



MicroContamination Solutions, Inc.

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To: Jeff Winters, Michael Freier
From: Edward Vitenberg
Subject: MultiMetrixs End-Effector Cleanliness Test Report
Date: October 4, 2002

MultiMetrixs End-Effector Cleanliness Test Report

I. Overview

For the test performed within Front End System Minienvironment on October 3, 2002, at IRSI facility in Santa Clara, we had the following objective:

Provide additional evaluation and acquire airborne particulate data in a close vicinity of critical moving components of MultiMetrixs edge-gripping end-effector IEG 300 during a cleanliness test based on ISO 14644 Standard guidelines in order to analyze this end-effector's performance.

Particles ≥ 0.1 micron were measured. Our MetOne particle counter automatically segments particles into 6 size thresholds: 0.1, 0.2, 0.3, 0.5, 0.7, and 1.0 micron. All air samplings were done at a flow rate of 1 cubic foot per minute (cfm), which is the flow rate typically used for cleanroom certifications. Also, our MetOne particle counter automatically printed out the results of particulate cleanliness test and two rolls of continuous consecutive printouts are available for your reference.

II. Test Facility

As mentioned above, the test was performed within the Front End System Minienvironment unit placed in a regular non-classified room at IRSI facility in Santa Clara. The Minienvironment has an integrated ULPA filtration system combined with MCS proprietary diffusion panel that is sealably covering 100% of the internal cross-section. Thus, the internal background targets were met without any additional portable cleanroom even in the challenging and otherwise inappropriate ambient conditions.

III. Test Equipment and Materials

All test equipment devices were within current calibration, all self-diagnostics were within the specified ranges. The following test equipment and materials were used during the test:

- MetOne Laser Particle Counter, Model A2100B, 1 cfm sampling, 0.1 μm minimum threshold.
- Clear vinyl plastic film.
- Cleanroom tape.
- Isopropanol alcohol.
- Cleanroom wipes.



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IV. ISO 14644 Test Procedure

While Federal Standard 209E established by SEMI (Semiconductor Equipment and Materials International) specifies that the cleanliness Class 1, the most restrictive in the recent past, allows no more than 35 particles of a 0.1 micron size per cubic foot of air, the ISO (International Organization for Standardization) provided substantially more stringent requirements in an ISO 14644 Standard that specifies the following limits:

- ISO Class 1 limit of 10 particles of a 0.1 micron size per 1 cubic meter of air or the limit of only 0.283 particles of a 0.1 micron size per cubic foot of air.
- ISO Class 2 limit of 100 particles of a 0.1 micron size per 1 cubic meter of air or the limit of only 2.83 particles of a 0.1 micron size per cubic foot of air.
- ISO Class 3 limit of 1000 particles of a 0.1 micron size per 1 cubic meter of air or the limit of only 28.3 particles of a 0.1 micron size per cubic foot of air.

According to Standard ISO 14644, the use of sequential sampling procedure is recommended to dramatically reduce sample volumes and sampling times required to verify designated particle concentration limits. In order to comply with ISO Class 1 requirements, **at least 14** sequential samples of 1cfm of air must be taken from the same location with **no (or zero) counts** of particles of a 0.1 micron size or above. Therefore, since we have ultimately targeted the robot and end-effector compliance with ISO Class 1 requirements, during this test we were repeatedly acquiring from each same location 14 sequential samples of 1cfm of air.

As mentioned above, in order to comply with **ISO Class 2** requirements, a 1 CFM sample should contain **less than 3 particle** counts of a **0.1 micron** size or above.

