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# Analysis of the performance of a mobile secondary air unit for air purification: PURIFIAIR.620, asecos

The present report consists of 16 pages and Annexes A to C.

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# Contents

# 1 Introduction

The company asecos GmbH Safety and Environmental Protection, Weiherfeldsiedlung 16-18, in 63584 Gründau (Germany), produces and distributes mobile secondary air units for air cleaning (mobile air purifiers).

The mobile air purifier represented here and designated as PURIFIAIR.620 is equipped with a class E11 filter unit and a class H14 **H**igh **E**fficient **P**articulate **A**ir (HEPA) filter element.

Institut für Industrieaerodynamik GmbH, Institute at FH Aachen University of Applied Sciences (in the following I.F.I. for short) was commissioned by asecos GmbH on October 21, 2021 to determine the performance of the asecos PURIFIAIR.620. Basis for the commission was the quotation M/7016.0/08.21 dated October 9, 2021.

The following performance criteria were submitted to evaluation:

– Determination of the volume flow rate according to DIN EN 12599
– Validation of the particle reduction in a room in accordance with the experts' recommendation of the VDI (Association of German Engineers) VDI-EE 4300 Blatt 14
– Distribution of the purified air in a room


**Figure 1.1:** asecos PURIFIAIR.620

# 2 Description of the tested mobile air purifier

The asecos PURIFIAIR.620 is a mobile air purifier which has two air intake areas (left and right) that can be fitted with different filter elements.

The following configuration of filter elements was tested:

– One filter is a class H14 HEPA according to EN 1822, the second filter on the other intake area of the asecos PURIFIAIR.620 is a class E11 filter element.

At the front and the top of the purifier is a touch panel to control the different power stages of the ventilator.

The dimensions of the tested device can be obtained from the following Table 2.1:

**Table 2.1:** basic data of the asecos PURIFIAIR.620

| Basic data PURIFIAIR.620, asecos GmbH | |
|---|---|
| length x height x width [mm]: | 400 x 682 x 400 mm |
| manufacturer drawing: | LR.066.040.040.H3 PURIFI AIR.620 |

**Table 2.2:** filter elements of the tested asecos PURIFIAIR.620

| filter units PURIFIAIR.620, asecos GmbH | |
|---|---|
| filter 1: | HEPA H14 with G4 prefilter, Art.-Nr.: EP.L.33974 |
| filter 2: | E11 |

I.F.I. was supplied with two identical air purifiers with the following serial numbers: A2101-341699-0821-4 and A2101-341701-0821-9 for the inspection.

The air cleaner PURIFIAIR.620 is also equipped with a built-in particle counter that measures the PM 1.0 concentration in the room.

## 3 Determination of the volume flow rate

To determine the volume flow rate the compensation method according to DIN EN 12599 was used. An air tight box was attached to the inlet areas of the air purifier which was also connected to a ventilator via a duct system. The volume flow of the attached ventilator was determined by a volume flow measuring section. With this measurement method the ventilator is adjusted in such a way that – at the different power stages of the air purifier – the pressure difference between the box and the ambient pressure of room where the air purifier is placed is 0 Pascal. This way the additional ventilator delivers the same flow rate as the ventilator in the air cleaner. The additional ventilator is needed to compensate the pressure losses of the volume flow measuring section and test setup. Table 3.1 shows the results of the volume flow rate measurements for the different power stages of the air purifier.

**Table 3.1:** results of the volume flow rate measurements with a H14 and E 11 filter unit

| results of the volume flow rate measurements with the PURIFIAIR.620 of asecos GmbH, with a H14- and E11-filter unit | | |
|---|---|---|
| power stage | stage 2 | stage 4 |
| target - volume flow rate [m³/h] | 305 | 600 |
| actual - volume flow rate [m³/h] | 308 | 586 |

The measurements of the actual volume flow rate showed that the volume flow rates are almost identical to the target values. The volume flow rates as described by the manufacturer are hereby confirmed.

# 4 Determination of the particle reduction

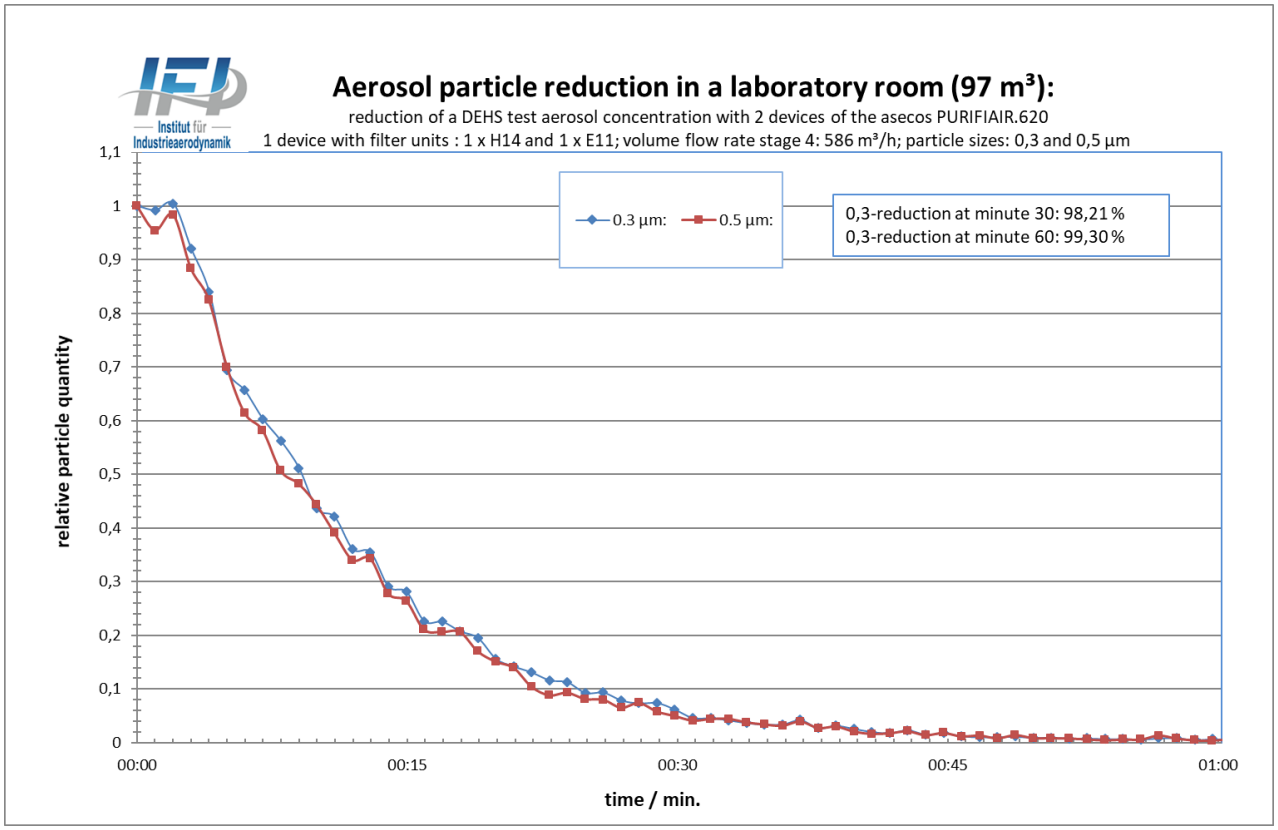
## 4.1 Reduction of the aerosol particle concentration (filter effect) in a laboratory room

