DRYDEN ENGINEERING COMPANY, INC.
210 Hammond Avenue
Fremont, CA 94539-7465
TEL 510-440-1890 / FAX 510-440-0280 / 1-800-DRYDEN 1

contamination control systems

AIRBORNE PARTICLE PROFILE

for two

ZAYTRAN , INCORPORATED
MAGNUM - PET - 130 - 13 GRIPPERS

TESTING PERFORMED BY:

DRYDEN ENGINEERING COMPANY
210 HAMMOND AVENUE
FREMONT, CA 94539

DATES OF TEST:

APRIL 16 - 17, 1996

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I. ANALYST'S STATEMENT

All test results were run under carefully controlled conditions, and are an accurate representation of the Zaytran, Inc. grippers' performance during the test period.

Background counts were run throughout the test period to define the cleanroom and assure a Class 1 test environment. These background counts are included with each summary graph in Section II. No subtractions for background counts were applied in the data presented.

Two grippers were tested. Gripper #1 was tested with and without vacuum applied to the vacuum port. Gripper #2 was tested only with vacuum applied.

This test was run in a through-the-floor return cleanroom. Measurements were made by placing the air probe 0.5 - 1.0 inches from the gripper surface at twelve representative locations. Grippers were cycled six times per minute for one hour prior to measurement. They were also cycled six times per minute during measurement.

For ease of interpretation, results are shown with tables and graphs. References to Class limits as described by Federal Standard 209E are included as an aid to interpretation.

Jack Menear

Jack Menear, Ph.D.
Senior Analytical Scientist

II. SUMMARY

A. Basic Test Procedure

The Zaytran grippers were positioned one-at-a-time onto a clean stainless steel bar below the cleanroom filters. The gripper action faced downward. A control circuit plus pneumatic solenoid combination cycled (open and close) the gripper six times per minute.

The controller mechanisms were placed on the floor of the cleanroom to prevent any interference with the test.

Background counts were taken 8 inches above the gripper.

Three one-cubic-foot samples of air were sampled at each of 12 measurement locations around the gripper.

Cumulative particle counts ≥ 0.1, ≥ 0.2, ≥ 0.3, ≥ 0.5, ≥ 0.7, and ≥ 1.0 micron per cubic foot of air are reported in tables. Cumulative particle counts ≥ 0.1, ≥ 0.2, ≥ 0.3, ≥ 0.5, and ≥ 1.0 micron per cubic foot of air are presented graphically.

B. Scope

This test describes the performance of two Zaytran grippers in a raised-floor Class 1 cleanroom. There were three test segments. One gripper was tested with and without vacuum. The other gripper was tested with vacuum only.

C. Conclusions

1. Each of the following five graphs describe the average particle count for one of five sizes (≥ 0.1, ≥ 0.2, ≥ 0.3, ≥ 0.5, and ≥ 1.0 micron) at the 12 measurement locations. All three test segments are shown on each graph. Where applicable, the Class 1 limit from Federal Standard 209E is indicated.

2. With the exception of "gripper #1/location 1/≥ 0.5 micron/no vacuum", all measurements at ≥ 0.10, ≥ 0.20, ≥ 0.30, and ≥ 0.50 micron were within the Class 1 limits. Particles ≥ 1.0 micron were also measured. Class 1 limits are undefined for particles ≥1.0 micron.