V. Airborne Particulate Cleanliness Test for MultiMetrixs Edge-Gripping End-Effector IEG 300

Our test was continued on October 3 with MultiMetrixs edge-gripping end-effector. Upon purging and background “static counts” check-up resulting in 7 sequential 1 cfm samples with ZERO particle counts, we went ahead with our dynamic test.

a) MultiMetrixs Gripper Test #1 (without wafer)

For this test, the end-effector’s fingers were repeatedly actuating performing “clamp-unclamp” motion 33 times per minute. The airborne sample probe was attached in close vicinity of a front actuating finger (1/4” below the end-effector) as shown in **FIG. 1** on page 3 . **Fifteen** sequential 1 cfm samples were taken at this position with **ALL ZERO** particle counts in a row. **Hence, it passes ISO1 requirements.**

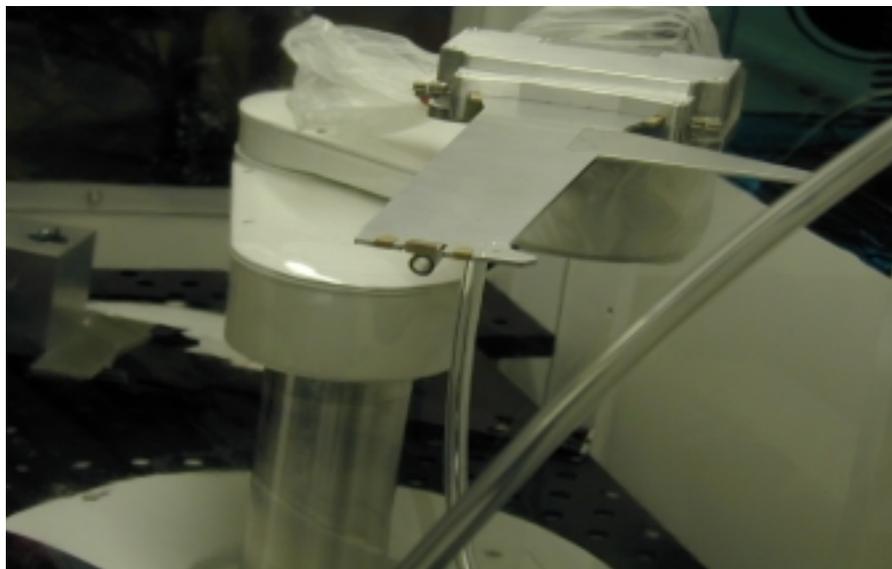


FIG. 1

b) MultiMetrixx Gripper Test #2 (without wafer)

For this test, the end-effector was flipped 90° and the end-effector's fingers were still repeatedly actuating performing "clamp-unclamp" motion. The airborne sample probe was attached 1/2" below the cutout in the gripper's body, through which a rear gripping finger is protruding as shown in **FIG. 2**. Upon purging and background "static counts" check-up resulting in 7 sequential 1 cfm samples with ZERO particle counts, we went ahead with our dynamic test. Multiple sequential 1 cfm samples were taken at this position.

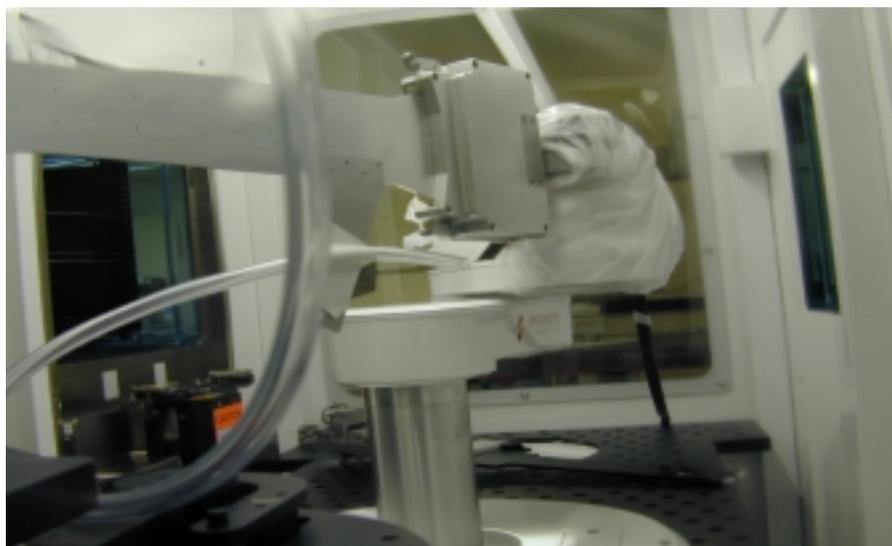


FIG. 2



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Two rounds of 14 sequential 1 cfm samples and one additional round of 7 sequential 1 cfm samples were taken at this probe position as shown in **FIG. 2** above. The following data table shown in **FIG. 3** illustrates airborne particle counts acquired during this phase of our test.

