



## TECHNICAL BULLETIN

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McMillan Corporate Headquarters:

Post Office Box 1340  
Georgetown, TX 78627-1340  
United States of America

Toll-Free: 800.861.0231  
Direct: 512.863.0231  
Fax: 512.863.0671

<http://www.mcmflow.com>  
[sales@mcmflow.com](mailto:sales@mcmflow.com)

### MCMILLAN UHP FLO-SENSOR PURITY ANALYSIS

Particle Generation and Metal Contamination for  
U701/U702/U705/U706/U707/U708 FLO-SENSORS

#### Objective

McMillan UHP products are specifically designed for use inline on ultra-high-purity liquid applications, such as those found in semiconductor manufacturing processes. Engineers must have confidence that such products are suitable for these critical applications, contributing little if any contamination to their processes. Industry-leading data must be presented to show that McMillan products contribute zero particles and minimal metallic contamination under normal operating conditions.

#### Testing Capabilities

McMillan utilizes a dedicated Class 1000 Cleanroom for quality control purity analysis for flow sensors manufactured for UHP applications. This cleanroom is equipped with multiple instruments which provide reliable, technologically advanced data required for semiconductor manufacturing processes.

For particle generation analysis, McMillan uses a Particle Measuring Systems Liquid Optical Particle Counter Model HSLIS M-50 (serial number 39521) which allows online particle counts and sizing down to  $0.05\mu$  (0.05 micron) in deionized water. For metals analysis, McMillan employs an Agilent ICP-MS (inductively coupled plasma mass spectrometry) Model 7500ce (serial number JP14101021) which allows both static and dynamic ion analysis down to ppt levels in both acid and deionized water.

#### Zero Particle Generation

As part of McMillan's standard quality control procedures, samples of flow sensors are routinely selected from production for particle testing. For this test, four randomly selected McMillan UHP microturbine flow sensors were chosen for online particle analysis. Test data was retrieved at  $0.20\mu$ ,  $0.15\mu$ ,  $0.10\mu$ , and  $0.05\mu$ . Data is presented as an average of all four units (table 1), then compared to competitive technology (table 2), and then each individual unit to show individual sensor data that produced average data (table 3). Data presented is corrected for baseline.