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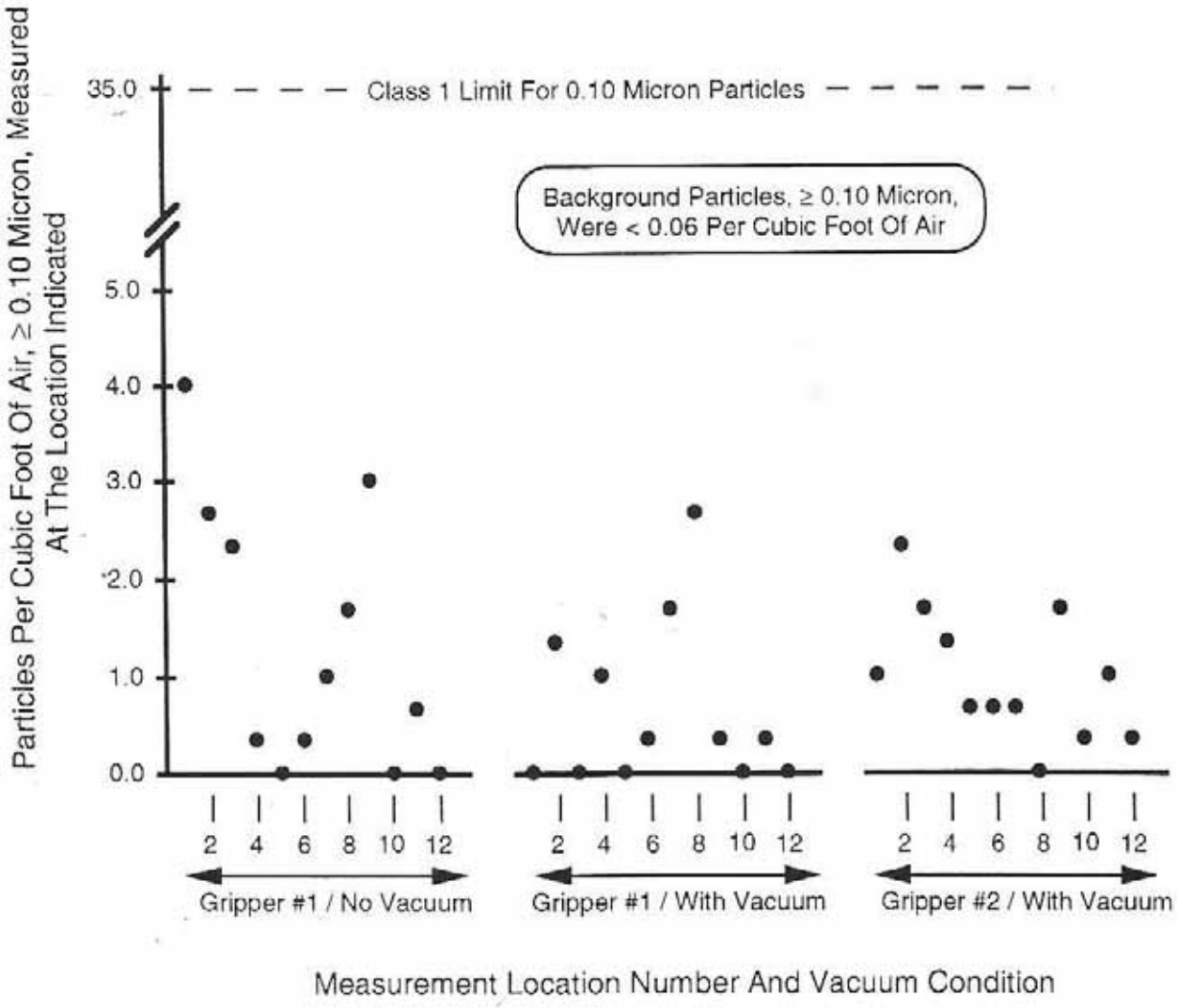
Graph: **0.10**

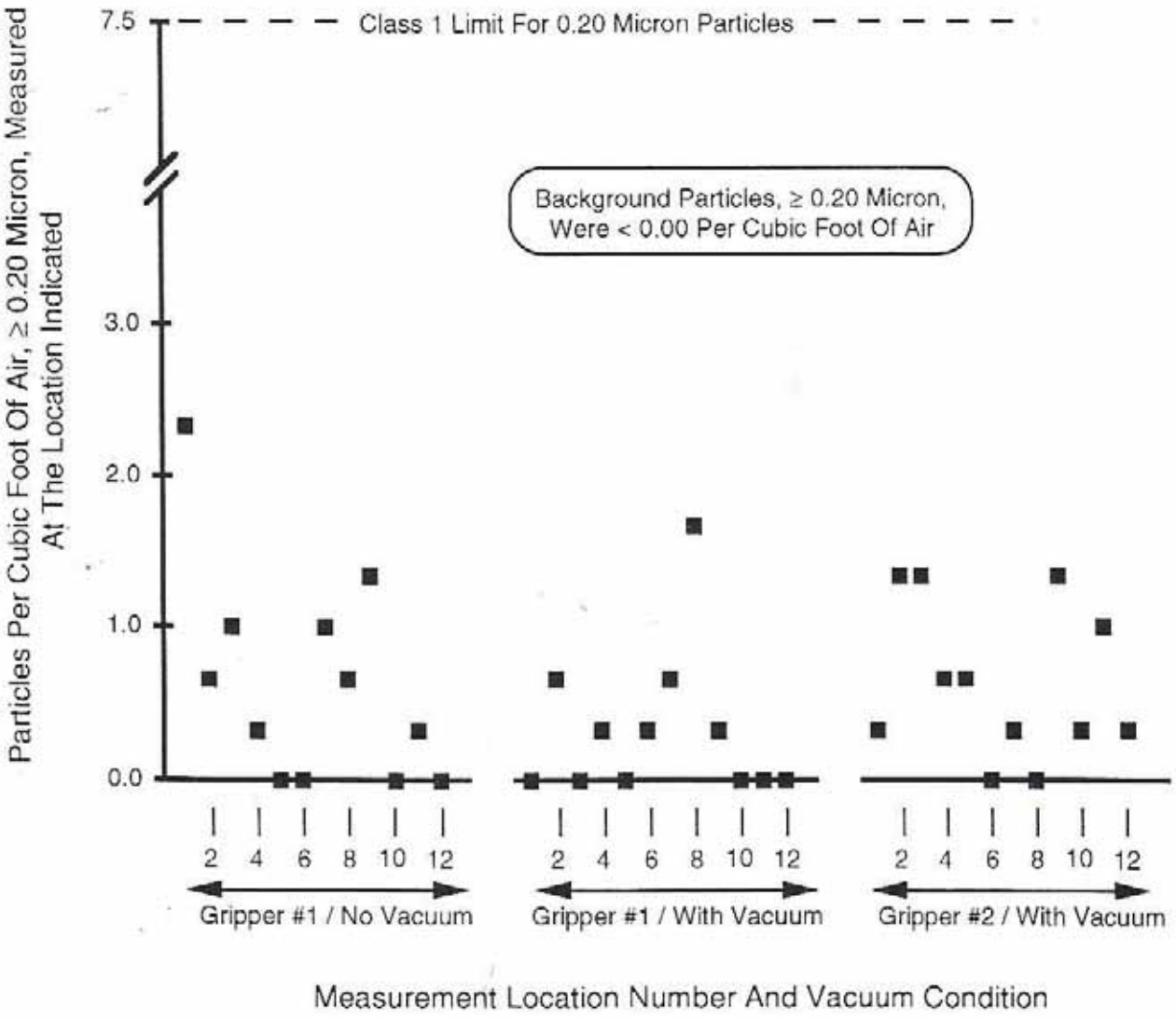
Particles Per Cubic Foot Of Air, ≥ 0.10 Micron, Measured At 12 Locations Around Zaytran Grippers. Two Grippers Were Tested. The First Gripper Was Tested With And Without Vacuum. The Second Was Tested With Vacuum Only. When Used, Vacuum Flow Was 21 Standard Cubic Feet Per Hour. Plotted Points Are The Average Of Three Measurements. For Each One-Cubic-Foot Measurement, The Gripper Was Opened And Closed Six Times. Measurement Locations Are Described In Diagram: **Location**.



