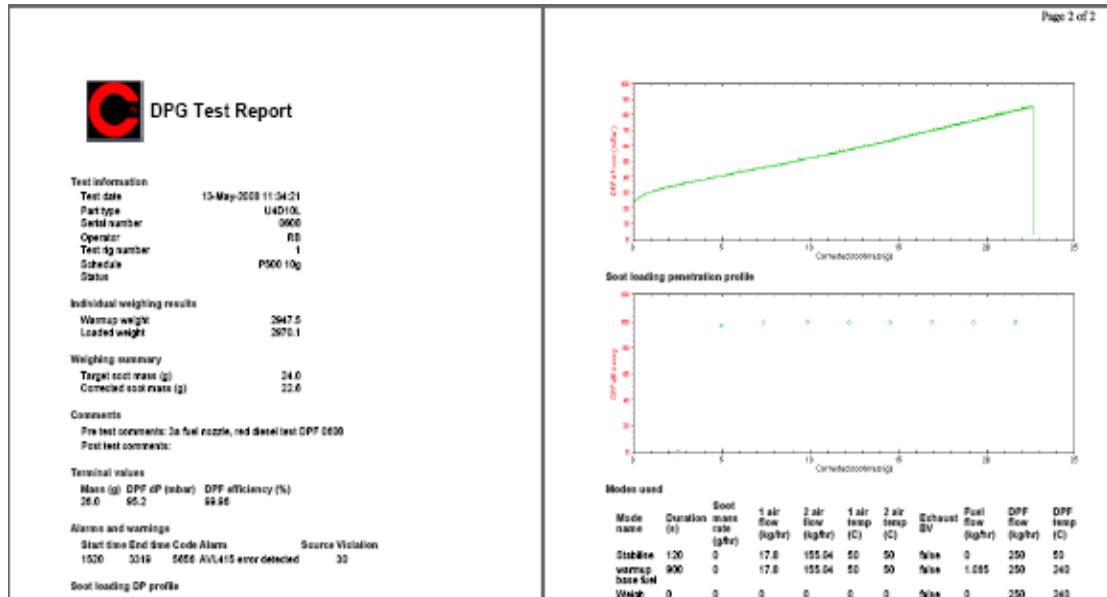
The backpressure is normally evaluated against the soot load determined from the empty and loaded weighings: this is shown below.

The diagrams indicate the 'pore filling' and 'cake formation' phases which are typical of loading of clean DPF parts. The data corresponds to 4 tests on the same part, tested twice on 2 different DPG systems.



**Automatic Test report**

The DPG system generates a summary report of data from a loading test (among other standard tests). The report is a .pdf file and an example is shown below.



### Operating Procedure

Fresh parts should be conditioned in the oven at 650°C for one hour before testing, or put through a DPG regeneration cycle; this is to stabilise the part weight and avoid errors in the soot mass measurement..

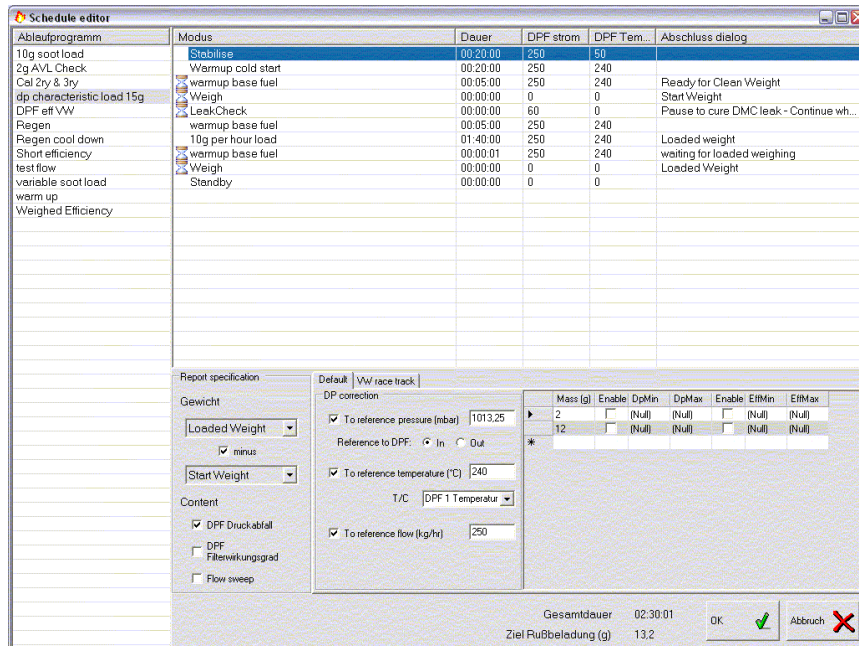
Ensure part orientation is correct in the Filter Test Housing.