TABLE 1: AVERAGED DATA FROM FOUR (4) MCMILLAN FLO-SENSORS

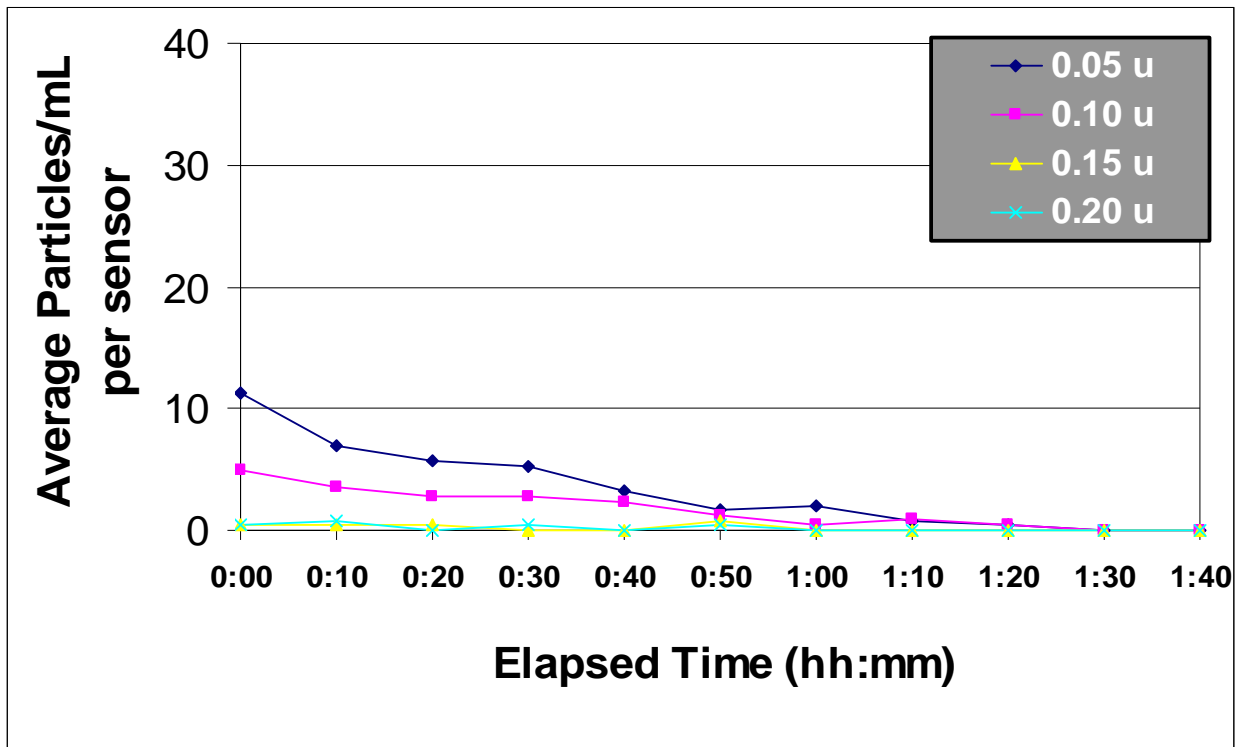