DRYDEN

Graph: **0.20**

Particles Per Cubic Foot Of Air, ≥ 0.20 Micron, Measured At 12 Locations Around Zaytran Grippers. Two Grippers Were Tested. The First Gripper Was Tested With And Without Vacuum. The Second Was Tested With Vacuum Only. When Used, Vacuum Flow Was 21 Standard Cubic Feet Per Hour. Plotted Points Are The Average Of Three Measurements. For Each One-Cubic-Foot Measurement, The Gripper Was Opened And Closed Six Times. Measurement Locations Are Described In Diagram: **Location**.



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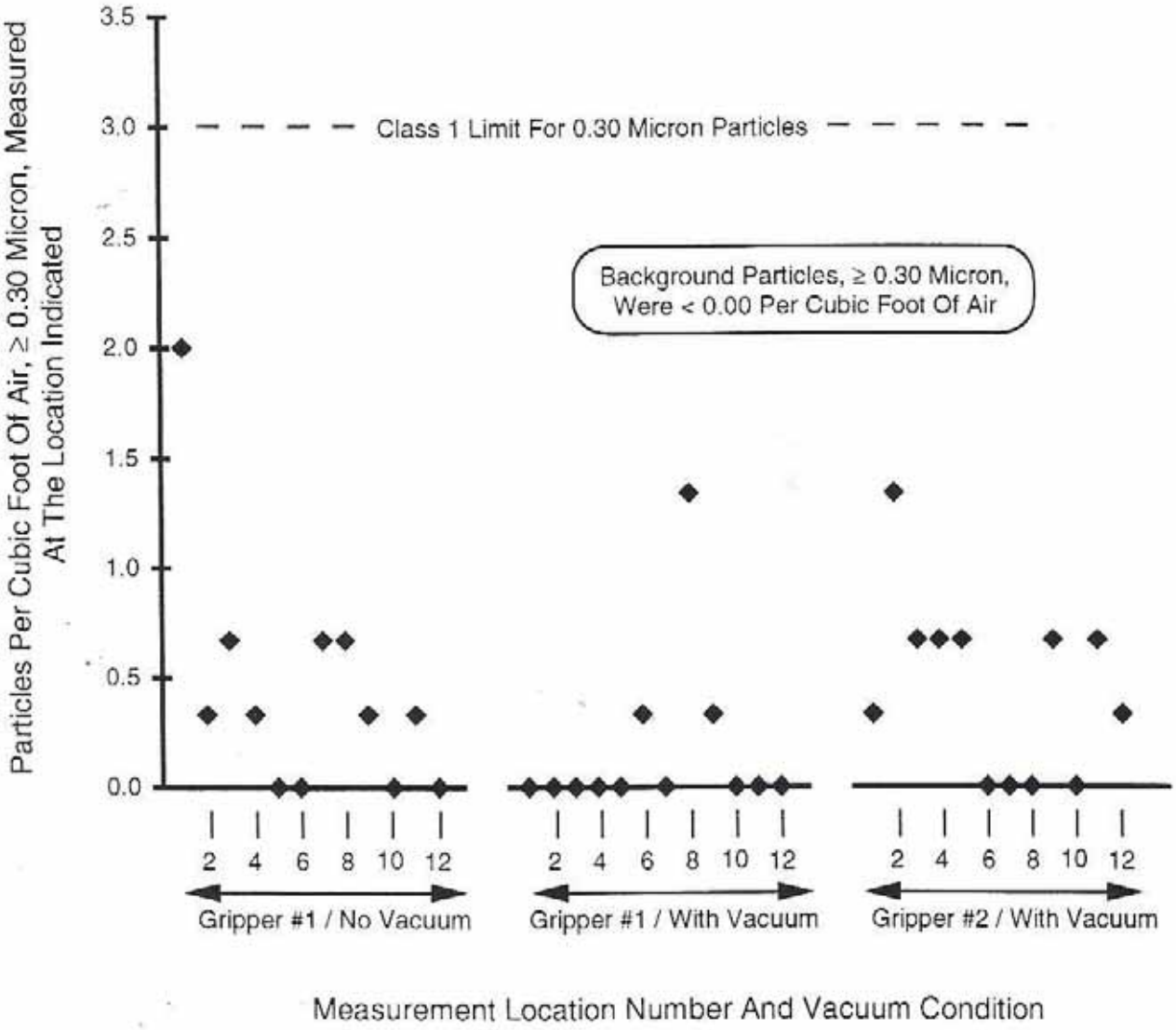
Graph: **0.30**

