

## PM-10 TUEV Approval Report for the Particulate Monitor FH 62 I-R with reference to European Standard EN 12341

The German testing organization, TUEV South, has evaluated **4 ESM Andersen FH 62 I-R continuous Particulate Monitors**, equipped with **two different PM-10 sample inlets**, with reference to the new European Standard, EN 12341, for PM-10.

Following successful testing, the FH 62 I-R – PM-10 approval was **published** in the December 2000 issue of the GMBI (Joint Ministerial Gazette of the Federal Ministries):

GMBI No. 60 (2000) page 1195

The new Council Directive, 1999/30/EC, introduced a new limit for PM-10 Particulate concentrations, which is now set at 50 micrograms per cubic meter. The European Standard EN 12341 specifies the field test procedure to be used to evaluate the reference equivalence of PM-10 instruments. It was confirmed, that no relevant differences are between the test results of the continuous FH 62 I-R monitors and the EN 12341 reference sampler method. To date this monitor has shown a very low detection limit.



Fig.1: Particulate Monitor FH 62 I-R

Four FH 62 I-R Particulate Monitors with two different PM-10 inlets were evaluated as part of the TUEV testing. Two monitors were equipped with the PM-10 ESM inlet (US-EPA design) and the other two monitors with the DPM10100 inlet (Digitel design). Both inlets had an airflow rate of 1 m<sup>3</sup>/h.

Duplicate measurements were performed for each inlet. The four FH 62 I-R instruments were tested in parallel at three different sites over an 8 month period (October 27, 1999 to July 31, 2000).

The **DPM10100 (Digitel)** – Inlet (Fig. 2) is the first European designed inlet to gain PM-10 equivalence. It's design is based on the European Standard EN 12341 (Annex B.1), Reference Inlet for LVS PM10 instruments.

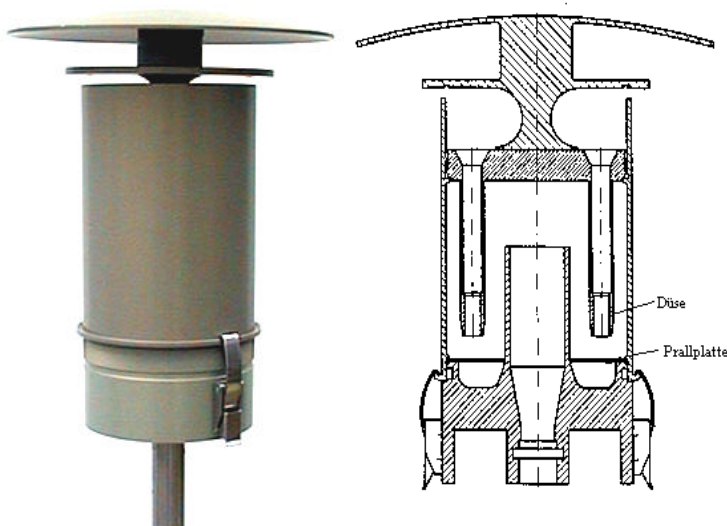


Fig. 2: PM10 inlet, DPM10100 (Digitel ; 1 m<sup>3</sup>/h)

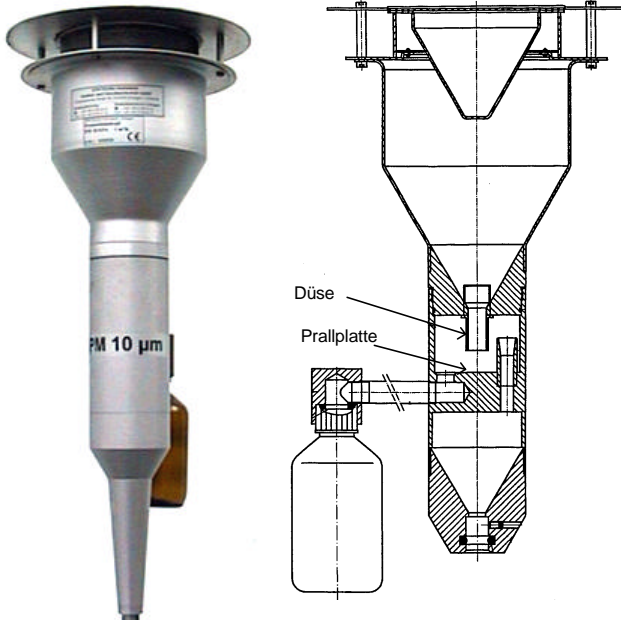
**PM-10 inlet, produced in Europe (Digitel Switzerland)**