TABLE 2: MCMILLAN DATA VS. COMPETITOR'S DATA\*

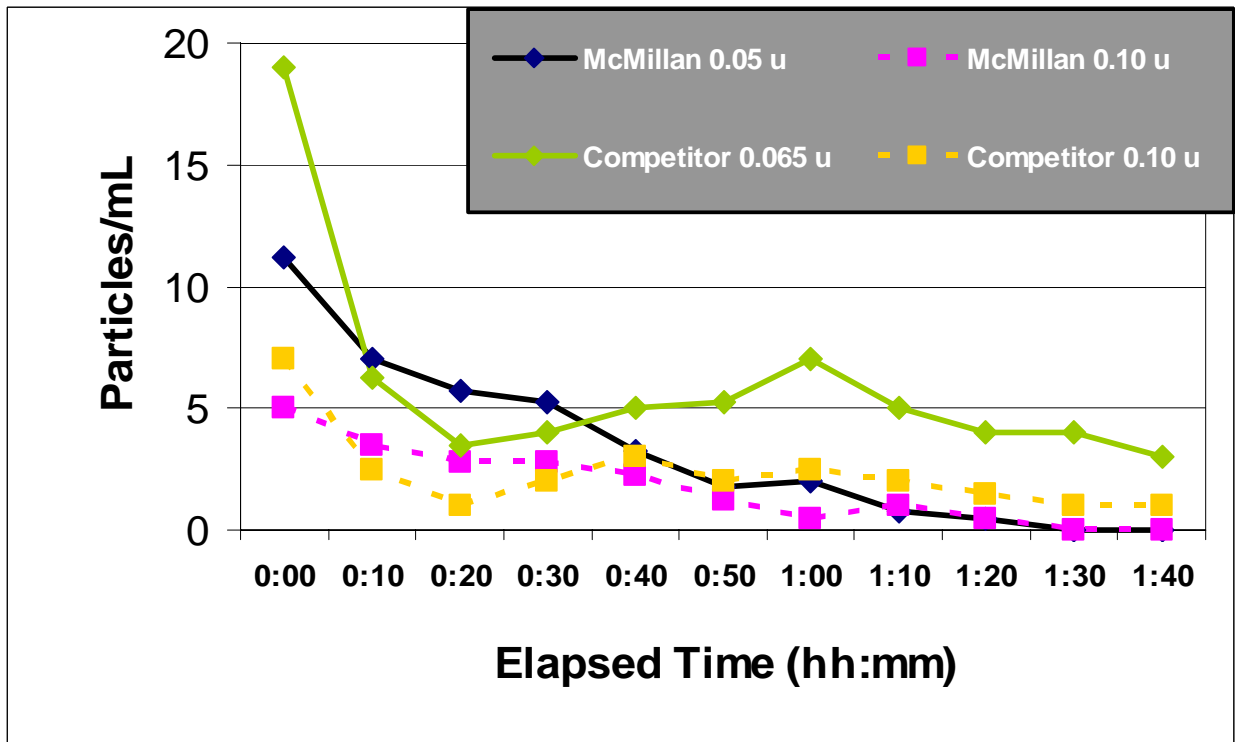
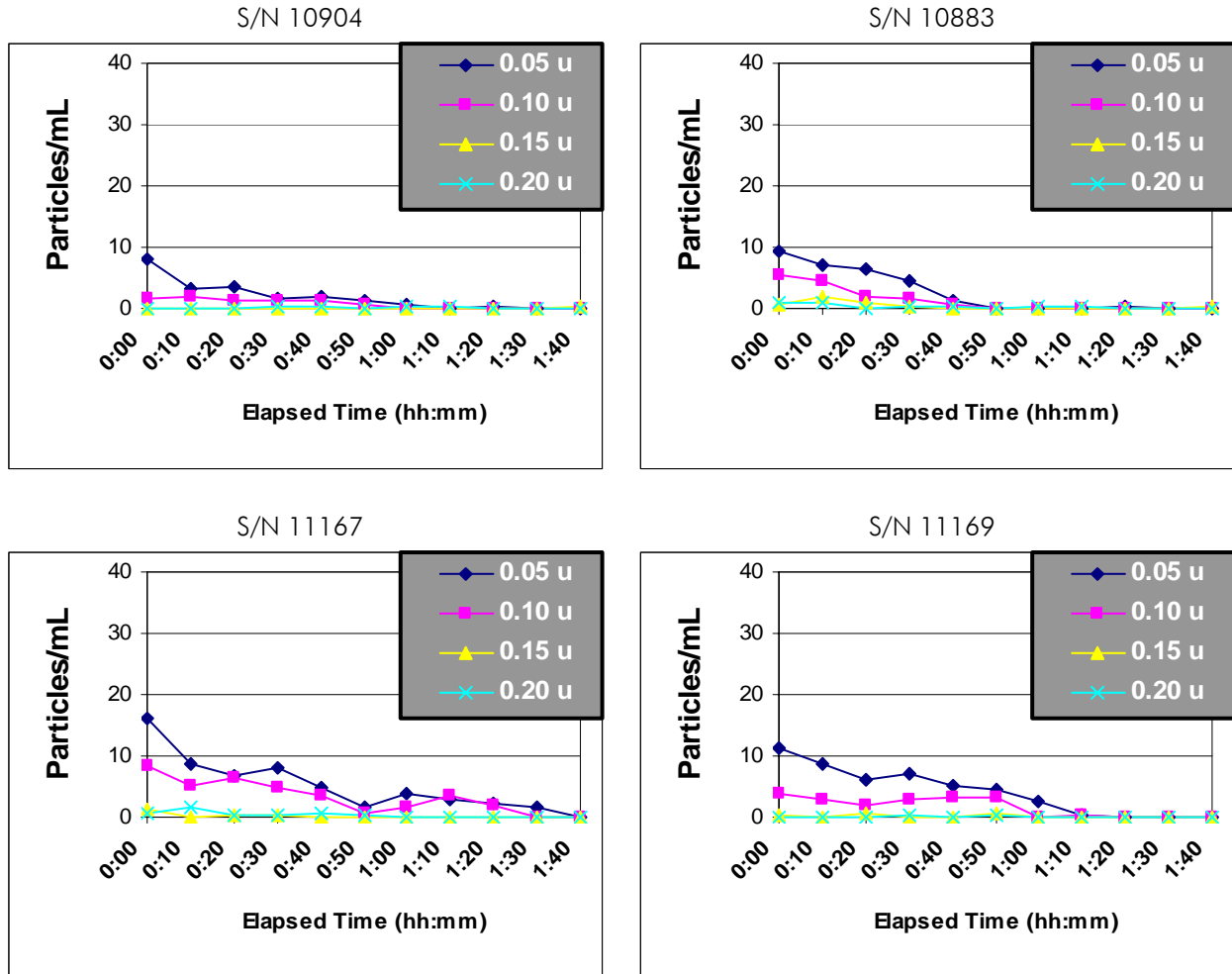