Particles Per Cubic Foot Of Air, ≥ 0.30 Micron, Measured At 12 Locations Around Zaytran Grippers. Two Grippers Were Tested. The First Gripper Was Tested With And Without Vacuum. The Second Was Tested With Vacuum Only. When Used, Vacuum Flow Was 21 Standard Cubic Feet Per Hour. Plotted Points Are The Average Of Three Measurements. For Each One-Cubic-Foot Measurement, The Gripper Was Opened And Closed Six Times. Measurement Locations Are Described In Diagram: **Location**.



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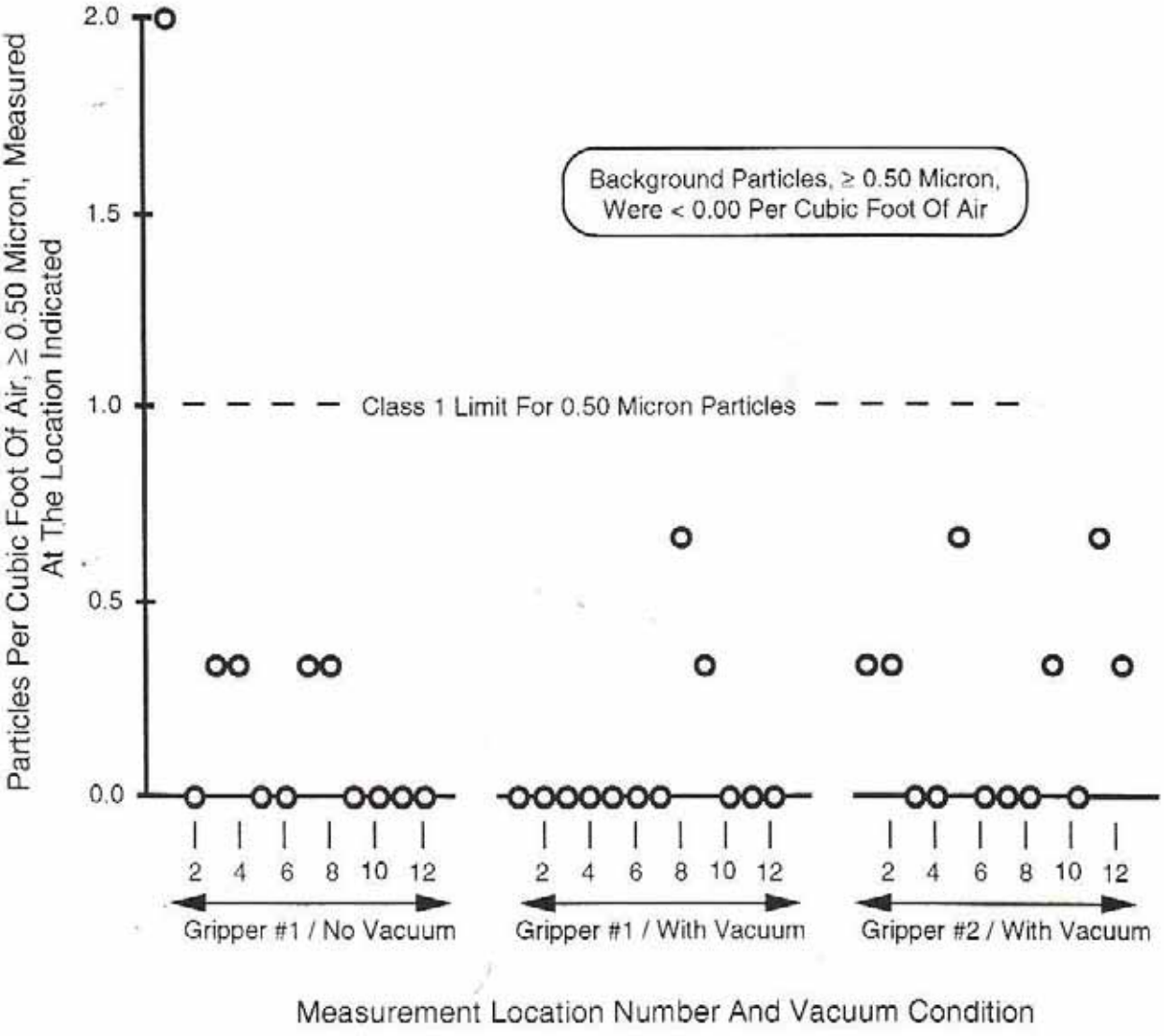