	Number of 0.1 µm particles per 1 CFM during 14 minute round															
1st round	0	0	0	0	0	0	0	0	0	0	0	2	1	2	2	ISO2
2nd round	0	0	0	0	0	0	1	0	0	5	0	0	0	1	ISO2	
3rd round	0	0	0	0	0	0	1								ISO2	

FIG. 3

Since the particle counts acquired at this probe position were encouragingly close to comply with ISO1 requirements, we decided to continue cleaning the minienvironment up and perform additional background verification. After obtaining **16** sequential 1 cfm samples with **ZERO** particle counts in a “static mode”, we continued the dynamic counts acquisition. As one can see from the data table shown in **FIG. 4**, the particle counts were in compliance with ISO Class 1 requirements two times in a row.

	Number of 0.1 µm particles per 1 CFM during 14 minute round															
1st round	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ISO1
2nd round	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ISO1

FIG. 4

c) MultiMetrixs Gripper Test #3 (with wafer on)

For this test, the end-effector was flipped 90° back to horizontal position, and the wafer was placed on the end-effector. The airborne sample probe was attached in close vicinity of a front actuating finger (1/4” below the end-effector) as shown in **FIG. 5**.

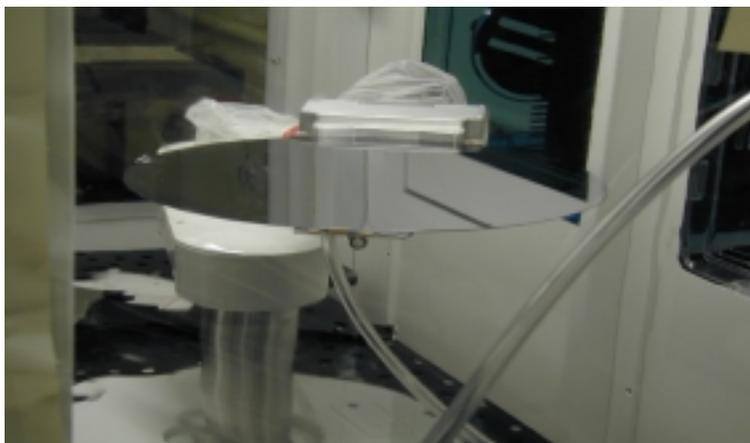


FIG. 5



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Upon purging and background “static counts” check-up resulting in 7 sequential 1 cfm samples with ZERO particle counts, we went ahead with our dynamic test. For this test, the end-effector’s fingers were repeatedly actuating performing “clamp-unclamp” motion 33 times per minute. **Fifteen** sequential 1 cfm samples were taken at this position with **ALL ZERO** particle counts in a row. **Hence, it passes ISO1 requirements** again with wafer on.

d) MultiMetrixs Gripper Test #4 (with wafer on)

The probe was replaced to the rear fingers with wafer still on as shown in **FIG. 6**.



FIG. 6

Upon purging and background “static counts” check-up resulting in 12 sequential 1 cfm samples with ZERO particle counts, we continued our dynamic test. We weren’t able to see results that complied with ISO1 at this time. As one can see from the data table shown in **FIG. 7**, the particle counts for this test with wafer were in compliance with ISO2 requirements with 7 sequential ZERO counts samples.

Number of 0.1 μm particles per 1 CFM during 17 minute round																		
0	0	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	ISO2

FIG. 7



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VI. Conclusion

These tests demonstrate that cleanliness performance of MultiMetrixs edge-gripping end-effector was significantly improved comparing to the previous test held on August 7 (see our report dated August 12) with **ISO1** achievement vs. Federal 209E **Class 1** or **ISO3** obtained previously.

Sincerely,

Edward Vitenberg,
MCS, Inc.