TABLE 3: ACTUAL DATA FROM INDIVIDUAL SENSORS USED FOR DATA IN TABLE 1



\* Competitor data in table 2 was taken from a differential-pressure based flow sensor recommended by its manufacturer for UHP applications. Note that 0.05  $\mu$  data was not available for competitive product, so 0.065  $\mu$  data was substituted. Data at 0.065  $\mu$  typically registers less particles than tests run at 0.05  $\mu$ . The McMillan product was tested at 0.05  $\mu$ . Reference Entegris, bulletin 3962-1626MAX-0204. Entegris is a registered trademark of Entegris, Inc. Any data presented is approximate and based on representations made by this specific bulletin as provided by Entegris as of the date of this bulletin. Test methods may vary from manufacturer to manufacturer and customers should perform their own analysis rather than relying on this report.

### Minimal Ionic Contamination

As part of McMillan's standard quality control procedures, flow sensors are routinely selected from production for metallic extraction testing. Four randomly chosen lots of McMillan UHP microturbine flow sensors were chosen for ICP-MS analysis of metals. Lots 1 & 2 each consisted of two flow sensors connected in series, and were tested dynamically with ultrapure deionized water samples. Lots 3 & 4 each consisted of five flow sensors connected in series, and were tested dynamically with a solution of 2% HNO<sub>3</sub> and 0.2% HF. All data on table 4 is reported in parts per billion (ppb) and is corrected for baseline. In addition, for some elements, a third party test lab contributed data.

TABLE 4a: METALLIC EXTRACTION DATA FOR MCMILLAN UHP FLO-SENSORS  
REPORTED IN PPB

ELEMENT	Detection Limit, H <sub>2</sub> O (Acid)	Lot 1 (H <sub>2</sub> O)	Lot 2 (H <sub>2</sub> O)	Lot 3 (Acid)	Lot 4 (Acid)
Ag	≤0.001 (≤0.01)	**	**	**	**
Al	≤0.003 (≤0.09)	**	**	**	**
As	≤0.005 (≤0.005)	**	**	**	**
Au	≤0.001 (≤0.001)	**	**	**	**
B	≤0.05	**	**		
Ba	≤0.001 (≤0.004)	**	**	**	**
Be	≤0.003 (≤0.003)	**	**	**	**
Bi	≤0.001	**	**		
Ca	≤0.12 (≤0.12)	**	**	**	**
Cd	≤0.001 (≤0.001)	**	**	**	**
Ce	≤0.001	**	**		
Co	≤0.001 (≤0.001)	**	**	**	**
Cr	≤0.004 (≤0.13)	**	**	**	**
Cs	≤0.001 (≤0.001)	**	**	**	**
Cu	≤0.003 (≤0.006)	**	**	**	**
Dy	≤0.001	**	**		
Er	≤0.001	**	**		
Eu	≤0.001	**	**		
Fe	≤0.02 (≤0.04)	**	**	**	**
Ga	≤0.001 (≤0.001)	**	**	**	**
Ge	≤0.003	**	**		
Hf	≤0.001 (≤0.001)	**	**	**	**
Hg	≤0.02	**	**		
Ho	≤0.001	**	**		
In	≤0.001	**	**		
Ir	≤0.001(≤0.001)	**	**	**	**
K	≤0.1 (≤0.1)	**	**	**	**
La	≤0.001	**	**		
Li	≤0.002 (≤0.015)	**	**	**	**
Lu	≤0.001	**	**		
Mg	≤0.002 (≤0.002)	**	**	**	**
Mn	≤0.002 (≤0.006)	**	**	**	**
Mo	≤0.004	**	**		
Na	≤0.007 (≤0.1)	**	**	**	**
Nb	≤0.001	**	**		
Nd	≤0.001	**	**		
Ni	≤0.004 (≤0.008)	**	**	**	**
Os	≤0.002	**	**		
Pb	≤0.001 (≤0.001)	**	**	**	**
Pd	≤0.001 (≤0.001)	**	**	**	**
Pr	≤0.001	**	**		
Pt	≤0.008 (≤0.008)	**	**	**	**

Table continued on next page...

U701-B001: McMillan UHP FLO-SENSOR Purity Analysis, continued...