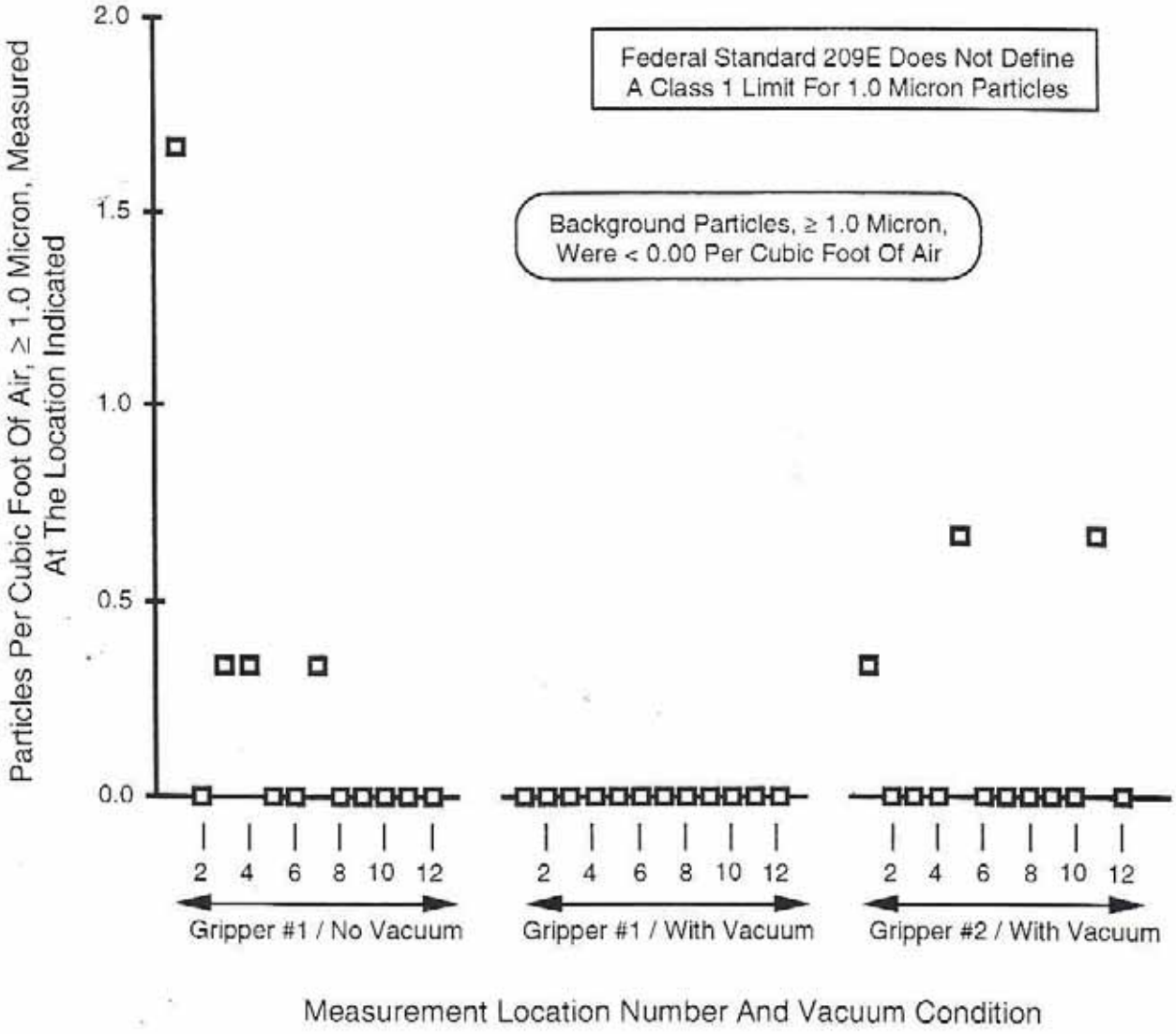
Graph: **0.50**

Particles Per Cubic Foot Of Air, ≥ 0.50 Micron, Measured At 12 Locations Around Zaytran Grippers. Two Grippers Were Tested. The First Gripper Was Tested With And Without Vacuum. The Second Was Tested With Vacuum Only. When Used, Vacuum Flow Was 21 Standard Cubic Feet Per Hour. Plotted Points Are The Average Of Three Measurements. For Each One-Cubic-Foot Measurement, The Gripper Was Opened And Closed Six Times. Measurement Locations Are Described In Diagram: **Location**.