For measurements at a given desired load, the DPG should be configured to load to a mass 10% higher to ensure there is enough mass on the part given variability in the loading rate.

The test Filter can should have an inlet face thermocouple fitted which should be connected to DPF 1 input.

If required, empty backpressure should be assessed from cold flow conditions before the burner is lit. Note that measurements during warm up are not reliable due to the extremely rapid variation of backpressure with tiny quantities of soot during the pore filling phase.

### DPG Schedule Setup



DPF temperature control should be from a DPF inlet face thermocouple.

Dp correction should be set up for

- to reference pressure of 1013.25 referenced to DPF In
- no correction for flow or temperature (these are controlled)

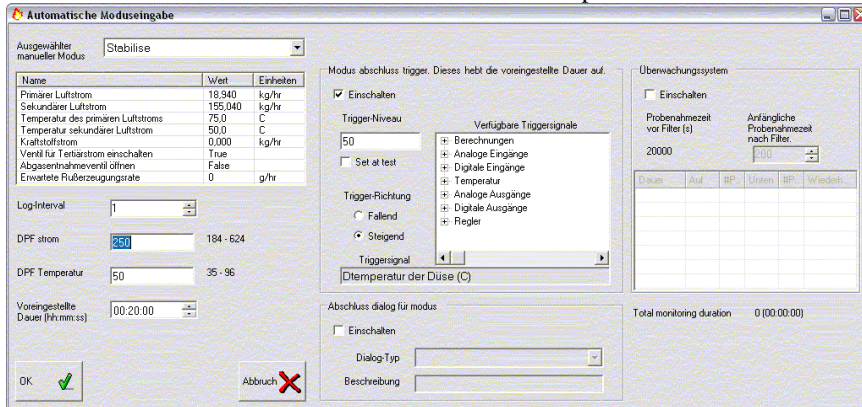
The Schedule should be configured with the flow and temperature recommended previously.

Configure reporting points at the soot loads required for various parts. Typically, soot loads corresponding to 0.5 g/l for an ‘end of pore filling’ condition, and 4.4 g/l for a loaded condition are recommended.

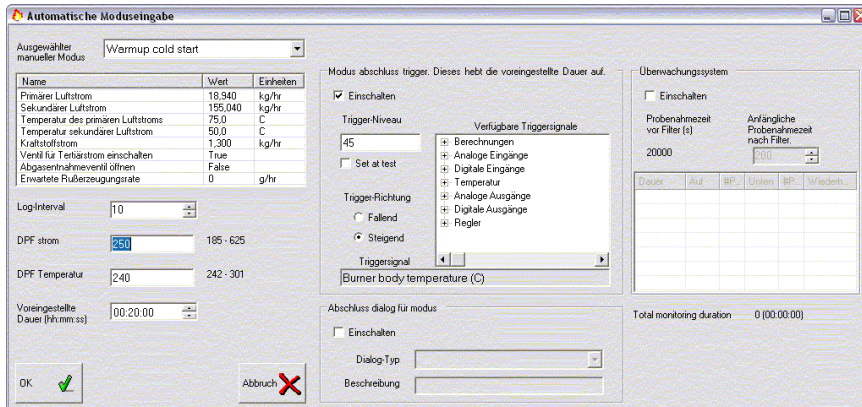
The report specification should be set up for (Loaded weight – start weight), and including the DPF backpressure graph.

Phases to include:

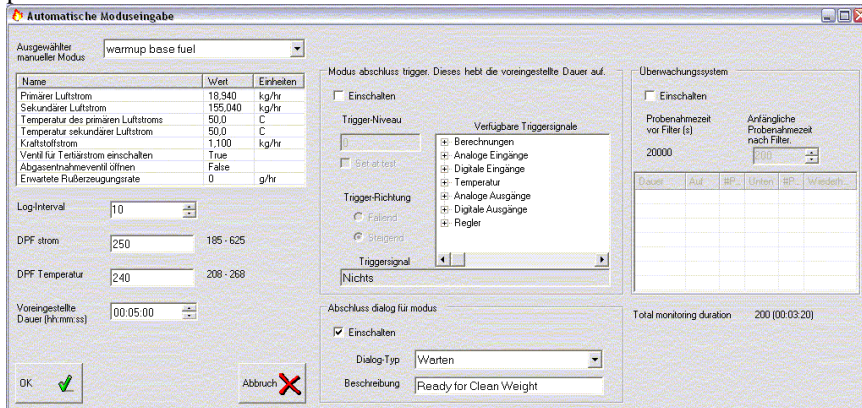
1. Stabilise mode for 20 minutes or until fuel nozzle temperature reaches 50°C.