For a statement regarding the efficiency of the air purifier asecos PURIFIAIR.620 the quantity of aerosol particles with a size of 0,3 µm and 0,5µm were measured at stated intervals in a nearly airtight laboratory room. To simplify, all aerosols (heterogeneous mixture of solid and liquid suspended particles in gas) will be designated as particles in the following.

Before the beginning of the test the natural aerosol background concentration was increased by 10 to 20 times using an aerosol generator and a DEHS test aerosol. Because of the small room size the aerosol concentration was measured for only one position for 1 minute at an interval of 1 minute and over a period of 60 minutes. The measurement height was H = 1100 mm at a distance of 1 m to the air purifier.

The testing was done at power stage 4 of the air cleaner, which equals an air exchange rate of 6 in the laboratory room, with a combination of filter units of a H14-HEPA and an E11 element.

The results are shown in Graph 4.1 and Table 4.1:




**Graph 4.1:** particle quantity over time in the laboratory room

**Table 4.1:** results of the examination of the aerosol particle reduction in a laboratory room

| results of the aerosol-reduction tests in a 97 m³-test room:<br>asecos PURIFIAIR.620 with filter units H14 and E11 | | |
|---|---|---|
| position air purifier / measurement position | DEHS-aerosol-reduction | reduction % |
| 0.5 m from left wall / centre | after 15 minutes | **71.86** |
| | after 30 minutes | **93.80** |
| | after 45 minutes | **98.21** |
| | after 60 minutes | **99.30** |

The measurements in the testing room showed that after 30 minutes over 90% of the initial particles have been filtered from the room, which indicates a high filter efficiency of the PURIFIAIR.620.

## 4.2 Reduction of the particle concentration in a common room

For a statement regarding the effectiveness of the PURIFIAIR.620 in a real common room, the evolution of the particles over time was measured in a class room.

The test class room was equipped with ten tables and chairs. In order to simulate the human thermal load (100 watt at rest), “thermal dummies” were positioned on the chairs. Cupboards complemented the spatial organisation and a mobile blackboard was placed at the front wall of the room.

The measurements of the effectiveness in a room were conducted in accordance with the VDI-EE 4300 Blatt 14 in a room with a width of 6.7m, a length of 10.1 m and a room volume of approx. 238 m³. This corresponds to the size of a common class room.

Before the beginning of the tests the natural aerosol background concentration was increased by 10 to 20 times using an aerosol generator and a DEHS test aerosol. At 5 different positions the concentration was measured for 1 minute at an interval of 1 minute and over a period of approx. 45 minutes. The measurement height was H = 1100 mm.

Due to the room size and manufacturer’s guidelines the measurements of the particle reduction time of the PURIFIAIR.620 air purifier were performed with 2 devices.

In agreement with the client one device was positioned in the middle of the right-hand side wall and the second air purifier was situated in the middle of the front wall in the lecture area.

Figure 4.1 and Figure 4.2 show the positions of the air cleaners and the corresponding measurement locations in the room.

**Figure 4.1:** asecos PURIFIAIR.620 in the class room for determining the reduction of DEHS-test aerosols according VDI EE 4300 Blatt 14

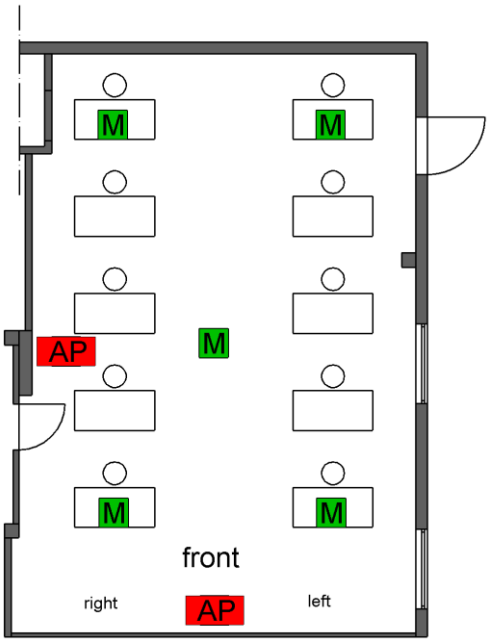



**Figure 4.2:** Measurement positions and locations of the air purifiers

The analysis with a H14- and E11- filter unit was performed at power stage 4. The overall volume flow rate on stage 4 was 2 x 586 m³/h (1172 m³/h) which corresponds to an air exchange rate of approx. 5 times per hour in the class room.

**According to VDI-EE Blatt 14 at each measured position in the class room a reduction of the initial particle concentration of at least 90 % in 30 minutes was verified.**

Table 4.2 presents the results of the particle reduction for each measurement position.

The separate particle concentration diagrams are shown in Annex B.