Graph: **1.0**

Particles Per Cubic Foot Of Air, ≥ 1.0 Micron, Measured At 12 Locations Around Zaytran Grippers. Two Grippers Were Tested. The First Gripper Was Tested With And Without Vacuum. The Second Was Tested With Vacuum Only. When Used, Vacuum Flow Was 21 Standard Cubic Feet Per Hour. Plotted Points Are The Average Of Three Measurements. For Each One-Cubic-Foot Measurement, The Gripper Was Opened And Closed Six Times. Measurement Locations Are Described In Diagram: **Location**.



III. INTRODUCTION

A. Test Parameters

Dryden Engineering Company was contracted to perform the particle profile test for the Zaytran Magnum-PET-130-13 grippers. This test was designed to assess particle contribution levels at a representative number of locations during continuous activation. The particle probe was placed very close (nominally 0.5 - 1.0 inch) to the surface of the gripper, while the gripper was cycled six times per minute.

Each gripper was suspended from a clean stainless steel bar during measurement.

B. Physical Test Set-up

All testing was done at the Dryden Engineering Class 1 cleanroom in Fremont, CA. A Class 1 cleanroom is important to maintain background counts to an acceptable level. All walls, floors, test apparati, and grippers were cleaned with lint free wipers and filtered nitrogen at 60 psi.

Vertical cleanroom air flow was 100 feet per minute.

Filtered nitrogen at 85 psi was used to cycle the gripper. For two test segments, vacuum at 21 standard cubic feet per hour was applied to the vacuum port.

C. Gowning And Handling Techniques

Gowning and handling were typical of airborne particle studies. Cleanroom suits, head/face covers, gloves, and shoecovers were used. The air probe was mechanically fixed in place, and the operator was well removed from the vicinity during measurement.

D. Particle Counting Equipment

The particle counter used in this test was the Met One Model 2090-plus. This is a 0.10 micron counter based on laser scattering. Each particle scatters the source light, and the scattered light is measured by the photodetector. The number of particles is determined by the number of scattering events, and the size of the particle is inferred from the magnitude of the scattering event. This counter samples the air at a rate of 1 cubic foot per minute. Hence, each one minute sample corresponds to one cubic foot of air.

Counter Serial Number - 94236301
Calibration Date - November 15, 1995

IV. DISCLAIMER

This report describes the test procedure and results for two Zaytran Magnum-PET-130-13 grippers (no serial numbers). Data and conclusions relate only to the units tested. Dryden Engineering does not warrant the performance of Zaytran, Incorporated products.

V. TEST PROCEDURE

A. Probe Placement

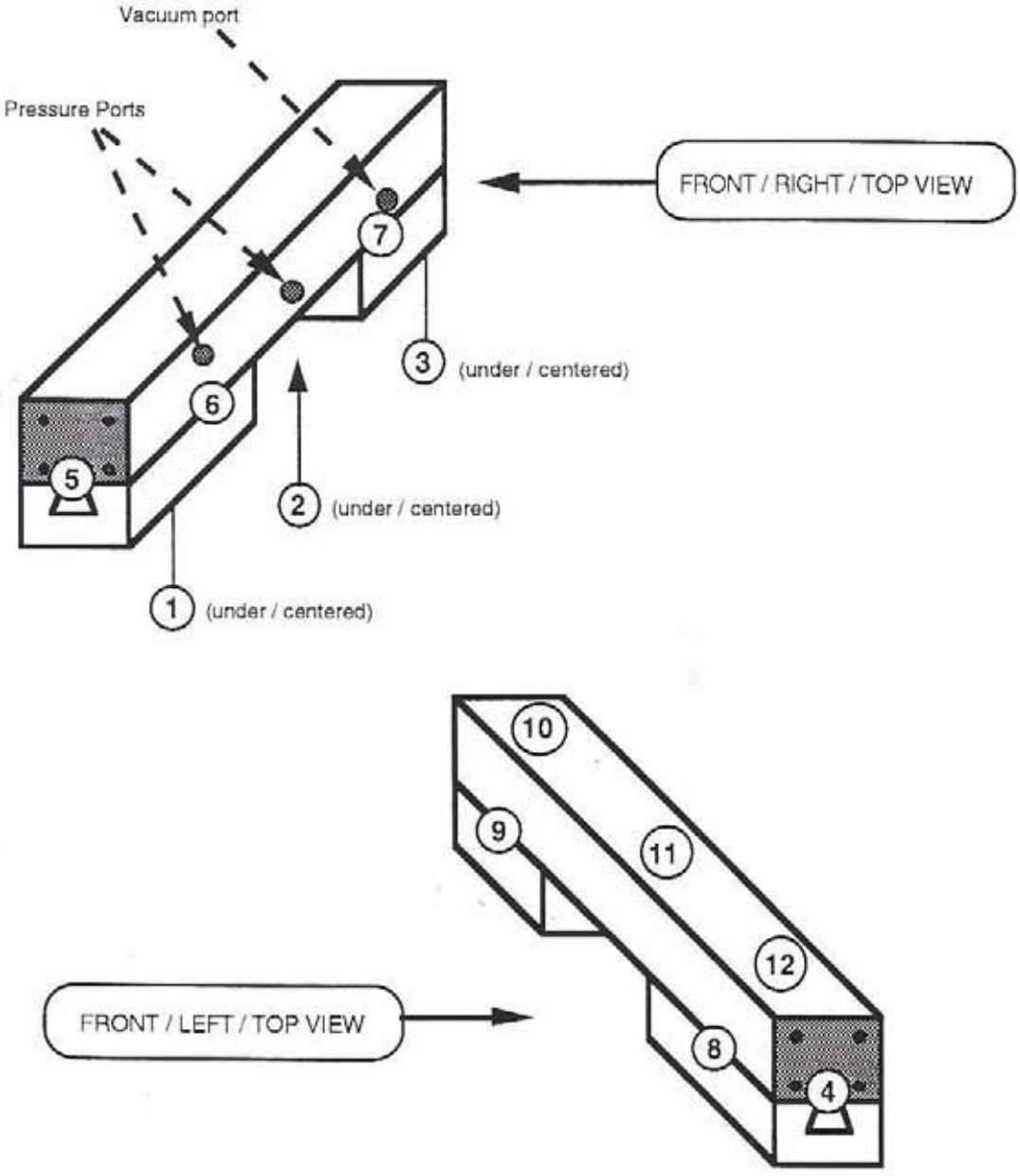
Twelve measurement locations were selected around each gripper. In all cases, the air probe was positioned 0.5-1.0 inches from the gripper, and pointed directly toward the measurement point. Diagram: **Location** on the following page shows the twelve measurement locations.