TABLE 4b: METALLIC EXTRACTION DATA FOR MCMILLAN UHP FLO-SENSORS REPORTED IN PPB

ELEMENT	Detection Limit, H <sub>2</sub> O (Acid)	Lot 1 (H <sub>2</sub> O)	Lot 2 (H <sub>2</sub> O)	Lot 3 (Acid)	Lot 4 (Acid)
Rb	≤0.001 (≤0.001)	**	**	**	**
Re	≤0.003	**	**		
Rh	≤0.001 (≤0.001)	**	**	**	**
Ru	≤0.001 (≤0.001)	**	**	**	**
Sb	≤0.002 (≤0.002)	**	**	**	**
Sc	≤0.01	**	**		
Se	≤0.02 (≤0.02)	**	**	**	**
Si	≤0.5 (≤0.85)	**	**	**	**
Sm	≤0.002	**	**		
Sn	≤0.004 (≤0.004)	**	**	**	**
Sr	≤0.001 (≤0.001)	**	**	**	**
Ta	≤0.004	**	**		
Tb	≤0.001	**	**		
Te	≤0.005 (≤0.027)	**	**	**	**
Th	≤0.003	**	**		
Ti	≤0.002	**	**		
Tl	≤0.006	**	**		
U	≤0.002	**	**		
V	≤0.003	**	**		
W	≤0.005	**	**		
Y	≤0.001	**	**		
Yb	≤0.001	**	**		
Zn	≤0.005	**	**	**	**
Zr	≤0.005 (≤0.01)	**	**	**	**

Blank results indicate element was not tested.

\*\* Results less than detectable limit.

### Additional Third Party Testing

A single, randomly chosen McMillan UHP FLO-SENSOR was submitted to an independent third-party test lab for anion, cation, and TOC testing. This data is represented in tables 5, 6 and 7 respectively. All tests were performed with deionized water.

TABLE 5: ANION EXTRACTION DATA FOR MCMILLAN UHP FLO-SENSORS IN PPB

ANION	Detection Limit	Baseline	270 min leach
Fluoride (F <sup>-</sup> )	≤0.1	**	**
Chloride (Cl <sup>-</sup> )	≤0.02	0.05	**
Nitrite (NO <sub>2</sub> <sup>-</sup> )	≤0.02	**	**
Bromide (Br <sup>-</sup> )	≤0.02	**	**
Nitrate (NO <sub>3</sub> <sup>-2</sup> )	≤0.02	**	**
Phosphate (PO <sub>4</sub> <sup>-2</sup> )	≤0.02	**	**
Sulfate (SO <sub>4</sub> <sup>-2</sup> )	≤0.05	**	**