**Table 4.2:** Results of the aerosol particle reduction for each measurement location in the class room

| Results of the aerosol particle reduction tests in accordance with VDI-EE 4300 Blatt 14:<br>2 air cleaners asecos PURIFIAIR.620 with H14 and E11 filter units | | |
|---|---|---|
| Location of air purifier | Measurement location of aerosols in head height (1100 mm) | Reduction of the test aerosol particle concentration after 30 minutes[%] |
| device 1: middle of right-hand side wall<br>device 2: middle of front wall | middle of the class room | **93.0** |
| | front left (lecture area) | **90.3** |
| | front right (lecture area) | **92.2** |
| | rear left (study area) | **92.6** |
| | rear right (study area) | **91.0** |

The mobile air purifier asecos PURIFIAIR.620 fulfils the requirements of VDI-EE 4300 Blatt 14 regarding particle reduction (reduction of 90% in 30 minutes) for the described room constellation with two devices on power stage 4.

## 5 Distribution of the purified air in a room

A key aspect for the performance of an air cleaner is the distribution of the purified air in the room. Are there any areas in the room that are not reached by the purified air and no exchange of air happens? To investigate this question the distribution of the filtered air was analysed using a tracer gas. The air that is emitted by the air cleaner is mixed with a gas that can be detected on different locations in the room with a measuring device. In this particular case propane was used that was measured at 14 positions in the room with a Flame Ionization Detector (FID). Figure 5.1 and Figure 5.2 show the test setup und different measurement positions in the room, which was also used for the analysis of the particle reduction rate.

**Figure 5.1:** measurement setup

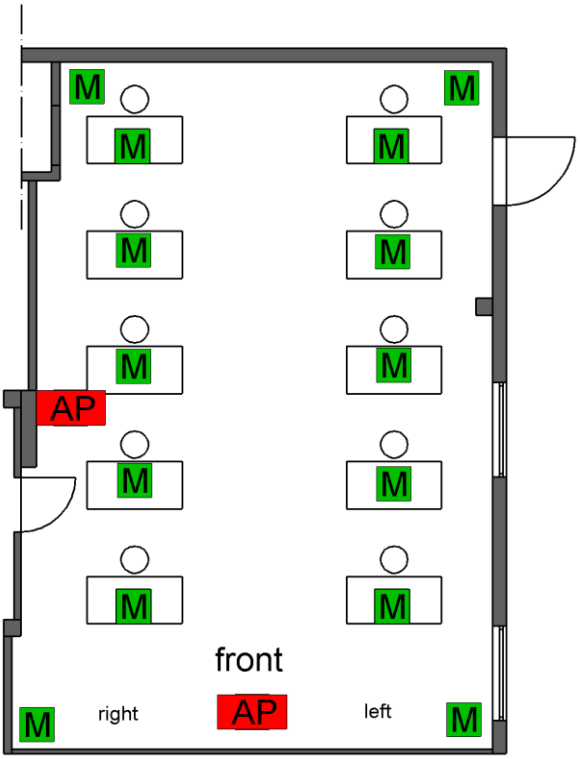



**Figure 5.2:** measurement positions in the class rom

The measurements of the gas concentrations were conducted at a height of 1.1 m which equals the head height of a sitting person. The tests were done at power stage 4 (volume flow rate 586 m³/h) of the air cleaner that was fitted with a H14 and E11 filter unit. The gas concentration was calculated so that at the outlet of the air cleaner a propane concentration of 1200 ppm (parts per million) was present. The release of propane was adjusted in such a way that with a room volume of 238 m³ and a fully equal distribution a theoretical concentration of 50 ppm should be present.

The results of the measurements are shown in Annex C 1 to Annex C 4 as a top-view of the room and a height of 1.1m after different periods of time following the release of propane.

The areas with a high propane concentration are supplied relatively early and fast with purified air. These are areas close to the air cleaner. After only 7.5 minutes the majority of the room is completely filled with purified air. After 10 minutes the whole room is covered with purified air. With this air cleaner configuration there is no area in the room that is not filled with purified air.

## 6 Measuring instruments

| | |
|---|---|
| Differential pressure: | Setra MR1SD differential pressure transmitter |
| Aerosol generator: | PALAS AGF 2.0 |
| Test aerosol: | DEHS (Bis(2-ethylhexyl) sebacate); CAS 122-62-3, Fa. Sigma-Aldrich/ Merck KGaA |
| Particle counter: | Trotec PC220 |
| Flame ionization detector: | SK-Elektronik Thermo-FID PT-84TE |
| Anemometer for volume flow rate: | 27106T Gill-Propeller Anemometer |