B. Particle Counter Setting

After probe placement, the particle counter was programmed to run three successive one-cubic-foot samples with a 5 second delay between samples.

Diagram: **Location**

Twelve Airborne Measurement Locations Around The Two Magnum-PET-130-13 Grippers. Circled Numbers Are The Measurement Locations. All Measurements Were Made 0.5-1.0 Inch From The Surface Of The Gripper With The Air Probe Pointed Directly Toward The Gripper.



VI. DATA REDUCTION METHODS

References to the class of air quality plus calculations are based on descriptions in Federal Standard 209E, Section 4 and Appendix E.40.

VII. DATA SUMMARY TABLES

The following three tables summarize the particle count readings for each of the three test segments. Each table segments the data into 6 size thresholds (≥ 0.1, ≥ 0.2, ≥ 0.3, ≥ 0.5, ≥ 0.7, and ≥ 1.0 micron).

Table names are descriptive. For example, Table: **Gripper 1 / Vacuum** describes the test segment where vacuum was applied to gripper #1 as the 12 locations were measured.

Table: **Gripper 1 / No Vacuum**

Particle Count Summary For Gripper #1 With No Vacuum Applied. Data Entries Are Particles Per Cubic Foot Of Air Measured At The Location Indicated. Each Cubic Foot Measurement Required 1 Minute. The Gripper Was Cycled (Open / Close) Six Times During That Minute. Measurement Locations Are Described In Diagram: **Location** On Page 11. The Means For Each Location Are Plotted In The Summary Graphs In Section II.

Location	Particles Per Cubic Foot Of Air, ≥ Size (In Microns) Indicated					
	0.10	0.20	0.30	0.50	0.70	1.0
1	1	0	0	0	0	0
1	9	5	5	5	5	4
1	2	2	1	1	1	1
Mean	**4.0**	**2.3**	**2.0**	**2.0**	**2.0**	**1.7**
2	6	2	1	0	0	0
2	1	0	0	0	0	0
2	1	0	0	0	0	0
Mean	**2.7**	**0.7**	**0.3**	**0.0**	**0.0**	**0.0**
3	1	1	0	0	0	0
3	5	2	2	1	1	1
3	1	0	0	0	0	0
Mean	**2.3**	**1.0**	**0.7**	**0.3**	**0.3**	**0.3**
4	0	0	0	0	0	0
4	0	0	0	0	0	0
4	1	1	1	1	1	1
Mean	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
5	0	0	0	0	0	0
5	0	0	0	0	0	0
5	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

6	0	0	0	0	0	0
6	0	0	0	0	0	0
6	1	0	0	0	0	0
Mean	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
7	0	0	0	0	0	0
7	0	0	0	0	0	0
7	3	3	2	1	1	1
Mean	**1.0**	**1.0**	**0.7**	**0.3**	**0.3**	**0.3**
8	1	0	0	0	0	0
8	3	1	1	0	0	0
8	1	1	1	1	0	0
Mean	**1.7**	**0.7**	**0.7**	**0.3**	**0.0**	**0.0**
9	5	3	1	0	0	0
9	2	0	0	0	0	0
9	2	1	0	0	0	0
Mean	**3.0**	**1.3**	**0.3**	**0.0**	**0.0**	**0.0**
10	0	0	0	0	0	0
10	0	0	0	0	0	0
10	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
11	0	0	0	0	0	0
11	1	0	0	0	0	0
11	1	1	1	0	0	0
Mean	**0.7**	**0.3**	**0.3**	**0.0**	**0.0**	**0.0**
12	0	0	0	0	0	0
12	0	0	0	0	0	0
12	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table: **Gripper 1 / Vacuum**

Particle Count Summary For Gripper #1 With Vacuum Applied. Data Entries Are Particles Per Cubic Foot Of Air Measured At The Location Indicated. Each Cubic Foot Measurement Required 1 Minute. The Gripper Was Cycled (Open / Close) Six Times During That Minute. Measurement Locations Are Described In Diagram: **Location** On Page 11. The Means For Each Location Are Plotted In The Summary Graphs In Section II.