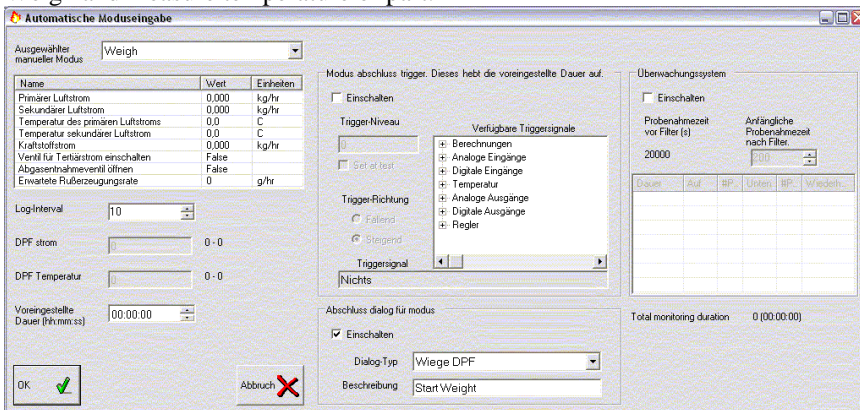
2. Warm up 20 minutes or until burner body achieves 45°C. Upstream AVL measurements may be performed in this phase to confirm no significant generation of particulate in the clean mode.



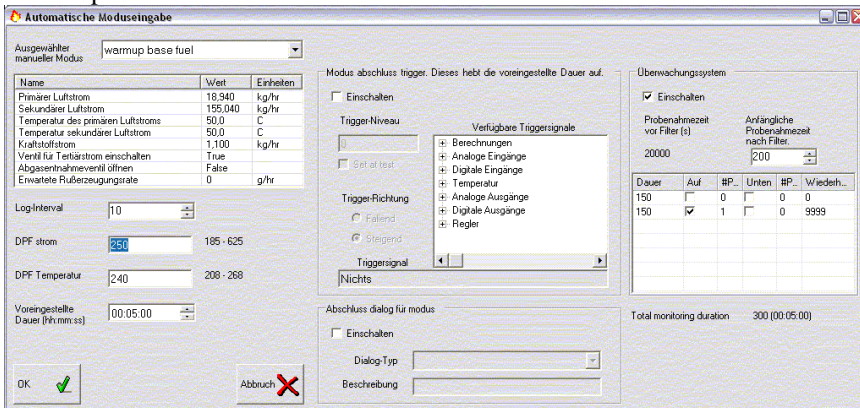
3. Warm up 5 minutes at the standard flow conditions, continued until operator is ready to weigh part



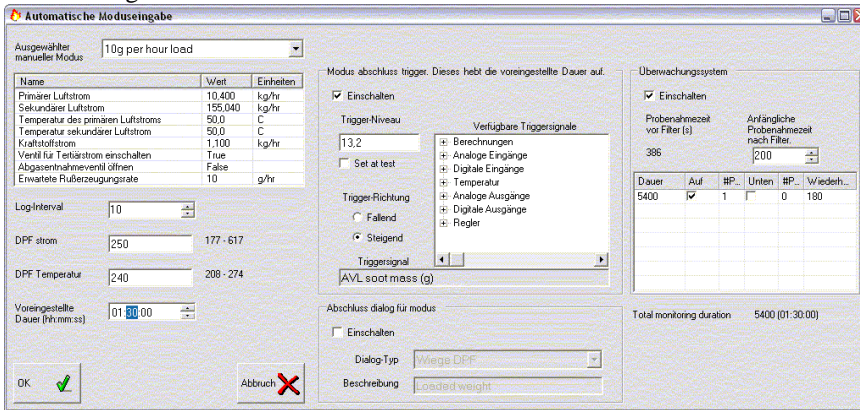
4. Weigh and measure temperature of part.



5. Warm up 5 minutes



6. Load at 10 g/hr.



7. Warm up until operator is ready to weigh part

8. Weigh and measure temperature of part.

**Other Operating Procedures.**

In order to achieve repeatable and reproducible results, we recommend several other operating procedures:

1. Follow the guidelines for FTH part fitting and FTA seal life in the FTH manual. In particular, the seals are validated for a life of 5 tests, but should not be exposed to a regeneration in this life.
2. Reference filters should be tested regularly, to confirm the stability of the DPG.
3. Follow the procedures in Cambustion process DPG016 to confirm the stable operation of the unit.

Refer to Cambustion Application note DPG007 for typical repeatability results from this testing.

**Criteria for Valid Test**

Weighed (corrected) mass achieved should be at least 95% of desired soot mass.

DPF temperature at weighing should be at least 200°C

Soot concentration in the first warm up phase measurement should not exceed  $2\text{mg}/\text{m}^3$  – this corresponds to less than 0.01g deposited soot.

Flow rate during the test should not fall below 95% of the desired flow.

No hardware failures should occur during the test.