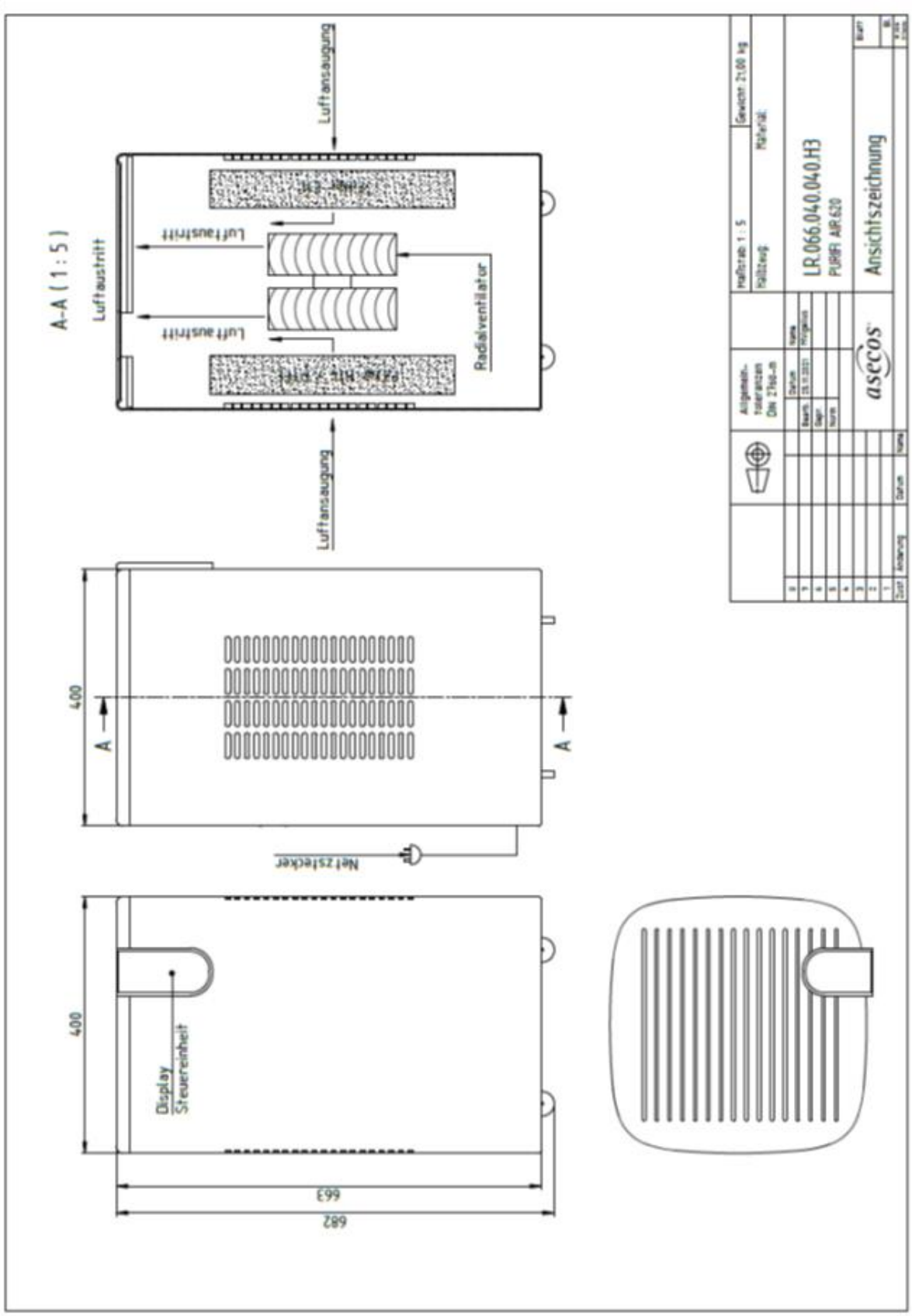
# 7 References

[1] VDI EE 4300, Blatt 14: Measurement of indoor pollution – Requirements for mobile air purifiers to reduce aerosol-borne transmission of infectious diseases

[2] DIN EN 12599:2013-01 Ventilation for buildings – Test procedures and measurement methods to hand over air conditioning and ventilation systems; German version EN 12599:2012

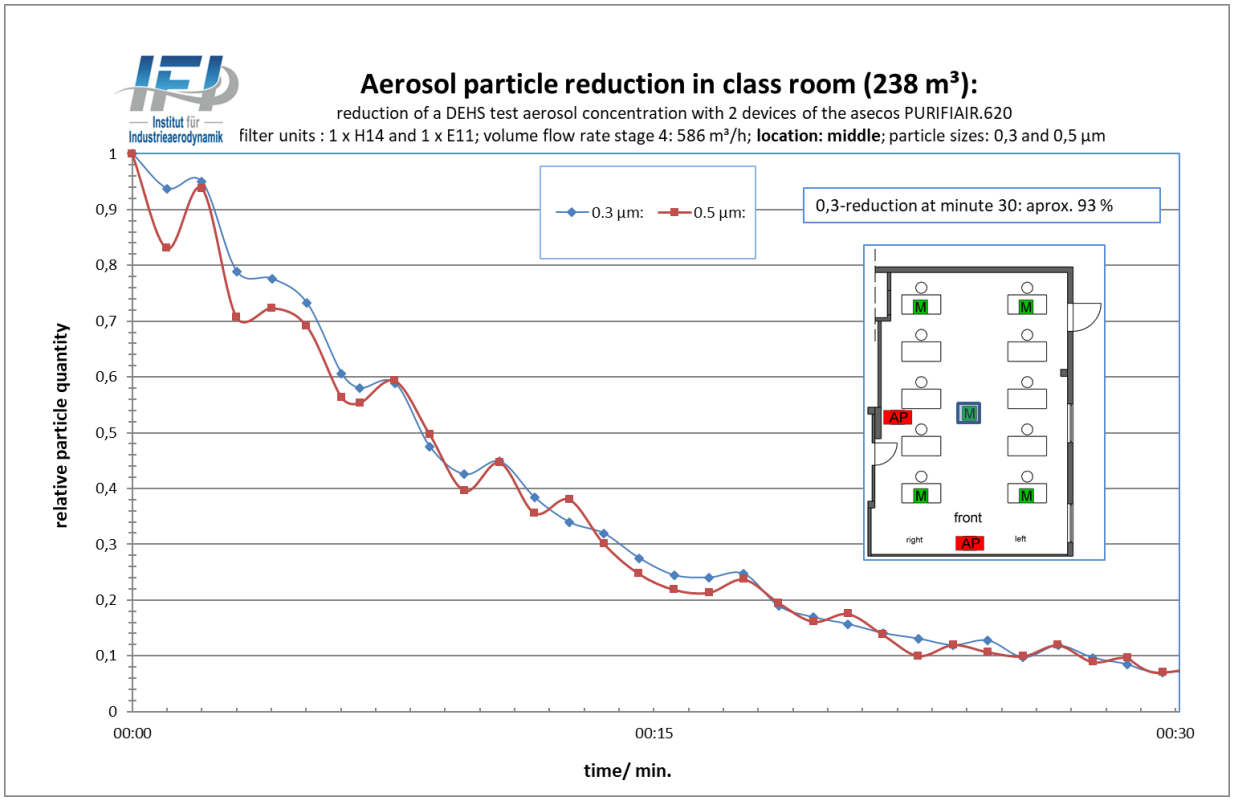
[3] DIN 1946, Teil 2, January 1994, Ventilation and air conditioning; Technical health requirements