ESM Andersen Instruments GmbH commissioned Digitel (Switzerland) to develop this PM-10 inlet. This design results in the following:

- Dimensions are revised for a change of air flow from 2.3 m<sup>3</sup>/h to 1.0 m<sup>3</sup>/h.
- Replacement of the internal filter holder with a tube connector.
- Improvements were incorporated to improve accessibility and maintenance.
- During testing a fly grid was

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integrated into the Inlet.



The **PM10 ESM** inlet (Fig.3) consists of a ring-shaped intake with a grid, a vent tube and a baffle plate. The coarse particles are deposited on the baffle plate.

Three nozzles on the baffle plate allow sample air (with PM-10 particles) to flow to the sample tube, and on to the analyzer.

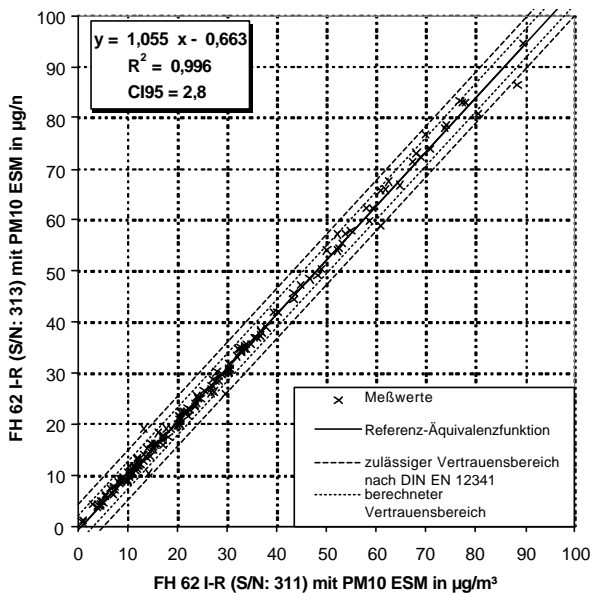
After passing through the inlet, the Sample air flow is drawn via a stainless steel tube (3 m long, 16 mm diameter), and through the filter tape.

A 2 meter length of the 3 meter sampling tube was heated to  $40\text{ °C} \pm 1\text{ °C}$ .

Fig. 3: PM10 ESM Inlet (1 m³/h) – USA EPA design

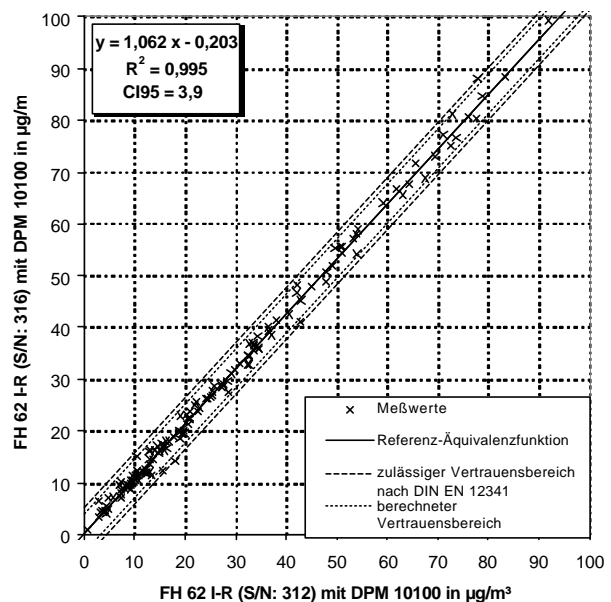
### Test Results

In compliance with the European Council Directive 1999/30/EC Annex IX, part IV a candidate monitoring instrument can be used for the surveillance of the PM-10 limits, if this instrument has been tested to demonstrate reference equivalence measurement according to the specification DIN EN 12341.