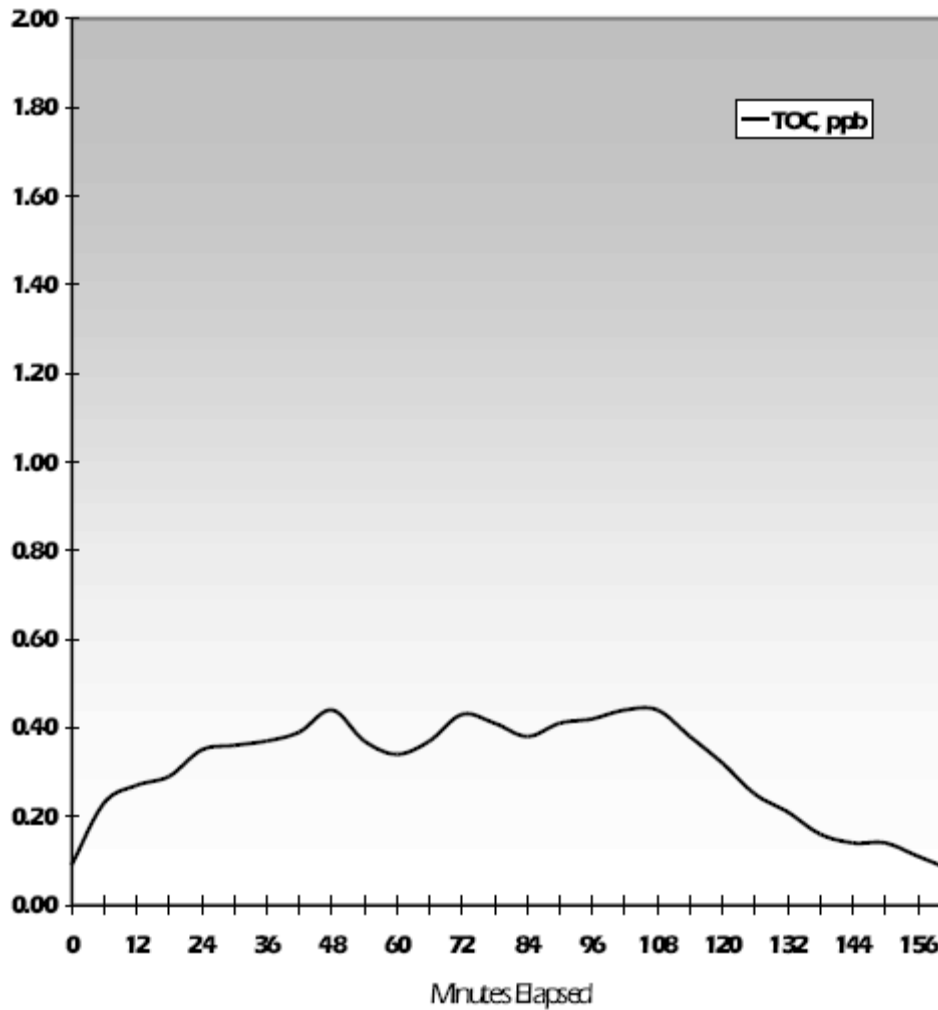
\*\* Results less than detectable limit.

TABLE 6: CATION EXTRACTION DATA FOR MCMILLAN UHP FLO-SENSORS IN PPB

CATION	Detection Limit	Baseline	270 min leach
Lithium (Li+)	≤0.01	**	**
Sodium (Na+)	≤0.01	0.01	**
Ammonium (NH <sub>4</sub> +) )	≤0.05	**	**
Potassium (K+)	≤0.02	**	**
Magnesium (Mg+2)	≤0.02	**	**
Calcium (Ca+2)	≤0.02	**	**

\*\* Results less than detectable limit.

TABLE 6: TOC EXTRACTION DATA FOR MCMILLAN UHP FLO-SENSORS REPORTED IN PPB



U701-B001: McMillan UHP FLO-SENSOR Purity Analysis, continued...

### **Summary & Conclusion**

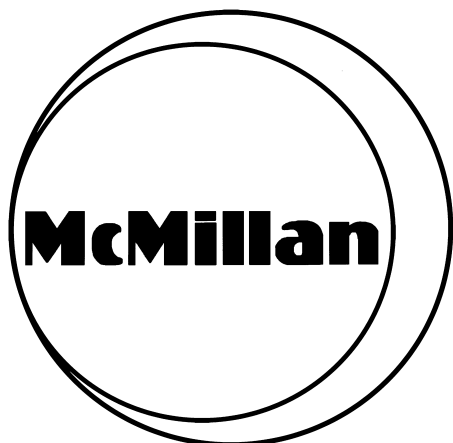
From both particle and metallic extraction data presented above, it is clear that McMillan U701/U702/U705/U706/U707/U708 products, all of which utilize McMillan's patented microturbine technology, are suitable for use in ultra-high-purity applications. Products used within operating specifications contribute zero particles of any size to the fluid stream, and metallic contamination is less than or equal to other common devices (such as tubing or fittings) and will have no adverse effects on semiconductor processes. McMillan's rigorous quality control procedures, including routine particle generation and metallic extraction testing, give the customer confidence that products will be suitable for their ultra-high-purity application.

### **Learn More**

McMillan products are sold worldwide through direct and distribution channels. To find the nearest McMillan sales office, or for more information about these and other McMillan products, please visit our website at [www.mcmflow.com](http://www.mcmflow.com) or call the factory at +1 512 863 0231.

In addition to McMillan's UHP product offering for high purity applications, McMillan offers a full range of gas and liquid flow sensors for non-high-purity applications. Contact McMillan or your nearest sales office for more information.

- 7 PAGES TOTAL -



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