## Annex A: technical documentation of the mobile air purifier

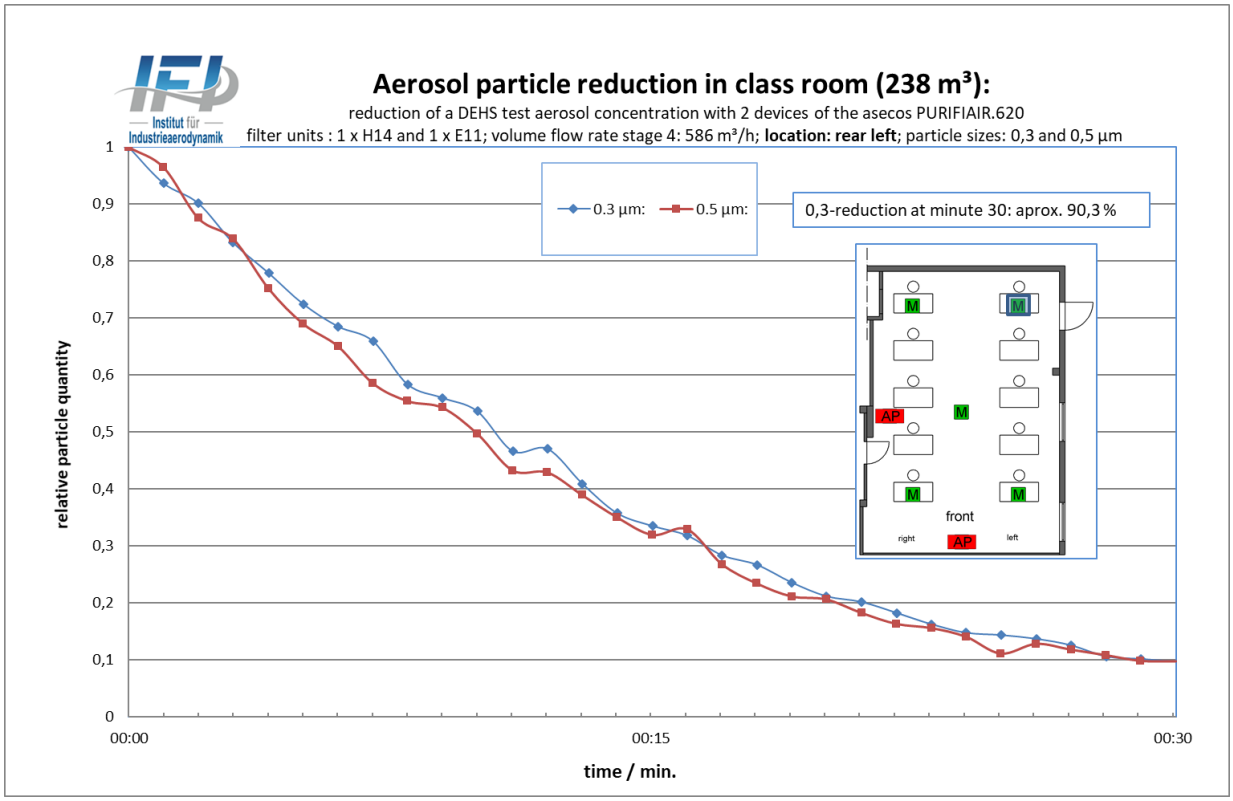



**Annex A 1:** technical documentation drawings

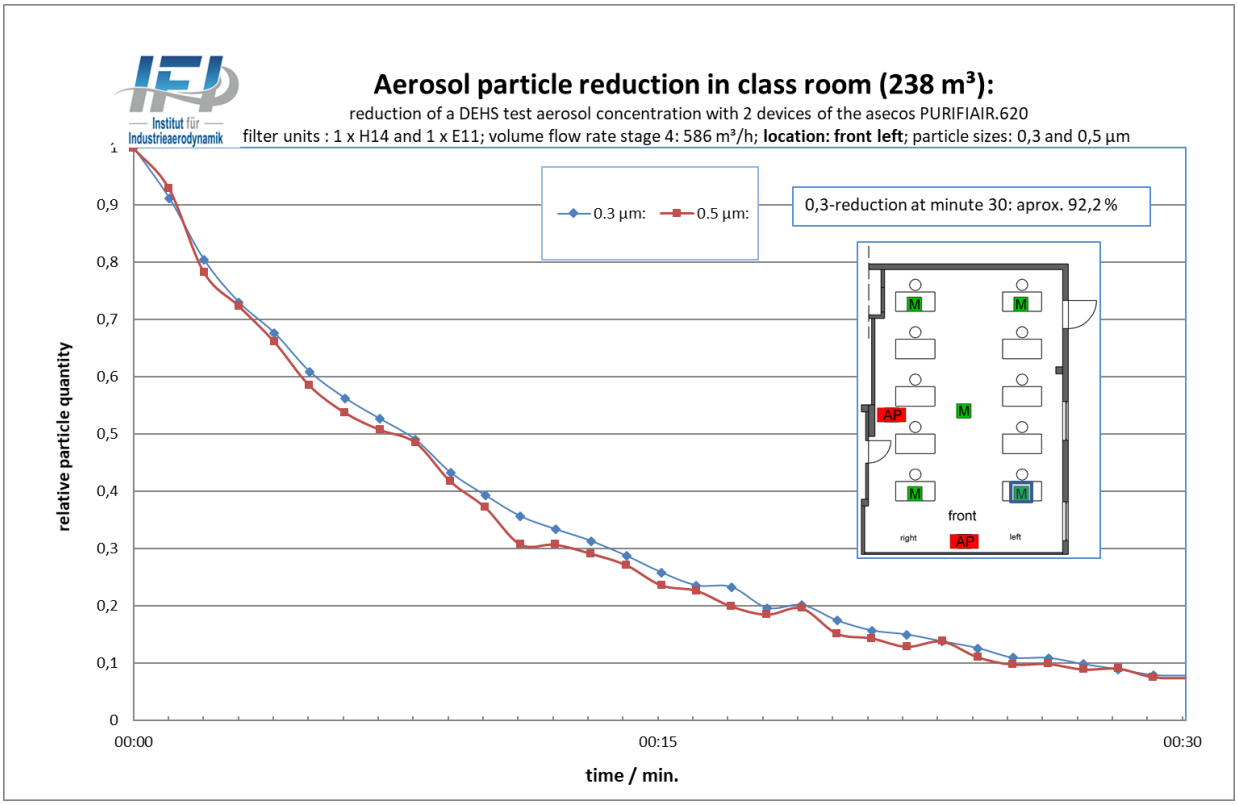
## Annex B: results of the reduction of the DEHS test aerosol in the class room