US-EPA design

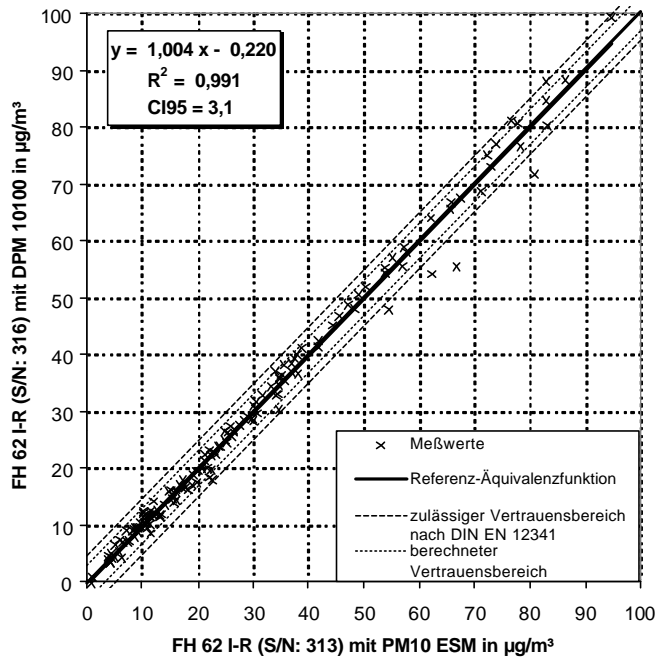
Fig. 4: Results of parallel test of FH 62 I-R monitors with:  
a) PM10 ESM-inlet



PM-10 inlet, produced in Europe (Digitel)

b) DPM 10100 inlet

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Comparison of results of the PM-10 inlet (produced in Europe) against the US-EPA PM-10 inlet shows excellent correlation between the two inlets.

FH 62 I-R PM-10 particulate monitors can be supplied with both types of inlet, to allow parallel operation within networks.

Fig. 5: Comparison FH 62 I-R with **DPM10100** (produced in Europe) – inlet against **PM10 ESM** (USA-EPA)-inlet

### Results of the FH 62 I-R against the Reference Sampler (EN 12341 Annex B1)

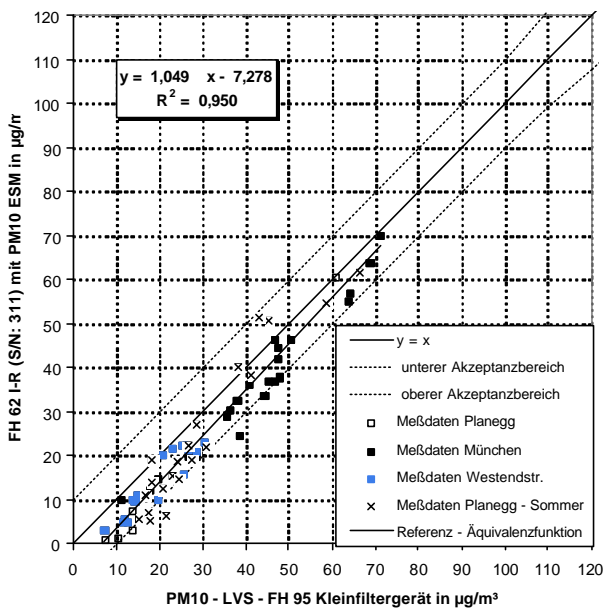


Fig 6: EN Reference Sampler versus FH 62 I-R with PM10 ESM – inlet / **US-EPA design**

