



**Fraunhofer**

**TESTED<sup>®</sup>  
DEVICE**

Festo AG & Co. KG  
Miniature valve MH 1  
Report No. FE 0705-402

DUPLIKAT

Statement of  
Qualification

# Statement of Qualification

**Manufacturer of object to be tested:** Festo AG & Co. KG  
Ruiter Straße 82  
73734 Esslingen-Berkheim

**Component tested:** Miniature valve

**Type:** MH 1

**Performed tested:** Random sample measurements of particle emission (airborne) at representative points  
Raman spectroscope analysis  
Energy dispersive x-ray analysis (EDX) in combination with the use of a scanning electron microscope (SEM)  
Gas chromatography in combination with mass spectrometry (GC/MS)  
High performance liquid chromatography (HPLC)

**Test parameters of object to be assessed:** Random measurements of particle emission and particle sampling: four miniature valves MH1 connected in parallel and operated with a pressure of 2.0 bars, a continuous volume flow rate of 1800 l/h and a switching time for each valve of 2 Hz; background particle emission from the set-up ISO Class 3 in accordance with ISO 14644-1; particulate contamination was collected in DI water with the aid of a gas washing bottle, particles were collected over a period of 9 hours, filtration step on membrane  
Assessment of volatile organic outgassing: heating duration over 1 hour at room temperature, 60 °C and 90 °C  
Assessment of inorganic anionic outgassing: Duration of rinsing: 3 hours; Volume of sampling chamber: 0.02 liters; Volume of purified water in gas washing bottle: 0.01 liters; Temperatures: 22°C (room temperature), 60 °C and 120 °C; Volume injected into ion chromatograph: 5 µl; Chromatographic sequence: isocratic, 15 min

**Test results / classification:** It can be derived that the system comprising four miniature valves MH1 connected in parallel and operated with a pressure of 2.0 bars, a volume flow rate of 1800 l/h and a switching time for each valve of 2 Hz is clearly suitable for use in cleanrooms fulfilling the specifications of ISO Class 5 (in accordance with ISO 14644-1; background particle emission from the test set-up ISO Class 3 in accordance with ISO 14644-1).  
A material analysis of the particles using a Raman spectrometer and EDX/SEM indicated two main particle origins: particles originating from the manufacturing environment and particles generated by the miniature valve MH 1 itself.



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## Standards used for the qualification:

For the organic outgassing tests, no substance could be detected which was released by the miniature valve MH 1 at room temperature, at 60 °C or at 120 °C.

Furthermore, the miniature valve MH 1 made by Festo AG & Co. KG is free of the anions chloride (Cl<sup>-</sup>), sulfate (SO<sub>4</sub><sup>2-</sup>), nitrate (NO<sub>3</sub><sup>-</sup>), phosphate (PO<sub>4</sub><sup>3-</sup>) and fluoride (F<sup>-</sup>).

VDI 2083 sheet 1 and 8; ISO 14644-1; IDEMA M11-99;  
SEMI E108-0301

## Test environment:

Cleanroom of Air Cleanliness Class ISO Class 1 (according to ISO 14644-1)

Air flow velocity: 0.45 m/s; Air flow guidance: vertical unidirectional air flow from ceiling to floor (raised floor)

Temperature: 22°C ± 0.5°C; Relative humidity: 45% ± 5%

Raman spectroscope instrumentation: Liquid Particle Explorer® and filtr.AID membrane® made by rap.ID Particle Systems GmbH

EDX/SEM instrumentation: EDX analyser GENESIS made by EDAX Inc.; SEM SUPRA 35 made by Leo/Carl Zeiss AG

GC/MS instrumentation: Finnigan MAT ITS 40 with gas chromatography column type CP-SIL 8CB-MS; 50m x 0,25 ID; DF = 0,40 µm of the Company Chrompack; Method of ionisation: Ionisation caused by electron collision

HPLC instrumentation: Dionex ion chromatograph ICS 3000, Eluent: 35 mM potassium hydroxide solution, Detector: conductivity detector with suppressor technology, Column: Dionex IonPac AS 18; 2 x 250 mm

The measuring equipment used for the qualification is regularly calibrated and is based on national and international standards. In the case where no national standards exist, the measuring procedure used corresponds with technical regulations and norms valid at the time of the measurement. The documents drawn up for this procedure are available for viewing.

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Stuttgart, 26<sup>th</sup> June 2007

Place, date

Signature of person responsible