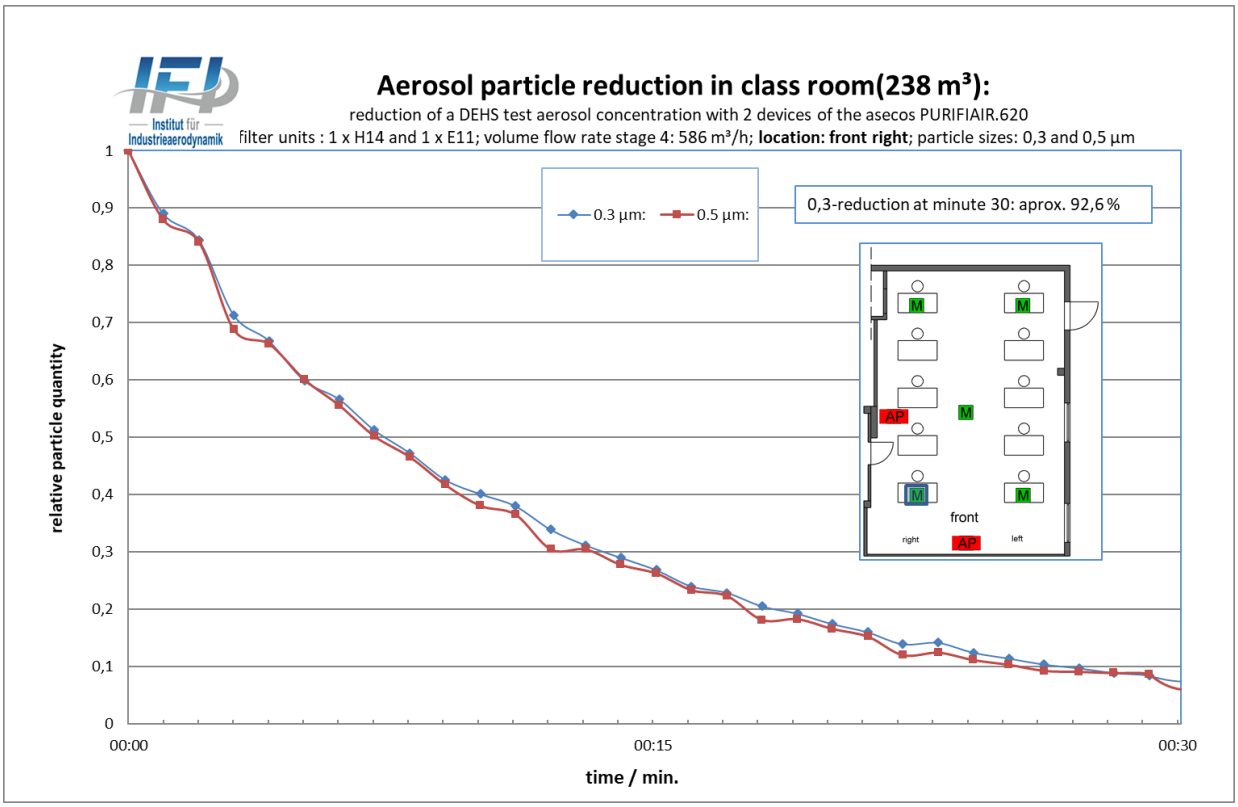

**Annex B 1:** Time curve of the reduction of the aerosol concentration for the measurement position in the middle of the class room