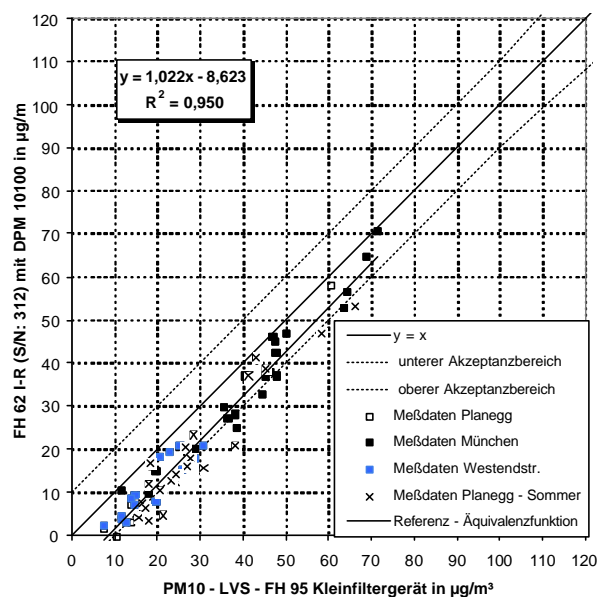


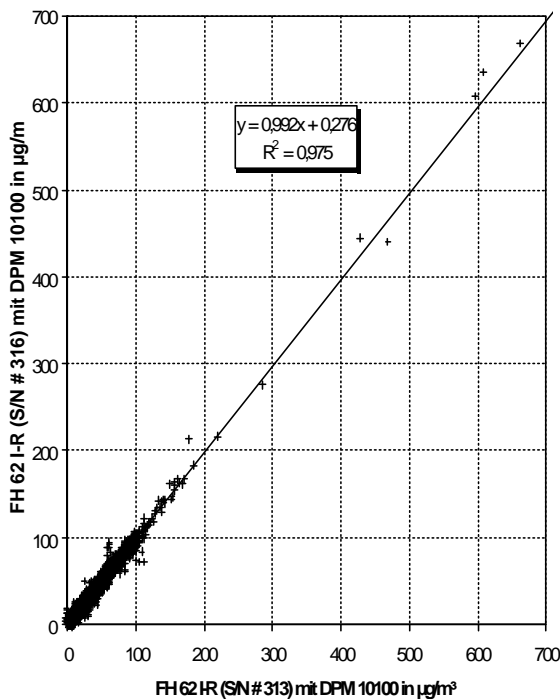
Fig 7: EN Reference Sampler versus FH 62 I-R with DPM 10100 – inlet / produced in **Europe**

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with DPM 10100 – inlet / produced in Europe

The reference equivalence function shown within a two-sided acceptance envelope is in the acceptance range  $y = (x \pm 10) \mu\text{g}/\text{m}^3$  for reference concentrations,  $\leq 100 \mu\text{g}/\text{m}^3$  for all FH 62 I-R monitors and the two inlets. The confidence level is better than  $R^2 > 0,95$ .

The FH 62 I-R with either PM-10 inlet fulfils the requirement of EN 12341 and demonstrates the PM-10 reference equivalence.

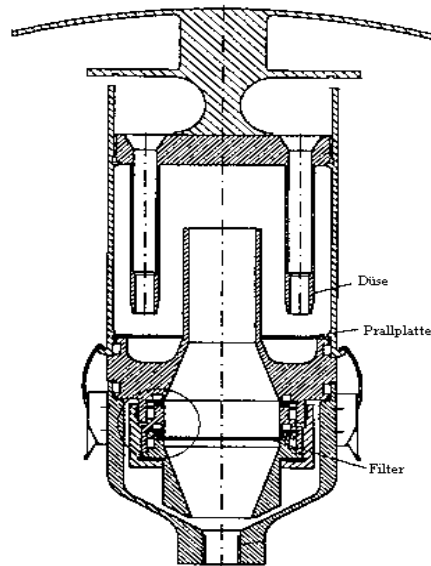


The graph in Fig. 8 shows the correlation of short time averages for low and high concentrations of PM-10 from  $5 \mu\text{g}/\text{m}^3$  to  $700 \mu\text{g}/\text{m}^3$ . This indicates the excellent dynamic detection range of the FH 62 I-R continuous PM-10 monitor.

Fig. 8: Correlation of 4000  
10- minutes averages

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**PM-10 Reference Sampler (2,3 m<sup>3</sup>/h ) as specified in EN 12341 Annex B1**



During the TUEV approval test procedure the LVS (Low Volume Sampler) - PM10 - FH 95 KF (ESM Andersen) was used as the **reference sampler**. Sample air flow was regulated at **2,3 m<sup>3</sup>/h**, and the sampler was equipped with the PM10 sample system as specified in **EN 12341 Annex B1**.