Location	Particles Per Cubic Foot Of Air, ≥ Size (In Microns) Indicated					
	0.10	0.20	0.30	0.50	0.70	1.0
1	0	0	0	0	0	0
1	0	0	0	0	0	0
1	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
2	0	0	0	0	0	0
2	2	1	0	0	0	0
2	2	1	0	0	0	0
Mean	**1.3**	**0.7**	**0.0**	**0.0**	**0.0**	**0.0**
3	0	0	0	0	0	0
3	0	0	0	0	0	0
3	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
4	2	1	0	0	0	0
4	0	0	0	0	0	0
4	1	0	0	0	0	0
Mean	**1.0**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**
5	0	0	0	0	0	0
5	0	0	0	0	0	0
5	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

6	0	0	0	0	0	0
6	0	0	0	0	0	0
6	1	1	1	0	0	0
Mean	**0.3**	**0.3**	**0.3**	**0.0**	**0.0**	**0.0**
7	0	0	0	0	0	0
7	3	1	0	0	0	0
7	2	1	0	0	0	0
Mean	**1.7**	**0.7**	**0.0**	**0.0**	**0.0**	**0.0**
8	2	1	1	1	0	0
8	5	3	2	0	0	0
8	1	1	1	1	1	0
Mean	**2.7**	**1.7**	**1.3**	**0.7**	**0.3**	**0.0**
9	1	1	1	1	0	0
9	0	0	0	0	0	0
9	0	0	0	0	0	0
Mean	**0.3**	**0.3**	**0.3**	**0.3**	**0.0**	**0.0**
10	0	0	0	0	0	0
10	0	0	0	0	0	0
10	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
11	0	0	0	0	0	0
11	1	0	0	0	0	0
11	0	0	0	0	0	0
Mean	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
12	0	0	0	0	0	0
12	0	0	0	0	0	0
12	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table: **Gripper 2 / Vacuum**

Particle Count Summary For Gripper #2 With Vacuum Applied. Data Entries Are Particles Per Cubic Foot Of Air Measured At The Location Indicated. Each Cubic Foot Measurement Required 1 Minute. The Gripper Was Cycled (Open / Close) Six Times During That Minute. Measurement Locations Are Described In Diagram: **Location** On Page 11. The Means For Each Location Are Plotted In The Summary Graphs In Section II.

Location	Particles Per Cubic Foot Of Air, ≥ Size (In Microns) Indicated					
	0.10	0.20	0.30	0.50	0.70	1.0
1	1	1	1	1	1	1
1	1	0	0	0	0	0
1	1	0	0	0	0	0
Mean	**1.0**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
2	2	1	1	1	1	0
2	0	0	0	0	0	0
2	5	3	3	0	0	0
Mean	**2.3**	**1.3**	**1.3**	**0.3**	**0.3**	**0.0**
3	0	0	0	0	0	0
3	1	1	1	0	0	0
3	4	3	1	0	0	0
Mean	**1.7**	**1.3**	**0.7**	**0.0**	**0.0**	**0.0**
4	0	0	0	0	0	0
4	3	2	2	0	0	0
4	1	0	0	0	0	0
Mean	**1.3**	**0.7**	**0.7**	**0.0**	**0.0**	**0.0**
5	1	1	1	1	1	1
5	1	1	1	1	1	1
5	0	0	0	0	0	0
Mean	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**

6	1	0	0	0	0	0
6	0	0	0	0	0	0
6	1	0	0	0	0	0
Mean	**0.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
7	0	0	0	0	0	0
7	1	0	0	0	0	0
7	1	1	0	0	0	0
Mean	**0.7**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**
8	0	0	0	0	0	0
8	0	0	0	0	0	0
8	0	0	0	0	0	0
Mean	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
9	2	1	1	1	0	0
9	2	2	0	0	0	0
9	1	1	1	0	0	0
Mean	**1.7**	**1.3**	**0.7**	**0.3**	**0.0**	**0.0**
10	0	0	0	0	0	0
10	0	0	0	0	0	0
10	1	1	0	0	0	0
Mean	**0.3**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**
11	0	0	0	0	0	0
11	3	3	2	2	2	2
11	0	0	0	0	0	0
Mean	**1.0**	**1.0**	**0.7**	**0.7**	**0.7**	**0.7**
12	1	1	1	1	1	0
12	0	0	0	0	0	0
12	0	0	0	0	0	0
Mean	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.0**