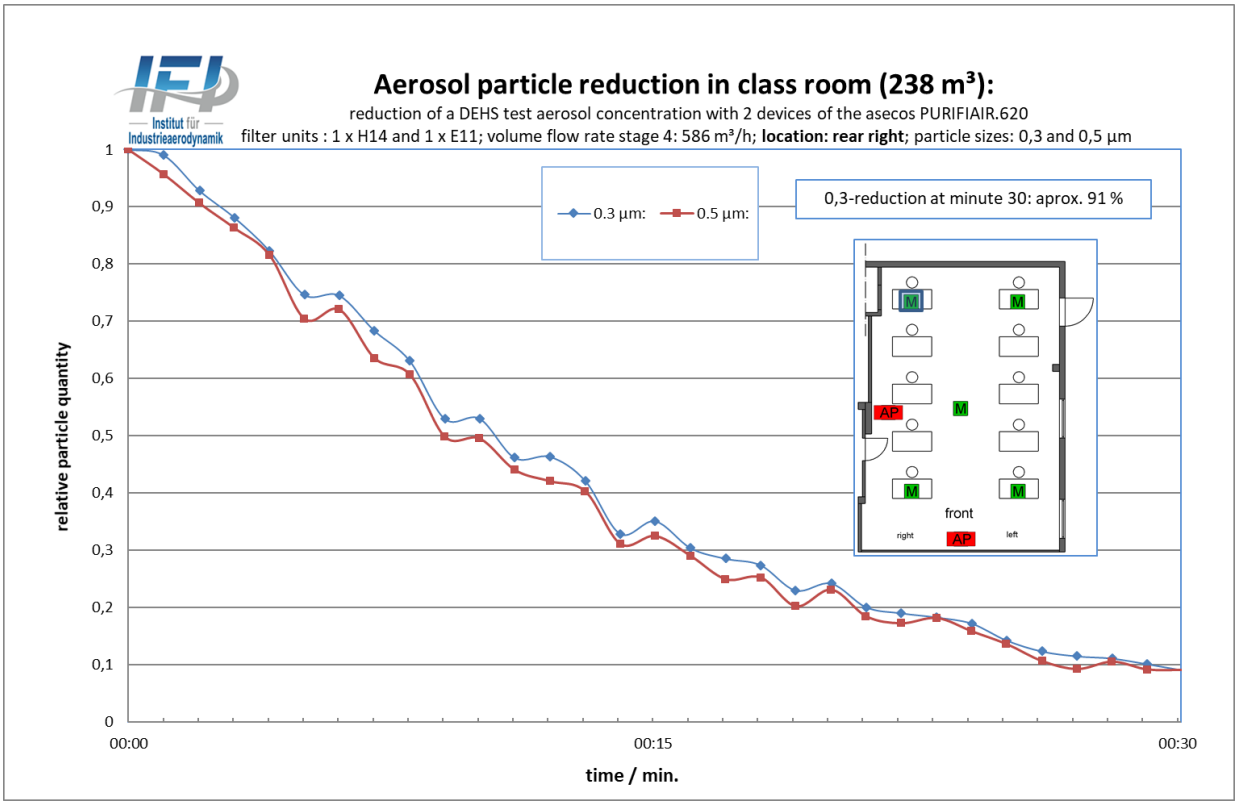

**Annex B 2:** Time curve of the reduction of the aerosol concentration for the measurement position in the rear left of the class room




**Annex B 3:** Time curve of the reduction of the aerosol concentration for the measurement position in the front left of the class room

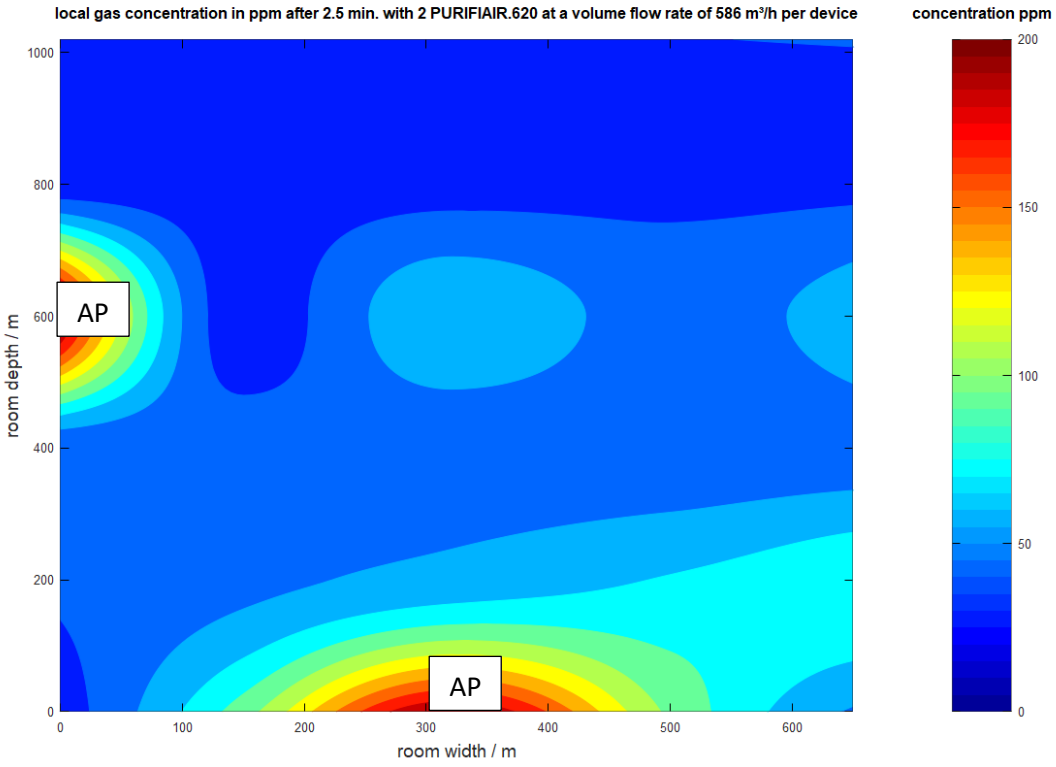



**Annex B 4:** Time curve of the reduction of the aerosol concentration for the measurement position in the front right of the class room

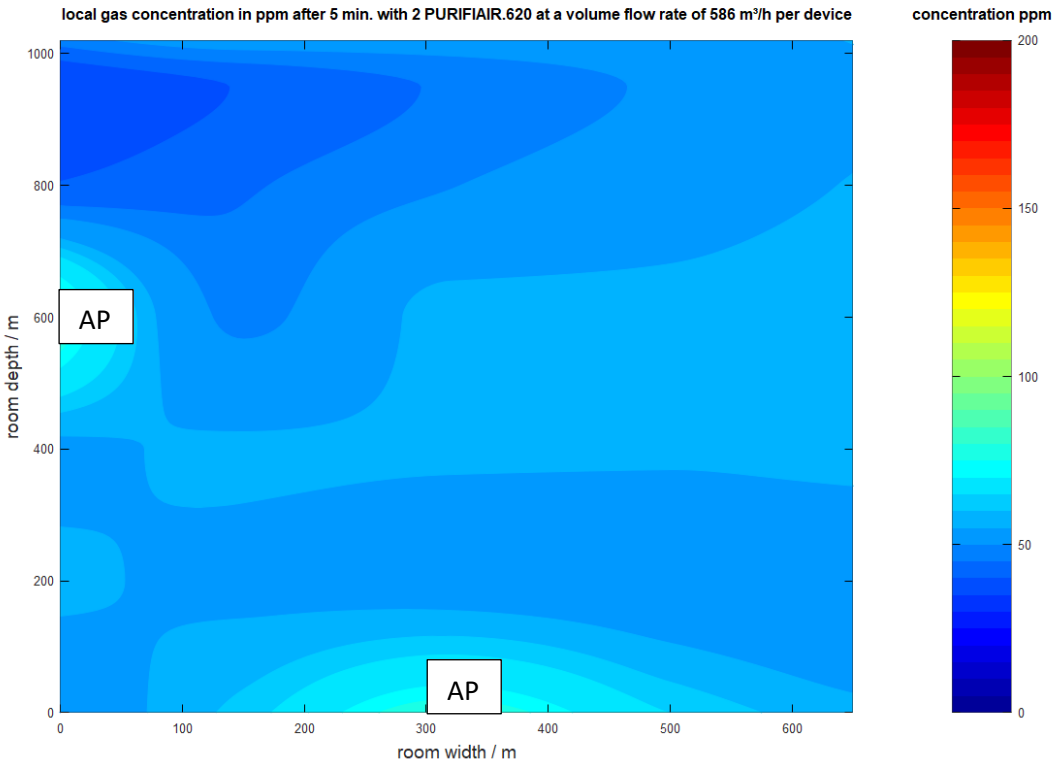



**Annex B 5:** Time curve of the reduction of the aerosol concentration for the measurement position in the rear right of the class room

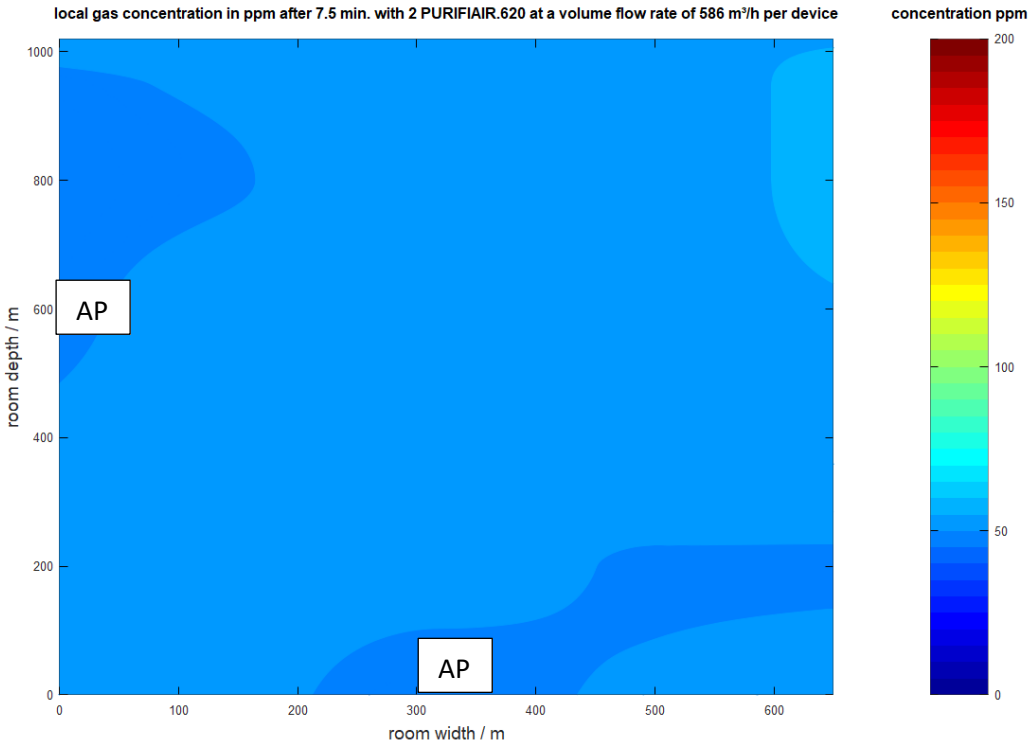
## Annex C: results of the analysis of the distribution of purified air



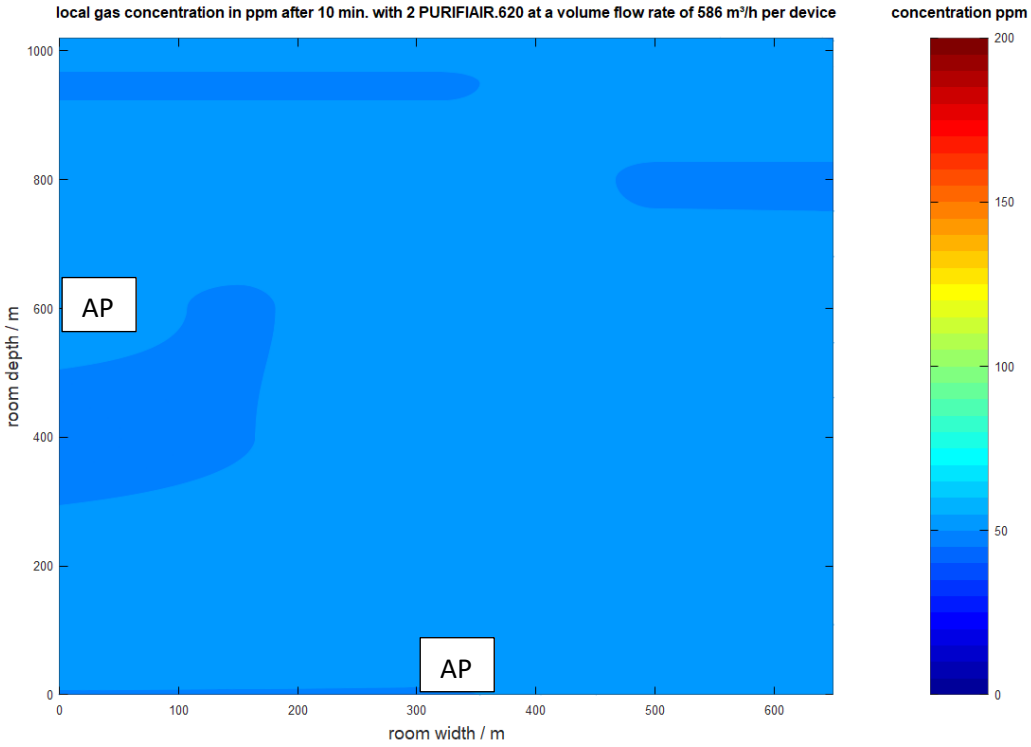

**Annex C 1:** local gas concentration after 2 minutes




**Annex C 2:** local gas concentration after 5 minutes




**Annex C 3:** local gas concentration after 7,5 minutes




**Annex C 4:** local gas concentration after 10 minutes